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Dr. med. KRUTSCH ALFRED-DIETER

BEYOND THE BASICS:
MASTERING WOMEN'S HEALTH, FERTILITY, MENOPAUSE, AND SURGICAL TECHNIQUES

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HIPPOCRATE

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Abbreviations

CT	Computer tomography
MRI	Magnetic resonance imaging
GVA	Generalized visceral afferent
CNS	Central nervous system
UPJ	Ureteropelvic junction
UVJ	Ureterovesical junction
TRH	Thyrotropin-releasing hormone
hPL	Human placental lactogen
EAS	External anal sphincter
IAS	Internal anal sphincter
VIP	Gastrointestinal intestinal peptide
CO	Carbon Monoxide
ICC	Interstitial cells of Cajal
IP3	inositol trisphosphate
GTP	Guanosine triphosphate
AMP	Aminosine triphosphate
EUS	Striated urethral sphincter
PFD	Pelvic floor dysfunction
CPP	Chronic pelvic pain
SD	Sexual dysfunction
SUI	Stress urine incontinence
PFPT	Pelvic floor physical therapy
PFMT	Pelvic floor muscle training
POP	Pelvic organ prolapse
UUI	Urgency incontinence
BMI	Body mass index
TNF	Tumor necrosis factor
COX-2	Cyclooxygenase-2
IL	Interleukin
uNK	Uterine natural killer
PF	Peritoneal Fluid
SNPs	Single gene polymorphisms
GWAS	Genome-wide association studies
eQTL	Expression quantitative trait locus
ER	Estrogens

AR	Androgens
PRA/PRB	Progestins
GR	Glucocorticoids
VEGF-A	Vascular endothelial growth factor
NRP-1	Neuropillin 1
DIE	Deep infiltrating endometriosis
PNS	Peripheral nervous systems
AFS	American Fertility Society
rASRM	American Society for Reproductive Medicine classification
AAGL	American Association of Gynecology Laparoscopists
IVF	In vitro fertilization
GnRH	agonists gonadotrophin-releasing hormone agonists
HT	Hormone therapy
NSAIDs	Nonsteroidal anti-inflammatory drugs
LNG-IUS	The levonorgestrel – releasing intrauterine system
OCP	Oral contraceptive pills
PSN	Presacral neurectomy
LH	Luteinizing hormone
PCOS	Polycystic ovary syndrome
hCG	Human chorionic gonadotropin
FSH	follicle-stimulating hormone
TSH	Thyroid-stimulating hormone
IUI	Intrauterine insemination
ART	Assisted reproductive technology
HH	Hypergonadotropic hypogonadism
AMH	Anti-Mullerian hormone
MH	Mullerian hormone
HSG	Hysterosalpingography
HyCoSy	Hysterosalpingo-contrast sonography
MHPs	Medical health practitioners
MT	Menopausal transition
ET	Estrogen therapy
HRT	Hormone-replacement therapy
VTE	Venous thromboembolism
WHI	Women's Health Initiative
VVA	Vulvovaginal atrophy

STD	Sexually Transmitted Diseases
UTIs	Urinary tract infections
RUTI	Recurrent urinary tract infection
DHEA	Dehydroepiandrosterone
DHT	5-Dihydrotestosterone
OP	Osteoporosis
BrCa	Breast cancer
CVD	Cardiovascular disease
TVH	Trans-vaginal hysterectomy
ACOG	The American College of Obstetricians and Gynecologists
AAGL	The American Association of Gynecologic Laparoscopists
SGS	The Society of Gynecologic Surgeons
TAH	Trans-abdominal hysterectomy
LAVH	Laparoscopic-assisted vaginal hysterectomy
QoL	Quality of Life

Female Anatomy and Physiology

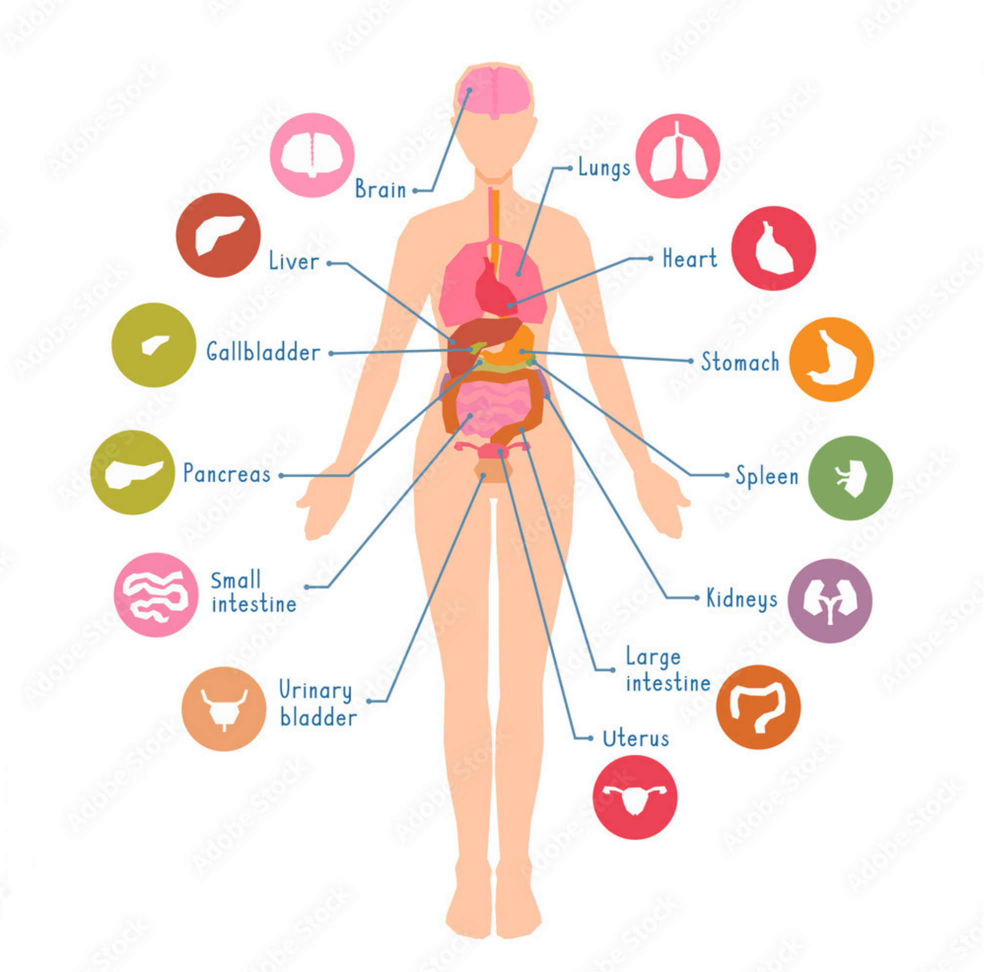

Figure 1. Female body diagram (1)

Anatomy of the abdominal wall

The anterior abdominal wall

The anterior abdominal wall gives thoracic support, contains abdominal internal organs, and assists in muscular actions like respiration and excretion. In gynecology, it is necessary to comprehend the layered anatomy of the front abdominal wall to access the peritoneal cavity or perform surgery without neurovascular problems (2). Langer lines explain the orientation of dermal fibers within the skin. Within the anterior abdominal wall, they are predominantly organized transversely. Vertical skin incisions endure greater lateral force than transverse skin incisions, resulting in scars that are typically broader. The subcutaneous layer is located beneath the skin. The subcutaneous layer is located beneath the skin. On the anterior abdominal wall, that layer is divided into the superficial, primarily fatty Camper fascia and the deeper, more membranous Scarpa fasciae. The Camper and Scarpa fasciae are not distinct layers, instead, they form a continuum. Scarpa fascia and Colle's fascia in the perineum are continuous, according to the caudal tracing. Clinically, Scarpa fascia is more developed in the lower abdomen, and it is easiest to identify during surgery in the lateral parts of a lower transversal incision, immediately superficial to the rectus fascia. During midline incisions, however, this fascia is seldom identified (2).

Rectus Sheath

The external oblique, internal oblique, and transversus abdominis muscles (flank muscles) all have lateral muscle and medial fibrous aponeurotic tissue. Each of their aponeuroses unites to form the rectus sheath's layers. The Linea alba is formed by the aponeurotic layers in the midline. Along a vertical line along the anterior superior iliac spine, the transition from the muscular to the aponeurotic part of the external oblique muscle occurs in the lower abdomen. The transition between muscle and aponeurosis or the internal oblique and transversus abdominis muscles occurs at a more medial location. Muscular fibers of the internal oblique muscle are frequently observed beneath the aponeurotic layer of an external oblique muscle after low transverse incisions. The rectus sheath anatomy both above and below the arcuate line is important. With low transverse abdominal incisions, only two layers are identified surgically because the aponeuroses of the internal oblique and transversus abdominis muscles in the lower abdomen are used. In contrast, while performing a midline vertical incision, one fascial layer, specifically the Linea alba is identified. The primary orientation of the fibers that make up the flank muscle and the rectus sheath is transverse, just like the orientation of the fibers that make up the skin. It is necessary for the suture lines that are placed in a vertical fascial incision to be able to sustain a greater amount of stress than those that are placed in a transverse incision. As a consequence of this, vertical fascistic incisions have a greater propensity for dehiscence and the development of hernias. Along the Linea alba, incisional hernias and ventral wall hernias are the two types of hernias that occur most frequently (2).

Transversalis Fascia

Between the inner surface of the transversus abdominis muscle and the preperitoneal fat is a layer of tissue known as the transversalis fascia. This layer of tissue is very thin and brows. It plays a role in the overall fascial layer which surrounds the abdominal cavity and functions as a portion of that layer. The pubic bones' periosteum and the transversalis fascia converge inferiorly. This fascia is most easily identified after surgery as the layer of the anterior surface of the bladder that is abruptly or bluntly dissected during entrance into the abdominal cavity. The last tissue layer to be pierced to achieve extraperitoneal access to the retropubic area is this one (2).

Peritoneum

The parietal peritoneum is the peritoneum that covers the inner wall of the abdomen. There are five parietal peritoneum elevations in the anterior abdominal wall, each elevated by a different structure. The five are collectively called umbilical ligaments and all five converge on the umbilicus. The urachus, a severed tube that connects the umbilicus to the bladder's apex, forms the single median umbilical ligament. The urachus, a fibrous remnant of the allantois, runs from the umbilical cord to the urogenital sinus, which develops into the bladder, throughout fetal life. Urine may leak into the abdominal cavity after surgical transection of a patent urachus. In addition, the urachal cyst, urachal sinus, and urachal diverticulum are included in the differential diagnosis of a midline anterior abdominal wall cyst (2).

Blood Supply

Femoral Branches

The external pudendal artery, the superficial epigastric artery, and the superficial circumflex external iliac artery all originate from the femoral artery, which is located just beneath the inguinal ligament in the trigone. This triangle is bounded on three sides by the sartorius muscle, the adductor longus muscle, and the ligament. These arteries provide nourishment to the skin as well as the subcutaneous layers of the mons pubis and the anterior abdominal wall. In a manner analogous to that of the inferior "deep" epigastric vessels, the superficial epigastric vessels travel in a diagonal direction toward the umbilicus (2). During surgery, while a low transverse skin incision is being created, the superior epigastric vessels are typically identifiable halfway between the skin and the rectus fascia, which is a few centimeters off the midline. These vessels can be shown during laparoscopic surgeries in skinny patients by using a technique called transillumination (2). An extensive network of anastomoses connects the external pudendal vessels to their contralateral equivalents as well as other superficial branches. These anastomoses handle the copious amounts of bleeding that often occur after incisions are performed in the mons pubis region, such as retropubic mid-urethral sling incisions or retropubic mid-urethral sling incisions (2).

External Iliac Branches

The inferior "deep" epigastric and circumflex ex iliac vessels are branches of the external iliac vessels. This supplies the anterior abdominal wall's muscles and fascia. The inferior epigastric veins supply the rectus abdominis muscle, which they initially supply laterally and then posteriorly. They travel anterior to the posterior rectus sheath and between it and the rectus muscles (2). An anastomosis connects the inferior epigastric vessels, which are branches of the internal thoracic vessels, with the superior epigastric artery and veins, which are also found close to the umbilicus. The Hesselbach triangle is a part of the anterior abdominal wall that is medially bordered by the lateral border of the rectus muscles, laterally by the inferolateral epigastric vessels, and inferiorly by the inguinal ligament. In surgical procedures, low transverse abdominal incisions that go beyond the rectus muscles' lateral edges might cause an anterior abdominal wall hematoma or inferior epigastric vascular laceration with substantial hemorrhage. Identifying and ligating these vessels is necessary when making a Maylard incision.

The deep circumflex iliac vein acts as the caudal border during pelvic lymph node dissection, which is another surgical landmark (2).

Innervation

The anterior abdominal wall is supplied with sensory information through the abdominal extensions of the intercostal nerves (7-11), the subcostal nerve (12), as well as the iliohypogastric and the ilioinguinal nerves (L1) (2).

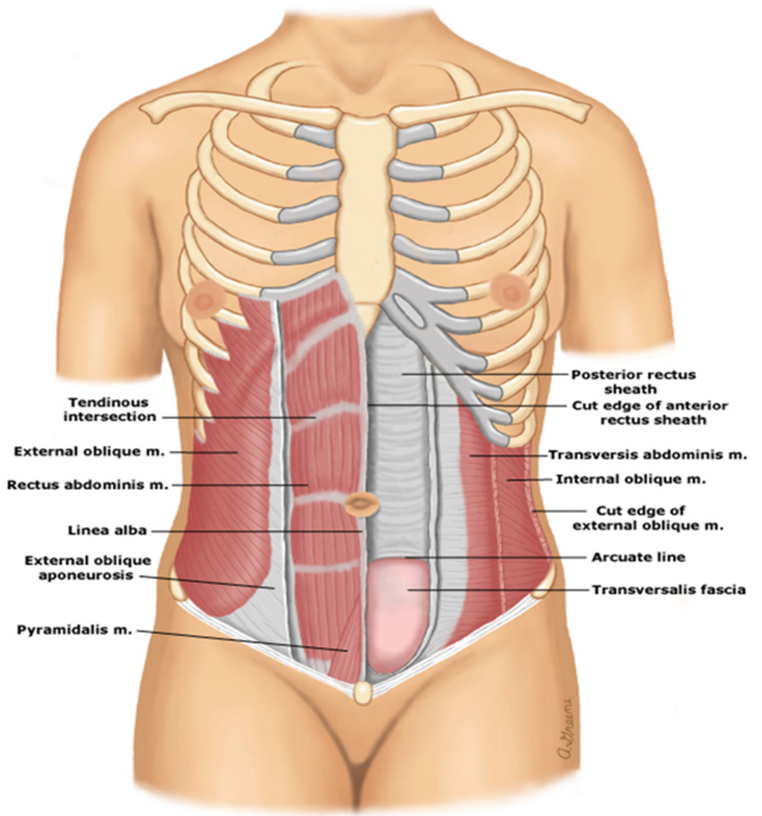

Figure 2. Anterior abdominal wall (3)

Anatomy of the Lower Abdominal Wall

Because the majority of intraabdominal gynecologic procedures are performed via lower abdominal incisions, it is essential to examine the anatomy of the low abdominal wall, paying particular attention to the muscles and fasciae. After passing through the skin, subcutaneous fat, superficial fascia (Camper), and deep fascia (Scarpa), the anterior rectus sheath is reached. The rectus sheath consists of the aponeuroses of the three lateral abdominal wall muscles. The two rectus abdominis muscles are partially encased by the Linea alba, which is formed when the aponeuroses converge in the midline to form the Linea alba (4). The composition of the upper and lower sections of the rectus sheath varies. Above the midpoint between the umbilicus and symphysis pubis, the rectus muscle is enveloped anteriorly by the aponeurosis of the external oblique and the anterior lamina of the internal oblique aponeurosis, and posteriorly by the aponeurosis of the transversus abdominis as well as the posterior lamina of the internal oblique aponeurosis (4). The posterior aponeurotic layer of the sheath finishes off in a free crescentic border known as the semilunar fold of Douglas in the lowest fourth of the abdomen. Each rectus abdominis muscle extends from the superior aspect of the symphysis pubis to the ventral aspect of the fifth, sixth, and seventh costal cartilages, and is sheathed in the rectus sheath on either side of the midline (4). Each muscle has three to five tendinous crossings that cross it irregularly, and any transverse rectus surgical incision produces a new fibrous junction as it heals. The muscle can be retracted laterally, as in the Pfannenstiel incision, after being separated from the anterior sheath because it is not linked to the posterior sheath. Each rectus muscle has a strong aponeurosis at the symphysis pubis, and this tendinous aponeurosis can be cut if necessary to facilitate exposure, as in the Cherney incision, and restored firmly during abdominal wall closure (4).

Abdominal Wall Incisions

The Pfannenstiel incision is the most typical lower abdominal incision used in gynecologic surgery (4). It provides cosmetic benefits for large operations because the scar is later covered by pubic hair and is typically just 2 cm above the symphysis pubis. A transverse muscle-cutting incision (Bardenheuer or Maylard) at a little higher level in the lower abdomen provides adequate exposure for extensive pelvic treatments (such as radical hysterectomy and pelvic lymphadenectomy). The skin incision follows Langer's guidelines, increasing the likelihood of a pleasing aesthetic outcome. A midline incision through the Linea alba or a paramedian vertical incision is advised when upper abdominal exploration is anticipated to be necessary, such as in a patient with probable ovarian cancer (4).

Anatomy of the Female Genitalia

External genitalia

The diagnosis of various gynecological illnesses and the interpretation of the results of ultrasonography, computer tomography (CT), and magnetic resonance imaging (MRI) are both aided by anatomical knowledge of the female genital organs and their relationships to neighboring structures scanning. Gynecological surgery allows for a better understanding and treatment of pelvic organ deformities while preventing serious damage to vital organs like the bladder, ureter, and rectum. To stage different genital tract cancers and perform their surgical dissection, it is essential to comprehend the lymphatic drainage of the pelvic organs (5).

The Vulva

The vulva, also known as the pudendum, is part of the perineum that contains all of the external genital organs that are visible. Mons pubis, labia majora, labia minora, hymen, clitoris, vestibule, urethra, Skene's glands, Bartholin's glands, and vestibular bulbs are all components of the vulva (6). In gynecological practice, the vulva is an ill-defined region that encompasses the entire external genitalia and includes the perineum. Therefore, it is bordered anteriorly by the pubis, laterally by the labia majora, and posteriorly by the perineum (5). Keratinized stratified squamous epithelium covers the vulvar region (6).

Mons veneris (mons pubis): In an adult female, this refers to the pad of subcutaneous adipose connective tissue that is located just in front of the pubis. Most women have a triangle escutcheon, with the base pointing upward (6).

Labia Majora

The labia majora extends from the mons veneris to the skin covering the perineal body. They form skin folds that encase various amounts of fat and develop most effectively throughout the childbearing years. In prepubescent children and postmenopausal women, the quantity of subcutaneous fat in the labia majora is generally low, and the cleft between the labia is thus prominent. During puberty, pudendal hairs appear on the mons veneris, the outer surface of the labia majora, and in some circumstances, the perineum. The inner surfaces of the labia majora are hairless and have softer, moister, and pinker skin than the outer surfaces. The labia majora are made up of squamous epithelium and sebaceous glands, sweat glands, and hair follicles. There are added specialized sweat glands known as apocrine glands, which create a distinctive odor and are the source of the rare tumor hidradenoma of the vulva. During sexual arousal, the level of secretion rises. All these structures in the labia majora make them susceptible to common skin disorders including folliculitis, boils, and sebaceous cysts. Its male equivalent is the scrotum (5).

Bartholin's Gland

Bartholin's gland is found posterolateral to the vaginal entrance, deep to the bulbospongiosus muscle, and superficial to the triangle ligament's outermost layer. It is embedded in the vestibular bulb's erectile tissue near its posterior extremity. It is generally impalpable in a healthy state but can be palpated easily between the finger and the thumb. Bartholin's gland is a compound racemose gland with low columnar epithelium lining its acini. The epithelium of the duct is cubical at the acini, transitional in the middle, and squamous at the duct's mouth. The function of the gland during coitus is to secrete lubricating mucus. The labia majora integrate into the perineum imperceptibly near the posterior commissure. Its vascular bed explains why there is always significant bleeding after removal. Its duct travels forward and inward before opening just on the inner side of the labia minora, outside the hymen. The gland, which has a diameter of around 10 mm, is found close to the point where the middle and posterior thirds of the labium major converge. By applying pressure to the gland, the duct of the gland, which is roughly 25 mm long, can express a thin mucous discharge. Acute gonorrhea results in infection of the Bartholin's gland and its duct when the reddish mouth of the duct is visible on the inner surface of the labium minus to one side of the vaginal orifice below the level of the hymen. Compound racemose Bartholin's gland has low columnar epithelium lining its acini. The duct's epithelium is cubical close to the acini, transitional towards the duct mouth, and lastly squamous. The gland's primary job during coitus is to secrete lubricated mucus. The posterior commissure is where the labia majora joins and almost imperceptibly becomes the perineum (5).

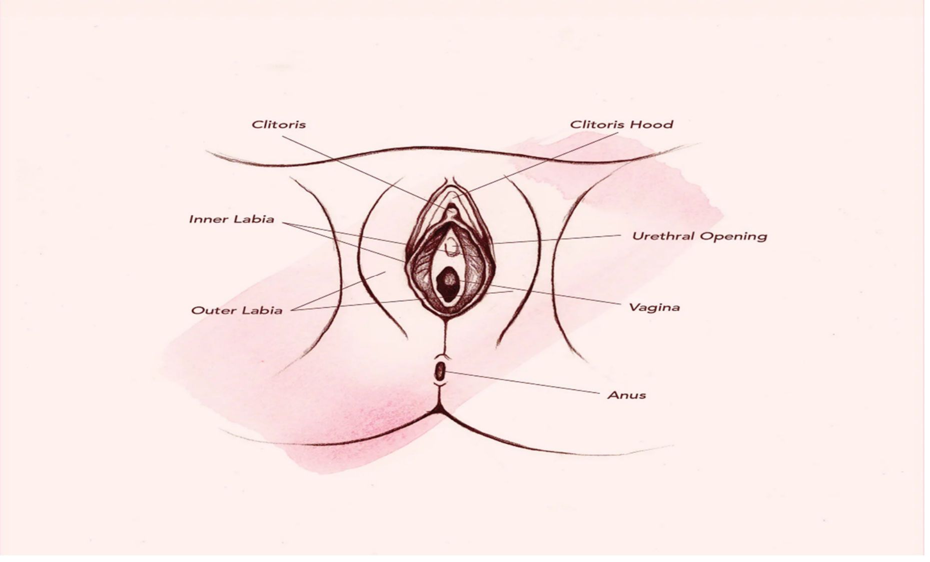

Figure 3. Anatomy of the female external genitalia (7)

Labia Minora

The labia minora are little folds of skin that are found on the inside of the labia majora and cover elastic tissue and veins. When engaged in sexual activity, the circulatory labia minora is erectional tissue; they lack sebaceous glands and hair follicles. They surround the clitoris anteriorly, creating the prepuce on its upper surface and the frenulum on its underside. They come together in the back to form the fourchette. The fourchette is a little skin fold that is visible when the labia are parted and is often ripped during childbirth. The tiny depression between the hymen and the fourchette is known as the fossa navicularis. Labia minora and the ventral side of the penis are anatomically similar (5).

The clitoris is a tiny, cylindrical erectile body that measures 1.5 to 2 cm and is in the vulva's most anterior region. It is made up of two crura, a body, and a glans. There are two cylindrical corpora cavernosa that make up the clitoris (erectile tissue). The gland has a squamous epithelial covering and is densely populated with nerves. Due to their connection to the vestibular bulb, the clitoris vessels are susceptible to damage during birthing. Clitoris is similar to the male penis but differs in that it is wholly distinct from the urethra. The suspensory ligament holds it to the underside of the symphysis pubis (6).

The vestibule is a triangle region bordered anteriorly by the clitoris, posteriorly by the fourchette, and laterally by the labia minora (6). Into the vestibule, there are four openings: Urethral opening, vaginal orifice, and hymen, the opening of Bartholin's ducts and Skene's glands (6). The external urinary meatus is found right behind the clitoris. The vaginal opening is found posterior to the meatus and encompassed by the hymen. In virgins, the hymen is represented by a thin membrane with squamous epithelium on either surface. It typically has a little eccentric hole that is typically too narrow to accommodate the fingertip. Coitus causes the rupture of the hymen; the ensuing lacerations are many and radially organized. Occasionally, coital rupture might result in severe blood loss. During labor, more lacerations occur: the hymen is considerably stretched, and the resulting skin tags are known as carunculae myrtiformes. With the widespread use of internal sanitary tampons, the loss of hymen integrity is no longer an evidence of loss of virginity (5).

During the childbearing years, the vulval tissues react to hormones, particularly estrogens. Due to estrogen insufficiency, the vulval skin becomes thinner and drier during menopause, which may result in atrophic vulvitis and itching. Mons pubis is a fatty region that overlaps the pubic symphysis. At puberty, an abundance of hair will cover it (5).

The glands of Skene are the largest of the paraurethral glands. Skene's glands are comparable to the male prostate. The two Skene ducts may open on either side of the external urethral meatus in the vestibule (6).

Blood supply

Arteries are branches of the internal pudendal artery, with the principal ones being the labial, transverse perineal, vestibular bulb, and deep and dorsal clitoris arteries. The femoral artery branches are superficial and deep external pudendal (6).

The veins drain into (a) the internal pudendal vein, (b) the vesical or vaginal venous plexus, and (c) the long saphenous vein. Varicosities are frequent during pregnancy and may rupture spontaneously, resulting in apparent bleeding or hematoma formation (6).

Nerve supply

The supply is via bilateral spinal somatic nerves: (a) the anterosuperior part is supplied by the cutaneous branches of the ilioinguinal and genital branches of the genitofemoral nerve (L1 and L2), and the posteroinferior portion is supplied by the pudendal branches of the posterior cutaneous nerve of the thigh (S1.2.3). The vulva is supplied by the labial and perineal branches of the pudendal nerve between these two groups (S2.3.4) (6).

Lymphatics

Vulval lymphatic drainage is bilateral in a superficial inguinal lymph node, intermediate groups of inguinal lymph nodes such as the gland of Cloquet, and external and internal iliac lymph nodes (6).

Internal Genitalia

Females have internal genital organs such as the vagina, uterus, fallopian tubes, and ovaries. These organs are found inside and require specialized inspection equipment (6).

Vagina

The uterus and the introitus are connected by a tube called the vagina, which is made up of fibromuscular tissue. The hymen and the introitus of the vagina are found at the same level as the vaginal apex, which is the lowermost part of the vagina. Currently, it is encompassed by the erectile tissue of the bulb, which is analogous to the corpus spongiosum in the male. The vagina's path is about parallel to the brim of the real pelvis; it is gently bent forward from above downward, and its anterior and posterior walls are near one another. Being almost twice as capacious in its upper part and having a flask-like shape, it is not of uniform caliber. The anterior, posterior, and lateral fornices are formed by the vaginal section of the cervix projecting into its upper end. The cervix's part vaginalis development determines the depth of the fornices. The fornices are shallow in young girls and older women whose uterus has undergone postmenopausal atrophy, while they are deep in people with the congenital extension of the cervix's portion vaginalis. The posterior fornix is the deepest of the fornices, and the posterior vaginal wall is longer than the anterior because the vagina is linked to the cervix at a greater level there than elsewhere. The front wall is 11.5 cm long, while the posterior is 9 cm long. During coitus and parturition, the transverse folds in nulliparae's vaginal walls allow the vagina to extend and enlarge. Women who have had several children have these folds partially eliminated. Three sulci in the anterior vaginal wall can be seen (5). One is referred to as the submeatal sulcus and is located directly above the meatus. The transverse vaginal sulcus, which is found about 35 mm above this sulcus in the anterior vaginal wall, roughly corresponds to the intersection of the urethra and the bladder. The bladder sulcus, which marks where the bladder connects to the anterior vaginal wall, is found higher up. The nonkeratinized squamous epithelium that lines the vaginal mucosa is composed of cuboidal cells in the basal layer, prickle cells in the middle, and cornified cells in the superficial layer. Until puberty, the newborn's epithelium is almost of a transitional type, and there are few cornified cells. There are no glands that open into the vagina, and the vaginal secretion is made up of a combination of mucus secretions from the cervix and transudation through the vaginal epithelium (5).

The vascular subepithelial layer is rich in erectile tissue. The big vessels are in the connective tissues surrounding the vagina, and a muscle layer outside of the subepithelial layer is made up of a complicated interlacing lattice of plain muscle. The upper two-thirds of the vaginal mucosa produce columnar epithelium if the mother consumed diethylstilboestrol while pregnant, which increases the risk of the female fetus developing vaginal adenosis and vaginal cancer during adolescence. Due to the vagina's exposure to the environment when there is a prolapse, the vaginal mucosa keratinizes, and an ulcer may develop on top of it (decubitus ulcer). The keratinized mucosa resembles skin and is brown. The vagina atrophy because of menopause (5). In healthy women, there is little vaginal discharge, which is made up of coagulated white material. Squamous cells that have been lost from the vaginal epithelium and Döderlein's bacilli are the only things that can be seen when it is examined under a microscope. Large rod-shaped Gram-positive Döderlein's bacillus develops anaerobically on acidic media. Lactic acid makes the vaginal discharge acidic, and this acidity prevents the growth of harmful germs. During reproductive life, the vagina's pH hovers around 4.5 on average. After menopause, the acidity, which is unquestionably estrogen-dependent, becomes neutral or even alkaline. During childhood, the pH is around 7. The glycogen of the epithelial cells, which is dependent on the presence of estrogen, is likely to be affected by either enzyme or bacterial activity (Döderlein's), and its insufficient activity can be increased by the injection of oral or local estrogen. The vagina's acidity decreases during the puerperium and in situations of leucorrhea, which allows harmful organisms to persist. Because healthy cells contain glycogen, the squamous cells of the vagina and cervix stain a dark brown color when exposed to an iodine solution (positive Schiller's test). Schiller's test turns out to be negative in postmenopausal women due to a lack of or low level of superficial cells that carry glycogen (5). Estrogen and progesterone, two ovarian hormones, have an impact on the vaginal epithelium. Glycogen-containing surface cells are multiplied by estrogen, and intermediate cells are multiplied by progesterone. When these hormones are absent, a menopausal woman's thin vaginal mucosa and basal cells are all left. Additionally, lacking glycogen and incapable of absorbing the stain are diseased and cancerous cells. That, due to protein coagulation, these abnormal cells become white when exposed to acetic acid. These regions are chosen for biopsy to find cancer (5).

The blood supply of the vagina

The implicated arteries are the Cervicovaginal branch of the uterine artery, the vaginal artery, which is a branch of the anterior division of the internal iliac or has a common origin with the uterine artery, the middle rectal, and the internal pudendal. They connect to generate two azygos arteries, the anterior and the posterior (6).

Veins discharge into internal iliac veins and internal pudendal veins (6).

Lymphatics

The lymphatics on each side drain into the following groups: the upper one-third, which is the internal iliac group; the middle one-third, which is the internal iliac group up to the hymen; and the lower one-third, which is the superficial inguinal group (6).

Nerve supply

Sympathetic and parasympathetic nerves from the pelvic plexus supply the vagina. The pudendal nerve supplies the lowest part (6).

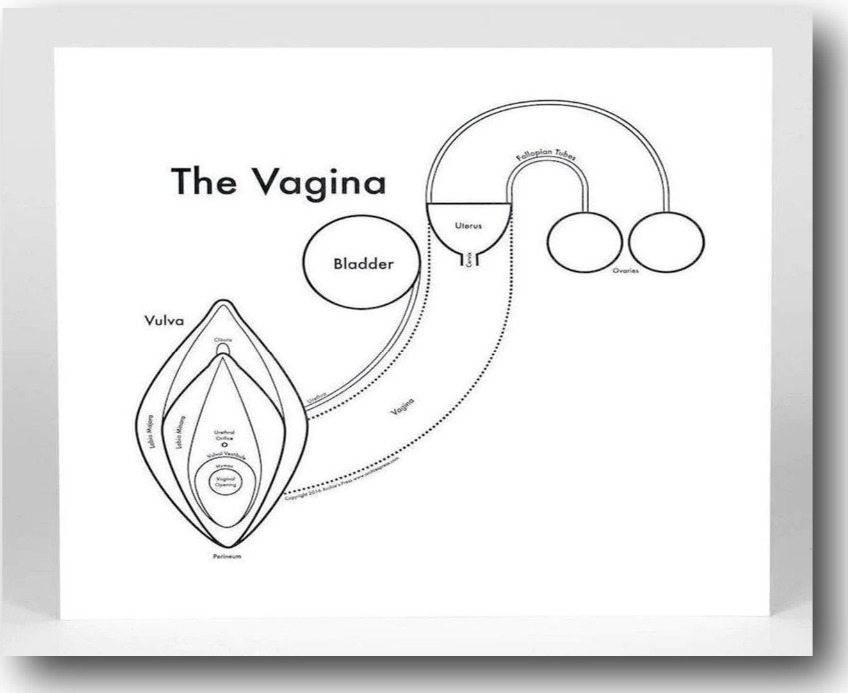

Figure 4. Schematic representation of the female reproductive system (8)

Relations of the Vagina

Anterior Relation

In its lower part, the vagina is strongly associated with the urethra and paraurethral glands (Skene's tubules), so closely that the urethrovaginal fascia is a fused structure that can only be dissected with a sharp knife. In its upper half, the vagina is connected to the bladder in the region of the trigone, and the vesical and vaginal fasciae are easily separated via the vesicovaginal gap by blunt dissection. Significant vascular and lymphatic intercommunication exists between the vesical and vaginal vessels, a perilous relationship that influences the surgical treatment of malignant disease in this region (5).

Posterior Relations

The bottom third of the vagina is connected to the perineal body, the middle third is connected to the ampulla of the rectum, and the top third is connected to the anterior part of the sack of Douglas, which includes big and small bowel loops. This partition separating the vagina from the peritoneal cavity is the thinnest part on the entire peritoneal surface and, as a result, is a place of choice for pointing and opening pelvic abscesses or the formation of a hernia or enterocele. This location is also good for colpocentesis when diagnosing ectopic pregnancy.

The Pouch of Douglas is a peritoneal cul-de-sac in the rectovaginal region of the pelvis. It is bordered anteriorly by the peritoneum that covers the posterior vaginal wall and posteriorly by the peritoneum that covers the sigmoid colon and rectum. Laterally, the uterosacral ligaments define their limit, whilst the peritoneal cavity's floor reflects the peritoneum (5).

In the pouch of Douglas, there are endometriotic nodules and ovarian cancer metastases, as well as a pelvic inflammatory mass. In advanced cervix cancer, the uterosacral ligaments are thickened and become noduled (5).

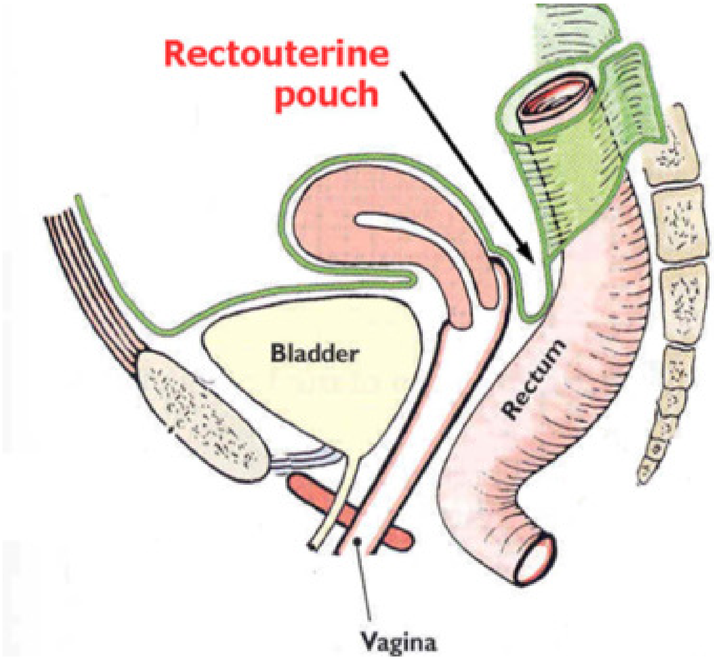

Figure 5. Pouch of Douglas (9)

Lateral Relations

From below upwards, the lateral relations consist of the cavernous tissue of the vestibule, the superficial muscles of the perineum, the triangle ligament, and at approximately 2.5 cm from the introitus, the levator ani, which is lateral to the ischiorectal fossa. Above the levator is the endopelvic cellular tissue, and its condensation, called Mackenrodt’s ligament, on either side. This tissue is traversed by the ureter in the ureteric canal around 12 mm anterior to the lateral fornix (5).

Superior Relations

The uterine vessels, Mackenrodt's ligament, and the ureter are connected to the cervix's four fornices (anterior, posterior, and two lateral). Posteriorly, encircling the pouch of Douglas are the uterosacral ligaments, which can be seen during a vaginal examination, particularly if thickened by endometriosis and cervical cancer (5).

Squamocolumnar junction, also known as the transitional zone, is a clinically significant junction where the squamous epithelium lining the vagina fuses with the columnar epithelium of the endocervix and is 1–10 mm in width (5).

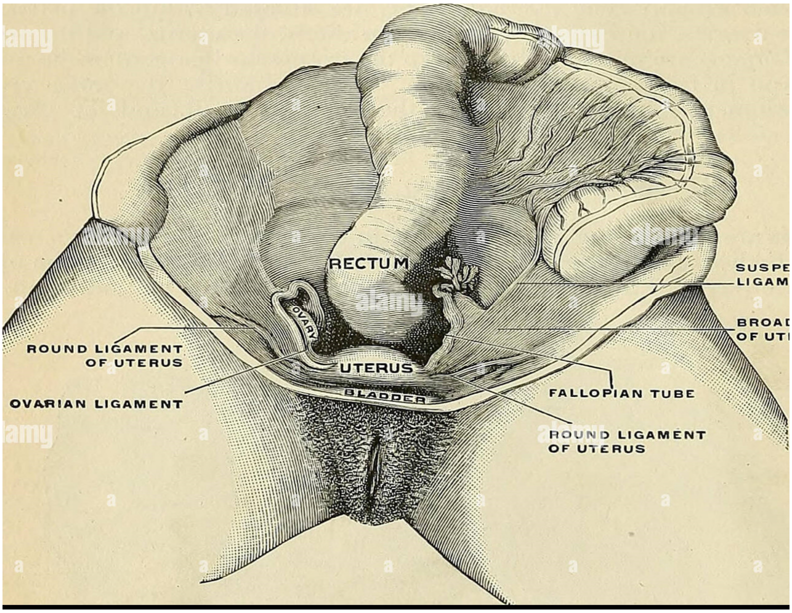

Figure 6. Descriptive and applied anatomy of the female reproductive system (10)

The Uterus

The uterus is approximately 9 centimeters in length, 6.5 centimeters in width, and 3.5 centimeters in thickness. It is physically and functionally separated into the body and the cervix. It weighs 60 g (5). The line of division coincides with the level of the internal os, and it is at this point that the mucous membrane that lines the cavity of the uterus begins to become continuous with the mucous membrane that lines the cervical canal. At this level, the peritoneum of the anterior uterus is reflected onto the bladder, and the uterine artery, after passing virtually transversely across the pelvis, reaches the uterus, makes a right-angle turn, and ascends vertically along the uterine lateral wall. There are vaginal and supravaginal regions of the cervix (5). The fundus of the uterus is that region of the corpus uteri which sits above the insertion of the fallopian tubes. The uterine cavity communicates with the fallopian tube openings and is in direct communication with the peritoneal cavity via the abdominal Ostia. The uterine cavity is triangular with a capacity of 3 ml. The internal os creates the lower angle. The lateral angle linking the fallopian tube to the uterus is known as the cornual end. The uterine wall is composed of three layers: the peritoneal covering known as the perimetrium, the muscle layer known as the myometrium, and the mucous membrane known as the endometrium. The uterus is capable of distension during pregnancy and during hysteroscopic examinations with distended media. Otherwise, the two walls oppose one another (5).

Perimetrium

The peritoneum around the uterus is incomplete. The entire body of the uterus is covered anteriorly by the peritoneum. The bladder reflects the peritoneum at the level of the internal os. Therefore, the cervix of the uterus lacks an anterior peritoneal covering. Posteriorly, the peritoneum covers the entire body of the uterus and the supravaginal region of the cervix. In the region of the posterior fornix, the peritoneum is reflected from the supravaginal section of the cervix onto the posterior vaginal wall. Laterally, the peritoneal layer is incomplete due to the insertion of the fallopian tubes, the round ligament, and the ovarian ligament into the uterus, and below this level, the two sheets of peritoneum that make up the wide ligament leave a thin exposed space laterally on either side (5).

Myometrium

Of the three layers that make up the uterine wall, the myometrium is the thickest. The myometrium in the cervix is made up mostly of simple muscle tissue and a lot of fibrous tissue, which gives it a hard consistency. Without being organized, the muscle fibers and fibrous tissues are mingled together. Myometrium averages 10–20 mm thick in the uterine body, and it has three distinct layers that are most noticeable in the uterus during pregnancy and menstruation. The external layer, which is longitudinal and immediately below the peritoneum, passes from the cervix anteriorly over the fundus to the posterior surface of the cervix. This layer in the nulliparous uterus is thin and difficult to see. When the fetus is expelled from the body, this layer performs a detrusor action, which is its primary role. The middle layer is the thickest of the three and is made up of bundles of muscle that are separated by connective tissue, the precise amount of which varies with age; plain muscle tissue is best defined in the childbearing period, especially during pregnancy, whereas before puberty and after menopause it is much less plentiful. Plain muscle tissue is better marked in the childbearing period, especially during pregnancy (5). There is a predisposition for the muscle bundles to entwine with one another, and because the blood vessels that supply the uterus are dispersed throughout the connective tissues, the diameter of the vessels is in part controlled by the degree to which the muscle cells in the uterus contract. As a result, the goal of this layer is to a certain extent hemostatic, although its role in expelling is equally vital. This layer is crucial for controlling the amount of bleeding that occurs during the third stage of labor. It is sometimes referred to as the living ligatures of the uterus. These muscle fibers' inability to effectively contract and relax leads to protracted labor, which in turn leads to atonic postpartum hemorrhage (PPH). The inner part of the muscle is composed of circular fibers. The greatest representation of this layer is the circular muscle fibers around the internal os and the apertures of the fallopian tubes. It can be considered sphincteric in operation. Since the myometrium is thickest at the fundus (1–2 cm) and thinnest at the cornual end (3–4 mm), care must be taken not to perforate the cornual end during curettage and endometrial ablation (5).

Endometrium

The endometrium or mucous membrane lining the uterine cavity is structurally distinct from the endocervix (5,6). The endometrium is directly opposed to the muscular coat since there is no submucous layer. Lamina propria and surface epithelium make up this structure. A single layer of ciliated columnar epithelium makes up the surface epithelium (6).

Stromal cells, endometrial glands, blood arteries, and nerves are all found in the lamina propria. The glands are straightforward tubular structures bordered by nonciliated columnar epithelium that secretes mucus and can occasionally even permeate the muscle coat. When a woman is pregnant, the endometrium transforms into decidua (5).

The cervix has a spindle-like form and measures approximately 2.5 centimeters (or a little bit more). It is confined on the upper side by the internal os and on the lower side by the external os.

The absence of a submucosa distinguishes the mucosal lining of the cervix from that of the uterine body. The endocervix is bordered with a single layer of high columnar ciliated epithelium with spindle-shaped nuclei and copious cytoplasm and mucin that lies next to the basement membrane. The cilia are directed downwards toward the external os. The glands are racemose and produce mucus rich in fructose glycoprotein, mucopolysaccharide, and sodium chloride. The discharge has an alkaline pH of 7.8 and contains fructose, which makes it attractive to ascending spermatozoa. This secretion may prevent ascending infections by accumulating as a stopper in the cervical canal (5). The cervix is composed primarily of collagen and just 10% muscle fibers. A light microscopic inspection reveals 29% muscle fibers in its top one-third, 18% in its middle one-third, and just 6% in its lower one-third, while the uterine body includes 70% muscle fibers (5). Both structurally and functionally, the uterine body and the cervix differ significantly. The cervical epithelium does not undergo periodic changes during the menstrual cycle, and the decidual response of pregnancy is rarely seen in the cervix. Similar to the malignant illness of the uterus, which is an adenocarcinoma of the endometrium, carcinoma of the cervix is typically a highly malignant squamous cell development (5). Between the body's endometrium and the mucous membrane of the cervical canal is a 6 mm-long isthmus, a transitional zone. Its epithelial lining resembles and behaves similarly to the body's endometrium. During pregnancy, the isthmic part extends and transforms into the lower uterine segment. This portion of the isthmus is less contractile during pregnancy and labor but expands further as a result of uterine contractions. During cesarean birth, it is identifiable by the loose fold of the peritoneal lining covering its anterior aspect (5). The proportion of cervix length to uterine body length changes with age. Before puberty, the ratio of the cervix to the corpus is 2:1. During the reproductive years, the cervix-to-corpus ratio may be 1:3 or even 1:4. During puberty, the ratio is reversed to 1:2. The entire organ atrophies after menopause, and the part vaginalis may eventually disappear. In contrast to the sparse and fluid character of endometrial secretion, cervical secretion is profuse and varies in quality and amount throughout the menstrual cycle because of diverse hormonal impacts. The cervical mucus has a high concentration of fructose, glycoprotein, and mucopolysaccharides. Sperms are nourished by fructose during their passage through the cervical canal. Under the estrogenic influence in the early follicular phase, the glycoprotein network is structured in parallel and enables sperm penetration, but under progesterone secretion, the network forms interlacing bridges and blocks their passage into the cervical canal. This feature of progesterone is used in the contraceptive pill and intrauterine contraceptive devices containing progesterone. During ovulation, the amount of sodium chloride in the mucus increases, forming a fern-like pattern when a drop of mucus is dried and examined under a microscope (5).

Position of the Uterus

The normal uterine position is one of anteversion and anteflexion. Approximately at the level of the internal os, the uterine body is anteflexed on the cervix, and this forward inclination of the uterine body on the cervix represents anteflexion.

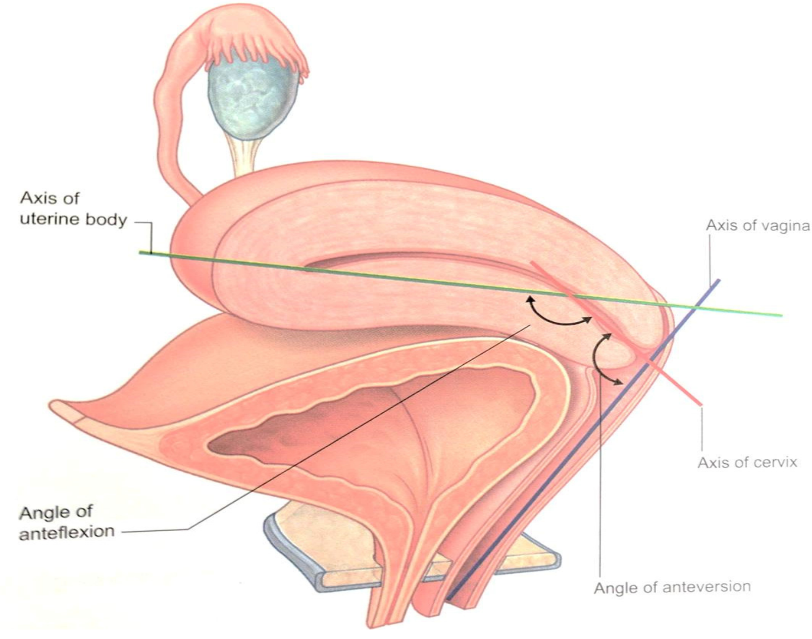

Figure 7. The normal uterine position is in anteversion and anteflexion (11)

The position of the uterus determines the orientation of the axis of the cervix. In anteversion, the external os is oriented downwards and backward, so that the anterior lip is the lowest part of the cervix upon vaginal inspection. The cervix is directed downwards and forwards when the uterus is retroverted, and the lowest part of the cervix is either the external os or the posterior lip. As a result of its typical anteflexion position, the uterine body rests against the bladder (5). The uterovesical pouch is a pouch of the peritoneum that is found between the uterus and the bladder. At the level of the internal os, the peritoneum is reflected from the front of the uterus onto the bladder (5). The uterus and the rectosigmoid colon are found posteriorly and are separated by a sizable peritoneal pouch. Two folds of the peritoneum can be seen going backward from the uterus and into the parietal peritoneum, which is lateral to the rectum if the uterus is dragged forward. These folds, known as the uterosacral folds, pass backward and upwards, lying at the level of the internal os. The uterosacral ligaments, which are a condensation of the pelvic cellular tissues, are located within the uterosacral folds and at a lower level. The pouch of Douglas is a pouch of peritoneum that lies beneath the level of the uterosacral folds and is bordered in front and behind by the peritoneum that covers the top part of the posterior vaginal wall and the sigmoid colon and upper end of the rectum. Only the posterior vaginal wall and a thin layer of peritoneum separate the vagina from the peritoneal cavity, placing the posterior fornix of the vagina close to the latter wall. As a result, a collection of pus in the Douglas pouch may be easily removed by making a small cut in the vagina at the posterior fornix. However, accessing the uterovesical pouch via the vagina is challenging; first, the vagina must be cut open, then the bladder must be separated from the cervix, and finally, the vesicocervical space must be crossed before the uterovesical fold of the peritoneum is reached (5).

The Appendages of the Uterus

The uterus rises from the pelvic floor into the peritoneal cavity, carrying two folds of peritoneum on each side that pass laterally to the pelvic wall and form the broad ligaments. The fallopian tubes protrude from the uterine cornua and are found near the upper border of the broad ligaments. The ovarian ligaments and round ligaments both pass into the uterine cornua, albeit at a slightly lower level than the fallopian tubes. Peritoneum covers both these ligaments and the fallopian tubes. The round ligament runs from the uterine cornua beneath the broad ligament's anterior peritoneal fold to the inner abdominal ring. It is shaped and lies just underneath the peritoneum in this section of its path, making it easily identifiable. The round ligament travels down the inguinal canal and eventually becomes adherent to the skin of the labia major. Multiparae have much more developed round ligaments than nulliparae. They are most notably hypertrophied in the presence of massive fibroids, reaching a diameter of 1 cm. They correspond developmentally to the gubernaculum testis and are morphologically continuous with the ovarian ligaments, as the ovarian and round ligaments are continuous during intrauterine life and connect the lower pole of the primitive ovary to an inguinal canal. Except during labor, the round ligaments are lax and tension-free. There is no evidence that the normal anteflexion and anteversion of the uterus are caused by round ligament contraction. The ligaments, on the other hand, can be surgically shortened or surgically attached to the anterior abdominal wall to cause anteversion in a pathologically retroverted uterus (5). The ovarian ligaments travel upward and inward from the internal poles of the ovaries to the cornua of the uterine cavity, just below the level of the fallopian tube attachment. They are about 2.5 cm long and lie beneath the broad ligament's posterior peritoneal fold. They are made up of plain muscle fibers and connective tissue, just like round ligaments, but they are less visible because there is less plain muscle tissue (5).

The infundibulopelvic ligament is the section of the broad ligament that runs from the fallopian tube infundibulum to the lateral pelvic wall.

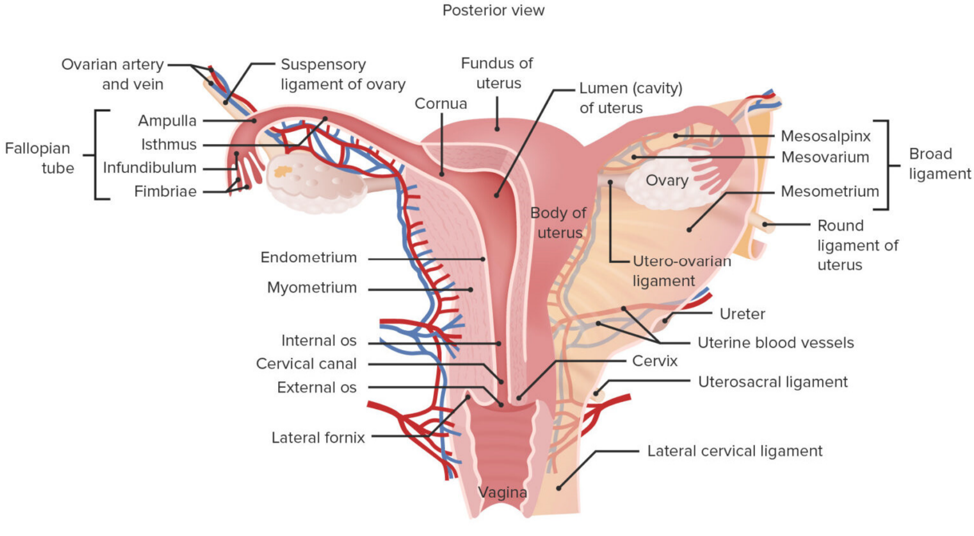

Figure 8. Gross anatomy of the female reproductive system (12)

Mesovarium connects the ovary to the posterior fold of the broad ligament and contains the ovary's vessels, lymph nodes, and nerves. Mesosalpinx is found between the fallopian tube and the ovary, and it contains the anastomotic vessels between the ovary and uterus, as well as the vestigial structures of the Wolffian body and the duct (5).

Fallopian Tubes

Each fallopian tube is linked to the uterus cornu and passes upwards and backward in the broad ligament. The fallopian tube is at least 10 cm long and approximately 8 mm in diameter, but the diameter narrows to 1 mm near the uterine cornu. The fallopian tube is anatomically divided into four sections:

1. The interstitial part
2. The isthmus
3. The ampulla
4. The fimbriated extremity or infundibulum (5).

The interstitial portion is the innermost portion of the tube traversing the myometrium and opening into the endometrial cavity. It is the briefest segment of the tube. The isthmus includes the subsequent and innermost section of the tube and accounts for approximately one-third of the total length, or 35 mm. It is narrow but slightly wider than the interstitial portion, and its lumen measures 2 mm in diameter. Its muscle wall is composed of both longitudinal and circular fibers, and it is covered by the peritoneum except for a small, ligament-related bare area in its inferior part. It is straightforward. The ampulla is the lateral, widest, and longest part of the tube, forming roughly two-thirds of the tube's length and measuring between 60 and 75 mm. The mucous lining is arborescent and intricately folded. Fertilization takes place in the ampullary segment of the fallopian tube. The infundibulum or fimbriated extremity is where the abdominal ostium enters the peritoneal cavity. The fimbriae are mobile and nearly prehensile, with a wide range of movement and action. One fimbria, the ovarian fimbria, is larger and longer than the others and is connected to the ovary. This fimbria encircles the ovary during ovulation, seizes the ovum, and transports it to the ampullary part (5).

The fallopian tube is the cranial end of the Müllerian duct, and its lumen communicates directly with the uterine cavity. Therefore, spermatozoa and the fertilized ovum can pass through the tube. Fluids such as dyes and gases such as carbon dioxide can be injected through the uterus and into the peritoneal cavity via the fallopian tubes, allowing the patency of the fallopian tubes to be evaluated clinically by dye test. The fallopian tubes are in the upper portion of the broad ligaments and are covered with the peritoneum, except for a thin area located inferiorly that is exposed due to the reflection of the peritoneum that forms the two layers of the broad ligament. The blood supply of the fallopian tube is primarily derived from the tubal branches of the ovarian artery, but its inner part is supplied by the anastomosing branch of the uterine artery (5). The three layers of the fallopian tubes are serous, muscular, and mucous. The mesothelium of the peritoneum forms the serous layer. There is a well-defined subserous layer between the mesothelium and the muscle layer that has numerous small blood vessels and lymphatics. Outer longitudinal and inner circular fibers compose the muscular layer. Near the fimbriated extremity, the circular fibers are at their densest in the isthmus and thin out as they approach the extremity. The mucous membrane is folded into plicae or folds (5).

Near the isthmus, three folds can be identified; however, when traced laterally, they divide and subdivide, becoming extremely complicated in the ampullary area. Each plica is composed of a stroma covered by epithelium. The stroma is cellular, and its cells resemble those of the endometrium in some ways. In the ampullary region, the blood vessels of the stroma are numerous and prominently marked. The epithelium of the mucous membrane is composed of three cell types, with ciliated columnar or cubical cells being the most prevalent. Its purpose is to propel a fluid current toward the uterus, and it also contributes to the transport of the immobile ovum, which, unlike the sperm, lacks its motility. Next in frequency is a non-ciliated, goblet-shaped cell that does not exhibit histochemical reactions for mucin. Its purpose is to lubricate and possibly nourish the ovum. In addition to small rod-shaped cells, it is possible to identify a cell type intermediate between the two already mentioned. The function of these so-called peg cells is unknown. During the menstrual cycle, it has been possible to show differences in the histological appearances of the fallopian tube epithelium (5).

Blood supply

The uterus and the ovaries provide an arterial supply. The ovarian veins get venous drainage through the pampiniform plexus (6).

Lymphatics

The lymphatics travel from the para-aortic nodes along the ovarian veins (6).

Nerve supply

The uterine and ovarian nerves are the source of the nervous system. The tube is quite delicate when handled (6).

The Ovaries

Each ovary weighs between 4 and 8 grams and measures between 35 and 25 millimeters in length, width, and thickness. The ovary has the shape of an almond, is pearl-grey due to a compact tunica albuginea, and has a slightly corrugated surface. The ovaries are small and found near the pelvic rim before puberty. They atrophy and shrink after menopause, and the surface's ridges and furrows become pronounced. The menopausal ovary has a volume of 8 mL or less and measures 20 mm x 10 mm x 15 mm. The ovary is connected to the broad ligament's posterior by a thin mesentery, the mesovarium. The ovary is connected laterally to the fossa beneath the bifurcation of the common iliac artery and the ureter. It is close to the Fallopian Tube fimbria, which stretches over it during ovulation. It is connected to the uterine cornu by the ovarian ligament. The infundibulopelvic ligament is the outermost edge of the broad ligament and has ovarian vessels, nerves, and lymph nodes. The ovaries are typically not palpable during a bilateral examination, but they are painful to the touch. The epoophoron, also known as the organ of Rosen Müller, is the Wolffian body's cranial end. Between the fallopian tube and the ovary, it consists of a series of vertical tubules in the mesovarium and mesosalpinx. Each tubule is encompassed by smooth muscle and lined with cubical cells (5). The Wolffian duct (Gartner's duct) is imperfect in the mesosalpinx that runs parallel to but below the fallopian tube. The duct descends by the side of the uterus to the level of the internal os, where it enters the cervix's tissues. It then extends forward until it reaches the anterolateral aspect of the vaginal wall, and it may extend as far as the hymen. The duct may require surgical enucleation if it forms a cyst called Gartner's cyst in the broad ligament or vagina (5).

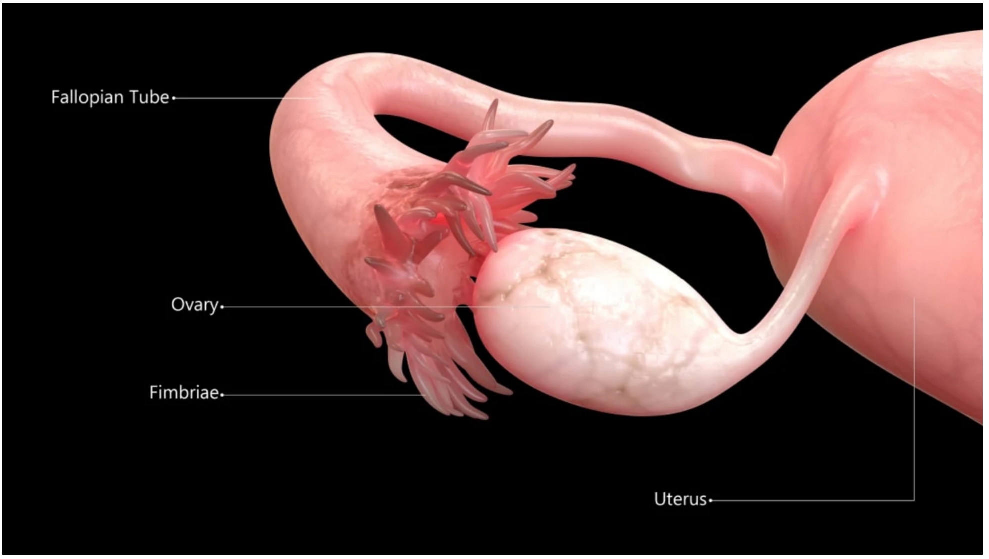

Figure 9. Ovary presentation (13)

Bloody supply

The ovarian artery, a branch of the abdominal aorta, provides arterial circulation. Venous drainage occurs through the pampiniform plexus to create the ovarian veins, which on the right-side drain into the inferior vena cava and the left side into the left renal vein. Because some of the placental site's venous blood drains into the ovarian veins, thrombophlebitis in the puerperium may develop there (6).

Lymphatics

The para-aortic lymph nodes are drained by the ovarian vasculature (6).

Nerve supply

From the T10 segment, sympathetic supply descends the ovarian artery. Ovaries are delicate to hand pressure (6).

Anatomy of the Pelvis and Perineum

Anatomy of the Bony Pelvis

The pelvic skeleton consists of two pairs of anterior bones and the sacrum. At the front attachment of both innominate bones is produced the symphysis pubis. The adult sacrum consists of five to six fused vertebrae. In the sacroiliac joints, the sacrum articulates dorsal with each innominate bone. The sacrum articulates superiorly with the fifth lumbar vertebra and inferiorly with the coccyx (4). The real (lesser) pelvis is formed posteriorly by the sacrum and coccyx, anteriorly by the pubis, and laterally by the ischium. The true pelvis has pelvic organs, which include the uterus, vagina, bladder, fallopian tubes, and ovaries, as well as a part of the rectum and anus. The false (larger) pelvis is bordered posteriorly by the lumbar vertebrae, bilaterally by the iliac fossae, and anteriorly by the abdominal wall. During pregnancy and labor, the pelvic skeleton plays a crucial role. By performing pelvimetry, it is clinically vital to establish whether the pelvis is suitable for vaginal birth. This may be performed via a pelvic examination or, more accurately, with computer tomography (4).

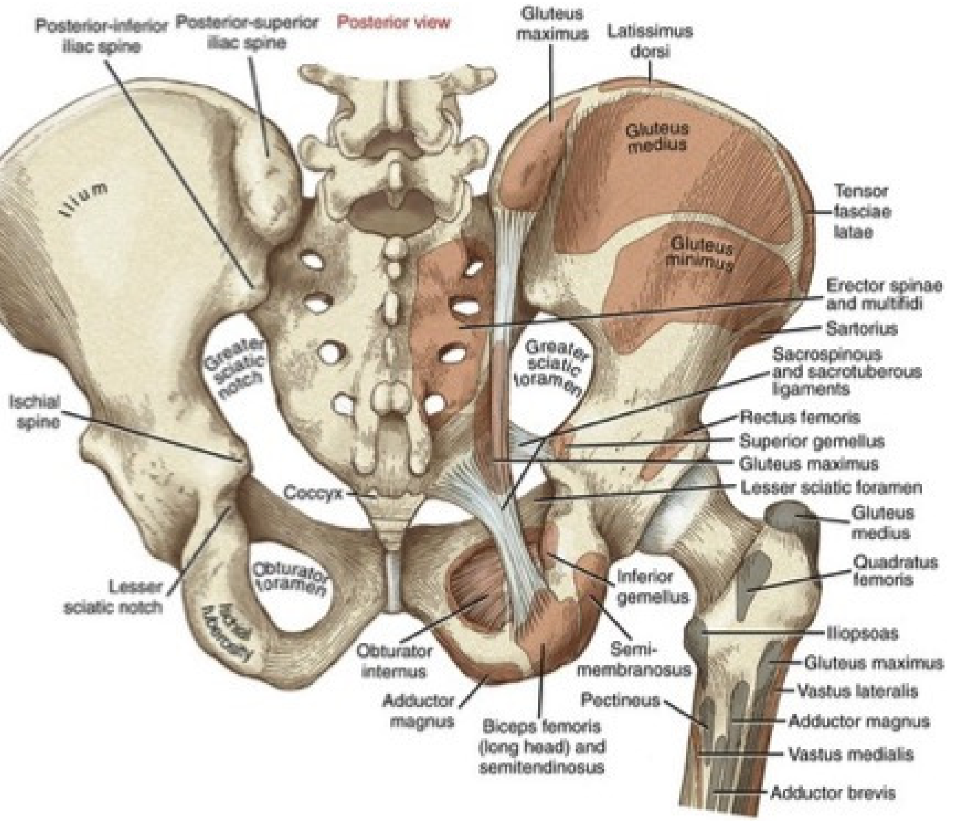

Figure 10. Anatomy of the Bony pelvis (14)

Perineum

The female perineum is a structure in the shape of a diamond that lies beneath the pelvic diaphragm and in between the symphysis pubis and coccyx. The anterior urogenital triangle and the posterior anal triangle make up the perineum, while the vulva is the external genitalia (15). The pelvic floor is a multipurpose structure made up of muscles, ligaments, and fascia. The endopelvic fascia, the muscular pelvic diaphragm, the perineal membrane, and the superficial perineal pouch are among the layers that make up the pelvic floor, even though they are frequently mistakenly viewed as a single muscular layer (16). The anterior urogenital triangle and the posterior anal triangle are separated by an illustrative (interischial) line between the ischiopubic rami in the perineum. The urogenital triangle and the anal triangle both have anterior and downward-facing triangles in a sagittal view.

The distal two-thirds of the urethra, the distal vagina at the level of the introitus, and the anal canal are all found within the perineum (15). The superficial and deep fascia line the anal triangle, which is made up of the anal canal, sphincters, the ischioanal fossa, which has fat, and neurovascular bundles (16). Although the terms "ischiorectal fossa" and "ischioanal fossa" have been used interchangeably, the latter is more suitable because the fossa is found next to the anal sphincter rather than the rectum, which is located above the pelvic diaphragm. The anal canal and its sphincters are in the center of the ischioanal fossa, which runs from the underside of the pelvic diaphragm to the perineal skin and is covered with loose adipose tissue. The levator ani (pubococcygeus, puborectalis, and iliococcygeus) and coccygeus muscles make up the pelvic diaphragm (16–18). The smooth muscle layer of an internal sphincter, the fat-containing intersphincteric space, and the outer striated muscle of which the latter consists of the puborectalis muscle's outer sling and the lower half the cylindric external sphincter - extend outward from the innermost mucosal lining define the multilayered cylindric structure of the internal pudendal vessels and accompanying nerves (16). The urogenital triangle forms a triangular plane that slopes downward from its attachment to the pubic bones to the perineal body. It is bordered anteriorly and laterally by the ischiopubic rami and pubic symphysis. The urogenital triangle consists of the superficial perineal pouch and the perineal membrane, also called the urogenital diaphragm (15). The perineal membrane unites inferiorly to the investing muscle fibers of the superficial perineal pouch and superiorly to the fascia of the levator ani muscle. The perineal membrane is considered a musculofascial unilayer structure that contains multiple muscles, including the deep transverse perineal muscle, which extends across the perineal membrane, and the intrinsic muscles of the urethral sphincter mechanism, which includes the compressor urethra and sphincter urethrovaginalis. Moreover, the perineal membrane fuses with the perineal body to promote urine continence. The superficial perineal pouch is found inferior to the perineal membrane and is composed of the ischiocavernosus, bulbospongiosus, and superficial transverse perineal muscles; it is traversed by the urethra and vagina and includes the clitoris. The muscle fibers stretch anteriorly from the perineal body and adhere to the corpora cavernosa of the clitoris, which creates the body of the clitoris, before continuing to the glans clitoris (19,20). The bulbospongiosus muscles contribute to clitoris erection by expressing the secretions of the larger vestibular glands. The ischiocavernosus muscle, which is linked to the ischiopubic ramus and covers the crus clitoris, aids in clitoris erection (15). The perineal body, which consists of strong fibromuscular tissue and is placed among the anal canal and urogenital triangle, is an important structure. Superiorly, it is continuous with fibers of the levator ani and rectovaginal septum. Anteriorly, it obtains components from the deep and superficial transverse perineal and bulbospongiosus muscles (21).

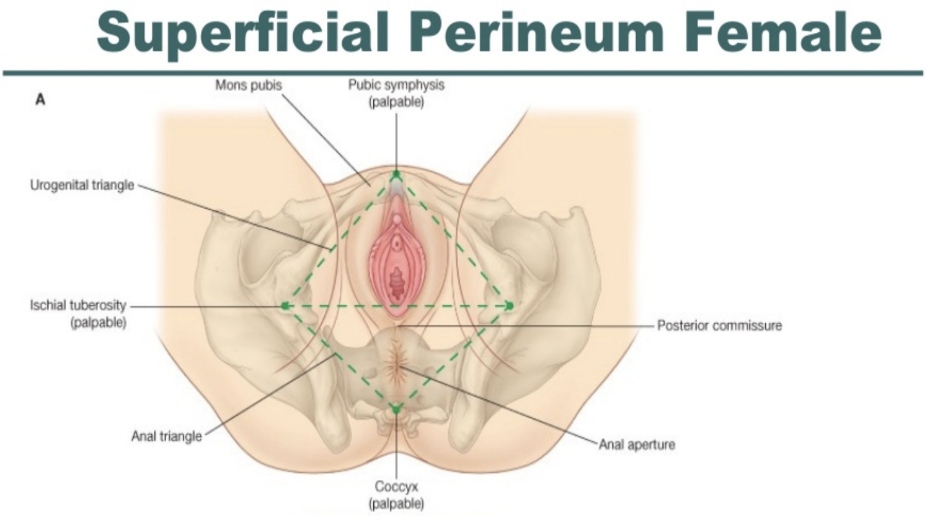

Figure 11. Female Perineum (22)

Pelvic organs

The Female Urethra

The urethra has a length of 35 mm and a diameter of 5–6 mm. It travels straight down and forward from the bladder's base behind the pubic symphysis to the external meatus. Its epithelial lining is composed of the squamous epithelium at the external meatus and transitional epithelium in the canal. The layer beneath the epithelium is rich in small blood vessels and connective tissue. The urethral wall is composed of spirally arranged inner longitudinal and outer circular involuntary muscle fibers. During micturition, the longitudinal fibers contract and shorten the urethra. The outer circular fibers maintain the sphincter's closure. The neck of the bladder (internal urethral sphincter) is situated above the levator ani muscles and keeps urinary continence by receiving the same abdominal pressure as the bladder itself. The base of the bladder forms an angle of 100 degrees with the posterior urethral wall (posterior urethrovesical angle), which is also responsible for maintaining urinary continence (5).

Relations of the Urethra

Posteriorly, the upper part of the urethra is easily dissected because it is loosely connected to the vagina by vesicovaginal fascia. The lower one-third of the urethra is firmly attached to the vagina by the pubourethral ligament, needing a precise dissection. It is flanked laterally by areolar tissue, the compressor urethra, and superficial perineal muscles. Pubourethral ligament maintains urinary continence by connecting the mid-urethra to the pubic bone and the lateral pelvic wall. The areolar tissue separates the urethra from the pubic bone anteriorly (5).

The external urinary meatus is in the vestibule, two centimeters below the clitoris, and is partially concealed by the upper end of the minor labia. Numerous periurethral glands surround the urethra and are connected to its lumen by minute ducts (5).

These are equivalents to the prostate in men. The paraurethral glands of Skene are significant pairs of glands that lie along the urethral floor and are connected to the external meatus by minute ducts. Infected glands produce periurethral abscesses and cysts (5). The proximal urethra receives its blood supply from the inferior vesical artery, while the distal urethra receives its blood supply from the internal pudendal artery. The veins empty into the internal pudendal vein and vesical plexus. The urethra is supplied with nerve fibers by the internal pudendal nerve. The cloaca gives rise to the urethra. Due to its proximity to the vagina, the urethra is susceptible to infection from the lower genital tract. The most prevalent pathogens are gonorrhea, chlamydia, and trichomonads. The organisms can be identified by the urethral swab, culture, and urine culture (5).

The Bladder

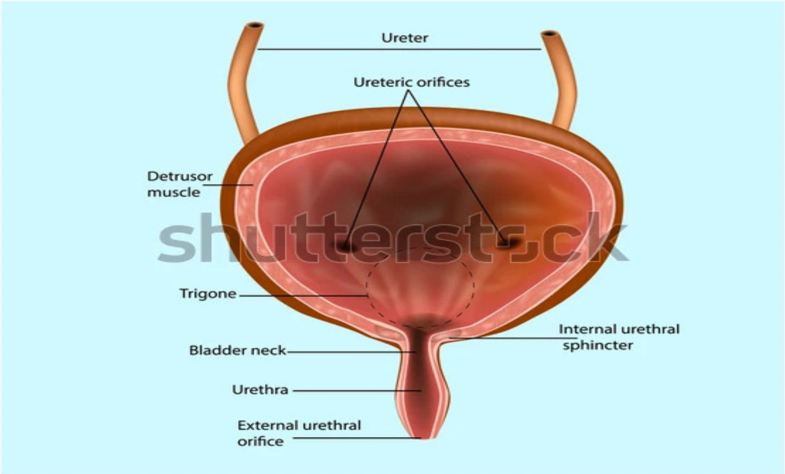

Figure 12. Female urinary system bladder (23)

The bladder is a subperitoneal, muscular, hollow organ that functions as a urine reservoir. When empty, the bladder resides in the lesser pelvis; when full, it extends into the abdominal cavity. Before puberty, the bladder in children is situated in their abdomen but it does not completely descend into the pelvis. The bladder is a distensible organ capable of holding approximately 500 milliliters of urine (24). The size of a child's bladder can be estimated using the formula: (Age + 2) x 30 mL (24). The location of the bladder is just posterior to the pubic symphysis. In females, the anterior vaginal wall is located posteriorly behind the bladder. The bladder is supported by the muscles of the pelvic diaphragm. Except for some fixed ligamentous connections at the bladder neck, the bladder is a relatively free organ in the subcutaneous fat of the sub peritoneum. The peritoneum covers the superior and a portion of the posterior surfaces of the bladder. Endopelvic fascia covers the bladder's inferior portion and inferolateral sides (24). In terms of anatomy, the bladder is connected to the ureters located above it and the urethra located below it. The apex or dome, the body, the fundus, and the neck are the four anatomical parts that make up this structure. The region of the bladder that faces the abdominal wall and is found anteriorly and superiorly is called the apex. The fundus, also known as the base, is the section of the bladder that is found posteriorly and inferiorly. The wide area that can be found between the apex and the fundus is referred to as the body.

The constricted part of the bladder that connects to the urethra is referred to as the "neck of the bladder" (24).

The bladder is an organ that stores urine and plays an active role in the process of excreting it. The kidneys produce urine, which is then transported to the bladder via the ureters, the ureterovesical junction, and finally the vesicles. When the bladder is full of urine, sensory nerves that are traveling back to the central nervous system communicate with efferent somatic and autonomic nerves to control the release of urine by stimulating the detrusor (bladder) muscle and simultaneously relaxing the internal and external urethral sphincters. This causes urine to be expelled from the body (24).

Bloody supply

The superior and inferior vesicular arteries fill the bladder with blood. These are indirect branches of the iliac internal arteries. The bladder is also supplied with blood via the obturator artery and the inferior gluteal artery. In certain instances, the inferior vesicle artery is a branching of the internal pudendal artery.

The vesical venous plexus flows into the internal iliac vein to remove the blood from the bladder. Lymphatics are drained by lymph nodes connected with veins in the region, with the external iliac lymph nodes performing the majority of the drainage (25).

Nerve supply

A network of parasympathetic, sympathetic, and somatic nerve fibers innervates the bladder. The sacral spinal nerves (S2-S4) that come together to produce the pelvic splanchnic nerves give rise to parasympathetic fibers. The superior and inferior hypogastric plexuses and nerves, which are responsible for sympathetic regulation, originate from the lower thoracic and upper lumbar spinal levels (T10-L2). The external urethral sphincter's striated muscles are under voluntary somatic control of the pudendal nerve (S2-S4), a branch of the sacral plexus (26). These fibers have their beginnings in Onuf's nucleus, which is in the ventral horn of the sacral spinal cord (24). The bladder wall's mechanoreceptors contract in response to a muscular stretch. These receptors use the generalized visceral afferent (GVA) fibers of the hypogastric and pelvic splanchnic nerves to send sensation information to the central nervous system (CNS). While sensory information from the inferior part of the bladder follows the parasympathetic nerves' course, that from the superior bladder wall follows the sympathetic innervation. A minimally distended bladder will generate slow impulses, while a fully distended bladder will enhance the speed of the stimuli to the CNS. The degree of distension of the bladder determines the speed of the stimulus sent back to the CNS (26). The micturition center, which controls the filling and emptying of the bladder, is in the pons of the brainstem (pontine micturition center). In general, the parasympathetic response promotes urinary bladder emptying, whereas the sympathetic response promotes urinary bladder filling (26). To facilitate micturition, parasympathetic neurons cause the detrusor muscle to contract and the internal urethral sphincter to relax. Relaxation or filling of the detrusor muscle and constriction of the internal sphincter are facilitated by sympathetic activation. Local spinal reflexes are principally responsible for regulating bladder fullness, whereas voiding requires action from the pontine micturition region in the brainstem (24,26,27). The main muscle of the bladder is called the detrusor. The body, fundus, apex or dome, and neck incorporate this structure. The detrusor muscle is a smooth muscle made of urothelium or transitional epithelium. The form of the cells of the transitional epithelium, a stratified epithelium, changes depending on how much urine is present in the bladder. The urothelium has big, rounded cells that are present when the bladder is empty. The bladder's cells change when pee accumulates into flatter cells, which may hold more urine. Muscarinic (M3) receptors are found in the wall of the detrusor muscle and are controlled by parasympathetic nerves. Beta-adrenergic receptors for sympathetic control are also present (25). The bladder's neck, which extends into the urethra, houses the internal urethral sphincter. There are alpha-adrenergic receptors for sympathetic modulation and smooth muscle cells as well. When this receptor is stimulated, the bladder can fill more easily, and when it is disinhibited, the bladder can relax and urinate (27). Skeletal muscle with striae makes up the external urethral sphincter. These cells contain nicotinic receptors, which the pudendal nerve regulates. Somatic nerve fibers in the pudendal nerve fire continuously to maintain the sphincter's contraction until it is time to urinate. Humans learn to deliberately manage the external urethral sphincter's regulation during toilet training to prevent passing urine when it is not appropriate (27).

As a result of injury to the pelvic autonomic plexus during colorectal cancer surgery or gynecological surgery, urinary dysfunction is a well-known postoperative consequence. With procedures like abdominoperineal surgery having close to 50% complication rates or low anterior resections having 15% to 20% complication rates, newer surgical approaches have been developed that have lower complication rates. Urinary dysfunction is still a risk factor following gynecological, and other pelvic procedures in addition to colorectal surgery because of variations in pelvic anatomy. Numerous symptoms, including urine urgency, stress incontinence, and reduced detrusor contractility, are observed in patients (27).

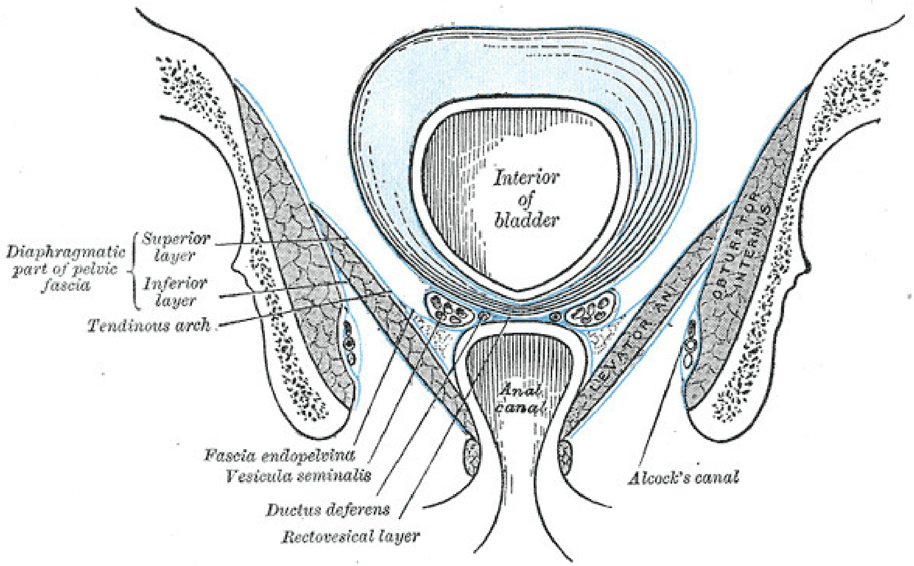

Figure 13. Anatomy of the Pelvic floor (24)

The Ureter

From the renal pelvis to the trigone, where they enter the bladder, the ureters are 25 to 30 cm long. Each descends immediately beneath the peritoneum, crossing the pelvic brim exactly before the common iliac artery's bifurcation beneath the ovarian arteries. The ureter begins its initial inferior path in the true pelvis just anterior to the hypogastric arteries and maintains proximity to them (4). Urine is transported from the renal pelvis into the bladder by the ureters. The peristaltic movement that the ureter performs to transfer urine from the kidneys into the bladder is caused by the muscular layers (28). The ureters originate at the ureteropelvic junction (UPJ) of the kidneys, which are located posteriorly to the renal vein and artery throughout the hilum. The UPJ is also known as the ureteropelvic connection (29). The ureters continue their descent lower and lower within the abdominal cavity. They enter the bladder through the trigone along the posterior bladder portion, which is located in the trigone, after passing across (in front of) the psoas muscle. There are three locations along the course of the ureter that are clinically significant for the lodging of renal stones. The ureterovesical junction (UVJ), the ureteropelvic junction (UPJ), and the crossover of the common iliac arteries are the three regions in question. At the UPJ, the pelvis of the kidney changes into the ureter, and at the UVJ, the ureters approach the bladder. The UPJ and the UVJ are in the lower urinary tract. The ureter receives blood supply in a segmental pattern. Blood travels directly from the renal arteries to the part of the upper ureter that is located closest to the kidneys. The middle section receives its blood supply from the gonadal arteries and the common iliac arteries, both of which are branches of the abdominal aorta. Blood is supplied to the part of the ureter that is furthest from the kidney via branches of the internal iliac artery (28). A ureteric plexus is formed when the ureters receive their innervation from T12 down to L2. The T12-L2 dermatomes may indeed be involved in pain (28). Because of its position, the ureter is susceptible to injury during procedures involving the colon, the rectal area, and gynecologic procedures (28). The inner mucosa, middle muscle layer, and outer serosa make up the three primary tissue layers that make up the ureteric wall. Transitional epithelium lines the inner layer. The lamina propria, which is positioned deeper to it, along with the epithelium, make up the mucosal lining. The smooth muscle layer, also known as the lamina propria, is the following deeper tissue layer. The ureter's smooth muscle layer is made up of two layers: an inner longitudinal layer and an outer circular layer (28). The ureter travels along the front edge of the psoas muscle, around where the gonadal arteries cross the ureter anteriorly and go a third of the way to the bladder. The common iliac arteries are crossed by the ureter, revealing the anatomical landmark of the common iliac vessels' bifurcation into internal and external iliac vessels (28). The ureters finally integrate into the trigone on the posterior wall of the bladder (30). The anatomical links between the ureters vary depending on which side of the body they are on. Near the ascending colon, cecum, and appendix is the right ureter. Close to the descending and sigmoid colon is the left ureter (29). The ureter's nomenclature is determined by how anatomically connected it is to neighboring structures. The portion of the ureter that runs from the renal pelvis to the iliac vessels is known as the abdominal ureter. From the iliac arteries, the pelvic ureter leads to the bladder (31). Another method of ureteral nomenclature is upper, middle, and lower segments. The upper ureter connects the renal pelvis to the sacrum's upper border. The middle ureter runs from the sacrum's upper to lower borders. The distal ureter extends from the lower border of the sacrum to the bladder (28). Multiple arterial branches supply the ureters with blood (32). The arterial branches in the upper or abdominal ureter come from the renal and gonadal arteries, the abdominal aorta, and the common iliac arteries. The arterial branches in the pelvic and distal ureters come from the vesical and uterine arteries, which are branches of the internal iliac artery. The arterial supply will run longitudinally along the ureter, forming a plexus of anastomosing vessels. This is clinically significant because it allows for safe ureter mobilization during surgery, which is critical when proper exposure from adjacent tissue is required (28). The ureter's venous and lymphatic drainage mirrors the arterial supply. Internal, external, and common iliac nodes receive lymphatic drainage (33). The left ureter's lymphatic drainage primarily drains to the left para-aortic lymph nodes, whereas the right ureter's drainage primarily drains to the right pericaval and interaortocaval lymph nodes (28). The ureter's exact role is unknown, but the innervation for ureteral peristalsis generates from its intrinsic smooth muscular pacemaker spots. The pacemaker sites are in the minor calyces of the renal collecting system (34). Preganglionic sympathetic input can be found from T10 down to L2 (35). Postganglionic fibers can be said to have their origin in the aorticorenal, superior, and inferior hypogastric autonomic plexuses, respectively. The ureter receives parasympathetic innervation from the spinal segments S2 through S4 (28).

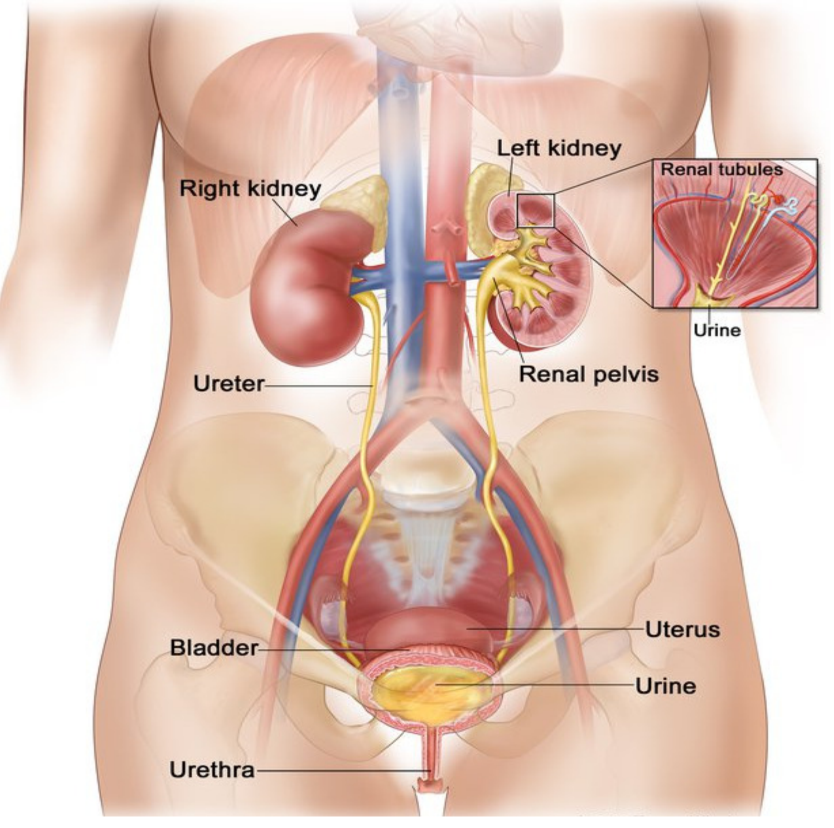

Figure 14. Female urinary system anatomy (36)

Rectum and Anal Canal

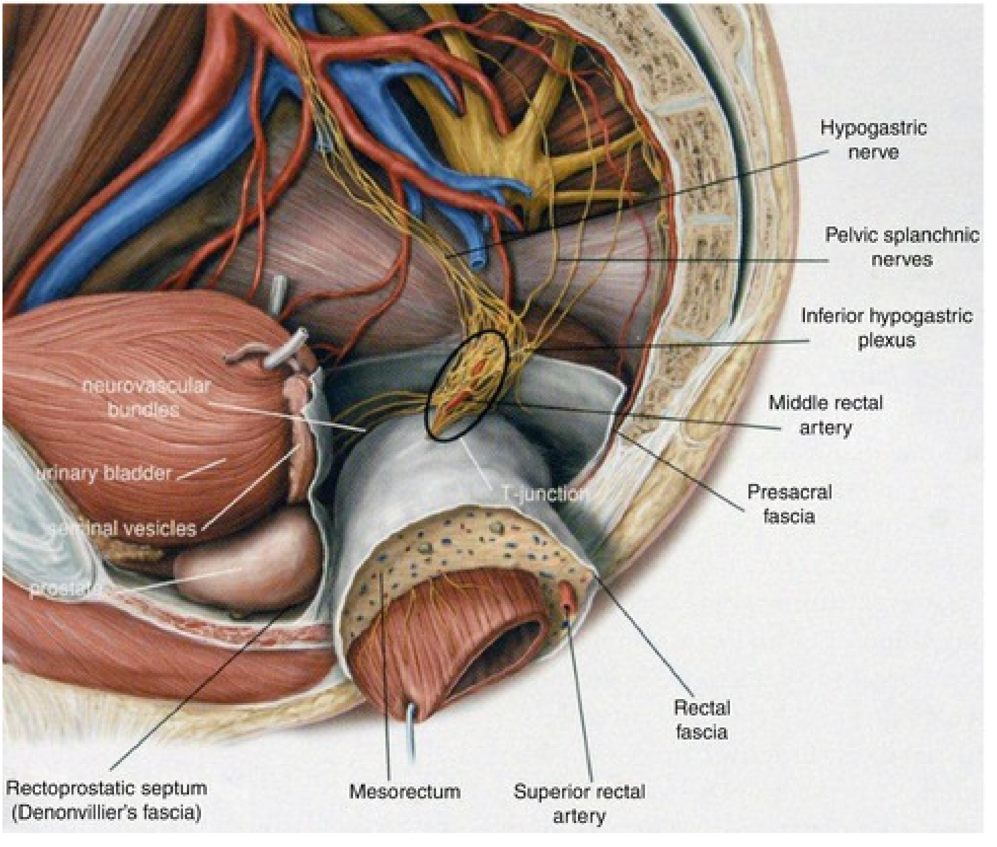

Figure 15. Anatomy and Physiology of the Rectum and anal canal (37)

The rectum begins in front of the body of the third sacral vertebra and is the continuation of the sigmoid colon in a direct manner. The direction of the rectum along its longitudinal axis is such that it corresponds to the ventral concavity of the sacrum. Therefore, the rectum will initially run downwards and backward, and then it will run downwards and forwards to reach the levator hiatus. The levator hiatus is the gap in the pelvic floor that is created between the two levator ani muscles, and it is through this gap that the viscera of the pelvis pass inferiorly into the perineum. The sacral flexure is the name given to the natural inward bend in the rectum that occurs ventrally. The rectum becomes continuous with the anal canal at the point where the levator hiatus is located. The anorectal junction can be found around four centimeters in front of the most posterior aspect of the coccyx. Because of its location, which is above the level of the pelvic floor but below the level of the pelvic brim, the rectum is an intrapelvic viscus (38). The rectum has a series of three smooth curves that face laterally and, in addition to the ventral bend, it also has a bend that faces posteriorly. The top and bottom curves are as follows: skewed to the right, with the center curve sloping to the left. Every one of the three 'curves' has a transverse fold in the shape of a sickle on the interior of the curve. These folds are caused by the thicker muscle in the rectal wall extending inwards with the overlying mucosa. They are also characterized as rectal shelves or the "valves of Houston." During a sigmoidoscopy, the mid-rectal shelf is typically the most consistent and noticeable of the three shelves, and it is virtually always observed. The moderately dilated lower portion of the rectum is known as the ampulla (38). The rectal wall is devoid of the haustrations, appendices epiploicae, and taeniae coli that mark the sigmoid colon as well as other colonic segments. It is this sudden shift in appearance that gives the surgeon confidence to find the rectosigmoid junction during surgery. The sacral promontory lies 6 cm below the level of the rectosigmoid junction. The rectosigmoid junction is shown to be 14–18 cm from the anal verge when approached from the distal end, as when completing a rigid or flexible sigmoidoscopy (38). The rectum doesn't have a mesentery, in contrast to the transverse colon and sigmoid colon. Thus, there is no peritoneal covering whatsoever on the posterior part of the rectum. The colon's ascending and descending segments are similar to the rectum in this regard; hence all of these segments can be referred to be retroperitoneal. The peritoneum covers the anterior and lateral surfaces of the upper third of the rectum, the anterior surface of the middle third, and only the anterior surface of the lower third of the rectum, which is below the level of the peritoneal reflection (the level where the peritoneum leaves the anterior rectal wall to approach the viscus in front). The level of peritoneal reflection can be conveniently and rather accurately determined by looking at the middle rectal shelf. When the peritoneum along both parts of the rectum is longitudinally punctured and the rectum is bent before mobilization and eventual excision during surgery for rectal malignancies, this interaction between the peritoneum and the rectum is easily understood (38). The perirectal fat, which is often more plentiful posteriorly than anteriorly, surrounds the whole length of the rectum (with the possible exception of the very distal centimeter). The epirectal and pararectal lymph nodes are situated in this perirectal fat and the superior rectal vessels pass through this perirectal fat before entering the rectum. The fascia propria of the rectum, a unique circumferential fascial layer, surrounds the perirectal fat in turn. The term "mesorectum" refers to the fascia propria that encloses the lymph nodes and perirectal fat. It is not implied by the word that the rectum has a suspensory mesentery. It is crucial to remove the rectum along with the mesorectum in its entirety for a satisfactory outcome in rectal cancer surgery.

The inferior mesenteric artery, which receives the name superior rectal artery at the point where it crosses the pelvis brim to enter the pelvic cavity, is the main artery supplying the rectum. The superior rectal artery enters the perirectal fat behind the rectum along with the pelvic attachment of the sigmoid mesocolon. In this location, it separates into two, occasionally three, longitudinal vessels that pass on either side of the rectum before entering the rectal wall (38). The middle rectal arteries, inferior rectal arteries, and median rectus arteries are supplemental arteries that help supply blood to the rectum. The analogous internal iliac artery gives rise to the right and left middle rectal arteries, which run inferno-medially. The size of the middle rectal arteries varies, and they are typically not noticeable blood vessels. They might not be present on one side or both. The internal pudendal artery, which gives off each inferior rectal artery as soon as it enters the perineum, is a segment of the internal pudendal artery (38). To access the anal wall, the inferior rectal artery must pass through the ischio-anal fossa from lateral to medial. It is the main artery that runs through the anal canal. It can supply the distal part of the rectum through the anal wall. The posterior part of the aorta, close to the aortic bifurcation, is where the median sacral artery originates. When it reaches the pelvic floor, it flows anteriorly until coming to an end in the rectal wall. It descends to the anterior side of the sacrum. When it comes to the rectum's blood supply, it is unimportant (38).

The artery supply and venous drainage of the rectum are according. Rectal blood is mostly conveyed through the superior rectal vein after entering the valveless, perirectal venous plexus from a rich and valveless intramural venous plexus. Alongside the artery, the superior rectal vein crosses the pelvic border from below up to become the inferior mesenteric vein. After that, the sigmoid colon, descending colon, and splenic flexure are all drained by the inferior mesenteric vein, which then empties into the splenic vein and ultimately the portal vein (38). Some venous blood circulates bilaterally in the middle rectal veins and empties into the internal iliac veins from the intramural and perirectal venous plexuses. The inferior rectal veins, which drop into the internal iliac veins via the internal pudendal veins, get venous blood from these rectal plexuses as well. So, natural portosystemic venous anastomoses occur at the anal mucosa and submucosa. These anastomoses are therefore found in the rectal wall, albeit to a lesser extent. These anastomoses could become significantly engorged and swollen in portal hypertension, and if they rupture, they could result in life-threatening rectal hemorrhage (38). Similar to the lymphatic drainage of the colon, the lymphoid follicles in the mucosa first receive rectal lymph. After that, three tiers of mesorectal lymph nodes (corresponding to epicolic, paracolic, and intermediate nodes) are successively traversed by the lymph until it reaches the so-called major nodes. The inferior mesenteric lymph nodes, which are found at the beginning of the inferior mesenteric artery, are the main lymph nodes that receive most of the lymph from the top two-thirds of the rectum. The inferior mesenteric lymph nodes and the internal iliac lymph nodes, located bilaterally, receive lymph drainage from the lower portion of the rectum (also called the pelvic side wall nodes) (38).

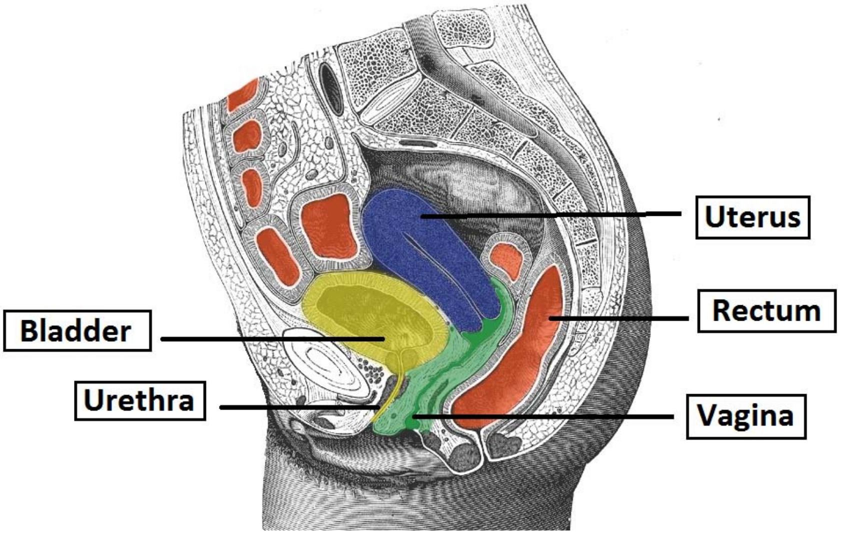

Figure 16. Sagittal Section of the female pelvis (39)

Anatomy and Physiology of the Breast

The mammary gland is a mammalian organ of ectodermal origin whose structure reflects its unique function: the generation of milk for lactation. The human breast has an undeniable aesthetic appeal since it has inspired countless works of art throughout the years. It also has an erotic significance, as the breast relates to sexuality and sensuality in many cultures (40).

The size and form of breasts vary widely among women. Some women have abundant breast tissue, resulting in bigger breasts. Others have less breast tissue and minimal breast fat. Infrequently are a woman's breasts identical in size; often, one breast is somewhat larger, smaller, higher, lower, or of a different form than the other (40). The interior part of the mammary gland is composed of epithelial components consisting of milk-producing lobules that link to ducts that lead to the nipple. These lobules and ducts are distributed throughout the background fibrous tissue and adipose tissue that compose the breast's primary mass (40).

Breast development from infancy to puberty

The breast currently is made up only of lactiferous ducts and lacks alveoli. The circulating estrogen induces the stroma and ductal epithelium to expand when puberty sets in. These ducts start to arborize, forming terminal duct lobular units and collecting ducts. These finally develop into buds that come before further breast lobules. Adipose tissue is replaced by more vascular and elastic connective tissue around the ducts, supporting the growth of ducts by replacing adipose tissue. One of the earliest signs of adolescence in girls is breast budding, which can start between the ages of 8 and 13.

Breast development during pregnancy

The breast develops to its fullest potential while a woman is pregnant. Under the impact of luteal and placental hormone production and prolactin, secreting alveoli appear and there is a noticeable expansion of the ducts, lobules, and alveoli. Under the influence of estrogen, duct sprout, and lobular proliferation occur during the first several weeks. By the second month, the breasts have substantially risen in size and have more areolar and nipple coloring (41). The secretory cells have formed a lumen around the alveoli. Progesterone induces the lobular formation to surpass the duct sprouting with a noticeable increase in prolactin levels during the second trimester of pregnancy (41,42). Colostrum is now present in the alveoli, and the breast is still growing. As the stroma surrounding the lobules shrinks in the third trimester to create a way for the hypertrophied lobules, the breast begins to secrete colostrum, which is later replaced by actual milk secretion. The glandular tissue recovers to its resting state when lactation stops (40).

Breast development during menopause

Menopause normally occurs between the ages of 45 and 50 and is accompanied by several symptoms caused by the loss of estrogen and progesterone. Breast glandular tissue atrophy, connective tissue decellularization, and collagen depletion. Loss of connective tissue strength typically increases breast volume and sagging. However, these variations in atrophy are inconsistent and vary among women (40).

Anatomy of the breast

The breasts are placed on the anterior and partly the lateral aspects of the thorax. Each breast can be measured as extending laterally to the midaxillary line, superiorly to the second rib, inferiorly to the sixth costal cartilage, medially to the sternum, and medially to the sternum (43,44). The axillary tail of the Spence is formed when the superolateral section of the mammary gland expands toward the axilla all along the inferior border of a pectoralis major muscle. This creates the mammary gland's lateral extension. The individual's age, the number of children they have, and whether they have gone through menopause all play a role in determining the shape and size of their breasts. The shape of a woman's breasts can range from hemispherical to conical to piriform to variably pendulous to slender and flattened. Each breast typically takes on a conical shape with a base that is 10–12 centimeters and a thickness that measures 5–7 centimeters (45,46). Typically, the upper outer quadrant of the breast is where most of the breast's mass can be found. This quadrant is the one that is most associated with breast cancer, as well as the majority of benign breast tumors (47). In women who have never given birth, the nipple-areola complex can be found in the space between the fourth and fifth ribs; however, when the breasts are hanging down, their location can shift significantly. The complex has a diameter of about three to four centimeters on average and should be situated in the exact middle of the breast mound. The nipple is where anywhere between 15 and 20 lactiferous ducts appear. The nipple and the areola are made up of keratinizing stratified squamous epithelium that has a substantial amount of melanin deposition at the basal layer. Because there are more melanocytes in the skin of the nipple and areola than in the rest of the breast, these areas have a darker color than the rest of the breast. The areola is a circle of skin that surrounds the base of a nipple. Depending on the individual's parity and race, the color of the areola can range from pink to dark brown. It has glands that produce sebum and sweat, as well as supplementary glands known as Montgomery's glands, which are visible and open as Morgagni tubercles around the perimeter of the areola. These tubercles are responsible for lubricating the genital tract during lactation (45,48,49). Under the skin of the areola is a layer of smooth muscle fibers that contract in response to an autonomic sympathetic and tactile stimulus. These fibers are responsible for nipple erection as well as areolar constriction (50).

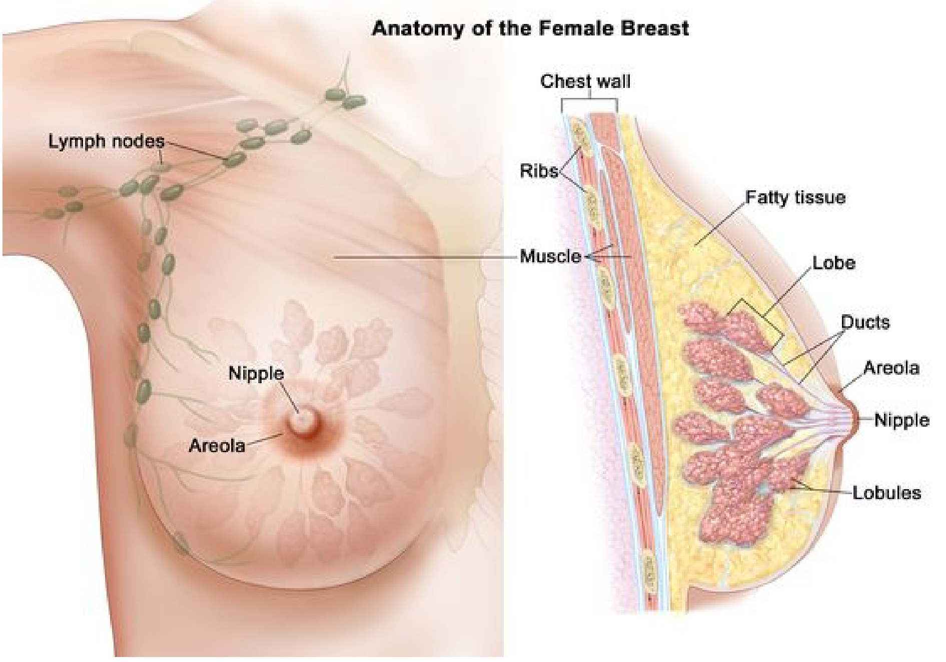

Figure 17. Mammary gland (51)

Chest wall and fascial support

The pectoralis major and serratus anterior muscles, as well as the external oblique and its aponeurosis (which forms the anterior wall of the rectus abdominis sheath), lie over the deep pectoral fascia along the breast's deep surface. There is tremendous value in understanding the breast's fascial connections. A layer of superior pectoral fascia covers the breast from the front, while another covers it from the back, both ventrally and dorsally. For rapid and relatively avascular flap dissection from the breast glandular mass, the superficial layer, which sits right beneath the dermis, has been used (47). The posterior surface of the breast is covered by a thicker layer of superficial pectoral fascia than the subcutaneous portion. This has a thin layer of areolar tissue separating it from the deeper pectoral fascia (retromammary bursa). During a mastectomy, this can be used to find a bloodless plane of dissection (52). The pectoralis major and serratus anterior muscles provide a fascial covering for the breast, allowing the breast to move without restriction. Deep tethering of a malignant breast mass is characterized by cancer's penetration via this region and into the underlying pectoralis fascia (47,53). Suspensory ligaments of Cooper link the two fascial layers and establish a structure for the parenchyma. These ligaments are flexible enough to allow a range of motion while preserving the breast's structural integrity. Breast carcinomas (peau d 'orange) are characterized by skin dimpling because of the contraction of that kind of tissue caused by malignant infiltration (45,47,53). Multiple other ligaments have been identified as participants in breast suspension. Beginning at the clavicle and extending to the breast's upper border and the retromammary area, the ligamentum suspensorium mammae supplies support for the breast (45). Some people have a clearly defined one, while others may have one that is practically obscure. The pectoralis muscle as well as the skin of the inframammary crease are connected by a fibrous bridge, which has recently been identified as another ligament structure. This ligament creates an inframammary fold and supports the breast parenchyma by acting as a sling (54–56). It was discovered that this continued medially with the fifth rib and laterally with the fascia between the fifth and sixth ribs. This structure appears to be a convergence of the rectus abdominis fascia in the middle and the serratus anterior and external oblique muscle fascia on the sides. When getting breasts augmented, this ligament needs to be carefully considered because keeping it attached to the bony structure while removing the pectoralis muscle would reduce the likelihood that the breasts would bottom out (40). It has also been described that there is a horizontal septum that runs across the glandular tissue at the level of the fifth rib (54–57). This septum curves upwards through vertical ligaments that join the breast to the thoracic wall and thickens all along medial and lateral margins. These ligaments connect medially to the inframammary fold ligament and lateral to the axillary fascia. They are made up of a superficial as well as a deep structure. These ligaments' elastic component is lost with time, or they stretch over time, which results in a loss of firmness and shape (40). Above the breast, the superior pectoral fascia is continuous with the superficial cervical fascia, while the anterior and posterior layers of the superior pectoral fascia are continuous with Camper's and Scarpa's superficial abdominal fascia at the inframammary fold (42,53). The clavipectoral fascia envelops the pectoralis minor muscle and extends deep to the pectoralis major muscle. The fascia tightens and joins to the clavicle superiorly. This is an important surgical landmark because it forms the axillary space's ceiling, generally termed the axillary fascia (40,42,47).

Parenchyma

The mammary parenchyma and surrounding tissue comprise the majority of the breast's volume. The breast's fibro glandular tissue, or parenchyma, is composed of 15–20 lactiferous ducts that appear from deeply inside the breast lobules and converge at the nipple in a radial configuration. These ducts are not always distributed uniformly across the breast. Typically, the top half of the breast, namely the upper outer quadrant, includes more glandular tissue than the lower half. Each duct delineates a lobe consisting of 20–40 lobules, each of which contains 10–100 alveoli. Before it ends in the subareolar tissue, the major duct from each lobe opens individually on the tip of the nipple and has a dilated sinus. The functional component of the breast is the ductal-lobular unit. The stratified squamous epithelium that lines the ducts progressively changes to a double layer, then a single layer, of cuboidal cells as they approach the nipple (40). There is no clear fascia dividing the lobules, but connective tissue surrounds them. The intralobular connective tissue has a lax texture, which permits the fast development of secretory tissue during pregnancy, but the connective tissue (stroma) which surrounds the lobules (intralobar) is dense and fibro-collagenous. The fibrous tissue supports the gland's mechanical coherence by encircling the glandular elements and extending to the epidermis and nipple. Variable levels of adipose tissue are present in the interlobar stroma, which significantly contributes to the growth in breast size during puberty (40,42).

Blood supply

The internal thoracic artery (internal mammary artery), axillary, and intercostal arteries all contribute to the breast's blood supply (47,58). The internal thoracic artery, whose perforating branches breach the chest wall next to the sternal margin in the first to fourth intercostal gaps and supply the inner quadrants with blood, gives rise to the largest vessels. The posterior intercostal arteries are also derived from the internal thoracic artery, and tributaries of the intercostal arteries pierce the deep surface of the breast. The superior thoracic artery, the pectoral branch of the thoracoacromial artery, the lateral thoracic artery, and the subscapular artery all originate from the axillary artery. The thoracoacromial artery's many muscle-piercing branches enter the breast from the upper quadrant through the pectoralis major. The lower edge of the pectoralis minor muscle is where the lateral thoracic artery runs. The external mammary artery, which emerges ventral side through the muscle to supply the upper outside quadrant of the breast, is produced as it travels along the muscle. Through collateral forks within both the breast and the skin above, all these arteries are linked to one another. The internal thoracic artery supplies 60% of the breast, the lateral thoracic artery 30%, and the thoracoacromial, intercostals, subscapular, and thoracodorsal arteries make up the remaining 10% (42). Through the subcutaneous tissue beneath and surrounding the areola, the venous drainage travels to an anastomotic plexus. The big subcutaneous veins that drain from this plexus then travel to the periphery. Following their arteries, these veins subsequently empty into the internal thoracic veins, intercostals, and axillary veins. Their contact with the prevertebral venous plexus is noteworthy (40).

Nerve supply

The somatic sensory nerves and the autonomic nerves that accompany the blood vessels are primarily responsible for the breast's innervation. The lateral ramifications of the thoracic intercostal nerve supply the supraclavicular nerves (C3, C4), which are found superiorly and laterally (40). The anterior branches of the thoracic intercostal nerves pierce the pectoralis major to reach the breast surface, supplying the medial aspects of the breast. The second through sixth intercostal nerves give rise to certain lateral and medial cutaneous branches. An intercostobrachial nerve (C8, T1) is the principal nerve supply to the upper outer quadrant of the breast. It supplies the breast with a broad branch as it penetrates the axilla. The placement of nerves inside the breast is quite variable. After traversing the intercostal gaps, nerves branch inside the breast, sometimes through the deep fascia and sometimes superficially through the breast's substance (40).

Lymphatic drainage

The breast's lymphatic drainage is widespread and varied. It operates through the superficial (subepithelial or subdermal) and deep lymphatic vessels (42,45). The subepithelial plexus is connected to the subdermal lymph system and the deep plexus via vertical lymphatics. In the mammary, the subepithelial and subdermal plexus confluence with the subareolar plexus, where the lymphatics of the lactiferous ducts and the NAC also converge. Lymph moves from the deep lymphatics to the axillary and internal thoracic nodes. Twenty to thirty lymph nodes are distributed across five anatomical groupings in the axilla (47). The apical nodes merge to form the subclavian trunk; on the left side, this trunk drains directly into the thoracic duct, whereas on the right side, it may drain directly into the jugulosubclavian junction or a shared right lymphatic duct (40). Based on their placement compared to the pectoralis minor muscle, lymph nodes within the axilla are categorized into three levels from a clinical and pathological standpoint (40,42,45,47).

Physiology of the breast

The breast is a specialized organ for milk production (lactation), containing milk synthesis, secretion, and ejection (42,47,49,59). The secretory units of breasts are alveoli, which are tiny saccules connected to lactiferous ducts. The generation of milk by these secretory units is regulated by a network consisting of hormones and growth factors. The fluctuation of these hormones causes significant histologic alterations in the mammary during pregnancy and menstruation (41,42,59,60)

The primary female hormone responsible for breast formation and maintenance is estrogen. It results in the development of the ductal system, maturation of the nipples, and proliferation of the ductal epithelium, myoepithelial cells, and surrounding stroma. Estrogen is lipid-soluble and is produced by the ovaries and, to a lesser extent, the adrenal glands in a woman's body. In the presence of other hormones such as hydrocortisone, insulin-like growth factors, and growth hormones, its activity is boosted. The ovaries secrete progesterone, which stimulates the development of terminal ducts and lobuloalveolar structures. To respond, it, like estrogen, requires the presence of other hormones, such as growth hormones and insulin. Both estrogen and progesterone can build connective tissue and fat in the breast, resulting in the full development of rounder breasts (40). The acidophilic cells of the anterior pituitary gland create prolactin. It collaborates with estrogen during ductal development and progesterone during lobuloalveolar development. Prolactin, along with cortisol and insulin, contributes to the differentiation of alveolar cells into milk-secreting cells. In general, it promotes mammary development and differentiation, and ultimately milk production. Prolactin is typically triggered by the thyrotropin-releasing hormone (TRH) and blocked by dopamine; however, it can also be generated by breast cells acting as a paracrine or autocrine factor (40). The maternal placenta produces human placental lactogen (hPL), and serum levels continue to climb throughout pregnancy. It relates to breast development and differentiation during pregnancy and reaches its peak in the last weeks of gestation, preparing the mammary for milk production. Serum levels drop precipitously after birth (40).

When a woman approaches menopause at roughly age 50, the breast suffers a few changes. Due to decreased ovarian activity, the lack of progesterone and estrogen causes a variety of general symptoms and alterations in the mammary gland. Night sweats, mood swings, vaginal dryness, hot flashes, and trouble sleeping are among the systemic symptoms (42,45,47).

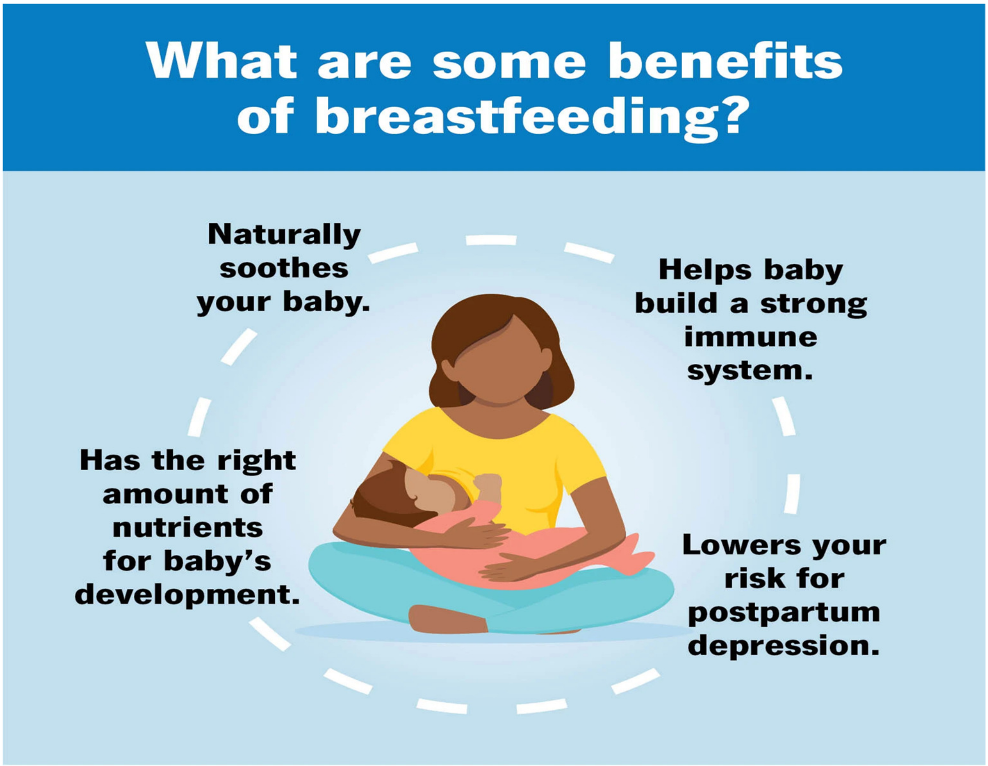

Figure 18. Benefits of breastfeeding (61)

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10. Limited A. . Anatomy, descriptive and applied. Anatomy. 1398 TFIE UBINOGENITAL ORGANS Each ovary {ovarium) presents an outer and an inner surface, an upper and a lower extremity, and an anterior and a posterior border. It lies in a shallow depression, named the fossa ovarii, on the lateral wall of the pelvis; this fossa is bounded above by the external iliac vessels, in front by the impervious hypogastric artery, and behind by the ureter. The exact position of the ovary has been the subject of considerable difference of opinion, and the description here given applies to the nulliparous woman. The ovary b Stock Photo - Alamy [Internet]. [cited 2023 Feb 10]. Available from: https://www.alamy.com/anatomy-descriptive-and-applied-anatomy-1398-tfie-ubinogenital-organs-each-ovary-ovarium-presents-an-outer-and-an-inner-surface-an-upper-and-a-lower-extremity-and-an-anterior-and-a-posterior-border-it-lies-in-a-shallow-depression-named-the-fossa-ovarii-on-the-lateral-wall-of-the-pelvis-this-fossa-is-bounded-above-by-the-external-iliac-vessels-

in-front-by-the-impervious-hypogastric-artery-and-behind-by-the-ureter-the-exact-position-of-the-ovary-has-been-the-subject-of-considerable-difference-of-opinion-and-the-description-here-given-applies-to-the-nulliparous-woman-the-ovary-b-image236752532.html

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Annex I Personal archive
Prof. Univ. Dr. Pirtea Laurențiu Cornel

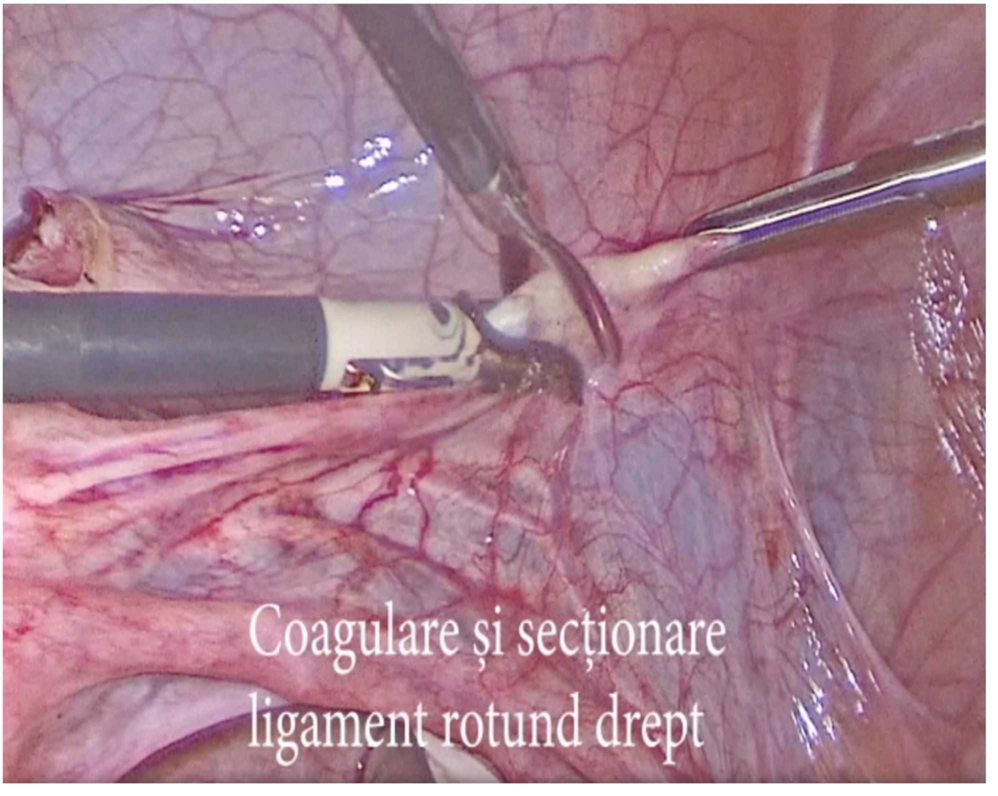

Figure 1. Coagulation and sectioning of the right round ligament

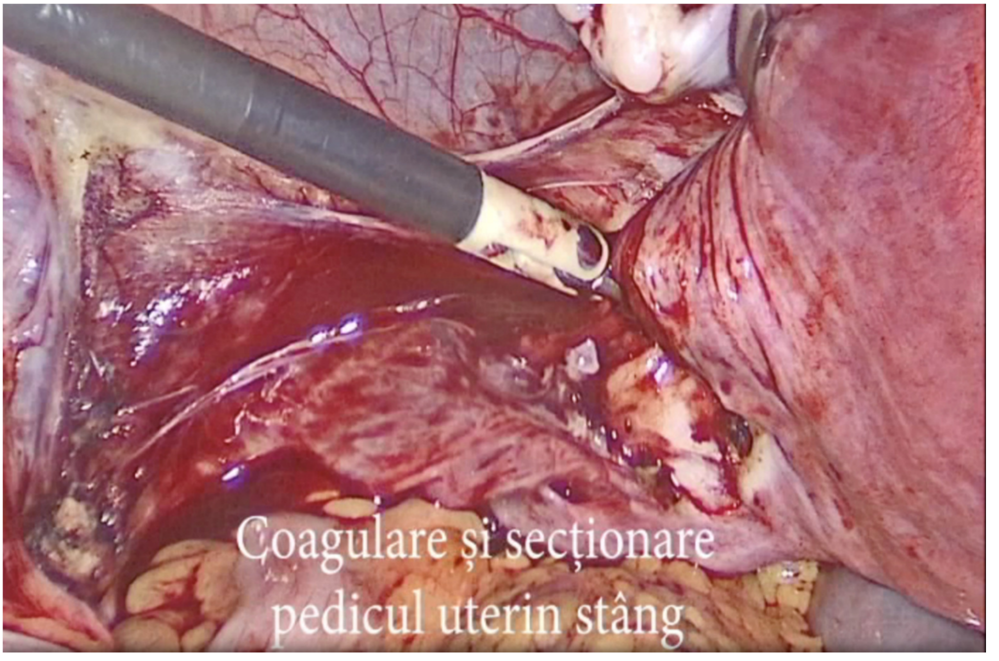

Figure 2. Coagulation and sectioning of the left uterine pedicle

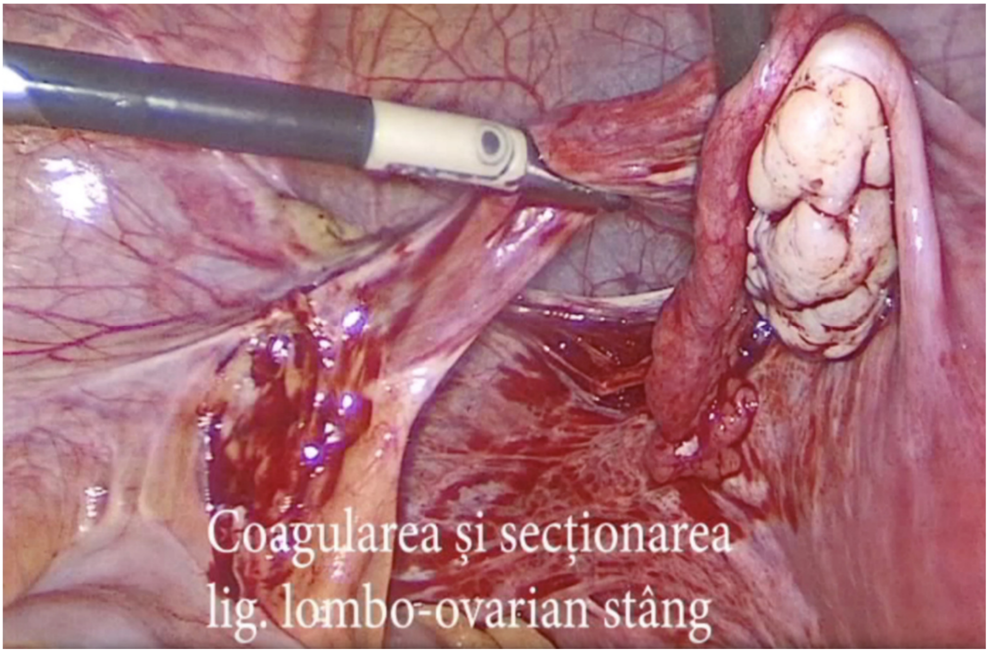

Figure 3. Coagulation and sectioning of the left lumbo-ovarian ligament

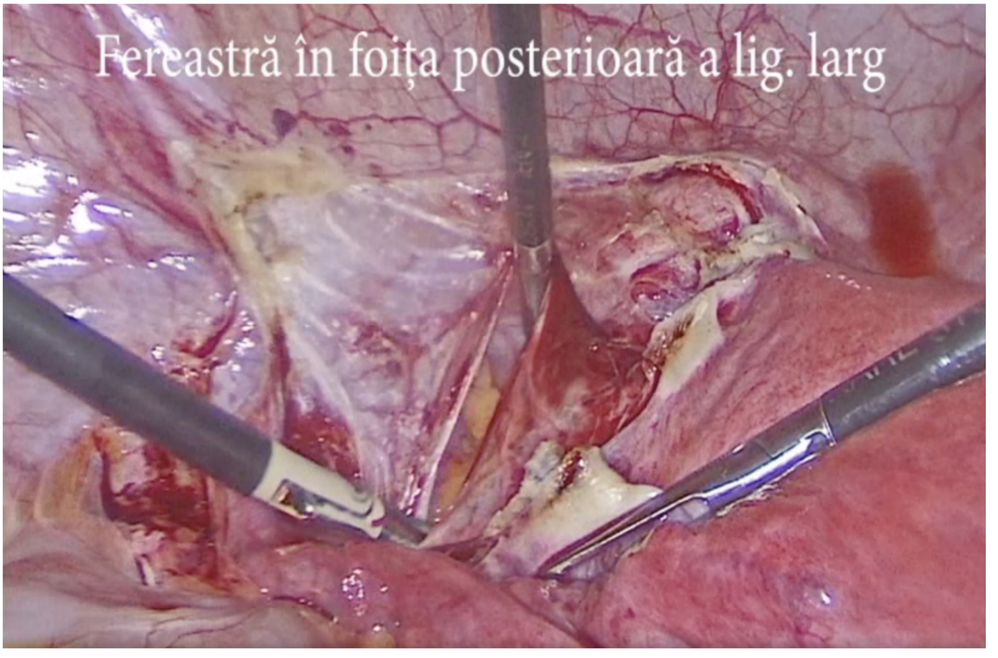

Figure 4. Posterior leaflet of the broad ligament

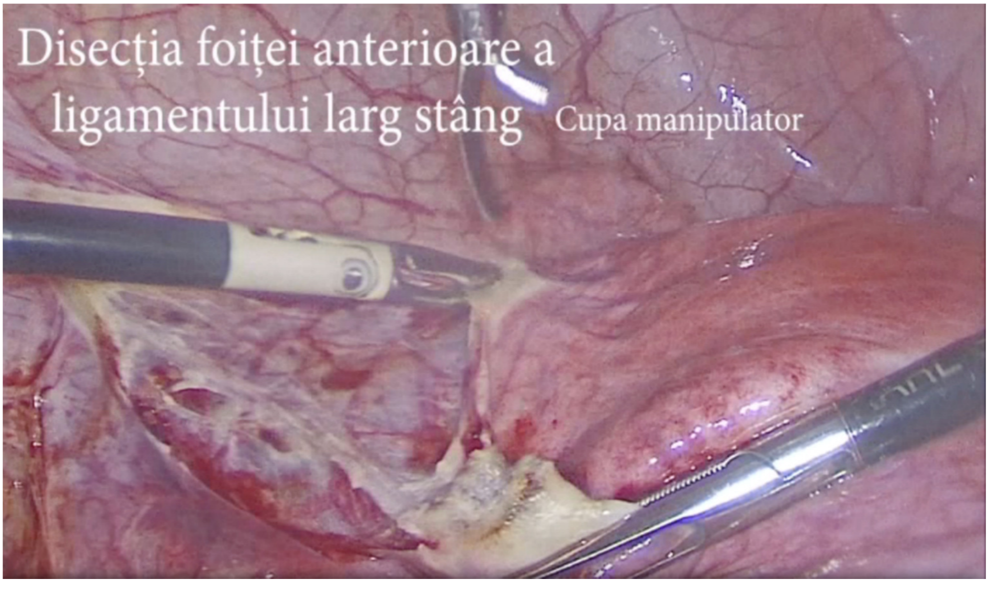

Figure 5. Dissection of the anterior leaflet of the left broad ligament

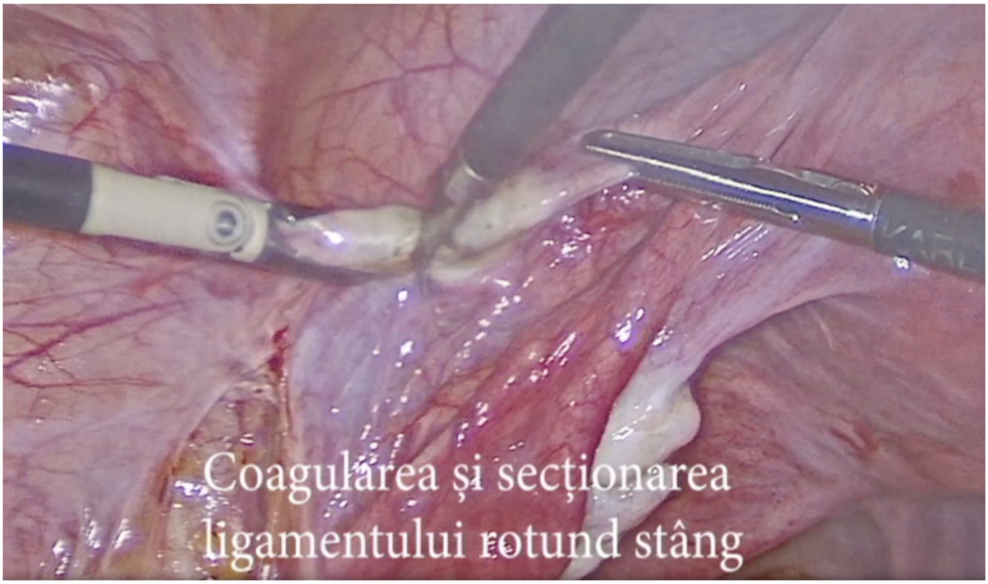

Figure 6. Coagulation and sectioning of the left round ligament

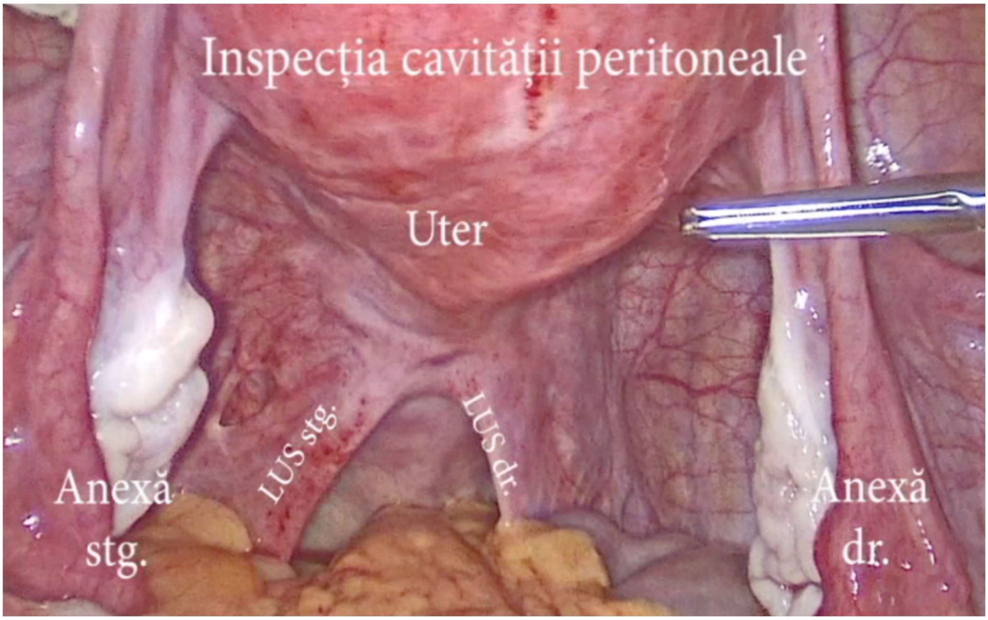

Figure 7. Inspection of peritoneal cavities

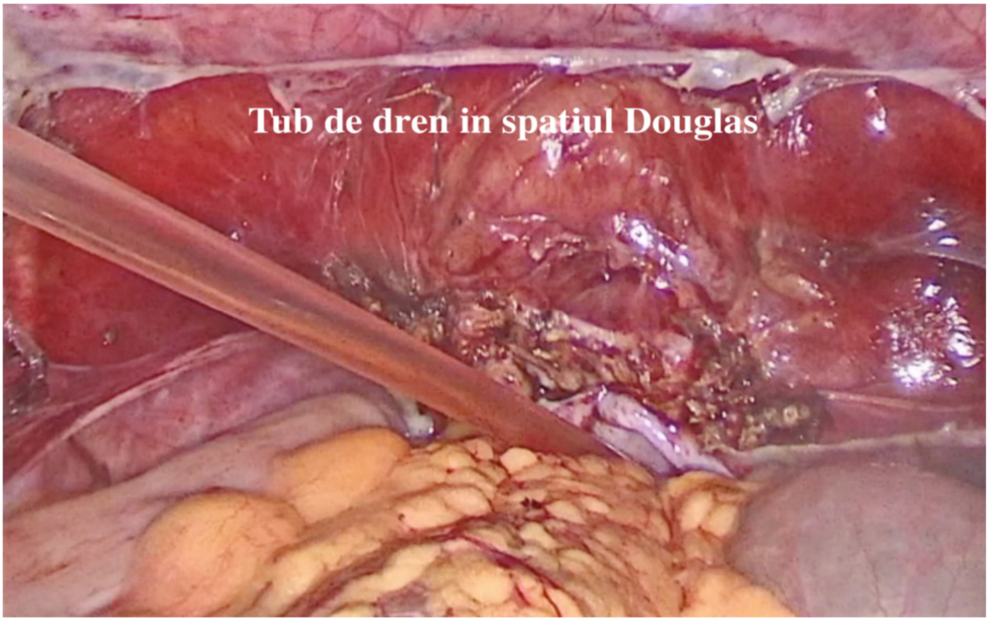

Figure 8. Drainage tube in Douglas space

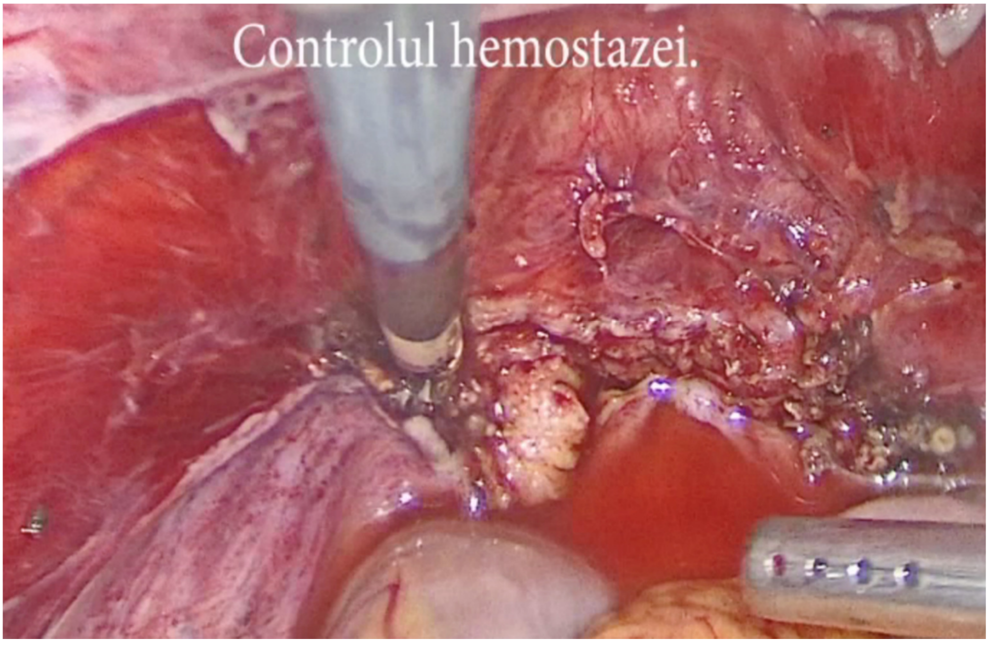

Figure 9. Hemostasis control

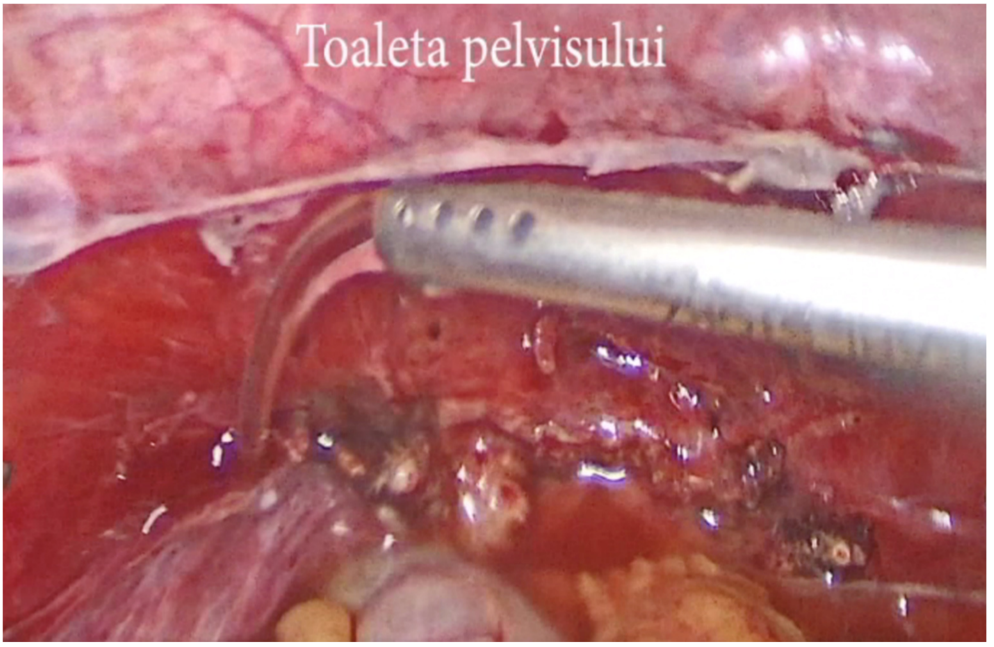

Figure 10. Female pelvic toilet

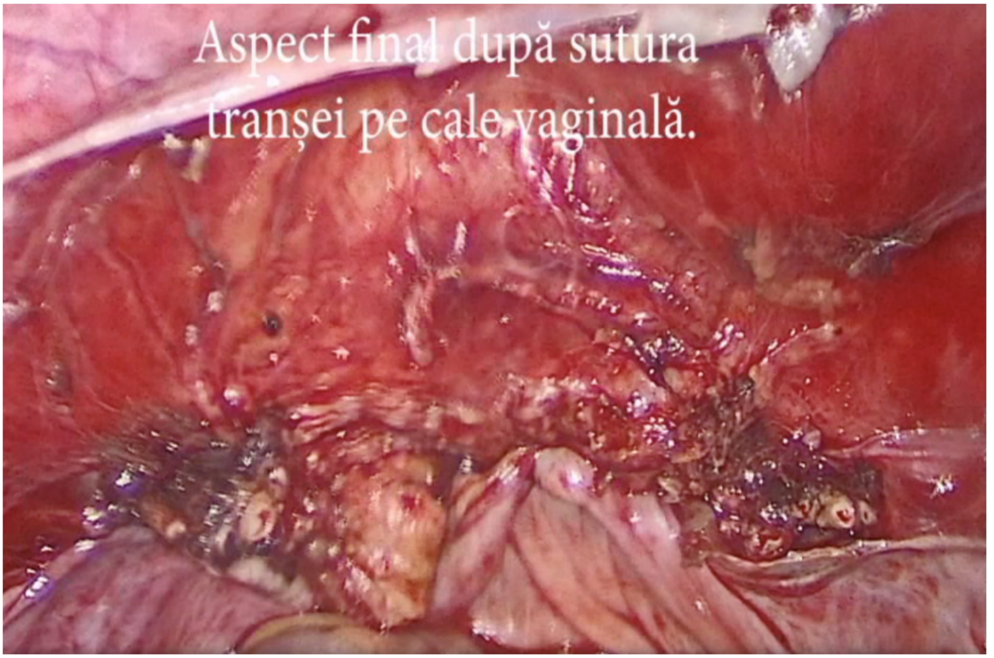

Figure 11. Vaginal suturing

Figure 12. Vaginal sectioning

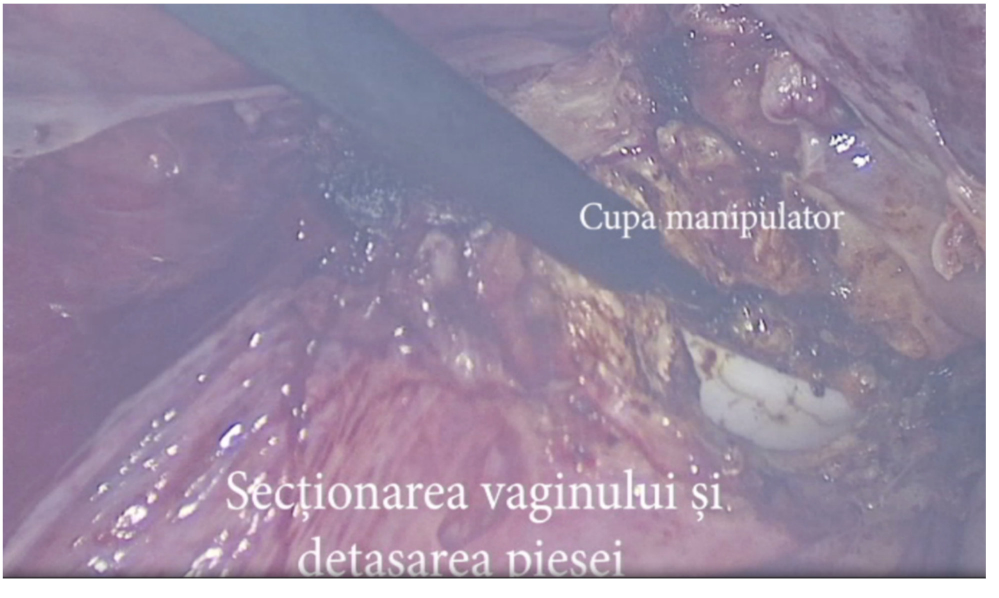

Figure 13. Vaginal sectioning and detachment of the part

Figure 14. Vaginal sectioning and detachment of the part

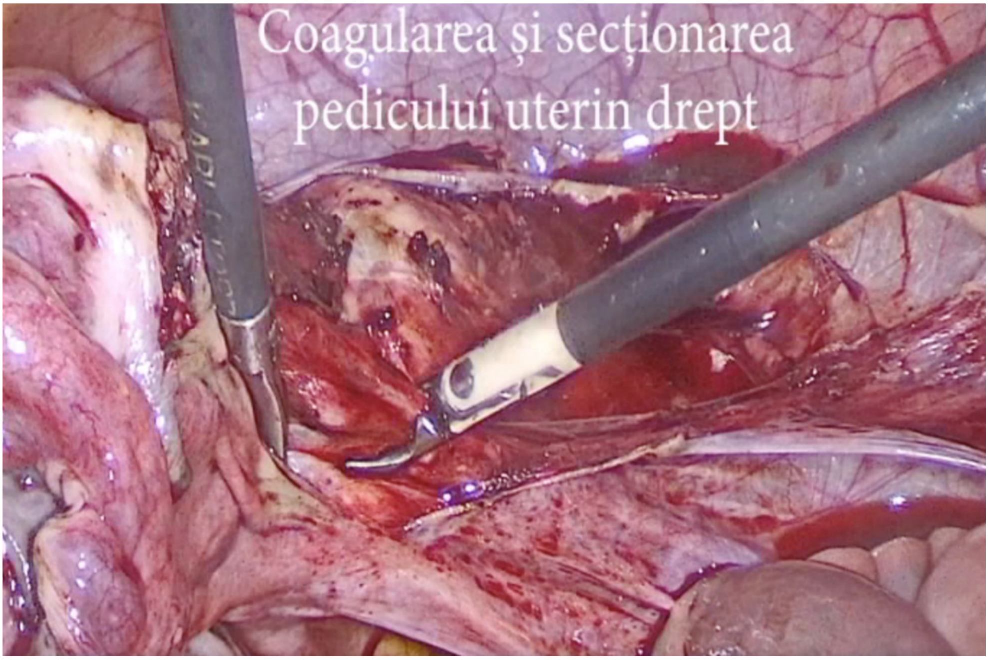

Figure 15. Coagulation and sectioning of the right uterine pedicle

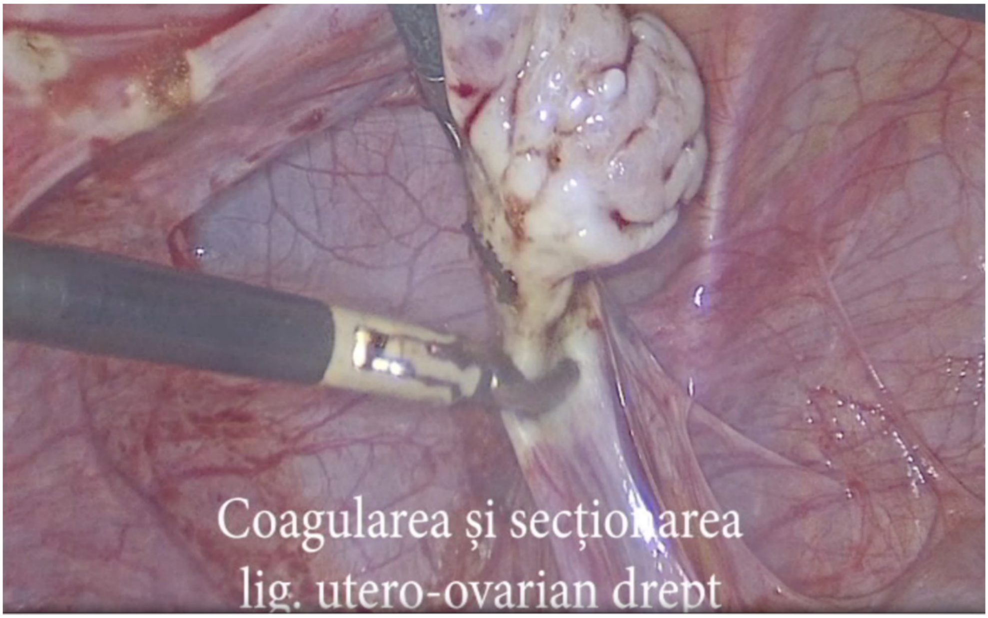

Figure 16. Coagulation and sectioning of the right uterine-ovarian ligament

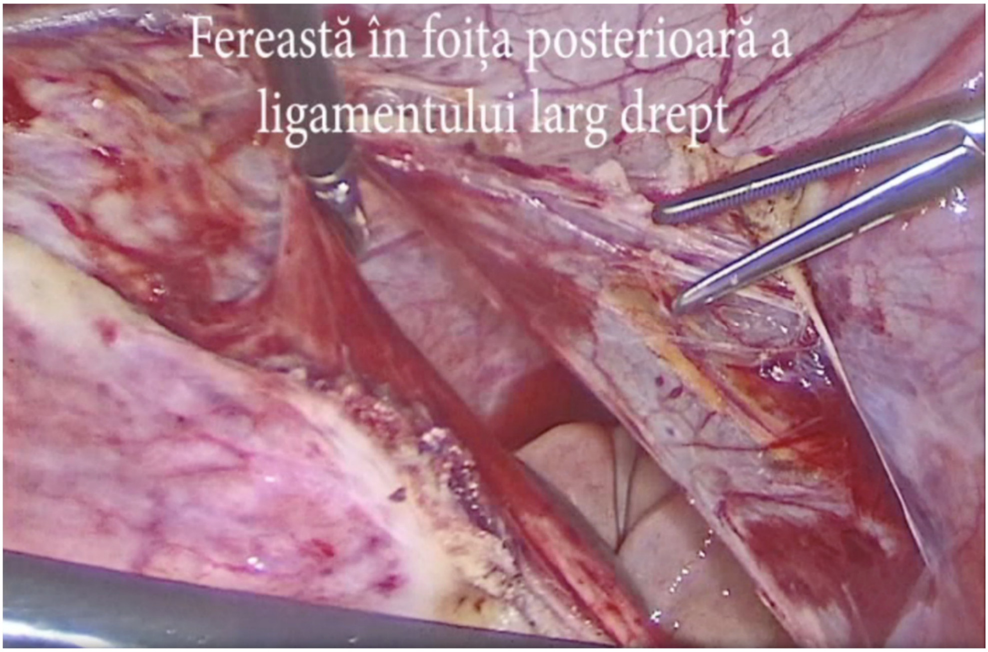

Figure 17. Window in the posterior leaflet of the right broad ligament

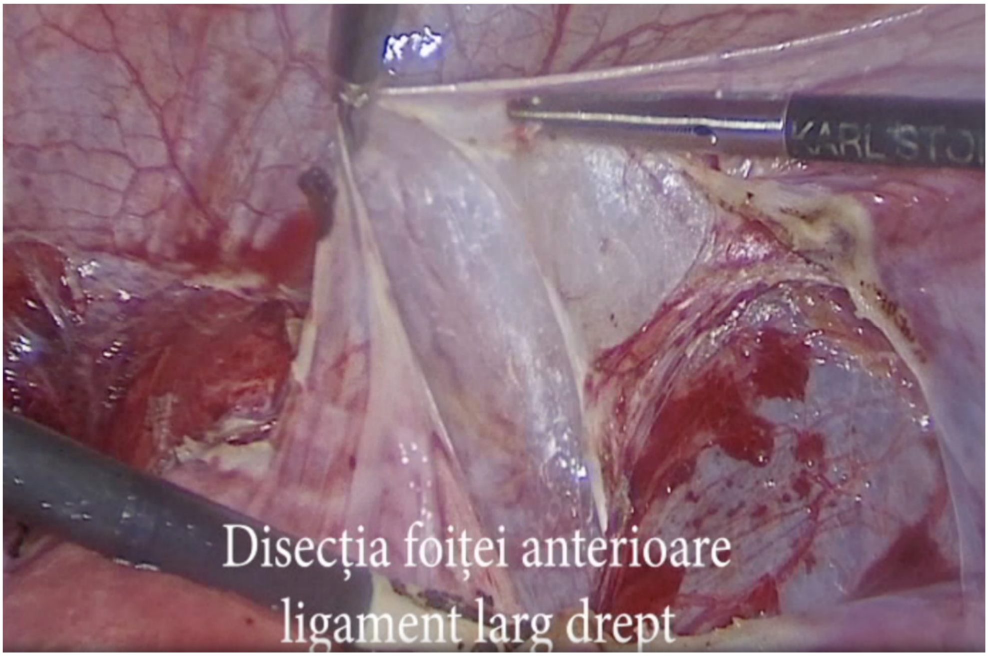

Figure 18. Dissection of the anterior leaflet of the right broad ligament

Pelvic Floor Health: Understanding and Treating Pelvic Floor Disorders in Women

Introduction

The pelvic floor is a region of the body that is vital to women's health yet is sometimes overlooked. The health of a woman's pelvic floor may be evaluated by looking at different stages of her life. Since women's health is not commonly addressed and only a small number of specialists are regarded as experts in this field, it is often neglected in the context of women's healthcare. Since it is handled differently by urologists, gynecologists, and colorectal surgeons, treatment for the pelvic region in the medical field may often become disjointed (1,2). Some physical therapists and nurses choose to specialize in female pelvic floor health, and the field of urogynecology, which combines two of these subspecialties, is a combination of the two. It is common practice to treat problems with the health of the pelvic floor only after symptoms have become apparent. On the other hand, engaging in healthy behaviors may improve the health of a woman's pelvic floor and help her maintain her quality of life as she gets older (1). According to estimates, a women's lifetime chance of developing a pelvic floor problem is one in four (3).

The female pelvic floor performs a variety of tasks, including those related to sexuality and pleasure, childbirth, urination and urine continence, defecation, and fecal continence, and the maintenance of proper positioning of the pelvic organs. For the pelvic floor to be able to perform all of these functions, its anatomical structure must be complete. This structure must include muscle, connective tissue, and nerves. In addition to this, the function of this organ is under the supervision of the central nervous system. Pelvic floor function and continence can therefore be impaired not only by direct anatomical injury (such as in vaginal delivery), but also by dysfunctional neural control, which can be seen in conditions such as neurologic disease, diabetic neuropathy, and cognitive disorder, among other conditions (4).

The most common forms of female pelvic floor dysfunction may lead not only to urine and/or fecal incontinence but also to a prolapse of the reproductive organs in the female body. Depending on how the condition is defined, the proportion of women who suffer from pelvic floor dysfunction varies anywhere from 30 to 50 percent (5).

Anatomy and Function of the Pelvic Floor

The bladder, urethra, uterus, and rectum are protected by the pelvic region, a bowl-shaped collection of bones, muscles, and ligaments. The tissues that bridge the aperture make up the bony structure's floor. The pelvic and abdominal viscera are supported by the muscles and ligaments that surround the vagina, urethra, and rectum. The endopelvic fascia, levator ani muscles, and perineal membrane are the three layers of the pelvic floor. A fourth layer of external genital muscles that are crucial for sexual function makes up the pelvic floor (2,6). The levator ani muscle, which generates a surprisingly efficient pelvic floor closure, provides the principal support (6).

The muscles that make up the pelvic floor serve two primary purposes: first, they supply support or act as a "floor" for the abdominal viscera, including the rectum, and second, they act as a constrictor or continence mechanism for the urethral, anal, and vaginal orifices. These three orifices include the urethra, the anus, and the vagina (in females) (7). The support mechanisms of the pelvic floor are essential for the protection of continence and the avoidance of prolapse of the pelvic organs.

The two innominate bones, often known as the hip bones, are what make up the bony pelvis (8). Sacrum, ileum, ischium, and pubis are the bones that make up the bony pelvis (7). These bones are joined to the sacrum in the back of the pelvis and each other in the front at the pubic symphysis. In children, the ilium, ischium, and pubis of each innominate bone are joined by cartilage; although, by the time a person reaches adulthood, these three bones have completely fused (8).

The major pelvis, also known as the bigger pelvis, and the minor pelvis, usually known as the smaller pelvis, are the two basins that make up the pelvis. The major pelvis is where all of the viscera of the abdomen is located, while the minor pelvis is the extension of the major pelvis farther downwards into the abdomen. The pelvic floor is responsible for closing off the inferior pelvic outflow (9). Bone is made up of cells, fibers, and ground material like other connective tissues, but unlike the others, its extracellular components are calcified, giving it a hard and solid consistency that is perfect for its supporting and protective role in the skeleton (10). The female pelvis is more rounded and has a larger diameter than the male pelvis. The larger intake makes parturition and head engagement easier. The broader outlet puts the pelvic floor at risk of weakening in the future. Ligaments, muscles, and fascial layers may adhere to several projections and shapes (9). It is important to highlight the thin and triangular sacrospinous ligament, which runs from the ischial spines to the lateral edges of the sacrum and coccyx anteriorly to the sacrotuberous ligament. This ligament connects the ischial spines to the sacrum and coccyx. Its anterior surface is composed of muscle, which forms what is known as the coccygeus; the ligament is sometimes considered to be the degenerated portion of the muscle (8,11). The larger and lesser sciatic foramina may be found either above or below the ligament, respectively (9).

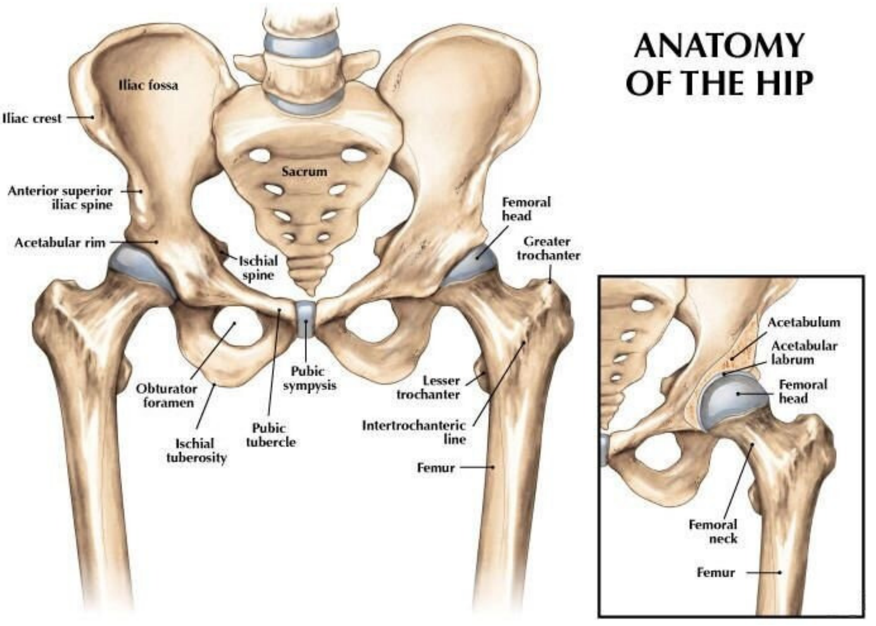

Figure 1. Anatomy of the hips (12)

Many muscles make up the pelvic floor, and they are arranged into superficial and deep muscular layers. While there is some debate over terminology, the external anal sphincter, perineal body, and potentially the puboperineal (or transverse perineal) muscles make up the superficial muscular layer and are important for anal canal function (7). Pubococcygeus, ileococcygeus, coccygeus, and puborectalis muscles make up the deep pelvic floor muscles. It is more correct to think of the puborectalis muscle as the intermediate muscular layer of the pelvic floor since it is in between the superficial and deep muscle layers. In addition to the skeletal muscles of the pelvic floor, the internal and external anal sphincters of the anal canal are formed by the caudal extension of the circular and longitudinal smooth muscles from the rectum into the anal canal, respectively. The function of each pelvic floor muscle and its contribution to the closure and opening of the anal sphincter is next discussed. First, we cover the important as well as some of the contentious parts of the anatomy of the pelvic floor and anal sphincter muscles (7).

Internal anal sphincter

The internal anal sphincter is formed when the circular muscle layer of the rectum stretches caudally into the anal canal. With distinct septa in between the muscle bundles, the circular muscles in the sphincteric area are thicker than the rectal circular smooth muscles. Like the puborectalis and external anal sphincter muscles (EAS), the longitudinal muscle fibers of the rectum extend into the anal canal and terminate as thin septa. Since some writers think that the puboanalis, a skeletal muscle of the pelvic floor, joins the smooth muscles of the rectum to create a conjoint tendon, the longitudinal muscle of the anal canal is also known as the conjoined tendon (muscle). Nevertheless, immunostaining for the smooth and skeletal muscles in this area reveals that the anal canal's whole longitudinal muscle layer is made up of smooth muscles (13,14). The internal anal sphincter is supplied by the autonomic nerves sympathetic (spinal nerves) and parasympathetic (pelvic nerves) (15). The superior hypogastric plexus is made up of sympathetic fibers that come from the lower thoracic ganglia. The inferior hypogastric plexus, which is made up of parasympathetic fibers that come from the second, third, and fourth sacral nerves, finally gives birth to superior, middle, and inferior rectal nerves that feed the rectum and anal canal. These nerves form connections with the rectum's myenteric plexus and the anal canal. The internal anal sphincter's tone is mostly myogenic or caused by the special characteristics of the smooth muscle itself. By activation of and relaxation via adrenergic receptors 1, 2, and 3, sympathetic nerves mediate IAS contraction. Low affinity 3 receptors predominate in the IAS, according to recent findings. Via nitric oxide-containing neurons in the myenteric plexus, stimulation of parasympathetic or pelvic nerves relaxes the internal sphincter. Other possible inhibitory neurotransmitters of the inhibitory motor neurons include gastrointestinal intestinal peptide (VIP) and carbon monoxide (CO), although they likely have limited functions. Moreover, there are excitatory motor neurons in the myenteric plexus of the IAS, and substances P and acetylcholine act as their mediators. Some researchers think that the Interstitial cells of Cajal (ICC) mediate the excitatory and inhibitory actions of myenteric neurons on the smooth muscles of the IAS, however, other researchers may not necessarily support these results (16). Hirschsprung's illness is characterized by the degeneration of myenteric neurons, which impairs IAS relaxation (17).

External anal sphincter

Several studies have shown that the external anal sphincter is made up of certain 3 parts. Yet, some researchers have shown that the EAS solely consists of superficial muscle bundles and subcutaneous tissue (18–21). The superficial section of the EAS encircles the distal part of the IAS, while the subcutaneous part lies caudal to the IAS. The author concludes that the puborectalis muscle has been mistaken for the deep component of the EAS, which is either extremely tiny or imperceptible merged with it. The EAS is divided into three parts. Based on magnetic resonance imaging and three-dimensional ultrasonography, scientists believe that the puborectalis muscle is the EAS's deepest region (22). The transverse perineal muscle and the perineal body are where the EAS is anteriorly connected. The anococcygeal raphae are where it is posteriorly attached. In actuality, the EAS is not a completely circular muscle; on each side, it is joined to the transverse perineal, also known as the puboperineal muscle (21). The craniocaudal extent of the posterior wall of the EAS is less than that of the anterior wall. The lower anal canal on the axial US and MR images should not be interpreted as having a muscle deficiency. Another result of this unusual architecture is that when the anal canal pressure is determined by circumferential side holes, the posterior side holes escape from the anal canal first, leading the anal canal pressure to seem to have a circumferential asymmetry (23). EAS has both fast and slow twitch muscle fibers, allowing it to maintain a tonic contraction during rest and contract quickly in response to intentional squeezing. The inferior rectal branch of the right and left pudendal nerve get their motor neuron input from Onuf's nucleus, which is situated in the sacral spinal cord, and innervate the EAS muscle (22).

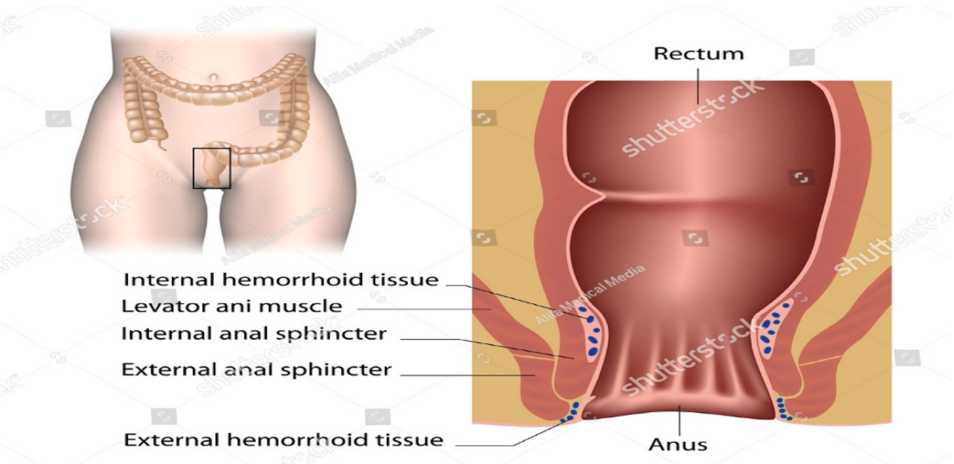

Figure 2. Anal canal anatomy (24)

Muscular Supports of the Pelvic Floor

Pelvic Diaphragm

The muscular floor of the pelvis is composed of the coccygeus muscle and the levator ani muscle. Both muscles are linked to the inner surface of the minor pelvis. They create the pelvic diaphragm together with the muscles that correspond to them on the other side of the body. The two primary muscles that make up the levator ani are the pubococcygeus and the iliococcygeus. They are found medially and laterally, respectively (9).

The pubococcygeus muscle, which derives from the anterior part of the arcus tendinous and the rear of the pubis, is the thicker medial component of the levator ani. A thick mass of connective tissue called the arcus tendinous of the levator ani runs along the surface of the obturator internus muscle from the pubic ramus to the ischial spine. Almost horizontally, the muscle returns to behind the rectum. The urethra, vagina, and anorectum travel through the levator (urogenital) hiatus, which is formed by the inner boundary (9).

The medial sections of the pubococcygeus have been given several muscular subdivisions to represent the attachments of the muscle to the urethra, vagina, anus, and rectum (25). Because of its relationship with and attachment to the midline viscera, some researchers refer to these areas as the pubourethralis, pubovaginalis, puboanalis, and puborectalis, or combined as the pubovisceralis (26).

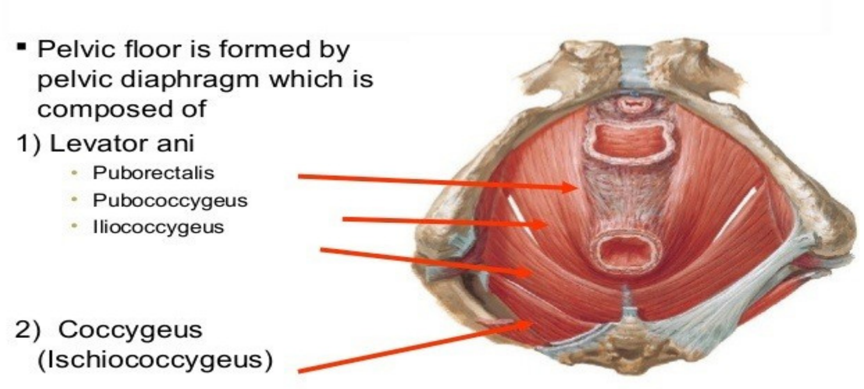

Figure 3. Pelvic floor anatomy (27)

The pelvic muscles resemble a urogenital diaphragm linked to the walls of the pelvic bones, similar to the respiratory diaphragm that spans the aperture at the bottom of the rib cage. The urethra, vagina, and anus undermine the structural integrity of this floor, which resembles a hammock or trampoline. Each of these three apertures relies on the muscles that surround it for support. Even though they are located more firmly inside the pelvis, these muscles offer support for the bladder and uterus. While a woman is standing, the pelvic muscles must not only support the pelvic organs but also the abdominal organs, because of gravity. More weight or physical activity increases the gravitational pressures exerted on these muscles (28). Like other muscles in the body, the pelvic floor muscles are susceptible to exhaustion and injury. To avoid weariness and injury, they may also be regularly trained to enhance their tone and size (28–31).

Healthy pelvic muscles are well-blooded, strong, and toned; they have not been overstretched, ripped, or undeveloped; they have not been allowed to lose condition and droop with age; and they have not been repeatedly overworked by straining, lifting, or coughing. Based on their differences in contractile properties, there are two different kinds of muscle fiber. Slow contraction speed is a characteristic of Type I, or slow-twitch fibers (every 100 to 120 msec). They are ideal for sustained exercise since they have double the blood flow per unit as other fiber types. They tire more gradually.

Faster contractions (every 40 msec) are characteristic of Type II, or fast-twitch, fibers, which make them ideal for speedy responses under stressful situations with raised intraabdominal pressure (32,33). The pelvic floor muscles vary in size and placement throughout the floor and are around 70% slow twitch and 30% quick twitch (6).

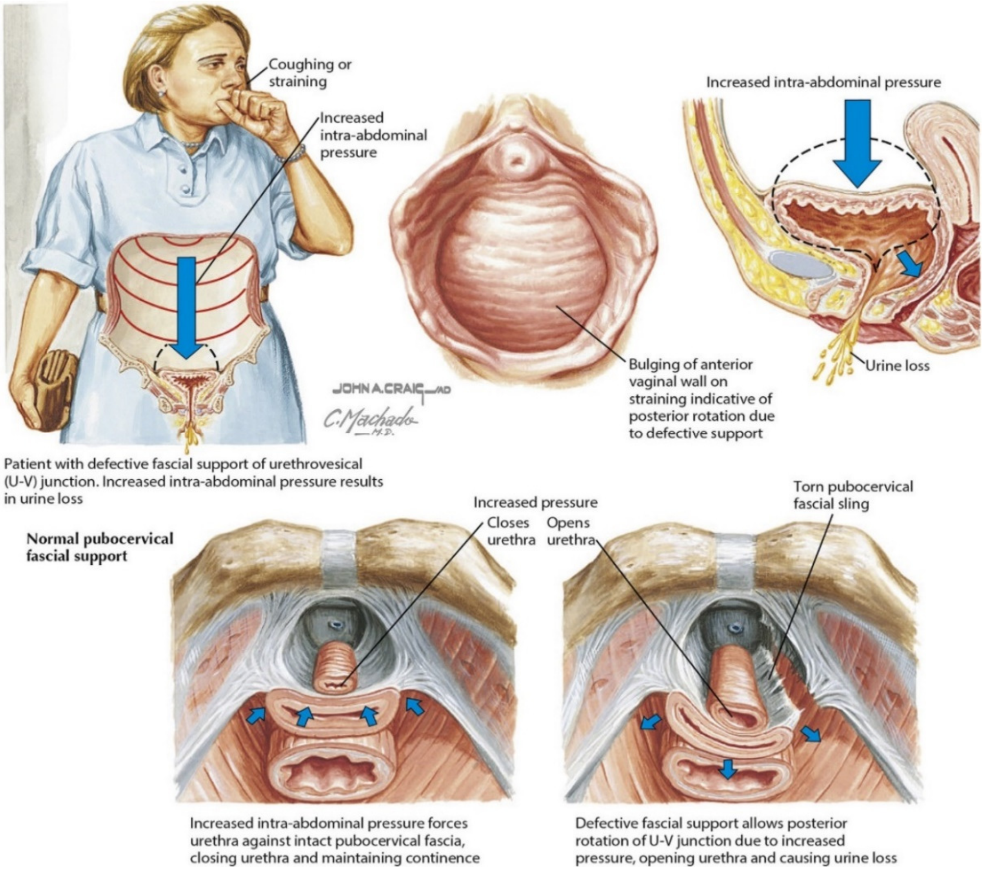

Figure 4. The role of pelvic floor muscles training (34)

In previously, pelvic floor ligaments were believed to be the most crucial components of pelvic support; biomechanical studies show that fibrous tissue is unable to handle the type of persistent strain that gravity and intraabdominal pressure exerted on the pelvic floor (35). If the muscles are destroyed, the pelvic organ must be supported by the ligaments and fasciae (2).

Before rupturing, ligament tissue may extend to a certain extent. Surgery is often necessary for a damaged ligament to mend and regain its structural function. Since it can stretch and contract back to its original form, muscle tissue is more forgiving. Muscle fibers may rupture if overstretched. Just around 15% of the pelvic muscles' nerves may be stretched without causing harm (36).

The vaginal and anorectal sections enter the vaginal walls, the perineal body, and the external anal sphincter muscle, whereas the urethral portion is a component of the periurethral musculature (11). The segment of the puborectalis that attaches to the anorectum travels posterior to the rectum, where it joins its counterpart from the other side to create a sling. This sling is found posterior to the anorectum. The coccyx also serves as an attachment point for other, more posterior elements of the pubococcygeus (9). The iliococcygeus muscle, also known as the thin lateral section of the levator ani muscle, originates from the arcus tendinous of the levator ani muscle, which attaches to the ischial spine. It is attached to the final two segments of the coccyx at its most posterior point. Both sets of fibers eventually come together to create a raphe, which then contributes to the formation of the anococcygeal ligament. The levator plate is the name given to the median raphe that is between the anus and the coccyx. It serves as a shelf for the pelvic organs and may be found between the anus and the coccyx (9,37). The iliococcygeus muscle and the posterior fibers of the pubococcygeus muscle join to produce this structure throughout development. The levator plate is in a horizontal posture when the body is in the standing position, and it supports the rectum and the top two-thirds of the vagina above it. If the levator ani muscle is weak, the sling that supports the anorectum may become slacker, which will cause the levator plate to droop (37). This causes the urogenital hiatus to become exposed, which increases the risk of prolapse of the pelvic organs. On clinical inspection, it has been shown that women who suffer from prolapse have a larger urogenital hiatus (38). The posterior part of the pelvic diaphragm is formed by the coccygeus muscle, which may be found extending from the ischial spine to the coccyx and lower sacrum. It is found on the front of the sacrospinous ligament where it may be seen. The urogenital hiatus may be seen in a three-dimensional magnetic resonance scan of the pelvic diaphragm. This scan also reveals the peripheral attachments of the diaphragm (39). The third and fourth sacral nerve roots, which are supplied by the pudendal nerve, are the most important contributors to the direct innervation of the cranial surface of the levator ani muscle (40). About the kind of striated muscle, it has been observed that the bulk of the muscle fibers in the levator ani is slow-twitch fibers that maintain constant tone (type I) (41). Nevertheless, there are an increased density of fast-twitch (type II) fibers dispersed in the periurethral and perianal portions of the body. This leads one to believe that the regular levator ani muscle maintains its tone when the body is in an upright posture to support the pelvic viscera. Moreover, deliberate squeezing of the puborectalis may enhance the tone to counteract increasing pressure inside the abdominal cavity (9).

The levator ani is the most significant set of muscles in the pelvis. The pelvic floor is sealed off by the levator and muscles, allowing the organs above to rest on their top surface. They serve as a barrier to stopping organ prolapse (6). They serve as a line of defense against organ prolapse (6). In general, exercise has not been very effective in developing the levator ani group of pelvic muscles in women. Seldom are they fully recovered after they have been damaged or stretched? This is due to a few factors. One is the lack of understanding and respect for the pelvic floor's complexity and role. The challenge of mastering the isolation of this muscle group comes in at number four. The third misconception is that many women and medical professionals believe pelvic floor weakening to be a normal part of aging. Fourth, women are reluctant to disclose the signs of pelvic floor dysfunction. More and more women are becoming aware of their health nowadays, and they are eager to adopt healthy habits into their lifestyle. The practice of taking responsibility for one's health is advantageous to women and ought to include pelvic floor health. It would be best if knowledge of excellent pelvic health followed the example of breast health and was publicly addressed as a component of women's healthcare. Understanding the pelvic floor's role and learning how to avoid issues brought on by its weakening is crucial for women (2,6,42).

Urogenital Diaphragm (Perineal Membrane)

In addition to the pelvic diaphragm, there is also a musculofascial structure known as the urogenital diaphragm that may be found above the anterior outflow of the pelvis. There is some debate as to whether this structure is made up of three contiguous striated muscles (compressor urethrae, sphincter urethrae, and urethrovaginalis) and an inferior fascial layer known as the perineal membrane or a transverse sheet of muscle that extends across the pubic arch known as the deep transverse perineal muscle sandwiched between superior and inferior fascia (11,43–45). The inferior appearance of the urogenital system is finished off with the larger superficially ischiocavernosus and bulbocavernosus muscles, in addition to the tiny slips of the superficial transverse perineal (45). The structure fills in the space that previously existed between the inferior pubic rami on both sides and the perineal body. It contributes to continence because it is connected to periurethral striated muscles and closes the urogenital (levator) hiatus; supports and has a sphincter-like action at the distal vagina; and, since it closes the urogenital (levator) hiatus, it closes the urogenital (levator) hiatus. In addition to this, it offers the distal urethra some structural support. There is neither a diaphragm nor a membrane that corresponds to the posterior triangle that wraps around the anus. Below the pelvic diaphragm, the areas that are laterally located near the anus are known as the ischiorectal fossae (9).

Perineal Body

The perineal body is a pyramidal fibromuscular structure that sits in the middle of the pelvis between the anus and the vagina. The rectovaginal septum is found at the perineal body's cephalad apex (11). The muscles and the fascia that surrounds them begin to converge and then interweave throughout the structure. The rectum, vaginal slips from the pubococcygeus, perineal muscles, and the anal sphincter are the structures that are attached to the perineal body. The perineal body also includes smooth muscle, elastic fibers, and nerve endings. The perineal body expands and then contracts as a normal part of the birthing process (43). It is a significant component of the pelvic floor, and the vagina and the uterus are located just above it. A weakening that develops in the perineal body over time may lead to elongation and increases the risk of birth abnormalities such as rectocele and enterocele (45,46).

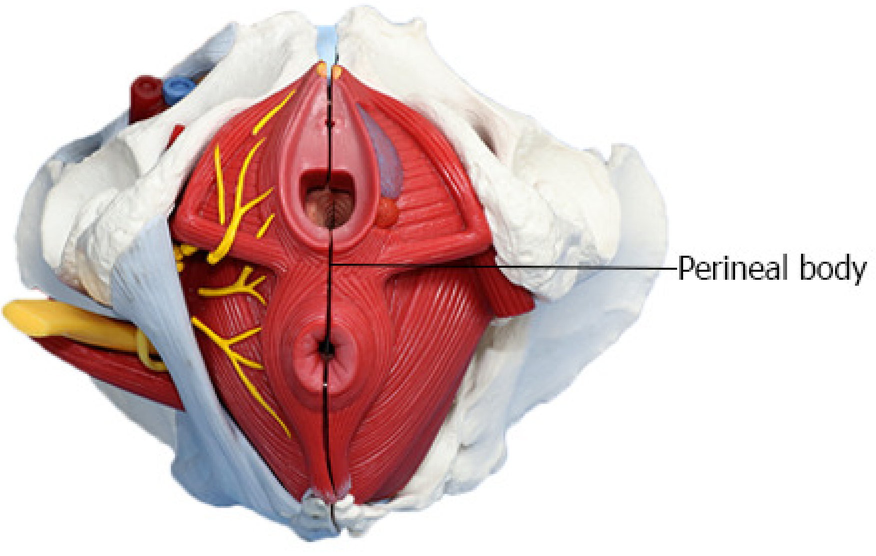

Figure 5. Perineal body view (47)

The pelvic outlet and the fascia covering the inferior face of the pelvic diaphragm, which is created by the levator ani and coccygeus muscles, define the perineum, a shallow area of the body. The perineal compartment separates the perineal compartment from the pelvic cavity. The surface of the perineum, also known as the perineal region, is the narrow area between the proximal parts of the thighs in the anatomical position; however, when the lower limbs are abducted, it becomes a diamond-shaped area that extends from the female mons pubis anteriorly, the medial surfaces (insides) of the thighs laterally, and the gluteal folds and superior end of the intergluteal (natal) cleft posteriorly (47).

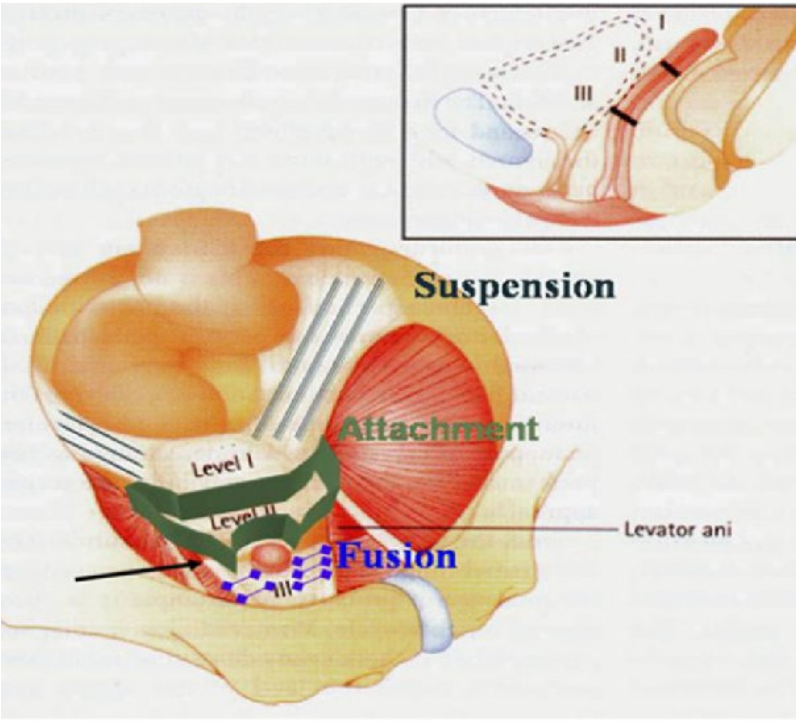

Figure 6. Levels of endopelvic fascia (48)

Endopelvic Fascia and Connective Tissue Supports

The bladder and urethra, as well as the vagina and uterus, are connected to a pelvic wall by a connective tissue structure known as the endopelvic fascia. This structure is located just underneath the peritoneum and also is a continuous unit with variable thickenings or condensations in different places (9). The endopelvic fascia connects to the visceral fascia, forming a capsule that houses the organs and enables displacements and volume changes. Individual names are given to the diverse areas of this structure, notably ligaments, and fascia, which have varying internal structures (9,49). Endopelvic fascia and ligaments are mesh-like structures made up of collagen fibers, elastin, smooth muscle cells, fibroblasts, and vascular structures. The cardinal ligaments, which connect the uterus to the pelvic wall, get their strength from the supporting collagen that forms the walls of arteries and veins. Some structures, such as the endopelvic fascia's pelvic sidewall connection (arcus tendinous of the pelvic fascia), are mostly fibrous collagen (49).

Researchers agree that the connective tissue that supports the urethra, bladder, and vagina extends to the arcus tendinous of the pelvic fascia on the pelvic diaphragm (25,43,50,51). There is also a consensus that the vesical neck and urethra are supported by a "hammock" made of tissue that is found on the anterior vaginal wall and bridges the gap that is located medially in the urogenital hiatus (50,52). Yet, there is still disagreement over the connective tissue structures that are related to this hammock (9). The connective tissue structures known as pubourethral ligaments go from the urethra to the pubic bone. These are structures that support the urethra and keep the vesical neck closed, according to several writers (53–55).

The connective tissues that surround the uterus and vagina are known as the parametrium and paracolpium, respectively. The paracolpium merges laterally with the pelvic wall and fascia in the midvagina (56). The lateral cervix and upper vagina to the lateral pelvic walls are the locations of the cardinal ligaments, also known as the transverse cervical ligaments of Mackenrodt. They come from a variety of places, including the lateral sacrum, the pelvic bones at the sacroiliac joint, and the area of the larger sciatic foramen above the piriformis muscles. These are condensates of the wide ligaments' lowermost portions. The connective tissue around the hypogastric veins and the cardinal ligaments are continuous laterally. They relate to the anterior vaginal wall's connective tissue, known as the pubocervical fascia, the paracolpium, the parametrium, and more in the middle (9,46). The upper vaginal fornices and cervix are posterolaterally joined by the uterosacral ligaments. In front of the sacroiliac joint, they connect posteriorly to the presacral fascia. The uterosacral ligaments' connective tissue and the cardinals' connective tissue surrounding the cervix are one continuous structure. Above the levator plate, the uterus and upper vagina are kept in place by the cardinal and uterosacral ligaments (9,46).

The paracolpium, which is connected to the endopelvic fascia (also known as rectovaginal fascia in this location) and pelvic diaphragm, supports the posterior vaginal wall from the sides, below the cardinals. At the walls of the vagina, the anterior and posterior fascial layers come together. The rectovaginal fascia is largely located towards the sides and is quite thin in the middle of the vaginal wall. Nonetheless, a posterior rectovaginal septum has been reported that runs from the peritoneal reflection to the perineal body and is made of fibromuscular elastic tissue (56,57).

The peritoneal cavity reaches the cranial portion of the perineal body when a fetus is developing, but it disappears early in life. Denonvillier's fascia's fused layers most likely form a portion of the rectovaginal septum attached to the underside of the posterior vaginal wall. The rectovaginal space, another possible region, has this fascia as its anterior boundary. The rectal and vaginal walls may move independently when the rectovaginal septum is healthy and undamaged (9). The vaginal wall connects directly to the surrounding tissues in the terminal vagina, 2 to 3 cm just above the hymeneal ring, without the need for a paracolpium. The vagina and urethra, as well as the muscles and connective tissue of a perineal membrane, merge anteriorly (urogenital diaphragm). It unites also with levator ani muscles laterally and the perineal body posteriorly. This portion of the vagina has the thickest rectovaginal fascia and the least mobility among its surrounding tissues (56). The middle rectal arteries are encircled by the lateral rectal ligaments, which stretch from the posterolateral pelvic side wall (level with the third sacral vertebra) to the rectum. There are often descriptions of added prerectal and pararectal fascial components (58).

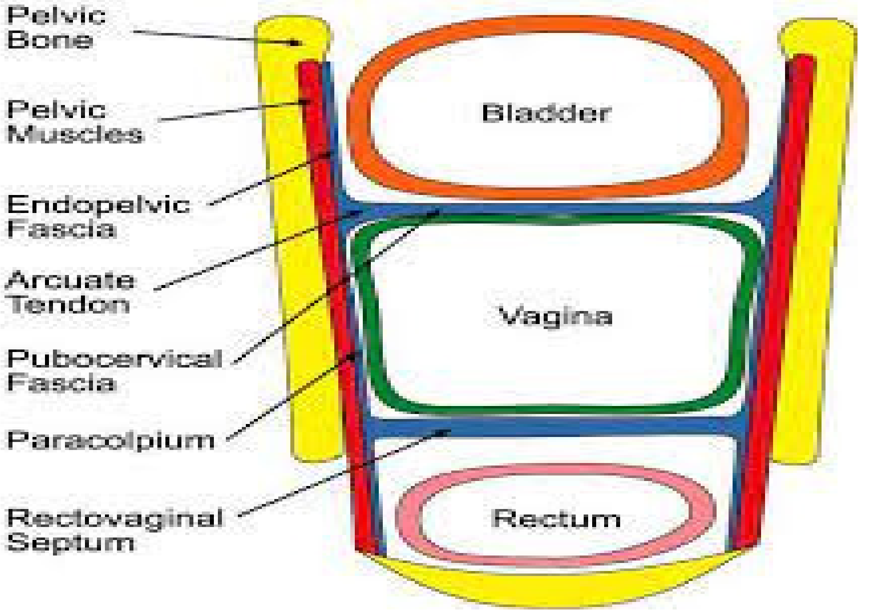

Figure 7. Triple compartment pelvic reconstruction (59)

Bladder, her functions, and disabilities

The urinary bladder is a delicate organ. Recommending a healthy lifestyle is crucial for excellent health in general, including the bladder. Diet, exercise, and the avoidance of constipation may all affect the function of the bladder. The average patient should urinate seven or fewer times a day with a volume between 300 and 700 mL and should not need to empty throughout the night. Typical postvoid residuals should be between 100 and 150 mL or less (60). Urinary problems may be caused by a variety of common medical illnesses as well as drugs. It is essential to be able to identify symptoms that could be urinary in origin but might be indicative of a more serious underlying medical problem. Urinary symptoms can be caused by several conditions, including diabetes, hypothyroidism, constipation, and genitourinary syndrome of menopause, which was formerly known as atrophic vaginitis. Because these conditions can lead to urinary symptoms, it is important to evaluate them and treat them medically, if necessary, before treating an overactive bladder (OAB) (3). Constipation should be avoided at all costs to maintain appropriate bladder function. If the rectum is stuffed with feces, the patient may have an increased desire to pee often or urgently. This is because the rectum is responsible for holding the stool. It has been suggested that eating foods rich in fiber might enhance bowel and bladder function. It is possible to achieve a more natural squatting posture and better empty the rectum by placing a stool or "Squatty Potty" in front of the toilet on which to place one's feet when defecating (3). Instruct patients to consume the recommended amount of liquids (water) each day. To ensure that they remain properly hydrated throughout the day, it is a good idea to recommend that they drink water with each of their meals and then consume the equivalent of one 16-ounce sports bottle's worth of water throughout the rest of the day. Water is the most beneficial fluid for the bladder to consume. Do not restrict fluid consumption if there is a problem with incontinence since this might induce urine concentration, which may further irritate the bladder. Instead, drink as much fluid as possible. It is also essential not to make patients drink against their will; rather, they should pay attention to their internal cues for thirst (3). The function of the bladder as well as the bowels may be improved by having a conversation about healthy toileting practices.

When the patient must empty their bladder or bowels, have them sit on the toilet seat with their feet propped up on a stool or the ground and encourage them to relax. Encourage them to relax and let their bladders perform the job rather than straining themselves. It is not healthy for women to hunch over the toilet since this causes the pelvic floor to constrict, which is the opposite of the relaxation that is required to urinate effectively. Instruct females to empty their bladders at regular intervals of between three and four hours. Advise them not to wait until it becomes an emergency before going to the bathroom if they have an urgent need to use the restroom (3).

The bladder is an organ that is quite sensitive. Some meals and drinks may increase bladder activity, leading to more irritative voiding or incontinence symptoms, which may lead to an increase in the severity of incontinence symptoms. It could be helpful to restrict or get rid of the following:

- Alcohol;
- Caffeine (cola, tea, and coffee);
- Foods and drinks with an acidic pH, such as citrus fruits and tomatoes;
- Artificial sweeteners, such as aspartame and other similar compounds;
- Foods with a hotter spice level;
- Cigarettes (3).

The following are examples of symptoms that a patient could have that would indicate the need for more testing and mandate that they be sent to a urogynecologist:

- Having trouble getting the flow of urine to begin might be difficult;
- Sensations of not having completely emptied one's bladder;
- Urinary frequency or urgency that cannot be controlled;
- Experiencing pain when urinating;
- Urine with a putrid odor or that is hazy;
- Urinating at night (nocturia);
- Urine seepage or leakage;
- Bladder pain;
- Blood was found in the pee;
- Dribbling after urine (3).

Urethra

The complicated tube structure known as the urethra extends from the bladder to the exterior meatus. It contains different muscle components connected both inside and externally that allow it to operate for both urination and storage (continence) (9). The smooth muscle of the urethra is connected to the smooth muscle of the trigone as well as the detrusor muscle (61). A conspicuous inner longitudinal layer sits under a small outer circular layer in this structure. The layers are distributed throughout the upper four-fifths of the urethra and may be found within the outer striated urogenital sphincter muscle. During voiding, the structure of the circular muscle suggests that it plays a role in reducing the lumen's diameter, while the longitudinal muscle may contribute to a reduction in the length of the urethra (56). The muscle of the striated urogenital sphincter, which is located in the middle three-fifths of the urethra's length, is responsible for the formation of the outer layer of the urethra.

Circular sphincter-like fibers may be seen in the top two-thirds of the structure. In the distal portion, the fibers leave the urethra and either forms a urethrovaginal sphincter that surrounds the vaginal wall or a compressor urethra that extends along the inferior pubic rami above the perineal membrane. Both structures are seen in the distal portion (11). Most of the muscle is made up of slow-twitch fibers, which are excellent for preserving the muscle's natural tone (62). When it is necessary, the constriction of the urethra may also be increased by the activation of voluntary muscles (9). The urethral mucosa is predominantly composed of non keratinizing squamous epithelium and extends from the bladder transitional epithelium to the external meatus of the urethra. It originates from the lower vagina, the vestibule, and the urogenital sinus all at the same time. It is susceptible to hormonal fluctuations and goes through alterations in response to stimulation (56). The submucosal tissue, which is sensitive to hormones, has a vascular plexus that is both abundant and conspicuous. Several specialized types of arteriovenous anastomoses have been demonstrated, and it is thought that they provide a watertight closure of the mucosal surface with an increase in blood flow that may occur with an increase in pressure on abdominal vessels. This idea is supported by the fact that these anastomoses are capable of being performed successfully (61). There is a significant amount of connective tissue that is interspersed throughout the muscle and submucosa of the urethra. This is in addition to the vascular and muscular tissue that are found in the urethra. This tissue, which is composed of collagen and elastin fibers, is believed to contribute to the passive process of urethral closure (56). In conclusion, the submucosa contains some glands, the majority of which are located along the vaginal surface of the urethra. The middle and the bottom third of the urethra are where you will find the greatest number of them. The presence of a functioning sphincter is due to the combination of striated and smooth muscle, connective tissue, mucosa, and submucosa (52). A watertight apposition of the urethral lumen, compression of the wall surrounding the lumen, and a way of correcting for variations in abdominal pressure are all characteristics of a functioning urethral sphincter. In addition, a functional urethral sphincter possesses intact neurological control (9).

Neurophysiology of Micturition

The lower urinary tract is responsible for two primary functions: the storage of urine at low pressure in a continental reservoir and the timely ejection of urine that has been stored in a manner that is coordinated, effective, and comprehensive. The activity of the smooth and striated musculature of the bladder, urethra, and external urethral sphincter, which are all under the control of various neural circuits in the brain and spinal cord, ultimately determines which of these two functions is carried out. These functions are incompatible with one another. Even though these functions are the result of a complex interaction between the central nervous system and the peripheral nervous system, they are also influenced by a few anatomical factors such as the integrity of the pelvic floor support and the dynamic relationship of the bladder and its outlet to various points in the bony pelvis and adjacent organs when voiding. Both factors are important in determining how well these functions are carried out. In addition, as our knowledge of the neurophysiology of the lower urinary tract expands, so does the number of neurotransmitters and receptors that have been discovered as playing a role in the function and dysfunction of the voiding process. Voiding dysfunction may arise because of a neurologic illness or injury, a change of anatomical interactions between the pelvic and urinary organs, or as an undesirable and sometimes undiagnosed pharmacologic impact of medical treatment for other conditions. Alterations in the viscoelastic characteristics of the bladder wall may contribute to the development of voiding dysfunction, which can also be a side effect of the natural aging process. The innervation of the lower urinary tract is not static, as is the case with other neurologic systems; rather, it changes in response to illness and the effects of age. Neuroplasticity is the term used to describe these phenomena. Since the etiology of voiding dysfunction is multifactorial most of the time, it is vital to have a thorough grasp of the neuroanatomy and neurophysiologic processes that are involved in the lower urinary tract (58). Excitation-contraction coupling is the name given to the process by which a muscle generates force in response to ligand binding. It is a highly complicated process that happens when a neurotransmitter travels through the postsynaptic cleft. These modifications occur as a consequence of the neurotransmitter's action. The intricacies of these processes are beyond the scope of this chapter and are best left to be covered in more depth in a more comprehensive physiology book; nonetheless, the core ideas may be summed up as follows (58).

Actin is the primary contractile protein in smooth muscle, while myosin predominates in striated muscle, which causes a difference in the shape of smooth muscle cells.

Yet, the contact between these two myofilaments is what finally produces force. More research has been done on the cardiac muscle and striated muscle than on smooth muscle, although obstetrics and gastroenterology have taught us a lot about the physiology of smooth muscle. Smooth-muscle cells are initially excited by ligand binding (a neurotransmitter and its corresponding receptor) or membrane depolarization. As a result, the amount of free cytosolic calcium rises. Normal free calcium ion concentrations in the cytosol are 0.1 mM.

There is a significant pool of calcium that has accumulated within the cells, as shown by the greater calcium concentrations overall. The extracellular calcium may enter the cell membrane via certain voltage-sensitive channels, increasing the amount of cytosolic calcium, or it may be released from intracellular storage. Second messengers such as inositol trisphosphate (IP3), cyclic AMP, or guanosine triphosphate may cause the release of intracellular reserves (GTP). Myosin light-chain kinase may attach to the protein calmodulin thanks to the excess free calcium in the cytosol that interacts with it. Myosin light-chain kinase phosphorylates the myosin light chain, which interacts with actin and changes its conformation. This allows the proteins to slip past one another and shorten the muscle. During this process, adenosine triphosphate (ATP) is a crucial cofactor. If there is a trigger for contraction, this process may be done again (58). ATP plays a significant role in muscular relaxation as well. Certain ATP-dependent pumps (ATPases), which function to pump calcium (often against huge gradients) out of the cell or into storage locations, consume a large amount of energy in doing so, enabling calcium homeostasis and cell repolarization (58). Bladder compliance is the capacity of the bladder to hold expanding amounts of pee at low pressures (58).

The pelvic and hypogastric nerves both carry afferent (sensory) neurons out from the bladder and urethra to the spinal cord as well as efferent parasympathetic and sympathetic neurons. Both the storage and voiding phases of micturition are principally regulated by sympathetic and parasympathetic vesicourethral innervation, respectively. The somatic innervation, which is provided by efferent in the pudendal nerve, is significant primarily to the muscles of both the pelvic floor and the external or striated urethral sphincter (EUS) (11,63,64).

To maintain continence both at rest and during stress exercises, women must develop bladder outlet resistance. Continence is greatly influenced by urethral anatomy, including functional length and elastic closure. Moreover, when there is a rise in intra-abdominal pressure, the muscular pelvic floor and the connective tissue components that it is connected with work to maintain outlet resistance. The anatomic location of the urethra is another aspect contributing to continence (58).

Urinary incontinence

Urinary incontinence refers to the involuntary loss of bladder control over one's pee. The level of discomfort that a woman has as a result of leaking is the most crucial factor to take into account. According to the International Continence Society, urinary incontinence can be a symptom, which is defined as the "complaint of involuntary leakage of urine," or it can be a sign, which is defined as the "observation of involuntary loss of urine on examination." Both definitions apply to urinary incontinence (3). Urinary incontinence may be broken down into two primary categories: urgency and stress. Urgency incontinence is characterized by an unexpected and urgent need to urinate, while stress incontinence is associated with increased levels of physical activity. OAB refers to a more comprehensive set of symptoms that might include urine urgency and/or frequency, with or without incontinence, as well as nighttime urination. Urinary frequency is defined as voiding more than seven times throughout 24 hours and voiding one or more times during the night (3). When a woman suffers from both stress and urgency incontinence, medical professionals speak of her as having mixed incontinence. Although it is never considered normal to have pee seep out spontaneously, the changes that occur in a woman's urinary system as she ages may predispose her to have problems voiding. Additional variables that might contribute to the development of urine incontinence include genetics, race, having many children, being overweight or obese, smoking, and having a higher body mass index. As was said before, developing healthy routines, such as selecting nutritious foods and beverages and properly toileting (both urinating and defecating), might help in the amelioration or resolution of some urinary disorders. Patients who suffer from urinary symptoms such as the overactive bladder (OAB), urgency, or stress urinary incontinence may benefit the most from medication that is administered in stages. Patients should be taught about all of their treatment options and encouraged to begin with the fundamentals and work their way up to more involved procedures. Patients should also be urged to start with the most conservative and least intrusive treatment options first (3).

Pelvic floor dysfunction pathophysiology

Growing age (menopausal status), past hysterectomy, vaginal delivery, obesity, smoking, and inherited connective tissue condition are risk factors for having a PFD (3).

Because of the many different processes that might take place, the typical supporting structures of the pelvis can sometimes get disrupted. Birth malformations are relatively rare and often manifest themselves in infancy or youth. Varying degrees of pelvic floor relaxation can be caused by factors such as iatrogenic or traumatic damage as well as severe physical exertion. Women who have never given birth to a child have an increased risk of developing pelvic floor dysfunction as a result of postmenopausal tissue atrophy (65).

Pelvic organ prolapses, childbirth, and persistent constipation with straining may all result in neuromuscular injury to the pelvic floor. As a result of this denervation damage, the levator ani and coccygeal muscles atrophy and malfunction, which affects the pelvic floor's ability to contract and causes fecal and urine incontinence (25). The most frequent causes of inadequate pelvic support are delivery or hysterectomy. Loss of neural mass and tissue flexibility are two additional causes that age-related loss of pelvic support is accompanied by. Genitourinary and bowel signs of pelvic floor relaxation often appear shortly after menopause, when the hormonal environment changes, rather than typically occurring right after delivery. This provides more proof of the significance of dynamic changes in connective tissue and pelvic musculature after hormonal changes, which contribute to the loss of pelvic support. Stress urine incontinence is often the earliest sign of pelvic floor dysfunction in women. Yet, the lack of pelvic support has a profound impact on the bowel, urine, and sexual functions. Urinary incontinence results from intravesical pressures that are greater than those of the urethra and bladder neck due to a weakened bladder outlet resistance. Hence, the mechanisms that women use to maintain bladder outlet resistance are a crucial and essential part of pelvic floor dysfunction (58). Aging, being overweight, parity, and having had a hysterectomy in the past are all risk factors for PFDs, which affect 17% of women throughout their lives. Urinary incontinence affects more than 40% of women over 40 since the frequency of women developing it rises with age (66).

Classification

There are two possible classifications for pelvic floor disorders: high-tone pelvic floor disorder and low-tone pelvic floor disorder.

The high-tone pelvic disorder includes:

- Pelvic floor myofascial pain
- Dyspareunia and vaginism
- Vulvodynia.

Low-tone pelvic disorder:

- Stress urinary incontinence
- Overactive bladder
- Pelvic organ prolapses
- Anal incontinence
- Peripartum and the postpartum period.

Overview of symptoms that may indicate a pelvic floor disorder
While there are several forms of PFDs, the symptoms of each might vary or overlap. For instance, women who use PFDs may have:

- Experience of vaginal heaviness, fullness, tugging, or pain that worsens at the end of the day or is associated with a bowel movement;
- See or feel a vaginal "bulge" or "something coming out";
- Having difficulties beginning to urinate or fully emptying the bladder;
- Urine escapes with coughing, laughter, or exercise;
- Felt the desire to urinate often or frequently;
- Felt discomfort when urinating;
- Have diarrhea or problems regulating gas;
- Having constipation;
- Having difficulties reaching the restroom on time (67–69).

Chronic pelvic pain (CPP) in women is a condition of complexity. Pain intensity and sensitivity often do not coincide with the indicated lesion site, resulting in musculoskeletal and myofascial diseases as well as sexual dysfunction (SD). Despite the prevalence of physical symptoms, they are often misdiagnosed and undertreated owing to a lack of knowledge of the disease's genesis and spread. Often, patients describe pelvic pain as psychological discomfort manifesting in physical complaints, prompting doctors to suggest medication or surgical intervention to rectify or relieve these symptoms, typically with inadequate outcomes (70).

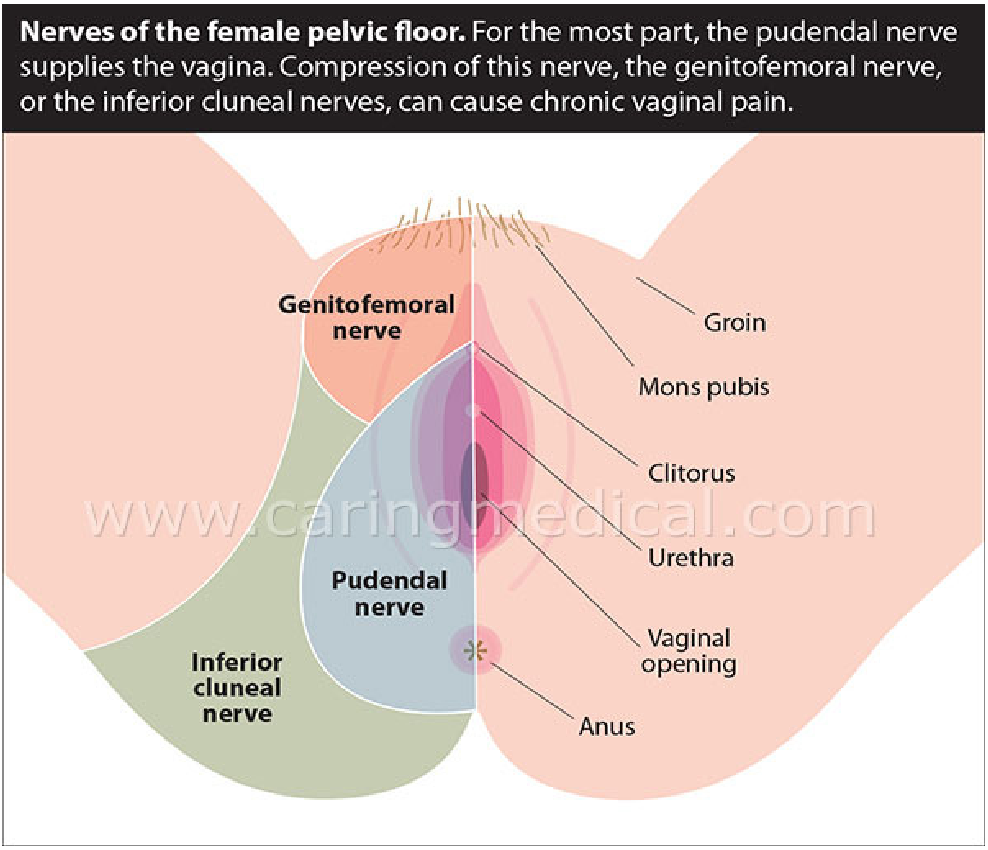

Figure 8. Areas of the groin and vaginal area are impacted by the genitofemoral nerve, the pudendal nerve, and the inferior cuneal nerve (71)

Diagnosis and Treatment of Pelvic Floor Disorders

A complete medical history and physical examination are necessary for diagnosis.

Establishing a habit of questioning patients about incontinence and prolapse symptoms may aid in the identification of individuals with pelvic floor disorders.

Consider including questions like "Do you feel like you're urinating more often than usual throughout the day or night?"

Do you have bladder leakage when you cough, laugh, exercise, or while attempting to reach the restroom?

Do you experience a vaginal bulge, ball, or pressure? (3);

Patients will not provide humiliating facts; hence it is necessary to inquire. Using a review of a symptom chart or a brief validated questionnaire on the intake form could serve as the initial step in providing the patient with the life-improving resources she needs. Patients may complete standardized severity questionnaires to ascertain the 528 Good & Solomon amount of discomfort they are feeling and to estimate what the examination may entail. Using the Pelvic Floor Disability Index-20 may be most beneficial for pelvic floor issues (3).

Pelvic Floor Disability Index (PFDI-20)

Name: ______________________________ Date: ______________

Instructions: For each question, please circle the ONE number that best describes your condition and how much they have bothered you over the last three months. All items use the following format with a response from 0 to 4.

Activities	Not Present	Not at All	Somewhat	Moderately	Quite a bit
Pelvic Organ prolapse Distress Inventory 6 (POPDI-6)					
Do you...					
1. Usually experience pressure in the lower abdomen?	0	1	2	3	4
2. Usually experience heaviness or dullness in the pelvic area?	0	1	2	3	4
3. Usually have a bulge or something falling out that you can see or feel in your vaginal area?	0	1	2	3	4
4. Ever have to push on the vagina or around the rectum to have or complete a bowel movement?	0	1	2	3	4
5. Usually experience a feeling of incomplete bladder emptying?	0	1	2	3	4
6. Ever have to push up on a bulge in the vaginal area with your fingers to start or complete urination?	0	1	2	3	4
Colorectal-Anal distress Inventory 8 (CRAD-8)					
Do you...					
7. Feel you need to strain too hard to have a bowel movement?	0	1	2	3	4
8. Feel you have not completely emptied your bowels at the end of a bowel movement?	0	1	2	3	4
9. Usually lose stool beyond your control if your stool is well formed?	0	1	2	3	4
10. Usually lose stool beyond your control if your stool is loose?	0	1	2	3	4
11. Usually lose gas from the rectum beyond your control?	0	1	2	3	4
12. Usually have pain when you pass your stool?	0	1	2	3	4
13. Experience a strong sense of urgency and have to rush to the bathroom to have a bowel movement?	0	1	2	3	4
14. Does part of your bowel ever pass through the rectum and bulge outside during or after a bowel movement?	0	1	2	3	4
Urinary distress Inventory 6 (UDI-6)					
Do you...					
15. Usually experience frequent urination?	0	1	2	3	4
16. Usually experience urine leakage associated with a feeling of urgency (a strong sensation of needing to use the bathroom)?	0	1	2	3	4
17. Usually experience urine leakage related to coughing, sneezing or laughing?	0	1	2	3	4
18. Usually experience small amounts (drops) of urine leakage?	0	1	2	3	4
19. Usually experience difficulty emptying your bladder?	0	1	2	3	4
20. Usually experience pain or discomfort in the lower abdomen or genital region?	0	1	2	3	4

Office will calculate: Scale Scores: Obtain the mean value of all answered items and multiply by 25 to obtain the scale score (range 0 to 100). Missing items are dealt with by using the mean from answered items only. Add the 3 scale scores together for the summary score (range 0 to 300).

Figure 9. Pelvic Floor Disability Index - 20 (72,73)

With a detailed medical history, more symptoms of medical problems that may contribute to urine incontinence as part of the illness process are elicited. Inquire about diabetes, multiple sclerosis, thyroid illness, past cerebrovascular damage, prior spinal cord injury, back discomfort, prior back injuries, and urologic diseases, for instance (recurrent urinary tract infections, kidney stones, and gross hematuria) (3).

Frequently prescribed drugs may potentially interfere with the natural functioning of the bladder. Muscle relaxants, opioids, alpha-blocking medications, and specific antihypertensive medicines (calcium-channel blockers and methyldopa) may worsen urethral smooth and skeletal muscle relaxation, resulting in stress urinary incontinence (SUI). The antihistamine and anticholinergic actions may be combined, resulting in urinary hesitancy and retention. Inhibiting the natural function of the urethral sphincter, decongestants and certain diet medications with alpha-adrenergic effects may induce urine retention (3).

A thorough genitourinary and pelvic floor examination should be performed during a physical examination to assist identify any anatomic reasons for the patient's complaints (3). Included in the assessment should be:

- A visual examination of the genital region;
- Assessment of nerve conduction;
- Observation of urethral hypermobility during coughing and/or the Valsalva maneuver;
- Palpation of the urethra for anomalies;
- A routine vaginal exam with a prolapse grading system;
- Assessment of the tone and strength of the levator ani;
- Examination of the uterus, cervix, and adnexa with two hands (3).

Treatment options, including lifestyle changes, physical therapy, and surgery

Lifestyle changes

Speak to your primary care physician or another healthcare practitioner about strategies to alleviate or lessen your symptoms. Your doctor or another medical professional may suggest that you take certain steps, such as the following:

- Reduce your consumption of meals and beverages that stimulate the bladder. Some meals and beverages, such as those containing caffeine or carbonation, citrus fruits and drinks, artificial sweeteners, and alcoholic beverages, might stimulate the bladder and cause you to need to use the restroom.
- Eat foods that are rich in fiber if you have specific gastrointestinal issues. The digestion process is aided by fiber in the diet. It helps make stool the proper consistency, which may also avoid constipation as well as the persistent straining that is involved with making a bowel movement when constipation is present. Fruits, vegetables, legumes (including beans and lentils), and whole grains are all good sources of fiber. Whole grains also include fiber. Furthermore, fiber supplements may be obtained.
- Reduce your weight. By reducing the amount of pressure that is placed on the pelvic organs, lowering weight may help women who are overweight or obese regain control of their bladders and have fewer symptoms of pelvic organ prolapse (74,75).

Physical therapy

Pelvic floor physical therapy (PFPT), also known as pelvic floor muscle training (PFMT), is a kind of treatment that is considered conservative and the first line for the management of a variety of pelvic floor conditions (76). The abbreviation PFPT refers to pelvic floor physical therapy, which is the practice of having a qualified physical therapist guide a patient through a series of exercises designed to relax and strengthen the pelvic floor muscles (77). PFPT may include behavioral instruction, manual therapy, biofeedback, or electrical stimulation, as well as the development of home exercise routines (78). PFPT is a first-line, minimally invasive treatment option for pelvic floor dysfunction, including pelvic organ prolapse (POP), fecal or urine incontinence, peripartum and postpartum pelvic floor dysfunction, and chronic pelvic discomfort, as supported by substantial data (76,79,80).

Internal as well as external factors are taken into consideration throughout the PFPT test and therapy. During the external examination, sensitive spots are felt in the lumbosacral and sacroiliac joints, the iliopsoas and piriformis muscles, the iliacus and rectus abdominis muscle insertions, and the abdominal viscera and bladder. In addition to this, an examination is carried out to check for diastasis recti abdominus, abdominal hernia, and inguinal hernia. During the internal examination, the muscles of the pelvic floor are evaluated for their tone, and suppleness, as well as places that are sensitive and painful (81). In addition, the examiner determines whether or not the patient can do voluntary contractions and voluntary relaxations. This allows the examiner to evaluate the patient's coordination, muscular length, strength, and endurance. An evaluation of pelvic organ prolapses and falls on the pelvic floor using the Valsalva technique is also carried out. The remainder of the internal examination consists of probing of the periurethral connective tissue, the vulva, the obturator internus, and the pudendal nerve when it is located in Alcock's canal. After the evaluation, the physical therapist will make a connection between the objective results and the particular symptoms to formulate a therapy strategy (82).

In addition to manual manipulation, techniques like electrostimulation, biofeedback, and vaginal dilators or vaginally weighted cones may be utilized to assist in the differentiation of pelvic floor muscles and enhance contraction. Electrical stimulation is the delivery of a low-level electrical current to the pelvic region to stimulate muscular contraction and aid the patient in isolating the relevant muscles. A vaginal or rectal pressure sensor is used in biofeedback, and it supplies auditory and/or visual feedback on the intensity of the muscle contraction. During physical activity, a vaginal weighted cone is placed into the vagina, and the cone is kept in place by the contractions of the pelvic muscles (83–86).

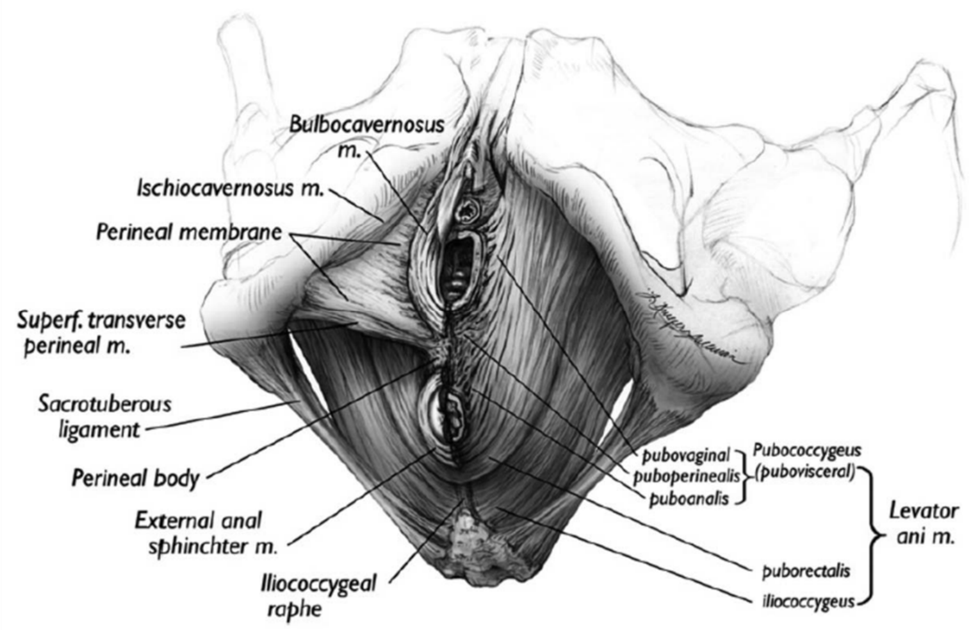

Figure 10. Superficial and deep muscles of the pelvic floor (87)

Non-Surgical treatment

Non-surgical treatment includes:

- Bladder training;
- Pelvic floor muscle training (PFMT);
- Medicine;
- Vaginal pessary (75,88).

Bladder training

This entails going to the bathroom at regular intervals on a predetermined schedule to recover control of one's bladder and using strategies to combat unwanted desires to pee. A woman begins by going to the toilet at regular intervals and gradually, over many months, extends the amount of time that passes between visits, with the end objective of going no more often than every 2.5 to 3 hours (75).

Pelvic floor muscle training (PFMT)

Exercises for the muscles of the pelvic floor (PFMT). The pelvic floor muscles are contracted and then allowed to relax as part of the PFMT, which is also commonly known as Kegel exercises. The PFMT has the potential to alleviate the symptoms of urinary incontinence and prolapse if it is carried out appropriately and regularly. Yet, PFMT is unable to repair the prolapse. Exercises for the pelvic floor may be performed by women either alone or with the assistance of a pelvic floor physical therapist (75). During pelvic floor physical therapy, biofeedback is sometimes used to instruct women which muscle group to contract to get optimal results.

Medicine

To address some issues with bladder control, as well as to avoid issues such as loose stools or frequent bowel motions, medicine is occasionally administered (89).

Vaginal pessary

The treatment for prolapse involves applying this particular plastic device. It is possible to use it to help improve bladder control in certain cases. Pessaries are medical devices that are inserted into the vagina by a woman or her healthcare professional to offer support to the pelvic organs. A pessary that is the proper size and form for a woman will be prescribed by her physician, and she will be given instructions on how to use and care for the device (69).

Surgical treatment

In some circumstances, surgery is the most effective method of therapy, particularly when other therapies have been unsuccessful (90,91). Some surgical operations may be done as outpatient procedures, which means that the patient can often return home the same day as the surgery once it has been completed.

For prolapse

During surgery, the prolapse will be repaired, and an effort will be made to restore a properly supported anatomy. This may be accomplished in a variety of methods, and the approach used will vary according to the kind of prolapse as well as other considerations. Women who suffer from uterine prolapse have the option of having their uterus removed (hysterectomy). Women who need surgery to fix a prolapse may also need further surgery to cure or avoid difficulties with their ability to regulate their bladder. Colpocleisis is a surgical procedure that some women opt to undergo. This surgical procedure cures prolapse by reducing the length of the vagina and making it narrower. While it is effective and has a minimal risk of side effects, it is not a viable option for women who wish to be able to engage in sexual activity through the vaginal canal (91).

For bladder control difficulties

Surgical procedures are an effective method for treating urine leakage issues that manifest themselves as a consequence of an action, such as sneezing, coughing, laughing, or exercising (stress incontinence). Exertion may create stress incontinence when it squeezes the bladder, which can then cause urine to flow out of the body since the support surrounding the urethra has become weaker. 6 A mid-urethral sling is the most common form of surgery used to treat this condition. The urethra is supported by the substance that the surgeon implants beneath it, which prevents urine from leaking out during physical exercise. 6 In yet another technique, so-called "bulking agents" may be injected close to the urethra and the neck of the bladder to make the tissues more robust and seal up the entrance of the bladder. More injections may be required over time (69,92).

About issues in maintaining control of bowel movements

To repair a broken anal sphincter muscle, inject drugs into the sphincter, or implant a stimulator for the nerves that govern bowel function, surgery may be required (93).

Prevention of Pelvic Floor Disorders

No of their age or parity, all women should have yearly screenings for urine incontinence, according to the Women's Preventative Services Initiative. Women should be screened to see whether they have symptoms of prolapse or incontinence, and if these symptoms have an impact on their quality of life. There are helpful validated questionnaires that may be used to determine if a woman is exhibiting uncomfortable prolapse or urinary incontinence symptoms. Many women suffer in silence while wearing PFDs because they mistakenly think that prolapse and incontinence are inevitable side effects of becoming older. Women's health care professionals may identify PFDs who may be suffering covertly and assist them with finding doctors who are qualified to treat their conditions.

Pelvic floor physical therapy for low-tone pelvic floor disorders

Patients often have a limited understanding of this treatment option, even though pelvic floor physical therapy (PFPT) for the treatment of pelvic floor diseases is a low-risk therapy with a high success rate. People who are uneasy with the idea of having an intravaginal exam could decide against having a PFPT. The rate of adherence is often rather low since patients could have time constraints, and their problems might only improve after attending numerous sessions. Thorough patient education on treatment specifics as well as expectations for treatment objectives may help lessen the anxiety and negative perceptions associated with PFPT (94–96).

Stress urinary incontinence

Stress urinary incontinence (SUI) refers to stress urinary incontinence, which is the involuntary loss of urine associated with increased intra-abdominal pressure that can occur during activities such as coughing, laughing, sneezing, impact movements, or squatting. SUI can be caused by some factors, including obesity, diabetes, and prostate problems (76,86). Maintaining continence and preventing urine leakage may be accomplished by contracting the muscles of the pelvic floor, which will increase urethral pressure and an elevation of the urethra beneath the pubic symphysis. PFPT is used to strengthen and maintain the tissues of the pelvic floor to reduce symptoms of stress urinary incontinence (97).

Overactive bladder

Urinary frequency, urgency incontinence (UUI), nocturia, and urine urgency are all indications of overactive bladder syndrome (98). The bladder detrusor muscle contracts uncontrollably, resulting in these symptoms. According to studies, activating the pelvic floor may prevent the contraction of the bladder (99). The frontal cortex of the brain, which controls the voluntary urine inhibition response, is thought to be activated by pelvic floor muscular contraction, which may enhance conscious control of bladder function (100). According to a second idea, the detrusor muscle may be relaxed via processes of reciprocal inhibition when the puborectalis, external urethral, and anal sphincters on the pelvic floor are activated (101). Using the pelvic floor muscles to restrict detrusor overactivity and prevent urine leakage, PFPT may be utilized to control UUI (82).

Pelvic organ prolapses

Pelvic floor physical therapy for non-surgical pelvic organ prolapses

POP occurs when the pelvic floor is weak and the connective tissue attachments to the bony pelvis are loose, enabling the pelvic organs (uterus, vaginal apex, bladder, or rectum) to fall or herniate abnormally from their usual location in the pelvis (102). Women who have POP often have low back discomfort, pelvic heaviness, fullness, and/or voiding, and/or defecation problems (103). The degree of vaginal wall descent concerning the hymen is used to define POP severity using an ordinal staging method (POP-Q): Stages 0 and 1 represent no descent, stage 2 represents limited descent, stage 3 represents descent that extends beyond the hymen but is less than 2 cm long, and stage 4 represents total descent of the vaginal walls (104). It is possible to increase the resting posture of the uterus, bladder, and rectum by using PFPT to enhance muscular strength and coordination. This will result in a decrease in symptoms, a reduction in the POP-Q stage, and an improvement in quality of life (105).

Anal incontinence

The prevalence of anal incontinence, which includes bowel movement, gas, and liquid incontinence, is believed to be between 2% and 24% (107). The unintentional loss of solid or liquid feces is known as fecal incontinence. This condition is sometimes referred to as inadvertent bowel leakage (108). In nonrandomized trials, the addition of biofeedback to PFPT for the treatment of fecal incontinence appears to minimize the number of bouts of incontinence (109–111).

Peripartum and the postpartum period

Pregnancy and delivery are usually recognized to be important risk factors for women with pelvic floor dysfunction, which may occur in as many as 46% of puerperal women. Symptoms of pelvic floor dysfunction can include pain, weakness, and incontinence (112). Up to 34% of postpartum women have urine incontinence, while 4% of postpartum women experience fecal incontinence (113,114).

Pelvic floor physical therapy for high-tone pelvic floor disorders

Pelvic floor myofascial pain

The symptoms of pelvic floor myofascial pain condition include short, tight, and painful pelvic floor muscles as well as myofascial trigger points that cause local and referred pain. Chronic vaginal soreness and dyspareunia are two of the symptoms of this condition (115). It is generally agreed that PFPT is the most effective treatment for myofascial pain and spasm (116).

Dyspareunia and vaginismus

Vaginismus is defined by a spasm of the perineal muscle that makes vaginal penetration difficult, while dyspareunia is characterized by pain during sexual intercourse or vaginal penetration. Dyspareunia is characterized by pain during sexual intercourse or vaginal penetration (117). The pelvic floor muscle training (PFPT) that promotes muscular relaxation, normalizes resting muscle activity, enhances vaginal flexibility, and improves muscle awareness and proprioception is an essential component of the multidisciplinary approach to treating dyspareunia and vaginismus (118).

Vulvodynia

In the absence of additional observations or diagnoses, vulvar discomfort, most usually described as a burning sensation, is referred to as vulvodynia (119). A malfunction of the pelvic floor may lead to increased tissue sensitivity, a reduction in blood flow, and referred pain in the vulva. PFPT has been incorporated into the American College of Obstetrics and Gynecology's recommendation (grade B) for the management of vulvodynia and is recommended as a treatment strategy for vulvodynia by the International Consultation of Sexual Medicine. The American College of Obstetrics and Gynecology recommends PFPT as a treatment strategy for vulvodynia (120,121).

Living with a Pelvic Floor Disorder

Every healthcare professional should discuss genitourinary health while providing treatment for women throughout their lifetimes. A woman's self-image and quality of life may be significantly impacted by pelvic floor disorders (PFDs), which include urinary incontinence and pelvic organ prolapse (POP). PFDs can affect women of any age. Sadly, these disorders may be stigmatized in many communities, which might cause women to put off getting treatment or not ask for it. According to studies, incontinence or prolapse in women may improve both their quality of life and sexual pleasure. These illnesses, which afflict women of all ages, are often underdiagnosed and undertreated.

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Advances in Endometriosis Management: A Comprehensive Approach

Epidemiology and History

Endometriosis is typically characterized by the existence of endometrial glands and stroma in extrauterine areas. This definition dates back more than three hundred years. Endometriosis is an estrogen-dependent, inflammatory condition that causes pelvic pain as well as infertility (1). Daniel Shroen published the first account of this illness in 1690 in his work "Disputatio Inauguralis Medica de Ulceribus Ulceri." Arthur Duff first described the signs of this illness in 1769 (2). In the second part of the nineteenth century, the first references to the pathophysiology of endometriosis appeared in the literature. Karl von Rokitansky first identified this disorder in 1860, defining it as the existence of an active endometrium outside the uterine cavity (3).

This condition affects between 35 and 50 percent of women who are either in pain or unable to have children or both. (4). However, endometriosis is underdiagnosed and has a 6.7-year mean latency from the onset of symptoms to a conclusive diagnosis, because the condition requires surgical diagnosis (5). Endometriosis is a crippling disorder that adversely affects each patient's quality of life (6). Endometriosis poses serious risks to both individual and societal health, making it crucial to comprehend its origin and pathophysiology to create sensitive non-surgical processes and efficient treatments. Much progress has been made over the past few decades in understanding the mystery surrounding this condition (1).

The definition of endometriosis is the presence of endometrial outside of the uterine cavity together with ongoing inflammation (7). Endometriosis is indicated by the formation of endometrial glands and stroma in ectopic sites, predominantly the pelvic peritoneum, gonads, and rectovaginal septum. Dysmenorrhea, dyspareunia, chronic pelvic pain, irregular uterine bleeding, and/or infertility are the stigmata of endometriosis, which affects 6-10% of women of reproductive age (8).

Endometriosis may have a significant negative influence on a woman's life, including discomfort, infertility, a decline in quality of life, and disruptions to everyday activities, interpersonal connections, and employment (9). The approach to an endometriosis diagnosis is difficult for many women and paved with obstacles and false diagnoses. A gold standard based on an intrusive surgical procedure (laparoscopy) and a variety of symptomatologies is inherent obstacles that contribute to the well-established delay of 4 –11 years between the start of the first symptom and the surgical diagnosis (9). Inflammation of the pelvic tissues, and adhesions, damaged fallopian tubes, changed immune system functioning, changes in the hormonal milieu of the ovaries, delayed implantation of a pregnancy, and reduced egg quality are just a few of the ways endometriosis can affect fertility. Due to a delay in diagnosis, this infertility often goes undiagnosed, resulting in high levels of stress (9). Endometriosis and malignancies are comparable in recurrence, hormonally growth, invasion, and continuous growth, and a predisposition to metastasis are a few of the processes (10). According to epidemiological research, ovarian and breast cancer, melanoma, asthma, rheumatoid arthritis, and cardiovascular disease are all more likely to strike women with endometriosis lesions (11).

Risk Factors for Endometriosis

- Having your first period at a younger age may increase your likelihood of developing endometriosis. This is because early puberty studies analyzing the cycle of women who have endometriosis have demonstrated that the premature first cycle (before the age of 11) is linked to the risk of endometriosis (12–15).
- Genital cycles shorter than 27 days, and genital abnormalities such as hymen enlargement or constriction of the cervical canal represent the greater risk of developing endometriosis, although this risk is independent of the number of days that women bleed or the amount of blood that is lost during menstruation (16).
- A low body mass index (BMI); • A small number of births; • Being Caucasian; • Being between the ages of 25 and 29 (17);
- •Endometriosis is more likely to be detected in infertile women who seem to be active smokers and those whose body weight (BMI) is normal or low (17).
- •Regularly consumption of alcohol in an amount of at least 10 g per day (17);

There has been a considerable increase in the frequency of endometriosis in obese women compared to women with normal weight. It is interesting to note that the most recent statistics indicate that there is generally no association between BMI and the incidence of endometriosis. Moreover, obesity increases the risk of severe cases of dysmenorrhea (18). Endometriosis can be prevented, in part, through proper dietary choices, which is a highly essential factor. It is generally agreed that the consumption of fresh fruits and vegetables, particularly those that are green, offers the greatest health benefits. In comparison to vegetables and fruits, the consumption of red meat is associated with an opposite effect on the progression of endometriosis. It is distinguished by its high content of dioxins, hormones, and fat, increasing the concentration of estrogens, and it has a significant potential for environmental pathogens. Maintaining an optimal lifestyle, which must include a significant amount of downtime, mobility, and exercise, is crucial for the prevention of primary endometriosis. One of the most crucial elements in the battle against illness is this (19).

Theoretical Approaches to Explaining the Origin of Endometriosis

There is no conclusive explanation available for the pathomechanisms that underlie the development of endometriosis at this time. The "retrograde menstruation" idea proposed by Samson is the one that is more commonly accepted. According to this theory, the formation of endometriosis foci is caused by the migration of menstrual blood into the peritoneal cavity via the fallopian tubes (20–22).

According to the research in the relevant literature, a retrograde discharge of menstrual blood is present in 80% of women who have open fallopian tubes, although endometriosis is only present in part of these people. This points to the existence of additional variables that determine the viability of endometrial cells in the peritoneal cavity as well as their ability to implant (23). It is believed that a local malfunction of the processes that prevent adhesion is to blame for implantation in the peritoneum. As a result, there is a rise in the production of cytokines by macrophages, such as tumor necrosis factor (TNF-) and interleukin (24).

Since studies reveal abnormal humoral and cellular immunity, immune processes are significant for interpreting the probable pathomechanisms of endometriosis sites (25).

According to published research, endometriosis is statistically more likely to co-occur with specific immunological disorders including rheumatoid arthritis or hypothyroidism (26).

Mayer's idea, which claims that peritoneal cells are changed into Muller-type cells under the influence of hormones, provided another method of producing endometriosis foci (27). This theory is predicated on the idea that the endometrium contains cells that can differentiate and that these cells serve as progenitors to the pelvic peritoneum and the mesodermal epithelium of the ovary. This theory is very helpful in explaining why endometriosis occurs in many bodily parts where there is a mesothelium, such as the pleural cavity (28,29).

Endometriosis is a condition that is classified as a persistent inflammatory disorder related to immunological processes (30). Nearly every stage of the development of endometriosis is accompanied by abnormalities in the immune system (31). It is well known that macrophages take part in identifying foreign cells and presenting them to T cells. Women with endometriosis exhibit an increase in activated macrophages with a decreased capacity to phagocytose inside the peritoneal cavity. Pro-inflammatory cytokines including IL-6, TNF-, IL-1, and IL-8 are secreted more frequently by them. Women experiencing endometriosis have higher levels of cyclooxygenase-2 (COX-2) mRNA expression in their peritoneal macrophages, which causes them to secrete more prostaglandins (32).

Pathogenesis

John Sampson is credited with developing the theory that retrograde menstruation is analogous to a "seed" growing in the peritoneal wall. Endometriosis lesions develop spontaneously in menstruating species, including humans, macaques, baboons, and some monkeys (33).

According to the traditional definition, an endometriosis lesion is a "piece of tissue" that looks like the endometrial lining of the uterus. This type of endometriosis lesion is sometimes referred to as the "eutopic endometrium" in research that compares its phenotype with that of ectopic lesions. The luminal portion of the eutopic endometrium, which degrades and is shed during menstruation, is a dynamic multicellular steroid-responsive tissue that is supported by a stromal compartment that contains a rich blood supply and fluctuating populations of immune cells. The eutopic endometrium has epithelial cells that are supported by the stromal compartment (34,35).

The endometrium is composed of an inner/luminal functional layer and a basal layer. The fluid-filled uterine lumen and endometrial tissue are separated by columnar epithelial cells on the inner (luminal) surface of the uterus. The endometrium responds to varying blood levels of ovarian sex-steroid hormones between menarche and menopause with cyclical growth and differentiation prepared to support a potential pregnancy. The functional layer is shed during menstruation in a non-pregnant cycle, but within a few days the luminal surface heals, and tissue integrity is restored, ready to start the following cycle (36). While sex-steroid hormones are necessary to maintain healthy uterine function and fertility, they may also play a role in the development of millions of women who suffer from hormone-dependent endometrial illnesses (34).

The endometrium releases a variety of immune cells during menstruation, including neutrophils, monocytes/macrophages, and uterine natural killer (uNK) cells, as well as epithelial (glands and luminal), stromal fibroblasts/decidual, vascular, and perivascular cells (37). Stem/progenitors, stromal fibroblasts, and immune cells have been discovered between the stromal and epithelial compartments of the human eutopic endometrium, potentially contributing to peritoneal lesions (38). The behavior of stromal fibroblasts from endometriosis-affected women has changed, leading to an abnormal response to estrogen (39). It is likely that the remarkable cell plasticity which has adapted to ensure rapid scarless repair of the endometrial lining in response to the "wound" caused by menstruation (including mesenchyme-to-epithelial transformation) also contributes to the formation of multicellular lesions when the cells are in extra-uterine locations. Transient hypoxia is one of the parallels between the processes that regulate menstruation and the ones that may support the creation of lesions (40). There is substantial evidence from animal models indicating the immune cells in endometriosis lesions are a mixture of those shed from endometrial and those recruited from the surrounding environment. Peritoneal fluid (PF) also contains a diverse population of immune cells (41,42).

Genetic and genomic impacts

Endometriosis is said to be “inherited," and twin studies' findings indicate that inheritance could be as much as 50% (43). Single gene polymorphisms (SNPs) that appear to be highly expressed in those with the more severe stages of the disease have been found by genome-wide association studies (GWAS) using samples from thousands of women in the United States, Australia, Japan, and Europe (with a low representation of other nationalities) (44–46). Even though they are broad, these GWAS studies are only able to detect the impact of the most prevalent SNPs; for uncommon variants, alternative methods like family-based sequencing are needed. There are no known unusual variations of endometriosis currently (47).

GWAS studies only have sufficient capacity to examine the effects of the most common SNPs. Other methods are needed to look at the effects of rare polymorphisms. When compared to other SNP datasets, common SNPs linked to endometriosis and other gynecological diseases like infertility, fibroids, and cancer were found to be the same (48).

The research analyzed transcriptome-wide differential expression in endometrium from 200+ women (endometriosis versus controls), and after accounting for cyclical tissue changes, discovered 39 genes that were differentially expressed, five of which co-localized with GWAS regions. This study demonstrates the potential application of this method, as well as the necessity for additional expression quantitative trait locus (eQTL) research, evaluation of distant genes, and larger datasets (49).

Linking GWAS with transcriptional datasets could help find the genes that are most likely to play a role in disease risk. SNPs that are important for the progression of breast and ovarian cancers have been found (50).

Hormonal regulation

Most publications on endometriosis call it an "estrogen-dependent" disorder. We think this should be changed to "steroid-dependent" to reflect the significance of all other steroids as well as their receptors in regulating cells in both eutopic and ectopic endometrium (47). To find out if there is a link between endometriosis and steroid hormone action, researchers have looked at the effect of ovarian endocrine hormones (the menstrual period) on cellular functions, scientific proof for local hormone metabolic activities within the lesions, and cell-specific patterns of expression of steroid receptors. Studies with cells/cell lines and animal models have been done to see how steroids affect the expression of genes involved in cell proliferation, angiogenesis, neurogenesis, and inflammatory pathways. These studies have helped us learn more about how endometriosis develops and why it happens. Normal endometrium expression of receptors that bind to estrogens (ERa, ERß, and GPER1), androgens (AR), progestins (PRA and PRB), or glucocorticoids (GR and MR) depends on the phase of the menstrual cycle (34,47,51). Endometrium and lesions from endometriosis-affected women have been found to have PR expression that is dysregulated, including altered epigenetic programming of the PR promoter (51). These results are in line with observations indicating stromal cells from endometriosis-affected women are less receptive to progesterone's effects, a condition is known as progesterone resistance, which compromises stromal epithelial crosstalk (39). Endometriosis lesions and lesion-derived stromal cells have been commonly documented to express more ERß (51).

Neuroinflammation, angiogenesis, and neuro-angiogenesis

Vascularization, including the development of new blood vessels (angiogenesis), is essential for the establishment, survival, and expansion of endometriosis lesions since they are complex multicellular structures (52). Research on lesions has benefited from knowledge gathered from profiling of angiogenic factors and angiogenic receptors in the normal endometrium, which showed significant levels of expression of vascular endothelial growth factor (VEGF-A) and neuropillin1 (NRP-1) as the major receptor mRNA (53). During menstruation, hypoxia is significant in the control of gene expression (54). The concept of "neuro-angiogenesis," which describes a connection between the development of new blood vessels and nerve fibers, has offered a possible method for understanding the relationship between the existence of ectopic tissue and pain pathways (55).

Endometriosis types

- Ovarian endometriosis - endometrial cysts and superficial lesions are two manifestations of ovarian endometriosis.
- Peritoneal endometriosis - white peritoneal raids, peritoneal defects, red, brown, black, and black foci, colorless dazzling vesicles, focal

dilated blood vessels, and petechiae are some of the several ways that peritoneal endometriosis may appear.

- Deep infiltrating endometriosis (DIE);
- Endometriosis of other locations (56).

Peritoneal endometriosis, ovarian cysts (chocolate cysts), and nodules of deeply infiltrating endometriosis in the stomach or vaginal–rectal septum are the three most common kinds of endometriosis (56). Endometriosis of the peritoneum can manifest intraperitoneally or subperitoneal, therefore 15–50% of women who have been diagnosed with endometriosis have endometriosis foci in the peritoneum (57).

The ovary is one of the prevalent sites affected by this illness. Deep infiltrating endometriosis is distinguished by endometrioid alterations that penetrate deeply into the extraperitoneal region and occupy multiple pelvic organs, including the bladder, ureters, large intestine, sacro-uterine ligaments, and vagina. The pathophysiology of DIE is not well understood (7).

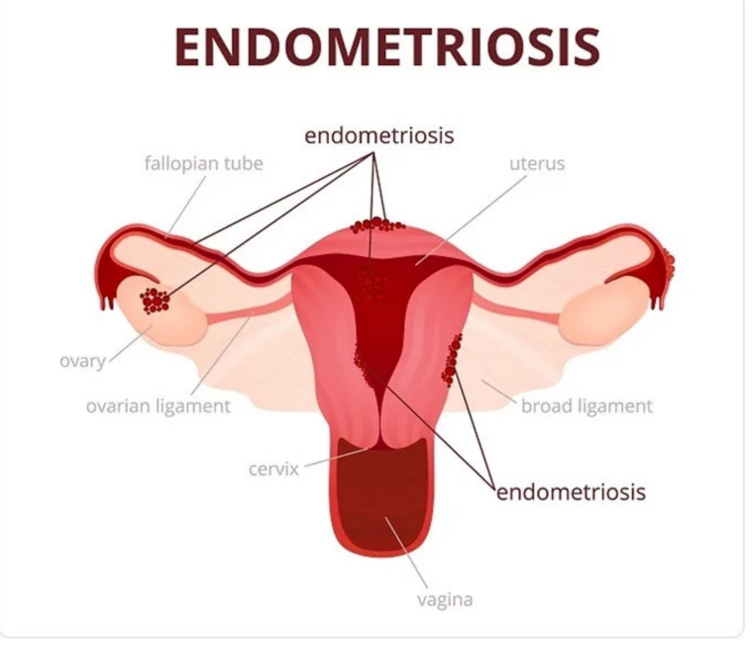


Figure 1. The possible localization of endometriosis (58)

Endometriosis classification

Many divisions and categories have been established to evaluate the site and extent of the disease (7).

As shown by Sampson, authors classify it as one of the following:

- Endometriosis affects the uterine muscle inside the uterus
- Endometriosis which develops outside of the uterine muscle is known as external endometriosis (59).

The classification of Martius and Kistner led to the development of subcategories of endometriosis based on the site of the disease (60,61).

Based on the Classical Classification of Martius, endometriosis is subdivided into endometriosis genitals internal (adenomyosis) and endometriosis genitals externa. Endometriosis extragenital is the presence of endometriotic lesions outside of the reproductive organs (61).

Using Kistner's classification system there are:

- Peritoneal endometriosis affects the ovaries, the uterus, ligaments, fallopian tubes, large intestine, thin intestine, appendix, etc.
- Retroperitoneal endometriosis affects the vagina, vulva, and perineum (61).

Based on the histological classification developed by Brosens (1993), different types of endometrioses can be distinguished such as mucosal, peritoneal, and glandular type (62).

The majority of diagnosed cases of endometriosis can be broadly categorized into three pelvic cavity subtypes: superficial peritoneal, which accounts for approximately 80% of endometriosis; ovarian (cysts or "endometrioma"); and deep (63). Endometriosis lesions have also been discovered in extra-pelvic areas, such as the upper abdominal visceral organs, the abdominal wall, the diaphragm, and the pleura (sometimes known as "thoracic endometriosis"), as well as the central and peripheral nervous systems (CNS and PNS) (64).

Among the many classifications of endometriosis based on the extent and severity of lesions, the American Fertility Society (AFS) classification is the most popular. The American Society for Reproductive Medicine recognizes four distinct stages. Endometriosis is divided into four stages, with stage I and II being mild and stage III and IV being advanced (65,66). The most important goal of classifying and determining the severity of endometriosis is to propose an effective treatment plan (67).

The ENZIAN scale for greatly invading endometriosis is a descriptive scale that takes into account both the presence of the lesion and its degree of penetration. The ENZIAN classification assigned the location of foci to distinct anatomical compartments (68).

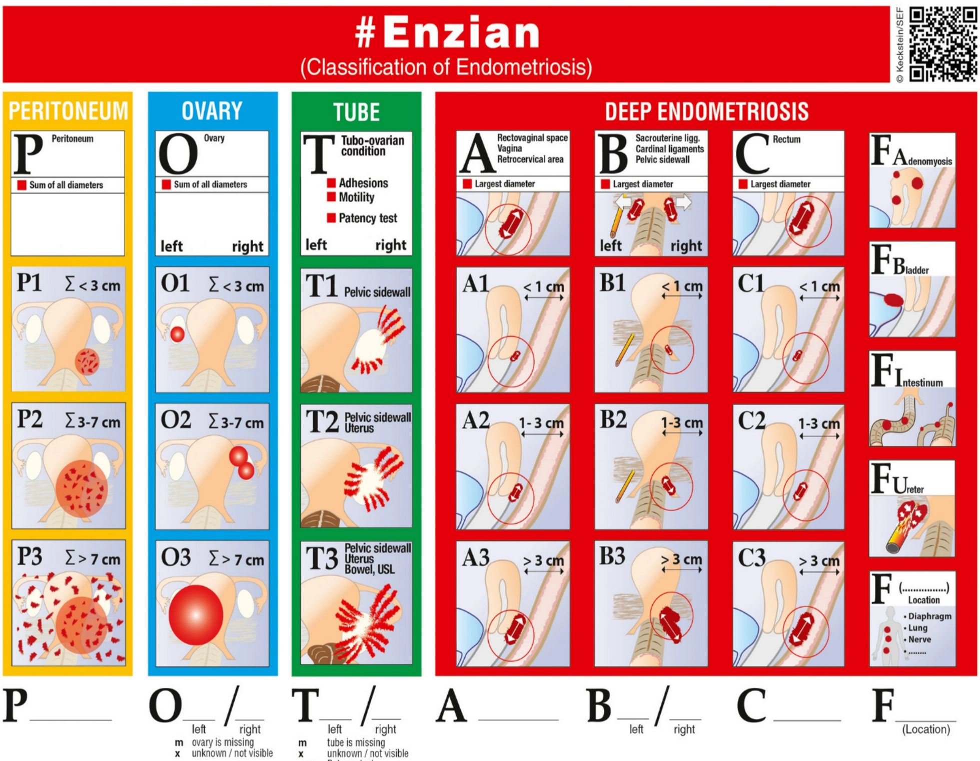


Figure 2. The Enzian Classification of Endometriosis (69)

A classification system that encompasses all aspects of the disease, such as peritoneal endometriosis, ovarian endometriosis, deep endometriosis, and secondary adhesions, is required in light of improvements in preoperative diagnostics and surgical techniques for the treatment of endometriosis, especially for deep endometriosis. Due to its insufficient definition of deep endometriosis, the widely used revised American Society for Reproductive Medicine classification (rASRM) has certain drawbacks. Nevertheless, it excludes peritoneal or ovarian illness as well as adhesions. In contrast, the Enzian classification, which has been in use for the last ten years, is the most effective method for staging deep endometriosis. To get around these restrictions, a thorough classification system for endometriosis that can be used with both diagnostic and surgical methods - the Enzian classification has been developed through a consensus process. It includes anatomical location, size of the lesions, adhesions, and the degree of involvement of the adjacent organs (69).

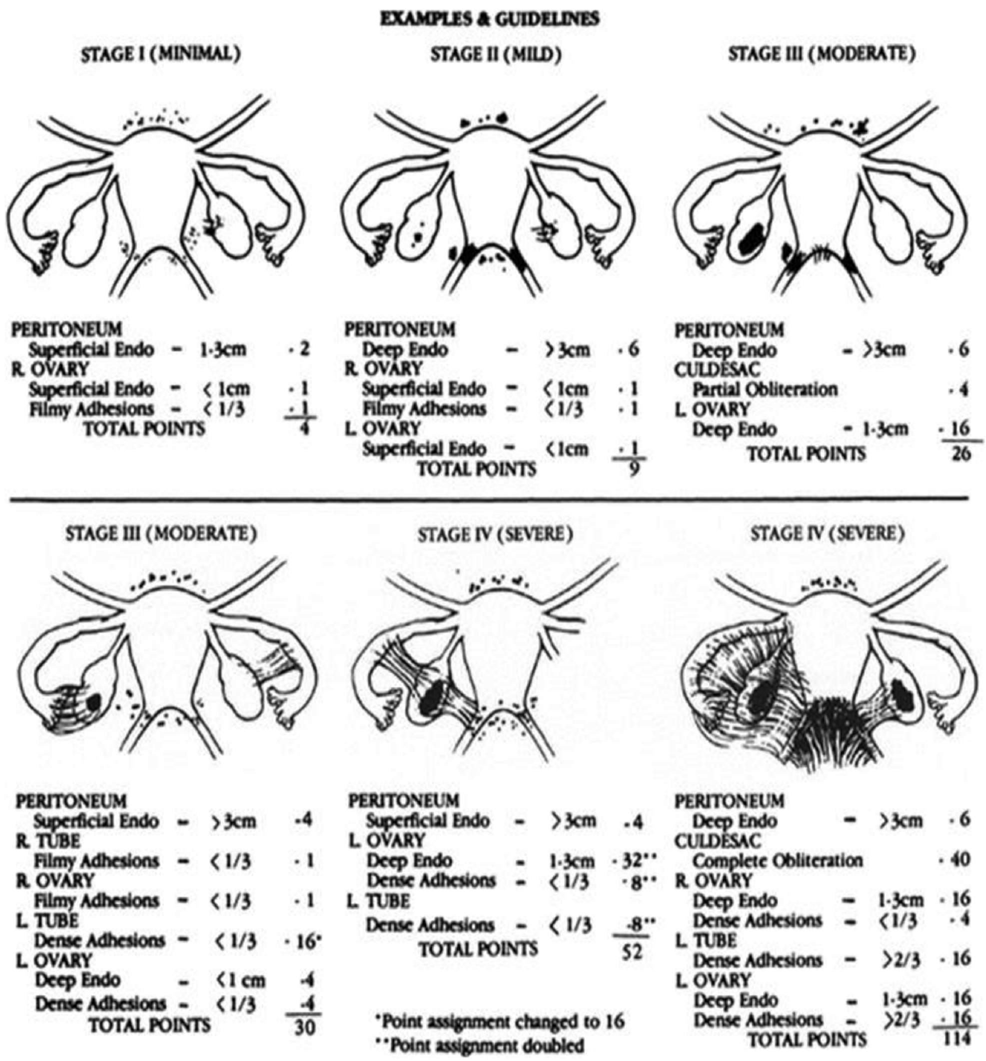


Figure 3. Classification of Endometriosis (70)

Calculation of the American Association of Gynecology Laparoscopists (AAGL) Score "The surgical difficulties for treating endometriosis", as evaluated by skilled surgeons, was calculated, and summarized for each anatomic site. The responses from professionals demonstrated a high degree of internal consistency in their ratings. The normalizing of these surgical difficulty ratings yielded the endometriosis point value at each anatomic site (71).

Superficial	Score
< 3 cm	2
≥ 3 cm	4

Vagina (muscularis)	Score
< 3 cm	5
≥ 3 cm	8

Left Ovary	Score
Superficial	2
< 3 cm	5
≥ 3 cm	7

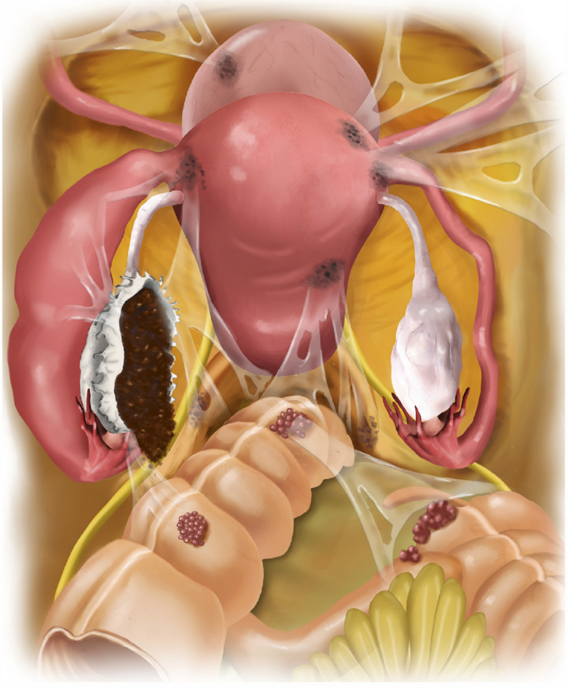
Left Ureter	Score
Extrinsic	6
Intrinsic	8
Hydroureter	9

Left Fallopian Tube	Score
Slight serosal involvement /damage	2
Moderate immobility	4
Severe immobility	6
Complete obstruction	7

Cul-de-sac obliteration	Score
Partial	6
Complete	9

Rectum/ Sigmoid colon	Score
< 3 cm	7
≥ 3 cm	9

Rectovaginal septum	Score
Present	8



Retrocervical	Score
< 3 cm	5
≥ 3 cm	8

Bladder/ detrusor	Score
< 3 cm	5
≥ 3 cm	7

Right Ovary	Score
Superficial	2
< 3 cm	5
≥ 3 cm	7

Right Ureter	Score
Extrinsic	6
Intrinsic	8
Hydroureter	9

Right Fallopian Tube	Score
Slight serosal involvement /damage	2
Moderate immobility	4
Severe immobility	6
Complete obstruction	7

Small bowel/ Cecum	Score
< 3 cm	6
≥ 3 cm	8

Appendix	Score
Present	5

AAGL Endometriosis Stage	Total Score
Stage 1	≤8
Stage 2	9 to 15
Stage 3	16 to 21
Stage 4	>21

Figure 4. American Association of Gynecology Laparoscopists - 2021 Classification of Endometriosis (71)

Signs and Symptoms of endometriosis

Endometriosis is commonly related to symptoms including persistent pelvic pain (both periodic and non-cyclical), menstrual pains, difficult sex, and discomfort during urination and defecation. Endometriosis is a condition that causes women to experience fatigue and sadness, symptoms that are shared with other conditions that cause chronic pain. Patients diagnosed with endometriosis have a much greater incidence of sub- or infertility as compared to the overall female population. According to the criteria of ASRM, evaluations of disease stage regularly reveal poor correlations between the abundance/location and sort of lesion and patient-reported pain symptoms (72). It is a poorly understood illness, and there is no general agreement over whether superficial peritoneal endometriosis can develop to become another subtype or spontaneously regress into a previous state. Very little is known about the cause of endometriosis that occurs outside of the pelvis. These concerns have led to the hypothesis that if we stop thinking of endometriosis as a singular "disease" with a diagnosis based purely on the existence of lesion(s) mimicking endometrium, we may make better progress in designing patient-focused treatments (73). Endometriosis should be classified as a "syndrome," diagnosed only when both visible lesions and symptoms are present, with a focus on treating the symptoms that are most important to the patient (12).

Endometriosis is one of the most prevalent disorders that might lead to a woman's inability to conceive a child. According to research conducted by the American Society for Reproductive Medicine, endometriosis affects anywhere from 24 percent to 50 percent of infertile women. Endometriosis may induce infertility in its mild and moderate forms; however, it may only be transitory. A woman can get pregnant after undergoing surgery to remove the endometrial tissue. The specific relationship between endometriosis and infertility is not fully understood by medical professionals. Endometriosis may cause scar tissue, which can interfere with the release of eggs from the ovaries or impede the route of an egg as it travels down the fallopian tube, preventing it from reaching the uterus. Endometriosis may also cause harm to sperm or fertilized eggs before they implant in the uterus, which can make it more difficult to have children. Even if they have endometriosis or endometriosis-related infertility, many women may still become pregnant and bring the baby to term without any problems. There are medical procedures, such as fertility preservation and in vitro fertilization (IVF), that women may undergo to increase their chances of conceiving a child (74).

Diagnosis

The diagnosis of endometriosis requires a histopathological investigation, although a thorough medical history, gynecological examination, imaging techniques, laparoscopy, and biochemical testing are also helpful in making the diagnosis (7). An ultrasound exam is typically used as the first step in determining whether or not a patient has endometriosis (75). The diagnosis of endometrial cysts of the ovary and congenital abnormalities of the reproductive organs that encourage the retrograde outflow of menstrual blood inside the peritoneal cavity can be assisted by ultrasound examination (76). Diagnostic procedures that do not involve surgery, such as transvaginal ultrasonography and magnetic resonance imaging (MRI), have the potential to be useful in the diagnosis of ovarian and deep endometriosis (77).

Visualization during surgery is currently the gold standard for making a diagnosis of endometriosis, determining its stage, and determining whether or not the disease has returned following therapy (78). Based on the type, localization, appearance, and depth of invasion of the lesions as well as the level of disease and adhesions, the American Society for Reproductive Medicine's updated scoring system is used to establish the disease stage. This stage can be found on a scale that goes from I, which indicates minimal disease, to IV, which indicates severe disease (78). Transvaginal ultrasonography and magnetic resonance imaging are ineffective in detecting peritoneal and ovarian implants and adhesions, but they detect ovarian endometriomas with a sensitivity of 80-90% and a specificity of 60-90% (79). Recognizing alterations during laparoscopic surgery is the most accurate approach to diagnosis (80). Although being the gold standard for endometriosis diagnosis, laparoscopy's requirement is a major roadblock to both current cares for this widespread and disabling condition and future research. It is not unexpected that significant attempts are being undertaken to improve the diagnosis by imaging techniques given that visual examination of the pelvis also has significant limitations, notably for the identification of posterior pelvis, bowel, and bladder endometriosis (79). Due to current or earlier bleeding, ovarian endometriomas and peritoneal endometriosis are predominantly hemorrhagic lesions that are readily seen during laparoscopy. Magnetic resonance imaging and transvaginal sonography both have low sensitivity for the detection of peritoneal and ovarian implants and adhesions, but transvaginal Sonography is the preferred technique for confirming a sizable endometrioma. It is less expensive than MR imaging and can be used if the diameter is greater than 2 cm (79). Pelvic endometriosis is an infiltrated adenomyotic lesion containing microendometriomata, which is increasingly being diagnosed using high-resolution transvaginal ultrasonography and MR imaging (79).

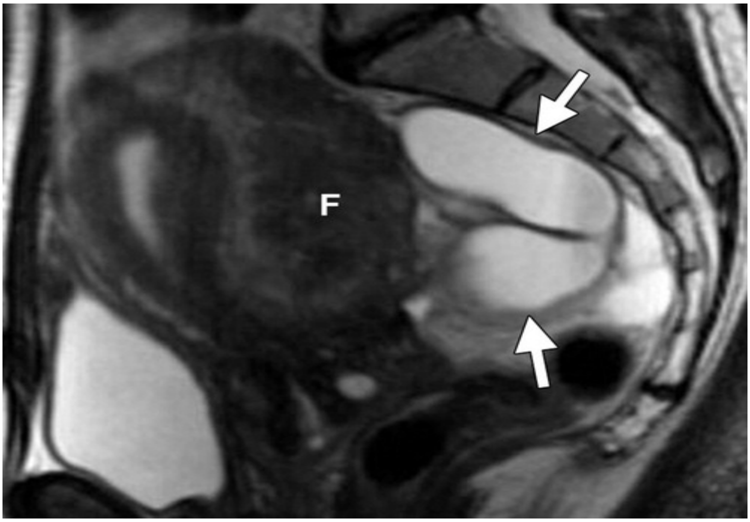


Figure 5. MRI Imaging of Endometriosis (81)

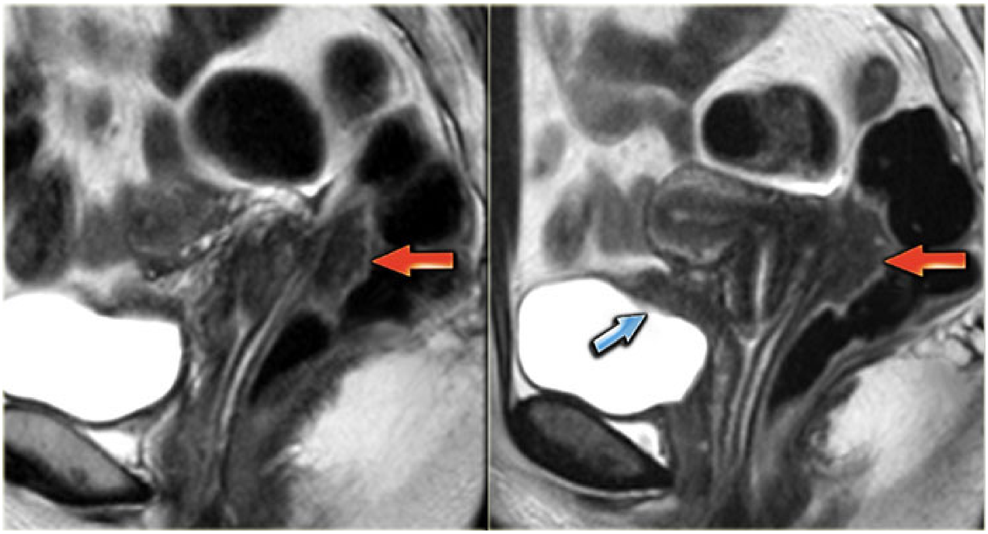


Figure 6. Endometriosis MRI detection – Cullen's syndrome (82)

Deep pelvic endometriosis, commonly known as Cullen's syndrome, is characterized by subperitoneal endometrial infiltration. MRI can be used to diagnose deep infiltrating lesions and to gauge the extent of the disease. To determine whether surgical intervention is necessary and if so, to plan a full surgical excision, it is important to map the disease extension before surgery (82).

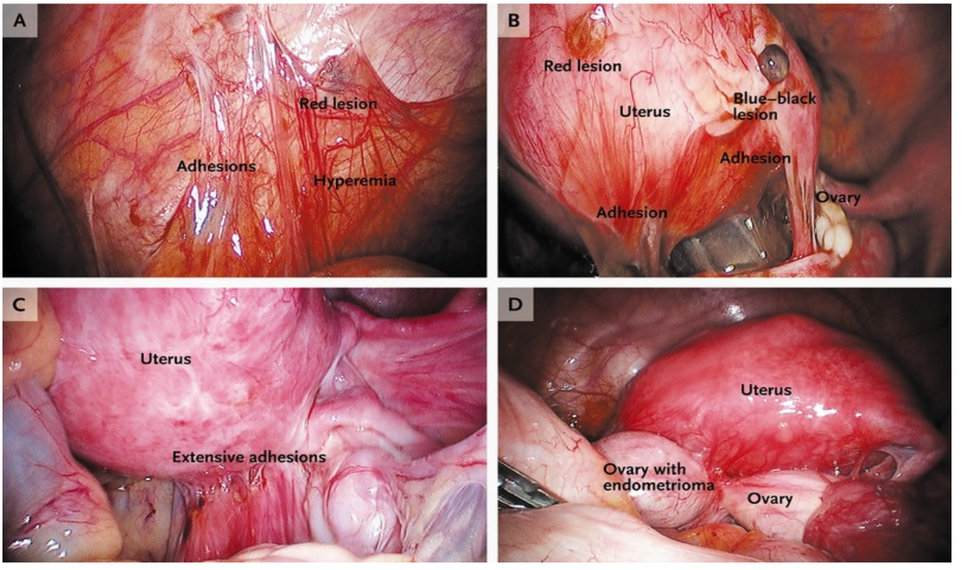


Figure 7. Peritoneal lesions and an Ovarian Endometrioma due to endometriosis (83)

The difficulty involved in making a diagnosis of endometriosis

It is not possible to define endometriosis using any pathognomonic characteristics or biomarkers that are both essential and sufficient. Rather, critical symptoms that now trigger surgical assessment, such as discomfort and infertility, can have many origins. Surgical evaluation is currently required when these symptoms are present (9). Endometriosis is typically described by its histology, which consists of the extrauterine lesion including endometrial glands, endometrial stroma, and/or hemosiderin-laden macrophages. This is how endometriosis is diagnosed. Lesions are further classified as superficial peritoneal lesions, ovarian endometrioma, or deep endometriosis based on their location and depth (9). Therefore, the existence of lesions does not rule out the potential of endometriosis as a cause of the patient's symptoms, nor does the absence of visible lesions rule out the possibility of endometriosis as a cause of the patient's symptoms. In addition, there is a weak association between the symptoms and the degree or extent of the disease, as measured by the several staging methods that are now in use (84).

Treatment of endometriosis

Even though endometriosis cannot be cured, science and clinical experience have given practitioners a few methods for treating its symptoms (85,86). Surgical excision of lesions and ovarian hormone-suppressing medications are currently used as therapies. About half of the women who have surgery will have another treatment within five years (11,87). Women with surgically diagnosed endometriosis have a higher risk of developing ovarian cancer than those with laparoscopic sterilization (87). According to patient surveys, the top priorities for research are better medical treatments that don't limit fertility and symptom relief (77). The surgical removal of lesions and a selection of pharmaceutical treatments are described below. There are no known treatments that prevent the development of the disease. Defining recurrence is difficult in and of itself due to the lack of precise non-invasive methods for diagnosing and monitoring disease progression. A recent review used a life-course impact analysis to examine the multifaceted effects of endometriosis, highlighting the need for both early detection and innovative, stage-appropriate treatment approaches (88).

Medical Treatment of Endometriosis

Without surgical confirmation of disease, empirical medical treatment is often initiated for pain management. This therapy aims to reduce pain through a variety of mechanisms, such as reducing inflammation, restricting, or suppressing cyclic ovarian hormone production, inhibiting the activity and production of estradiol, and reducing or eliminating menstruation (89,90).

Since steroids play a crucial role in the pathophysiology of endometriosis, hormonal inhibiting therapy is routinely prescribed. When endometriosis is presumed in young women before surgical confirmation of lesions, and after surgery when symptoms continue to persist or disease recurs, treatments are frequently initiated. By inhibiting ovarian activity (including the secretion of sex hormones) or acting directly on steroid receptors as well as enzymes observed in the endometrium and lesions, the most commonly prescribed drugs alter the hormonal environment. They also could reduce menstrual bleeding, thereby decreasing retrograde flow or preventing the activation of inflammatory pathways associated with menstrual pain (91).

Combination contraceptive pills, progestogens (oral, intramuscular, and intrauterine system), anti-progestogens, gonadotrophin-releasing hormone agonists (GnRH agonists), GnRH antagonists, and aromatase inhibitors are some examples (86). Combination hormonal contraceptives and progestin alone should be regarded as first-line treatments, whereas a GnRH agonist with HT add-back or LNG-IUS should be regarded as a second-line therapeutic option. Practitioners should use clinical judgment when providing analgesics ranging from nonsteroidal anti-inflammatory drugs (NSAIDs) to opioids pending remission of symptoms (76). Even if not approved in clinical guidelines, moderate-quality evidence indicates that the progesterone-receptor modulator mifepristone alleviates menstrual pain in women with endometriosis, and limited evidence suggests that this agent also alleviates pain with sex; however, cessation of the menstrual period and excessive sweating are common side effects (92). Due to its many androgenic side effects (a few irreversible), such as weight gain, hirsutism, and acne, as well as its tendency to negatively affect blood cholesterol levels, Danazol (a synthetic androgen) is no longer recommended in clinical guidelines for the treatment of endometriosis (93).

GnRH agonists successfully deplete the pituitary gland of endogenous gonadotropins and prevent further production, which interrupts the menstrual cycle and causes a hypoestrogenic condition, endometrial atrophy, and amenorrhea as a result. In a review of 15 randomized trials with 1821 women, the pain scores for dysmenorrhea went down by 60 to 100% when GnRH agonists were used. These results are the same as those for danazol, antiprogestins, and combined oral contraceptives (94). GnRH agonist therapy has a lot of side effects, including a condition called hypoestrogenic, which can cause bone loss of up to 13% in 6 months (which is partly reversible on discontinuation of therapy) (95)

Many women with confirmed or suspected endometriosis who seek pain relief will purchase nonprescription drugs such as paracetamol and nonsteroidal anti-inflammatory drugs (NSAIDs) (96). Findings that continuous use of NSAIDs or other COX-2 inhibitors may inhibit ovulation are also concerning for women trying to conceive (97). Neuromodulators differ from traditional analgesics such as nonsteroidal anti-inflammatory drugs (NSAIDs) in that they predominantly affect the CNS modulation of pain instead of peripheral mediators of inflammation. Initially, many neuromodulators were created as antidepressants or anticonvulsants. Endometriosis is treatable with tricyclic antidepressants (e.g., amitriptyline and nortriptyline), selective serotonin uptake inhibitors (e.g., duloxetine), as well as anticonvulsants (e.g., gabapentin and pregabalin). In a recent randomized controlled trial for the treatment of chronic pelvic pain (in the absence of endometriosis), gabapentin was not conclusively shown to be superior to a placebo (98).

Currently, patients seeking pain relief, especially those wishing to conceive, have limited medical treatment options. By targeting processes such as inflammation and angiogenesis or pathways implicated in the generation of painful symptoms, researchers have rethought their approach to the development of novel therapeutics in response to this unmet need. To expedite access to new drugs suitable for clinical trials, they have also considered parallels with both endometriosis and other disorders, as well as the possibility of repurposing already-approved drugs. Some of these new initiatives are highlighted below, along with drugs that have shown promise in preclinical animal models (47).

Surgical Management of Endometriosis

It is possible to use surgical methods to treat endometriosis-related pain, either as the primary treatment or as a backup for medical treatments that have been unsuccessful (99).

Operations might be categorized as conservative or definitive. Conservative treatment, sometimes known as fertility sparring, includes the removal of endometriomas, resection of deep-infiltrating implants, and ablation or excision of peritoneal implants. Although hysterectomy with or without oophorectomy is the only possibility for final surgical therapy, this further reduces fertility. With 5-10% of women of reproductive age suffering from endometriosis, there is a sizable patient group seeking surgical treatment (83).

Excision, fulguration, or laser ablation of endometriotic implants on the peritoneum as well as the resection of rectovaginal nodules, the lysis of adhesions, and the cutting off of nerve paths are all surgical operations (83). The pain associated with endometriosis can be alleviated through treatment with excision or ablation. Excision, as opposed to drainage or fulguration, is the treatment of choice for women diagnosed with endometriomas because it offers superior pain relief, a lower risk of recurrence, and a histological diagnosis (100).

Laparoscopic uterine nerve ablation on its alone does not provide appreciable relief from the discomfort associated with endometriosis (76). Women with endometriosis-related discomfort should only choose surgery as a last resort, and this may necessitate a multidisciplinary approach (76).

Laparoscopic ablation of endometriotic implants is 65% successful in reducing pain after 6 months, according to randomized, controlled studies, compared to a 22% rate of pain reduction associated with diagnostic laparoscopy alone (101). Nerve pathway disruption is an alternate method for reducing pain brought on by endometriosis. Compared to laparoscopic ablation alone, randomized, controlled trials have demonstrated that the combination of laparoscopic ablation of endometriotic tissue and presacral neurectomy moval of the nerve bundle within the boundaries of the interiliac triangle is more effective at improving dysmenorrhea and lessening severe midline pain (102).

Case studies have demonstrated that hysterectomy with bilateral salpingo-oophorectomy relieved pain in 80 to 90% of women with incapacitating symptoms who were unresponsive to medical or other surgical interventions; however, 10% of the women experienced pain recurrence within one to two years of surgery. As estrogen alone has been shown to encourage the formation of microscopic illness, postoperative hormone replacement should contain both estrogen and a progestogen (89).

In contrast to diagnostic laparoscopy, an operative laparoscopy (excision or ablation of endometriosis lesions) with adhesiolysis should be done on women with endometriosis stage I or stage II since there is a positive effect on live birth and continued pregnancy at 20 weeks of amenorrhea (85). Pregnancy rates and the benefits of surgical therapy for stage III–IV endometriosis. The incidence of postoperative pregnancy ranges from 30% to 67%. Even though severe peri-ovarian adhesions usually reoccur and impede tubal pick-up of the ovum, the main benefit of surgery is seen soon after the first operation. Subsequent surgeries are unlikely to be effective in boosting fecundity if the first operation does not lead to pregnancy. After revision surgery, pregnancy rates are reduced by 50% compared to after the original surgery (22% for revision surgery against 40% for main surgery). The choice between reconstructive surgery and IVF must consider the patient's symptoms, the existence of complicated cysts that need a histological diagnosis, their age, their ovarian reserve, their male factor infertility, and the accessibility of qualified surgeons. Between 6 to 12 months post-surgery, the main benefit is realized (103).

Dysmenorrhea is a fairly prevalent gynecological problem with detrimental effects on a sufferer's quality of life. It is the occurrence of uncomfortable menstrual cramps of uterine origin. Oral contraceptive pills (OCP) and nonsteroidal anti-inflammatory medicines (NSAIDs), which both work by decreasing prostaglandin levels, are two types of medical treatment for dysmenorrhea. Surgery has been an option for these situations because, although these therapies are extremely effective, there is still a 20 to 25% failure rate. The use of presacral neurectomy (PSN) and uterine nerve ablation (UNA), two surgical procedures, has increased recently as a result of improvements in laparoscopic techniques. Both of these treatments damage most of the cervical sensory pain nerve fibers. Several techniques are effective for treating primary dysmenorrhea in observational studies. The cervical sensory nerve fibers in the pelvic region are only partly interrupted by both procedures, therefore this kind of surgery may not always help women with dysmenorrhea (102).

Supplemental Medical Care

Postoperative medicine may help women with advanced sickness (stage III or IV), moderate to severe dysmenorrhea, and noncyclic pelvic discomfort manage their pain by lowering recurrent microscopic or residual disease.

Despite the benefits being inconsistent with longer follow-up (to 18 months) after therapy discontinuation, a metanalysis of six randomized trials comparing 3 to 6 months of postoperative treatment with a GnRH agonist, danazol, or combined oral contraceptives with no postoperative treatment or placebo found a significant reduction in pain scores in the active treatment groups. For individuals who received postoperative treatment with GnRH agonists (>24 months), the median time between surgery and symptom recurrence necessitating alternative medication was considerably longer than for those who got a placebo (12 months) (104).

Management of Infertility

The inability of a couple to conceive after a year of regular, unprotected sexual activity is known as infertility. Infertility affects 15% of American couples who are of reproductive age (105). While pregnancy may happen at any age, the typical reproductive age range is 15 to 44. Fecundability, or the likelihood of becoming pregnant during one menstrual cycle, is thought to be between 20% and 25% among young, healthy couples (105). Following 12 months of unprotected sexual activity, 85 percent of couples will get pregnant. Almost 50 percent of couples who have not conceived after 12 months without contraception will do so spontaneously during the next 36 months. Without medical help, infertility will likely remain if a couple has not conceived by this time (105).

Causes of infertility

To conceive, a woman must go through a complex sequence of events, including (1) ovulation of a competent oocyte; (2) production of competent sperm; (3) juxtaposition of sperm and oocyte in a functional reproductive tract and subsequent fertilization; (4) development of a viable embryo; (5) implantation of the embryo into the endometrium; and (6) maintenance of the pregnancy. Reduced fertility or infertility may occur when any of the crucial reproductive processes break down (105). Three primary types of conditions might have an impact on a couple's fertility:

1. Feminine variables accounting for 65%

2. Aspects related to men (20%)

3. Conditions that cannot be described or other conditions (15%) (105).

Evaluation of infertility

At the first stage of diagnosing infertility, a focus is placed on identifying the factors that account for the majority of cases of male and female sterility. It is essential to be aware that a couple's inability to conceive may be due to the interaction of more than one condition; hence, a complete examination is often called for. As is the case with any other medical condition, a careful history and evaluation should reveal factors that may be involved in a couple's infertility. These factors include medical disorders, medications, previous surgeries, pelvic infections or pelvic pain, sexual dysfunction, and environmental and lifestyle factors (for example, diet, exercise, tobacco use, and drug use) (105). When an initial examination should take place is mostly determined by the age of the woman in the relationship as well as the infertility risk factors that are present in the pair. Women over the age of 35 who have been trying to conceive for at least six months may benefit from an initial examination after just four months have passed. This is because there is a correlation between an increase in maternal age and a decrease in fecundity. In most cases, an obstetrician–gynecologist will be the one to perform the initial diagnosis as well as the treatment of infertility. An endocrinologist who specializes in reproduction may be able to provide a more specific examination and therapy (105).

Ovulation

Ovulatory cycles are most likely if there is a background of regular and predictable menstruation. In addition, many women report experiencing the characteristic symptoms that are linked to ovulation and the production of progesterone. These symptoms include unilateral pelvic discomfort (mittelschmerz), puffiness and tenderness of the breasts, reduced vaginal secretions, abdominal bloating, a slight increase in body mass, and occasional episodes of depression. Anovulatory women are very unlikely to have these alterations. As a result, a background of regular menstruation together with the related cycle alterations can be considered to constitute presumptive proof of ovulation. The corpus luteum is responsible for the production of progesterone, which is predominant during the luteal phase of the menstrual cycle and continues after conception has taken place (105).

As a result of progesterone's action on the endocervix, the thin and transparent endocervical mucus transforms into a mucoid substance that is sticky. The set point of the brain's thermoregulatory center is also altered by progesterone, which increases the basal body temperature. When there is no pregnancy present, involution of the corpus luteum is accompanied by a sudden drop in the synthesis of progesterone, stabilization of the basal body temperature, shedding of the endometrium, and the beginning of menstruation (105).

Two tests may be used to offer estimates of ovulation and assist in forecast when ovulation will occur. Urine LH kits can further prospectively determine the presence of ovulation and the time of ovulation based on increased excretion of LH in the urine. Ovulation takes place around twenty-four hours after there is evidence of a rise in LH in the urine. Basal body temperature measurements demonstrate a typical biphasic temperature curve throughout the majority of ovulatory cycles. Ovulation may also be determined by utilizing blood progesterone levels and the endometrial response to progesterone in other diagnostic procedures (105).

Deficiency in Ovulatory Function

If oligo-ovulation, also known as sporadic and unexpected ovulation, or anovulation, also known as the absence of ovulation, is established, often depending on clinical and laboratory data, then more testing is recommended to discover the underlying reason. Polycystic ovary syndrome (PCOS) is one of the most prevalent reasons why ovulatory dysfunction occurs in women of reproductive age. Other reasons include thyroid abnormalities and hyperprolactinemia. Oligomenorrhea and indicators of hyperandrogenism such as hirsutism, acne, and weight gain are common symptoms for women who have polycystic ovary syndrome.

Amenorrhea is a symptom that may be seen in infertile women, and it often indicates that the woman has not ovulated. Ovarian failure, blockage of the reproductive system, pregnancy, and hypothalamus dysfunction (typically due to stress) are all important reasons for amenorrhea. A pregnancy test should always be provided. The assessment of serum levels of human chorionic gonadotropin (hCG), thyroid-stimulating hormone (TSH), prolactin, total testosterone, dehydroepiandrosterone sulfate, follicle-stimulating hormone (FSH), luteinizing hormone (LH), and estradiol may be included in the testing for ovulatory dysfunction that is performed in the laboratory. It is possible that treating the underlying cause of ovulatory dysfunction could result in a return of ovulation and an increase in fertility (105).

Anatomical Considerations

To properly diagnose infertility, it is necessary to examine the pelvic anatomy. Infertility may be caused by abnormalities in some organs, including the uterus, the fallopian tubes, and the peritoneum.

The most often occurring uterine abnormalities are not sufficient to induce infertility; rather, these problems are often connected with the loss of a pregnancy. Nevertheless, if there is a history that raises concerns, such as irregular bleeding, pregnancy loss, premature birth, or past uterine surgery, it is very vital to have an evaluation of the uterus done. Leiomyomas, endometrial polyps, intrauterine adhesions, and congenital malformations (such as a septate, bicornuate, unicornuate, or didelphic uterus) are all examples of potential uterine abnormalities (105).

The fallopian tubes are dynamic structures that are crucial for the movement of the ovum, sperm, and embryos, as well as for fertilization. At the time of ovulation, the oocyte is retrieved from either the site of ovulation or the pelvic cul-de-sac by the fallopian tube's end tube that has a fimbriated tip. After being moved, the oocyte will arrive in the ampullary region of the fallopian tube, which is where fertilization will take place. After that, a zygote and ultimately an embryo are created from the fertilized egg. Five days after conception, the embryo travels via the fallopian tubes and reaches the endometrial cavity. This is followed by the implantation of the embryo further into secretory endometrium and subsequent growth and development of the embryo. Laparoscopy and HSG are both diagnostic tools that may be used to examine the fallopian tubes and pelvic (105).

Pelvic adhesions that damage the fallopian tubes or the peritoneum may form as a result of endometriosis, pelvic infection (such as pelvic inflammatory disease and appendicitis), or either pelvic or abdominal surgery, most notably tubal surgery. Scarring and blockage of the fallopian tubes are potential aftereffects of any one of the processes or events described below. Chlamydia trachomatis and Neisseria gonorrhoeae are two organisms that are regularly implicated in cases of acute salpingitis, which is typically caused by pelvic infections that relate to sexually transmitted diseases (105). Endometriosis affects a greater percentage of infertile women than fertile women, and it may lead to damage and malformation of the fallopian tubes as well as other pelvic organs (105).

Infertility in men

While analyzing an infertile marriage, it is essential to further do a test on the male partner's sperm due to the prevalence of male infertility (105).

After two to three days of abstinence, the semen samples are often acquired by masturbation; repeated ejaculations may reduce sperm concentration. Since the initial portion of the ejaculate has the highest concentration of sperm, it is crucial to capture the whole ejaculate. One hour after ejaculation, the material should be analyzed. The standard semen analysis assesses sperm concentration, sperm motility, and sperm morphology in addition to the amount and quality of seminal fluid. The World Health Organization has defined normal semen measurements. In more than 90% of heterosexual couples, a normal semen analysis rules out a male factor as the cause of infertility. Certain male infertility etiologies are linked to certain anomalies seen in semen analysis. Specialized diagnostic tests may be utilized to assess sperm function further; however, they are not often used (105).

Originally used to determine the viability of sperm present in ovulatory cervical mucus, the postcoital test is currently regarded as having little diagnostic and therapeutic use. Additionally, any abnormalities of the cervix or cervical mucus are disregarded during traditional reproductive procedures including intrauterine insemination (IUI) and in vitro fertilization (IVF) (105).

In some couples, a thorough assessment of both spouses fails to pinpoint the cause of their infertility. The findings of the test specifically show a normal semen analysis, ovulation evidence, a normal uterine cavity, and patient fallopian tubes. Unaccounted-for infertility is thought to affect 15% of infertile couples. The existence of one or more modest aberrations in the carefully planned series of circumstances that lead to successful conception is often indicated by this diagnosis. These anomalies may not be detectable by the testing used today. The age of the female spouse and the length of infertility have an impact on these couples' low incidence of spontaneous conception, which ranges from 1% to 3% each month. Subtle problems such as pelvic adhesions and mild endometriosis may be found and treated if the female partner undergoes laparoscopy. It's alright to continue with medical infertility therapy without conducting a laparoscopy (105).

Treatment

Infertility in a relationship may be caused by one or more disorders in either one or both spouses. The infertile pair may be treated using a variety of medical, surgical, and assisted reproductive technology (ART) procedures. Empiric therapy for couples with unexplained infertility may target one or several modest problems (105).

In certain cases, surgical treatments are necessary. When a woman complains of pelvic pain or infertility, a laparoscopic procedure may be performed to determine the source of the discomfort, treat it, and assess the pelvic anatomy from the perspective of fertility. If a fallopian tube blockage is discovered via HSG, it could be feasible to surgically remove the obstruction. The endo salpinx has to be in good condition for these procedures to be effective. An ART like IVF may be required if the fallopian tube injury is severe enough to hinder gamete transfer. When necessary, hysteroscopic surgery may be used to surgically treat uterine abnormalities such as submucosal leiomyomas, uterine tumors, uterine scar tissue, and a septum (105).

Women who have anovulation or oligoovulation might consider ovulation induction. Before beginning ovulation induction treatment, any recognized ailment linked to ovulatory problems must be treated. These ailments include hypothalamic dysfunction-causing thyroid problems, hyperprolactinemia, PCOS, and high amounts of stress (including emotional stress, strenuous exercise, and eating disorders) (105).

The drug clomiphene citrate is most often used to induce ovulation. Letrozole, an aromatase inhibitor, needs to be thought of as an alternate first-line treatment, nevertheless. The estrogen binding to the estrogen receptors in the brain and pituitary is competitively inhibited by the selective estrogen receptor modulator clomiphene. Clomiphene's antiestrogenic properties cause the pituitary to produce gonadotropin, which encourages the formation of follicles in the ovaries. In the follicular phase of the menstrual cycle, beginning between cycle days 3 and 5, clomiphene is injected every day for 5 days. In the absence of ovulation, the dosage is raised for the next month (105). Ovulation may be seen in several ways when using clomiphene, and it can happen anywhere between 5 and 12 days following the last tablet. Starting on cycle day 10, urine LH kits may be used every day; after ovulation has been place, exposure to sperm via sexual activity or IUI should take place. On cycle days 11 or 12, a transvaginal ultrasound may spot a growing follicle. When a mature follicle is found using ultrasonography (average diameter > 18 mm), ovulation may be induced by injecting hCG subcutaneously. Exogenous hCG successfully mimics the LH surge and causes ovulation; this approach facilitates the right timing of sexual activity or artificial insemination. Some couples would rather regularly engage in midcycle relations without keeping track of ovulation. In this case, a cycle day 21 serum progesterone level may show that ovulation has occurred. Clomiphene usage is linked to a 10% chance of multiple pregnancies, most of which are twin pregnancies, as well as a 1% risk of ovarian hyperstimulation and cyst development (105). The mechanism of action of aromatase inhibitors is the selective suppression of the last stage of estrogen synthesis. Recent studies show that people with PCOS who use aromatase inhibitors instead of clomiphene had higher rates of ovulation and live births. A trend toward fewer multifetal pregnancies has also been seen in several research projects (105).

Intrauterine Insemination

IUI may be advantageous for:

- Couples whose infertility is caused by medical issues are treated (endometriosis or low sperm count or quality).
- Unexplained infertility couples.
- Couples of same-sex females who use donor sperm.
- Sperm donation is used by single ladies who want to create a family (106).

A specimen of ejaculated sperm is cleaned to eliminate prostaglandins, bacteria, and proteins before IUI. The sperm are then suspended in a minute quantity of media. A speculum is introduced into the vagina, the specimen is put in a thin, flexible catheter, and the catheter is pushed past the cervix and into the uterine cavity, where the specimen is deposited, to do IUI. A total motile sperm count of at least 1 million (concentration multiplied by motility) must be present since pregnancy is unlikely with lower levels. IUI increases the likelihood of conception among infertile couples, especially those with moderate male infertility. To obtain conception, however, more severe male infertility may demand the use of ART. If the male partner is azoospermic and no sperms are detected after a testicular biopsy, or if a woman does not have a male partner, IUI with donor sperm is an option (105).

Since it is a less intrusive, less expensive alternative to in vitro fertilization (IVF), and because it may be conducted in the clinic for your convenience, intrauterine insemination (IUI) is a treatment option that is widely used (106).

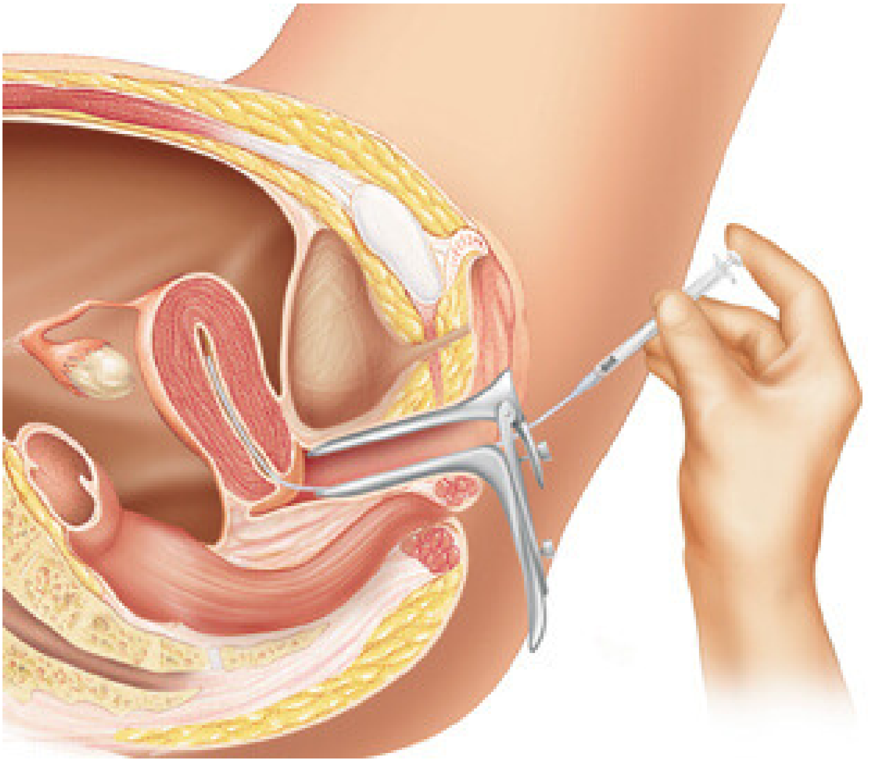


Figure 8. Intrauterine insemination treatment (106)

Technology for Assisted Reproductive Achievement

It was in England in 1978 when the first successful in vitro fertilization (IVF) treatment in humans was carried out. The therapy was carried out on a lady who had an unstimulated menstrual cycle, and doctors conducted a laparoscopic extraction of a single egg from the ovary. After that, the egg was fertilized in a laboratory dish, and the resulting embryo was implanted into her uterus (107). Since then, the technology behind in vitro fertilization has advanced and become more widely available around the globe (108).

ARTs include any fertility techniques that manipulate gametes, zygotes, or embryos to produce conception. In the United States, IVF accounts for even more than 99 percent of all assisted reproductive technology (ART) treatments. IVF includes ovarian stimulation to develop numerous follicles, oocyte harvest from ovaries, oocyte fertilization in vitro in the laboratory, embryo incubation in the laboratory, and embryo transfer into a woman's uterus through the cervix. IVF requires gonadotropins to encourage follicle growth, a gonadotropin-releasing hormonal analog (agonist or antagonist) to ensure adequate ovulation during follicle development, and hCG to trigger the final maturation of oocytes before retrieval. IVF requires meticulous monitoring of ovarian response using transvaginal ultrasound and serum estradiol assays. A needle is inserted through the vaginal apex under ultrasound guidance to aspirate fluid from mature follicles during oocyte retrieval. This fluid contains oocytes and is delivered to the laboratory to prepare them for fertilization (105).

Absent or blocked fallopian tubes, tubal sterilization, failed surgery to achieve tubal patency, severe pelvic adhesions, severe endometriosis, poor ovarian response to stimulation, oligo-ovulation, severe male factor infertility, unexplained infertility, and treatment failure with less aggressive therapies are all indications for IVF. The success percentage of in vitro fertilization depends on the cause of infertility and the age of the female spouse. Depending on the quantity and quality of embryos transplanted, the likelihood of conception with one IVF cycle may range from 40% to 50%, with a 30% risk of multiple pregnancies and at least a 15% incidence of spontaneous termination. Donor gametes may enhance the quality and quantity of embryos, and hence, the likelihood of pregnancy, under specific circumstances (105).

Before beginning assisted reproductive technology (ART), the patient is educated about the potential dangers to the mother posed by the various ART treatments as well as by pregnancy itself. Some maternal illnesses, especially cardiovascular disorders like pulmonary hypertension and heart failure, are conditions that should be avoided as much as possible during pregnancy. It is important to have counseling and assessment before becoming pregnant to check for disorders like these. Even with these types of patients, the use of gestational carrier alternatives is a possibility (109).

References third chapter

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Annex II Personal archive
Prof. Univ. Dr. Pirtea Laurențiu Cornel

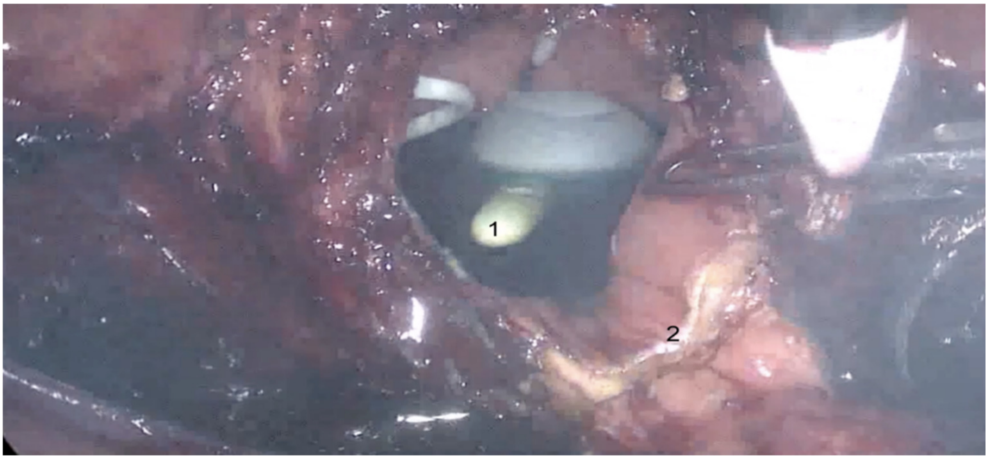

Figure 19. Partial cystectomy

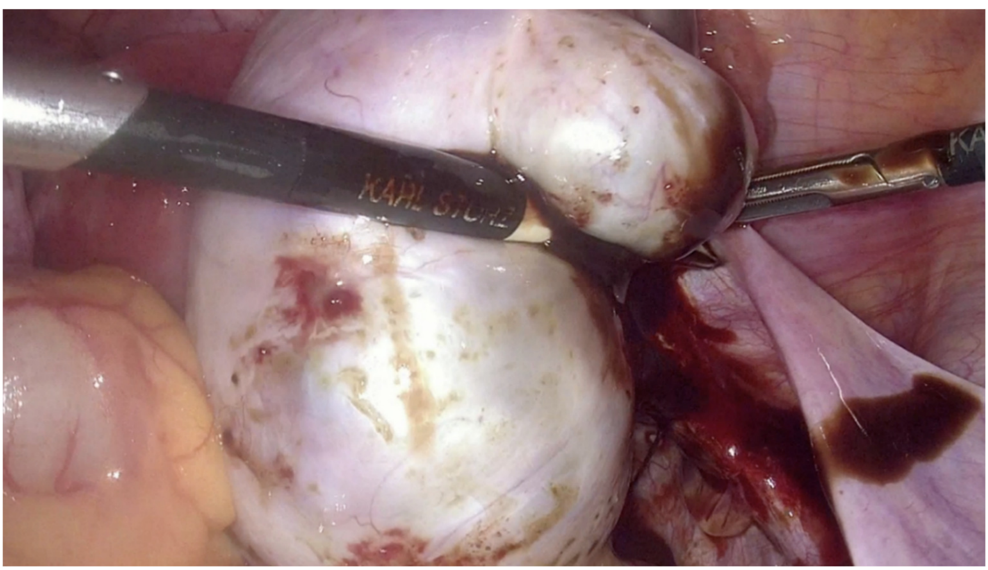

Figure 20. Endometriotic ovarian cyst

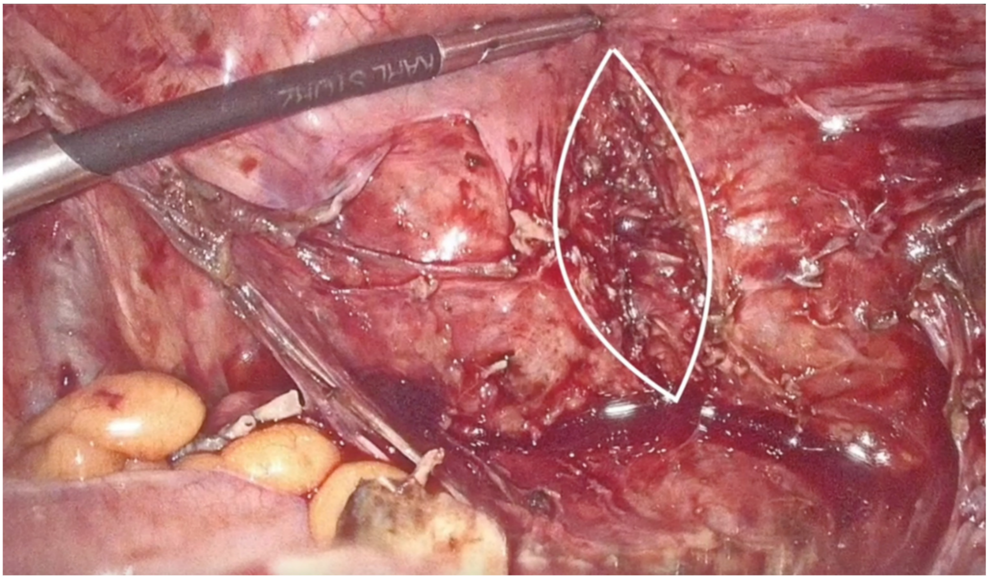

Figure 21. Status post mucosal skinning - bladder endometrioma

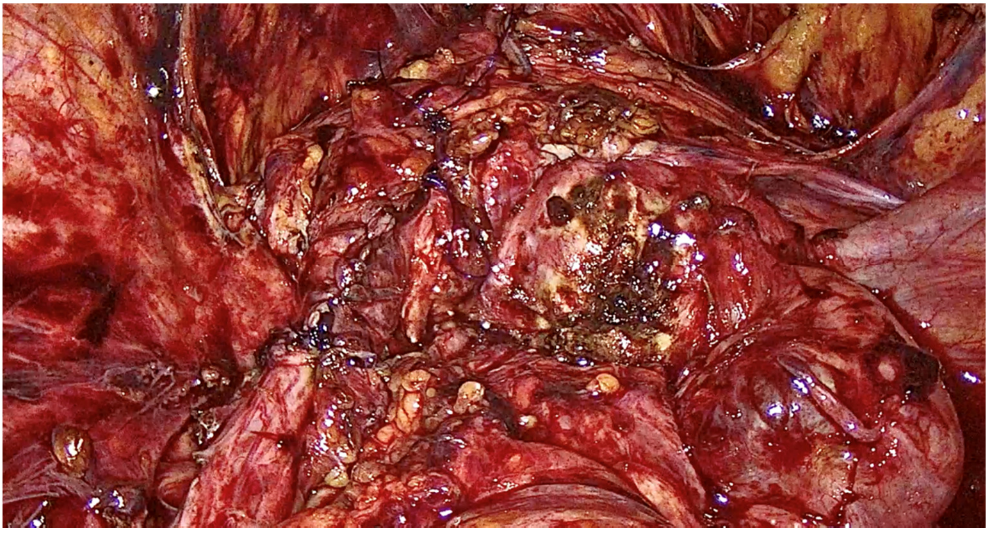

Figure 22. Replant ureter - technique Boari

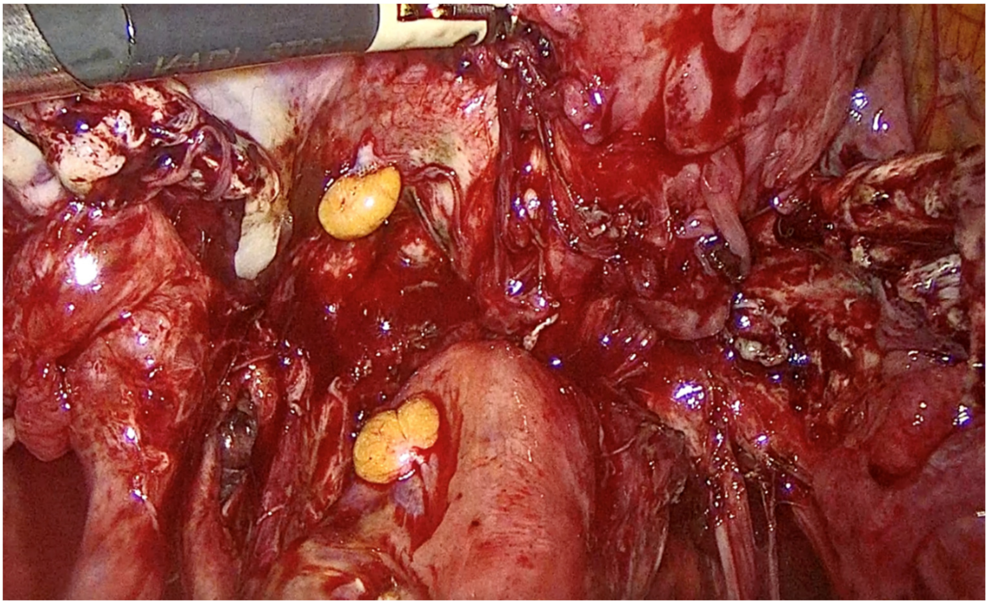

Figure 23. Endometriotic node - rectosigmoid junction

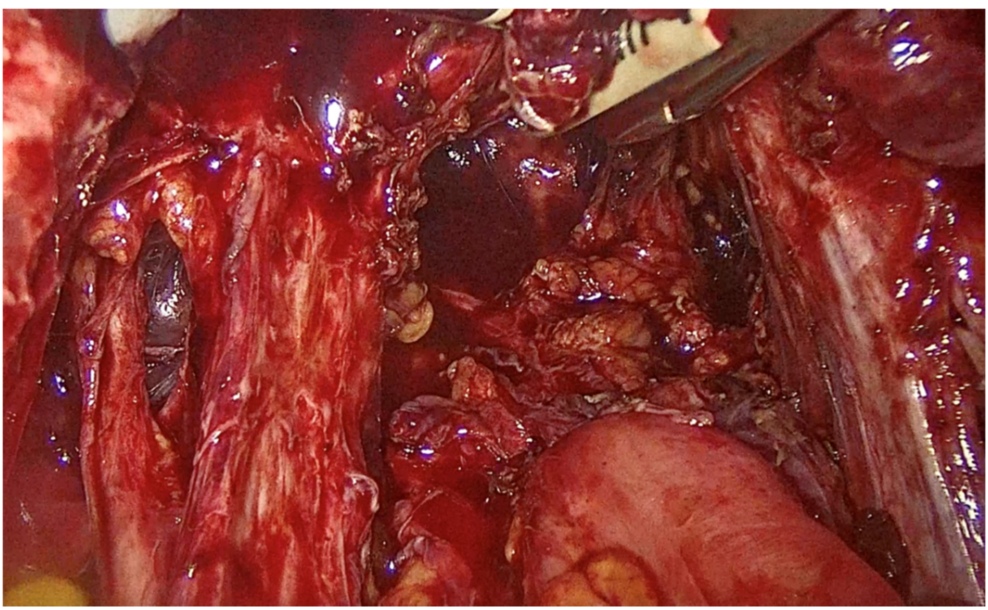

Figure 24. Endometriotic node - rectosigmoid jockstrap visible after spatial dissection

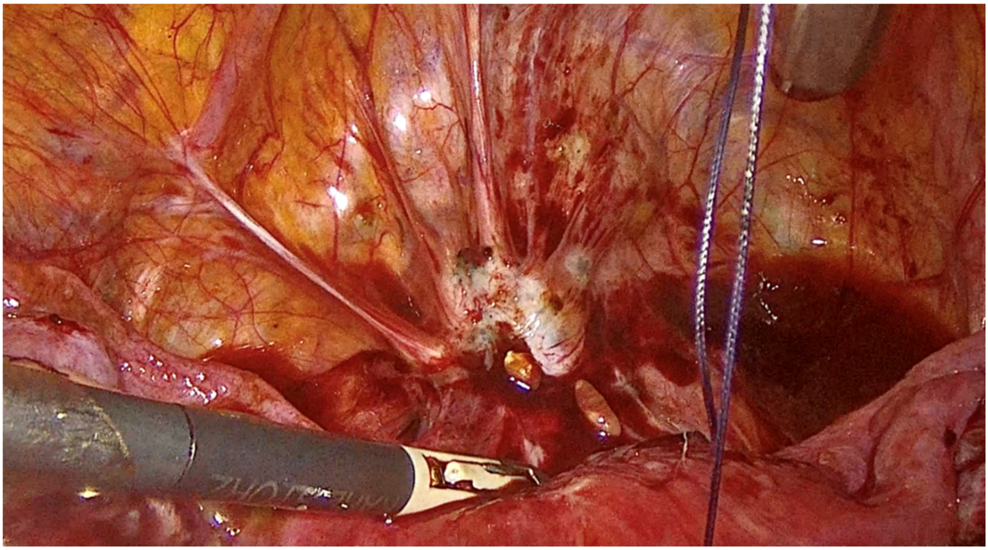

Figure 25. Endometrial node - vesical dome

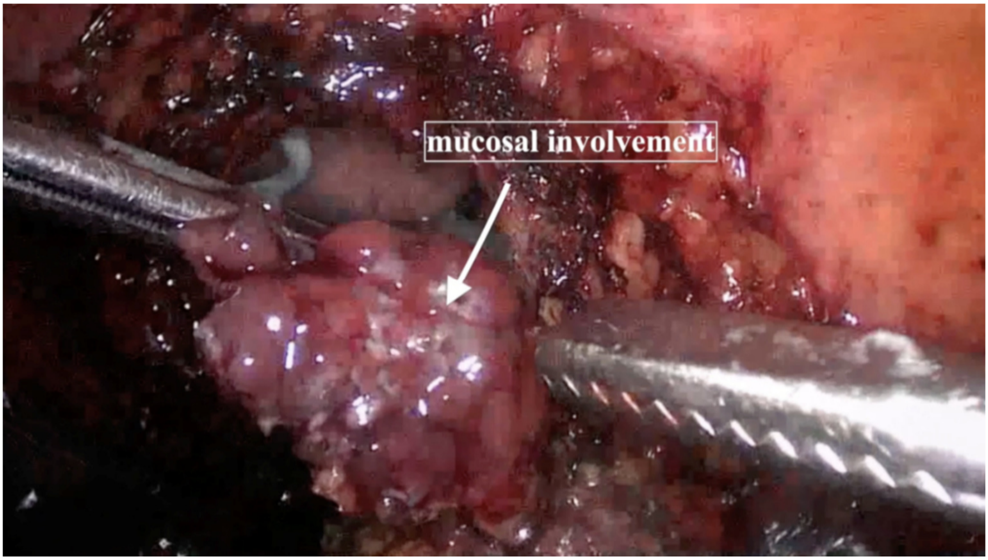

Figure 26. Mucosal involment - bladder endometrioma

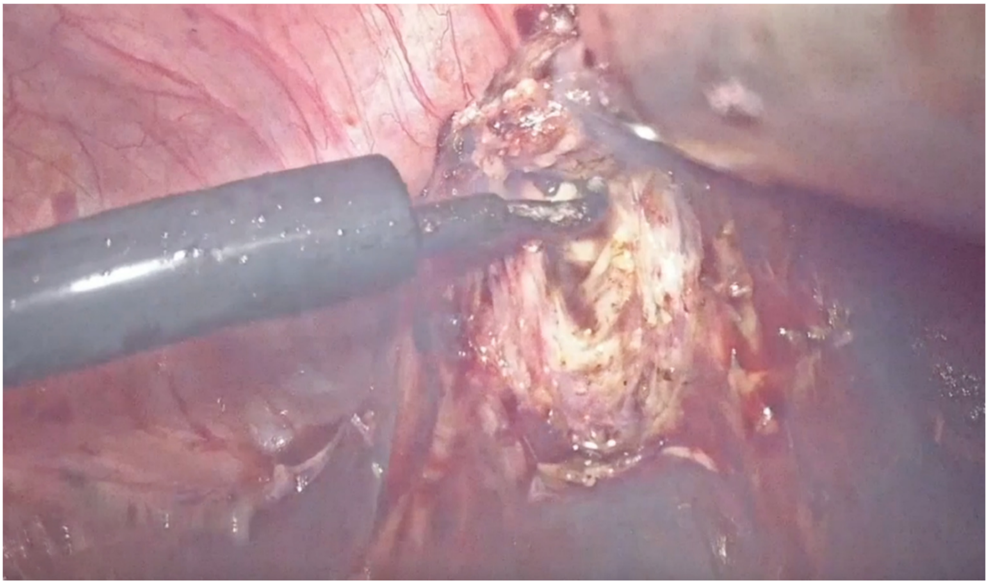

Figure 27. Mucosal skinning - bladder endometrioma

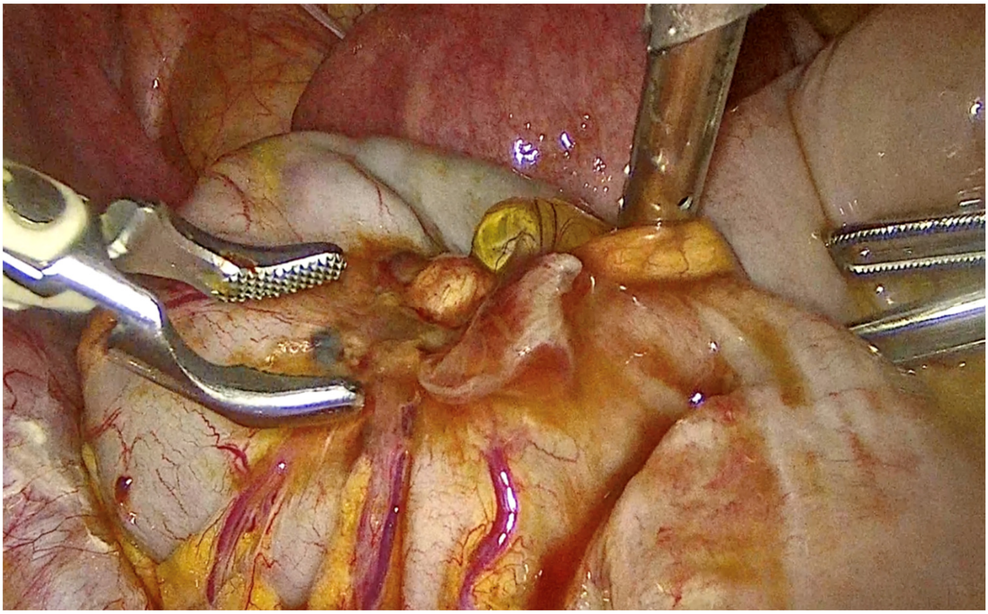

Figure 28. Sigmoid colon endometriosis lesion

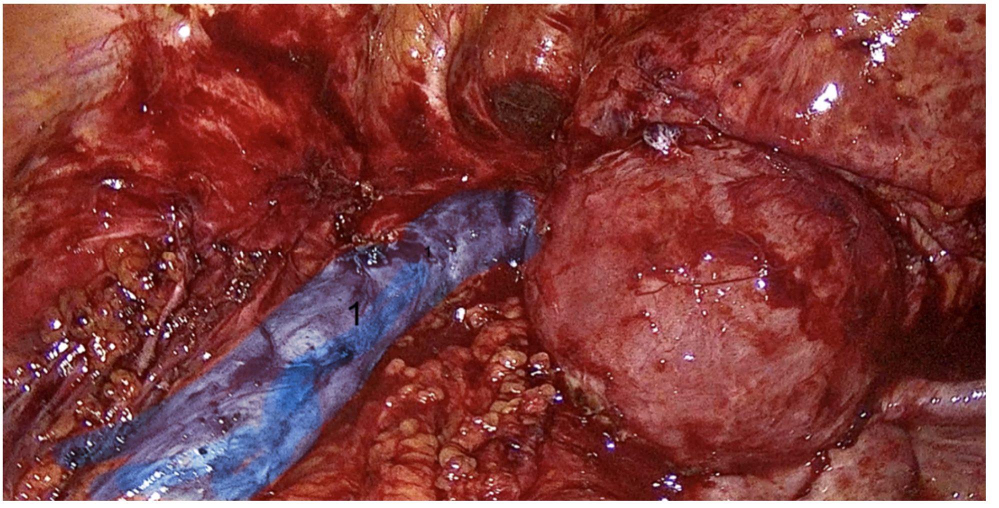

Figure 29. Distal ureter endometriosis with superjacent dilatation

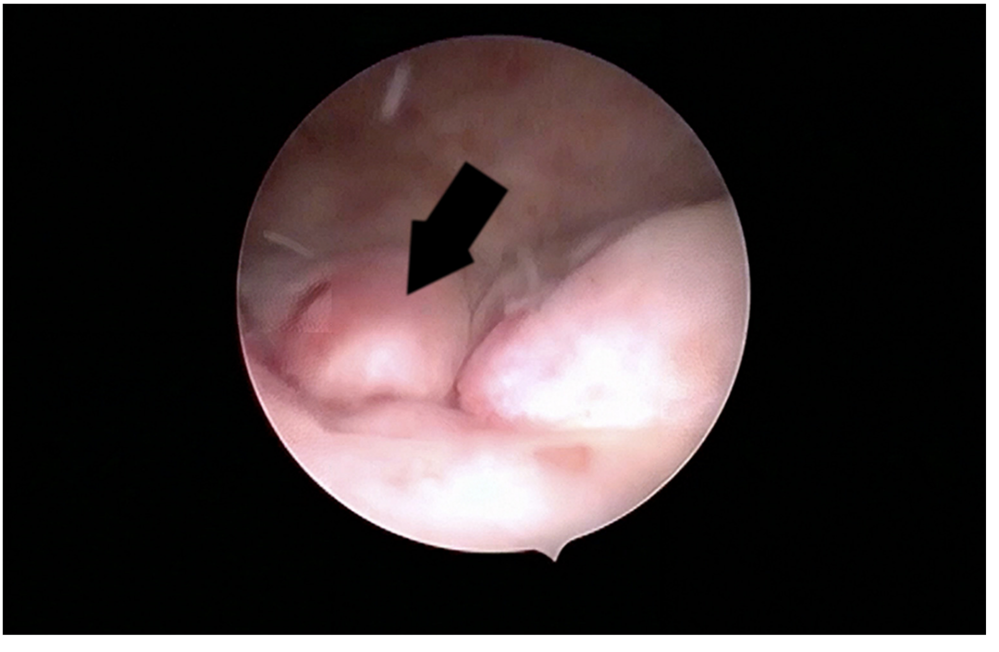

Figure 30. Cystoscopy view of bladder endometrioma

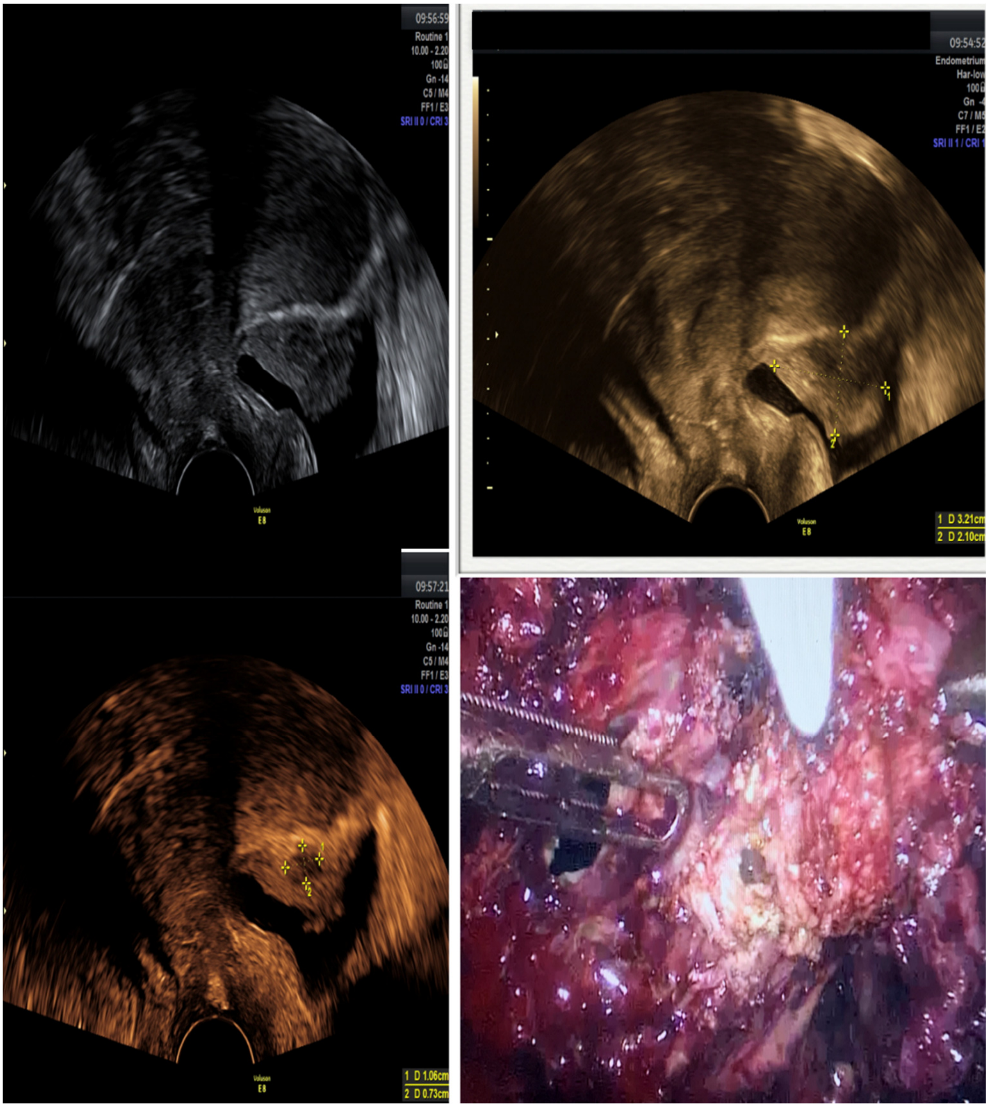

Figure 31. Bladder endometrioma visible on ultrasound

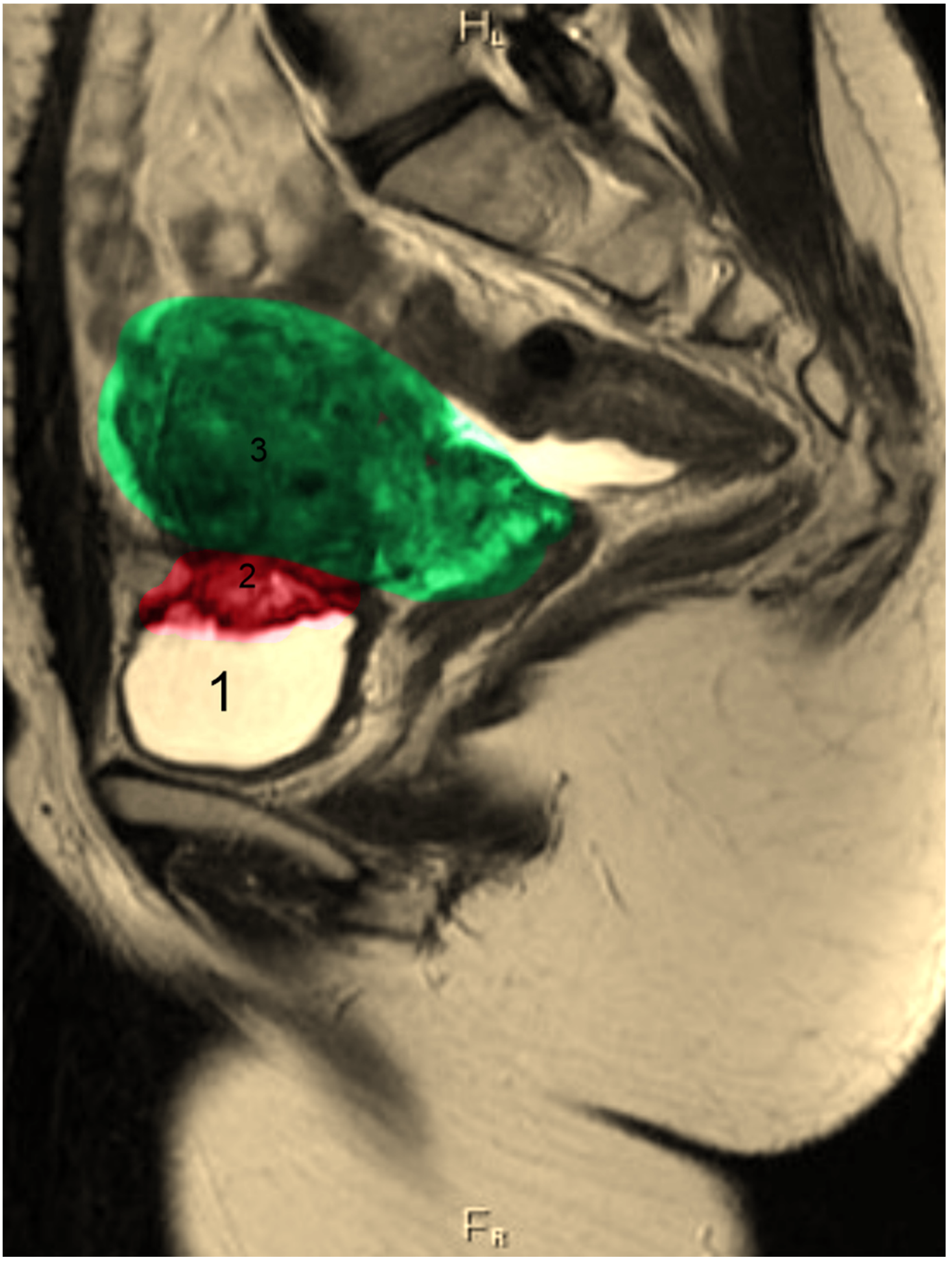

Figure 32. Endometrioma bladder visible on MRI

Overcoming infertility. Hopeful solutions: Strategies for evaluating and treating infertility

Introduction

Infertility has traditionally been seen as a social shame, and women who are unable to have children have often been seen as having a more detrimental impact on their social life, mental health, and physical health than males who are in the same situation. The notion of fatherhood was more social than it was biological, and as a result, the inability to have children was considered a valid reason for divorce and a source of shame for women (1). Each nation has its own set of practices and beliefs that have been passed down through the generations to help alleviate the suffering caused by a lack of children. The problem of the inability to have children might be solved in some ways; one of them was by taking a second wife. Nevertheless, divorce was another option. Throughout history, there have been several tales that have pondered the problems that humans face and the requirements that they have. There is no denying the fact that the many forms of infertility and the treatments for them in the current period have some historical precedence and were portrayed in a variety of ways in the various ancient civilizations (1).

It is believed that as many as 186 million individuals all over the globe suffer from infertility. Infertility is still seen to be a societal burden on women, although male infertility is responsible for more than half of all instances of childlessness around the globe. Unhappily, regions in the globe with the greatest rates of infertility tend to be those that have limited access to various assisted reproductive technologies (ARTs) (2).

Each year, roughly 12.7% of women in the reproductive age population in the United States seek infertility treatment. This review provides a concise summary of the most recent scientific information on the diagnosis and treatment of infertility (3).

Infertility treatment is provided to about one in eight women between the ages of 15 and 49. Even though success rates vary depending on age and diagnosis, many infertile couples who undergo treatment can realize their reproductive objectives with the help of a correct diagnosis, an effective treatment plan, and collaborative decision-making (3).

The focus of the infertility workup has always been the examination of female factors. In 50% of infertile couples, the male factor is thought to be at least partially responsible, and in 20% of instances, it may even be the only cause. To increase their chances of naturally becoming pregnant, it is vital to ensure that both spouses undergo the necessary tests to rule out any possible treatable reasons for infertility (4).

Definition of infertility

It is critical to have a standard definition of both subfertility and infertility to provide effective infertility treatment. Subfertility is a term used to describe any sort of diminished fertility that is accompanied by an extended period of unintended childlessness. When there is a very low probability of a woman becoming pregnant on her own, the term "infertility" may be used interchangeably with "sterility." The length of time that has passed since the last undesired pregnancy is used to grade the level of subfertility, which is the most important factor in determining whether or not a person will get pregnant on their own. The majority of pregnancies occur in the first six cycles, with intercourse accounting for the majority of those pregnancies (5).

Following then, significant subfertility must be anticipated in every other couple (ten percent), even though untreated live birth rates among them would approach fifty-five percent during the next three years if they have 12 failed cycles first (5).

After that period (48 months), 5% of couples are deemed to be definitively infertile, with an extremely low probability of getting naturally pregnant in the years to come. Since variability in fecundity grows with age because of a bigger number of infertile couples, the cumulative probability of becoming pregnant decreases with time. Likely, the cumulative chances of becoming pregnant don't change with age for couples who have viable eggs. Given the right conditions, a fundamental infertility work-up performed after six failed cycles of fertility-focused intercourse will identify couples with serious infertility difficulties. This will help couples of any age avoid both infertility under-treatment and over-treatment: Even if the couple undergoes therapy, there is no guarantee that they will have a higher likelihood of becoming pregnant if they have a pretty good prognosis, such as in the case of infertility that cannot be explained. The early intervention of assisted reproductive technology therapy might be beneficial for others (5).

Although pregnancy may happen outside of this age range, reproductive age is commonly considered to be somewhere between 15 and 44 years old. Fecundability refers to the likelihood of a woman becoming pregnant during her first menstrual cycle, which is believed to range from 20 percent to 25 percent in healthy young couples. Similarly, fecundity refers to the likelihood of having a live birth during a single cycle of a woman's menstrual cycle (6).

Causes of Infertility

The three most frequent causes of infertility are tubal illness, male factor infertility, and ovulatory dysfunction. Unknown infertility affects 15% of the remaining infertile couples. Smoking and obesity are only two examples of environmental and lifestyle variables that might harm fertility. Around 25% of diagnoses for infertility are related to ovulatory problems, while polycystic ovary syndrome affects 70% of anovulatory women. Infertility may also be a sign of a chronic condition that is related to infertility (3).

Causes of male infertility

Given that 40% to 60% of the time, a male element is the major or contributing reason, the guy should be assessed alongside the woman. Evaluation of the infertile man is crucial to identify curable anomalies, as well as life-threatening issues linked to infertility symptom and hereditary diseases linked to male infertility that might be passed on to kids via assisted reproduction (7). A typical semen sample should be 1.5 to 5 ml in volume and contain more than 20 million sperms per ml. Less than 40% of sperm should be aberrant, and more than 30% of sperm cells in a specimen should move properly. According to estimates, a lack of sperm production of unknown origin accounts for 40 to 90% of male infertility (8).

If the semen analysis findings are abnormal, the test should be repeated in 1 to 2 weeks. Semen anomalies that persist warrant additional study. A urologist or reproductive endocrinologist who specializes in male infertility should assess the male spouse (6).

Male infertility may sometimes be the first indicator of severe medical diseases, such as testicular cancer or a pituitary tumor. Male infertility etiologies include congenital, acquired, and systemic disorders that can be classified as a hypothalamic-pituitary disease that causes gonadal dysfunction (1%-2%), testicular disease (30%-40%), post-testicular defects that cause sperm transport or ejaculation (10%-20%), and unexplained infertility (40%-50%) (6).

- The testes are typically maintained at a temperature of 34 to 36 °C by the scrotal sac (9). Sperm production is significantly reduced or halted at temperatures higher than 36°C. Infertile males often have mean scrotal temperatures that are noticeably higher than those of fertile men. A temperature that is 3 to 4 degrees Celsius below the body's usual temperature is necessary for the active generation of sperm. The lower sperm counts seen in conditions like varicocele and cryptorchidism, as well as in instances of chronic sauna use and paralyzed people confined to wheelchairs, provide evidence for this reality (10).

- Infertility may result from aberrant sperm morphology (teratozoospermia), inadequate sperm motility, or a lack of sperm. A high percentage of infertile males are unable to pregnant with their female counterparts (asthenozoospermia) (8,11). Genetic disorders may have an impact on sperm production or transport. Men with azoospermia (no sperm) and severe oligospermia should undergo genetic testing (6).

- Spermatogenesis abnormalities are a primary cause of male infertility. Unlike oocytes, which grow in a cyclical pattern, the testes generate sperm continuously. When sperm grow in the testis' germinal epithelium, they are discharged into the epididymis, where they mature before ejaculation. It takes around 70 days for sperm to be produced and developed. Therefore, aberrant semen analysis findings may represent events that happened more than two months before the specimen collection. Alternatively, a minimum of 70 days after the start of any medication is necessary to see changes in sperm production (6). Abnormal sperm function or production brought on by undescended testicles, genetic flaws, medical conditions like diabetes, or infectious diseases like chlamydia, gonorrhea, measles, or HIV. Varicocele, or enlarged veins in the testes, may also lower sperm quality (12).

- Sperm delivery issues are brought on by sexual issues, such as early ejaculation, hereditary conditions, such as cystic fibrosis, structural issues, like a blockage in the testicle, or harm or injury to the reproductive organs (13). A rare cause of azoospermia, blockage of the ejaculatory duct occurs in less than 5% of people who are diagnosed with the condition (14,15). It is a factor that may be amenable to treatment in cases of male infertility. Ejaculatory duct blockage may be caused by several congenital disorders, including ductal atresia, stenosis, prostatic cysts, ejaculatory duct cysts, and seminal vesicle cysts. Infection, scarring from previous surgical procedures (such as bladder neck repair), prolonged catheterization, inflammation, and stone formation in the distal duct at the level of the ampulla can all be acquired conditions that can lead to proximal duct dilatation. Other causes of proximal duct dilatation include chronic inflammation (15).

- Fertility may be affected by cigarette smoking, alcohol use, marijuana use, anabolic steroids, and prescription drugs for depression, high blood pressure, and bacterial infections. Regular heat exposure, such as that seen in saunas or hot tubs, may increase body temperature and have an impact on sperm production (16).

- In the cattle, poultry, and dairy sectors, estrogen, and its derivatives as well as their synthetic analogs (diethylstilbestrol) are often exploited. High estrogen exposure is suspected to be the cause of prenatal testicular injury as well as postnatal depression of testicular function and spermatogenesis (8,17). Men who want to increase their fertility and sperm quality should probably avoid hormone-containing dairy products and meats and instead choose organic or hormone-free food because exogenous estrogens harm developing fetuses by preventing the growth of Sertoli cells, which determine the lifelong capacity for sperm production (8,17).

- Many instances of infertility are considered to be caused by infections in the male genito-urinary system, including infection of the epididymis, seminal vesicles, prostate, bladder, and urethra (18). It's a good idea to have a backup plan in place, especially if you're going to be away from home for an extended period. In the absence of additional clinical signs, the existence of anti-sperm antibodies is thought to be a reliable signal of a persistent infection. Many bacteria, viruses, and other organisms can infect the male genito-urinary system. According to estimates, chlamydial infection is present in 28 to 71% of infertile males (18).

- Damage brought on by cancer and the therapies used to treat it, such as chemotherapy or radiation. Sperm production may be negatively impacted by cancer treatment, sometimes significantly (13,19).
- Endocrine testing is used to further evaluate the infertile person. Those with aberrant sperm concentrations or symptoms of androgen insufficiency should have an endocrine examination. Primary hypogonadism (low testosterone or increased FSH and LH) or secondary hypogonadism (low testosterone, FSH, and LH) will be identified by serum testosterone, FSH, and LH levels. Exogenous steroid usage may be indicated by a low LH level in the context of oligospermia (sperm concentration of 5 million/mL) and a normal testosterone level. Men with low testosterone levels should have their serum prolactin levels checked (6).
- Older paternal age has been linked to a higher incidence of spontaneously autosomal-dominant mutations, with the risk rising with age; however, there are presently no standardized techniques in place to test for them. There is additional evidence that paternal age beyond 40 years increases the risk of miscarriage and pregnancy loss (6).

Causes of female infertility

The following were the most prevalent recognized female causes that contributed to female infertility, accounting for 81 percent of the condition: Ovulatory disorders; Endometriosis; Adhesions of the pelvic region; Tubal blockage; Additional anomalies of the tubal structures; Hyperprolactinemia (20).

- Ovulation disorders, impede the ovaries' ability to release eggs. Infrequent ovulation (oligoovulation) or missing ovulation (anovulation) causes infertility since an oocyte is not accessible every month for fertilization. Ovulatory women are those that have molimina, which includes breast discomfort, dysmenorrhea, and bloating in addition to their monthly periods. If menses and molimina are irregular or absent, pregnancy or another disorder related to oligo ovulation/anovulation is possible (20). The World Health Organization has identified three primary categories of anovulation and acknowledges hyperprolactinemia as an additional cause of the condition. This method helps diagnose anovulatory illnesses and treat them according to the underlying endocrine dysfunction. The hormone that increases the production of breast milk, prolactin, which is present in excess amounts in the condition known as hyperprolactinemia, may also prevent ovulation (20).

- Menstrual cycle disruption or infertility may result from either too much (hyperthyroidism) or not enough (hypothyroidism) thyroid hormone (21).

- Anomalies of the uterus or the cervix, such as polyps in the uterus or variations in the uterus' form. Uterine fibroids, which are benign (noncancerous) tumors of the uterine wall, may prevent a fertilized egg from implanting in the uterus or obstruct the fallopian tubes, both of which can result in infertility.

- Inflammation of the fallopian tube is often the cause of fallopian tube injury or obstruction (salpingitis). Pelvic inflammatory illness, which may be caused by bacteria like chlamydia or gonorrhea, is the principal factor responsible for tubal factor infertility. Other conditions that may interfere with tubal transport include severe endometriosis, adhesions from previous surgery or nontubal infection (for example, appendicitis, inflammatory bowel disease), pelvic tuberculosis, and salpingitis isthmic nodosa. Plugs of mucus and amorphous detritus as well as spasm of the uterotubal ostium can cause proximal tubal obstruction; however, this does not indicate real anatomic occlusion (20,22).

- It is possible for women who have a distal tubal blockage to develop hydrosalpinges, which lowers the chances of having a successful in vitro fertilization procedure (IVF). In addition to impeding the movement of sperm, hydrosalpinges seem to diminish fertility by the retrograde flow of contents from the tubules into the endometrial cavity. This results in an environment that is inhospitable to the implantation of an embryo. Removal of the hydrosalpinges boosts the success of IVF (20).

- The ovaries, uterus, and fallopian tubes may all be affected by endometriosis, which develops when endometrial tissue spreads outside of the uterus (20,23).
- Primary ovarian insufficiency, or early menopause, occurs before the age of 40 when the ovaries cease producing menstrual blood. Amenorrhea, a lack of ovulation, and elevated levels of gonadotrophins in the serum are the primary indicators of this condition (hypogonadotropic hypogonadism, HH) (24–26). Early menopause has several risk factors, including immune system disorders, genetic problems like Turner syndrome or carriers of Fragile X syndrome, radiation or chemotherapy treatment, and other ailments, even if the reason is often unclear (24).
- Therapy options for cancer. Female fertility is often hampered by certain diseases, notably reproductive tumors. Both chemotherapy and radiation may have an impact on fertility (27). Concerns about reproductive health, as it relates to initial treatment, are becoming more relevant as more young female patients with cancer survive the original illness they were treated for. Cancer treatment may often harm reproductive organs, which can result in problems with pubertal development, hormone management, fertility, and sexual function. These issues can harm the quality of life (27).

Several of the risk factors are the same for both male and female infertility

They are as follows:

- Age-related losses in women's fertility are noticeable, particularly in the mid-30s, and beyond age 37, it reduces quickly. Infertility in older women is most often brought on by the decreasing quantity and quality of eggs, however, it may also be brought on by fertility-related health issues. Males over 40 may have lower fertility than guys of earlier ages (20).
- The consequences of adult lifestyle choices, particularly smoking and eating in women, as well as general sedentary behaviors, are significant variables that influence the fertility of men and women, and they may also impact the fertility of their offspring (28).

- Both partners using tobacco may lessen the chance of becoming pregnant. Smoking lowers the potential efficacy of reproductive treatments. Women who smoke are more likely to have miscarriages. Men who smoke are more likely to have erectile dysfunction and poor sperm counts (29).
- There is no acceptable amount of alcohol consumption for women during pregnancy or conception. Alcohol use may be a factor in infertility. Heavy drinking may reduce sperm count and motility in males (30).

Level of consumption	Definition
Current use	≥ 1 drink in the past 30 days
Moderate use	Up to 1 drink per day for women, up to 2 drinks per day for men
Binge drinking	Drinking a quantity of alcohol to raise the BAC to 0.08 g/dL - typically 4 drinks for women and 5 drinks for men in 2 h
Heavy alcohol use	Binge drinking on ≥5 days in the past month

Figure 33. Definitions of Levels of Alcohol Consumption (30,31)

- The prevalence of alcohol use among women who are receiving reproductive therapy varies from study to study, but it seems to be somewhere between 26 and 41% of these women (32,33). Since drinking alcohol is so common, adopting healthier drinking habits might improve the success rates of assisted reproductive technologies (32). It is good knowledge that drinking alcohol while pregnant increases the risk of having a child born with a deformity (34). Yet, there is a lack of consensus about the impact that alcohol has on fertility. Epidemiologic studies of unintended pregnancies suggest that women with high alcohol consumption were more likely to present with infertility, so the fecundability has been reduced between women drinking medium or heavy amounts of alcohol (35,36).
- Being overweight and leading a sedentary lifestyle may raise the risk of infertility. The findings of many research suggest an increased chance of aberrant semen parameters among overweight men and an enhanced risk for subfertility among couples in whom the male spouse is obese. As a result, being obese is linked to an increased risk

of infertility due to male factors. Inducing sleep apnea, changes in hormonal profiles (reduced inhibin B and androgen levels accompanied by elevated estrogen levels), and increased scrotal temperatures, which ultimately manifest as impaired semen parameters, are some of the possible mechanisms that might account for the effect of obesity on male infertility, both directly and indirectly (decreased total sperm count, concentration, and motility; increased DNA fragmentation index). Insufficient research has been done on either the possibility of reversing male infertility linked with obesity via weight reduction or the efficacy of various treatment therapies. The rising incidence of obesity makes it imperative for there to be a higher clinical awareness of the consequences that it has on fertility, as well as a better knowledge of the underlying processes, and the research of potential therapeutic options for men. Being overweight might also have an impact on a man's sperm count (37).

- Obesity and overweight are both on the rise across the globe, and they are both associated with negative effects on a variety of functions and processes inside the human body, including reproductive health (38). It is quite usual for women of reproductive age to be obese or overweight. There is a lot of evidence pointing to the fact that obesity harms reproductive function. As a result of ovulatory problems and endometrial pathology, a significant number of obese women suffer from monthly irregularities and infertility (38,39). Obese women have disruptions of the "hypothalamic pituitary ovarian axis," and they commonly suffer from menstruation abnormalities that may lead to anovulation and infertility. In addition to the hormone imbalances and infertility that are typical of polycystic ovarian syndrome, the adipocytes that are present in obese individuals function as endocrine organs. Indeed, adipose tissue is responsible for the release of some bioactive molecules, specifically adipokines, which are known to interact in a variety of ways with multiple molecular pathways involved in insulin resistance, inflammation, hypertension, cardiovascular risk, coagulation, and the maturation and differentiation of oocytes. Endometrial implantation and other reproductive processes are negatively impacted in obese women, leading to difficulties such as delayed conceptions, an increased incidence of miscarriage, and lower success rates in aided conception procedures (38). Women who have eating disorders, such as bulimia or anorexia, or who adhere to an extremely low-calorie or restricted diet are at risk of having reproductive issues (38).

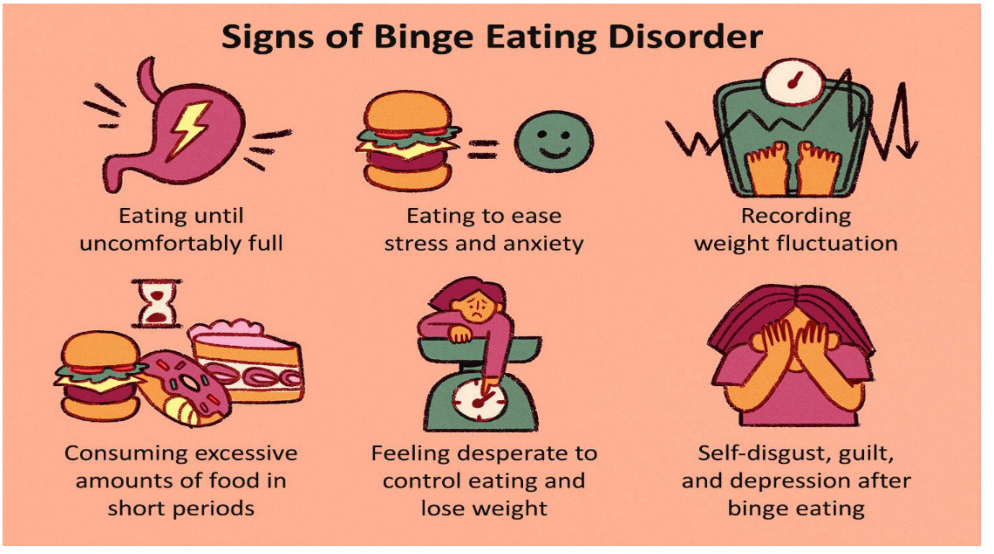

Figure 34. Signs of eating disorder problems (40)

Unexplained infertility

A full investigation of both spouses does not find an explanation for infertility in some couples. Test findings specifically indicate a normal sperm analysis, signs of ovulation, a normal uterine cavity, and patient fallopian tubes. Unexplained infertility affects around 15% of infertile couples. This diagnosis often denotes the existence of one or more minor anomalies in the finely organized chain of events that lead to successful conception. Some anomalies may be below the detection threshold of existing diagnostics. These couples have a low incidence of spontaneous conception, ranging from 1% to 3% per month; this rate is impacted by the female partner's age and the length of infertility. Subtle abnormalities such as pelvic adhesions and mild endometriosis may be diagnosed and treated if a laparoscopy is done on the female spouse. It is, nevertheless, permissible to continue with medical therapy for infertility without doing a laparoscopy (6).

Evaluation of Infertility

At the first stage of diagnosing infertility, a focus is placed on identifying the factors that account for the majority of cases of male and female sterility. It is essential to be aware that a couple's inability to conceive may be due to the interaction of more than one condition; hence, a complete examination is often called for (6).

For male

A complete medical history, physical examination, semen and hormone analysis, and imaging tests should all be part of the first diagnostic workup for male infertility. These tests should be carried out methodically to identify any previous causes that may have contributed to infertility (13).

Medical history

The patient's medical history should center on the identification of behaviors and/or risk factors that potentially have an impact on the patient's fertility. These include the length of time that the patient has been infertile, the ages of both the patient and his partner, any gynecologic cofactors that involve the male partner's female partner, medications that could affect the hypothalamic-pituitary-gonadal axis, cryptorchidism, sexual or ejaculatory disorders, the frequency of sexual intercourse, smoking history and alcohol consumption, genital surgery, and pubertal development and disorders (13).

Analysis of the Sperm and Hormones

The term "normal semen" refers to sperm that meets the following criteria: it must have a volume that is greater than 1.5 milliliters, a concentration that is greater than 15 million per milliliter, total motility that is greater than 40 percent, and a normal consistency that is greater than 4 percent (41,42). If the analysis of the sperm reveals azoospermia, a laboratory examination of the levels of follicle-stimulating hormone, luteinizing hormone, and testosterone, as well as the testicular volume, can be used to distinguish between obstructive azoospermia caused by an obstruction of the male ductal system and nonobstructive azoospermia (43,44).

Element	Reference Value
Ejaculate volume	>1.5 mL
Sperm concentration	>15 million/mL
Motility	>40%
Rapid progressive motility	>32%
Normal morphology	>4%

Figure 35. Reference values for semen analysis (6)

Imaging

The primary use of imaging is to identify the underlying reasons for infertility, such as congenital abnormalities and illnesses that inhibit the movement of sperm and have the potential to be treated. Imaging may also be used to guide the procedures that are used to impregnate the female partner. These procedures include sperm aspiration from the epididymis or seminiferous tubules, which is then followed by in vitro fertilization or intracytoplasmic sperm injection (45). Imaging modalities such as ultrasonography (US) and magnetic resonance (MR) imaging, in addition to invasive methods such as venography and vasography, are often used to examine the male reproductive system. Other imaging modalities include MR imaging (13).

Scrotal ultrasound is the modality of choice since it is noninvasive, safe, and affordable. Moreover, it enables multiplanar imaging. This examination may be used to examine the possibility of testicular abnormalities, determine the volume of the testicles, and detect peri-testicular abnormalities such as erectile dysfunction, varicocele, epididymal abnormalities, and prostatic abnormalities. A high-frequency linear-array transducer is used during the process of scrotal ultrasound. A color flow Doppler ultrasound of the testicular and spermatic cord vascularity is conducted in addition to a transverse and longitudinal ultrasound examination of the testes. Measurements of testicular volume, which have been shown to correlate with sperm profiles, should also be acquired (46).

The prostate may be evaluated using transrectal ultrasound, and it may be possible to discover more core origins of spermatic blockage with this method. Ejaculatory duct obstruction may be present when the diameter of the seminal vesicle is greater than 1.5 centimeters and the diameter of the ejaculatory duct is greater than 2.3 millimeters. This is especially true when the seminal vesicle and ejaculatory duct diameters are associated with cysts or calcification along the duct (47).

MR imaging is the preferable noninvasive modality for assessing intrapelvic structures because it eliminates operator dependence and the inability to evaluate small-caliber structures, both of which are acknowledged drawbacks of the transrectal ultrasound technique (13).

MR imaging can portray the comprehensive anatomy and pathophysiologic aspects of the reproductive tract, including the prostate, seminal vesicles, and ejaculatory ducts. This is possible as a result of MR imaging's superior soft-tissue contrast and its multiplanar capabilities. Imaging the accessory sex glands and their ducts is best done using magnetic resonance imaging, which may also assist guide diagnostic or remedial interventional operations. This imaging modality is the modality of choice. There has been some discussion on the magnetic field strength that is best for imaging the pelvis; nevertheless, the smallest field strength required for optimum magnetic resonance imaging of the pelvis is 1.5 T. The use of an endorectal coil may make it possible to get a greater signal-to-noise ratio; nevertheless, this technique often obscures the pathologic situation as a consequence of local field distortion and causes the patient to experience pain. Higher–field–strength (i.e., 3.0-T) magnetic resonance imaging systems make it possible to achieve greater signal–to–noise ratios, which may eliminate the need for an endorectal coil (48). T2-weighted magnetic resonance imaging shows the prostate, seminal vesicles, and other tissues in the surrounding area. Imaging with thinner sections without intersection gaps is possible with three-dimensional T2-weighted fast spin-echo MR imaging, which also generates higher signal-to-noise ratios and allows the acquired images to be reformatted in any desired plan (49). With non-enhanced T1-weighted magnetic resonance imaging, the presence of a hyperintense signal is suggestive of hemorrhage. The T2-weighted magnetic resonance imaging sequence with fat saturation provides the most accurate results when evaluating inflammation. For identifying malignant diseases, dynamic contrast-enhanced MR imaging might provide extra information on tissue perfusion that is very beneficial (13).

Computed tomography is used for evaluating infertility on a much less regular basis due to its restricted ability to resolve soft tissues. The evaluation of calcifications and stones that are causing blockage anywhere throughout the reproductive system is where CT proves to be most beneficial (13).

Vasography

Cannulation of the vas deferens is required for vasography, which is also known as seminal vesiculography. This procedure, which was formerly regarded as the gold standard for assessing the male reproductive system, now requires the patient to be under general anesthesia. This invasive examination is no longer routinely used to examine the male reproductive system since MR imaging has gained such extensive popularity. As a result of this, the examination in question is no longer commonly utilized. At the moment, vasography may be used to determine aplasia or blockage of the ejaculatory ducts in guys with azoospermia who have been shown to have normal spermatogenesis when they undergo a testicular biopsy. This is because vasography is a non-invasive diagnostic procedure (50). This procedure involves a risk of infection and strictures of the vas deferens at the injection site (13).

For female

Medical history

Personal and lifestyle history, which includes age, profession, exercise, stress, dieting/changes in diet, tobacco, and drinking usage, all of which may affect fertility (51).

A history of the condition in the patient's family, which may include infertility, birth problems, genetic mutations, or intellectual impairment in other family members. Women who have the fragile X premutation have a higher risk of developing premature ovarian failure, while boys with the premutation may have difficulties learning, developmental delay, or autistic characteristics (51).

Ovulatory status is determined by the length of time that a woman has been unable to conceive and the findings of any prior evaluations or treatments. The duration of a woman's menstrual cycle is another measure of ovarian reserve, and a meta-analysis found that short menstrual cycle length was associated with reduced ovarian reserve. A medical, surgical, and gynecologic history is also needed to identify conditions, surgeries, or drugs that may be connected with an inability to conceive (51,52). The examination of the patient's systems should include a determination of whether or not they are experiencing symptoms of thyroid illness, galactorrhea, hirsutism, pelvic or abdominal discomfort, dysmenorrhea, or dyspareunia. Obstetric history should be evaluated for incidents that could be connected with recurrent infertility or an unfavorable result in a subsequent pregnancy. Sexual history should include a discussion of sexual dysfunction and the frequency and timing of coitus. Family history may include family members with intellectual disabilities, infertility, birth deformities, genetic mutations, or other medical conditions. Personal and lifestyle history should include age, profession, exercise, stress, dieting/changes in weight, smoking, and alcohol usage (51).

Physical examination

During the physical exam, infertility risk factors and possible reasons should be looked for and evaluated. Since extremes of body mass index are related to impaired fertility, and abdominal obesity is connected with insulin resistance, it is important to assess the patient's BMI and make a note of the patient's fat distribution (51). A symptom of hypogonadotropic hypogonadism is inadequate development of secondary sexual characteristics in a patient who has primary amenorrhea. In individuals who do not have periods, the presence of Turner syndrome may be inferred if their body habitus is short and stocky, and their chest is of a square form (51). An endocrinopathy may be present if the thyroid gland is abnormal if galactorrhea is present, or if there are indicators of an excess of androgens in the body, such as hirsutism, acne, male pattern baldness, or virilization (hyper- or hypothyroidism, hyperprolactinemia, polycystic ovary syndrome, adrenal disorder) (51). Endometriosis and chronic pelvic inflammatory disease are both conditions that may be diagnosed when there is tenderness or lumps in the adnexa or posterior cul-de-sac (pouch of Douglas). Endometriosis may also be diagnosed based on the presence of palpable and sensitive lesions in the posterior cul-de-sac, uterosacral ligaments, or rectovaginal septum (51). If there are anomalies in the vaginal or cervical structure, or if there is discharge, this may indicate the existence of a Mullerian abnormality, an infection, or a cervical cause (51). Signs of a uterine abnormality, leiomyoma, endometriosis, or pelvic adhesive disease include an enlarged uterus, irregularity in the uterus' shape, or a lack of movement in the uterus (51).

Additional tests

Ovulatory function

Documentation demonstrating that ovulatory function is normal. Molimina symptoms are virtually usually present during ovulation in women who have regular menstrual cycles of around once every four weeks (51). Because ovulatory dysfunction is one of the most prevalent reasons for infertility, assessing the patient's ovulatory function is an essential aspect of the assessment process for the female partner. The goal of therapy for women who suffer from ovulatory dysfunction is to restore or instigate normal ovulatory activity. Many different therapeutic approaches may be taken (51). Women who have molimina symptoms before menstruation (breast soreness, bloating, exhaustion, etc.) frequently are most likely ovulatory. These symptoms include breast discomfort, bloating, and fatigue. Ovulation testing in the laboratory is something that must be done with women who don't report their cycles as being like that. A mid-luteal phase serum progesterone level is the most reliable indicator of ovulation, and it should be measured roughly one week before the predicted onset of menstruation to be accurate. The result of the test would be acquired on day 21 of a normal cycle that lasts 28 days. Ovulation has occurred very recently if the progesterone level is more than 3 ng/mL (51,53).

Another option is to have the patient utilize a urine ovulation prediction test that may be purchased over the counter. These kits can detect a luteinizing hormone, which allows for an accurate prediction of the time of the LH surge, which is a reliable indication that ovulation has occurred. The false positive and false negative rates for at-home testing might range from 5 to 10 percent. Those who are unable to identify a urine LH spike may thus benefit from confirmation by serum (51).

The patient is investigated for possible reasons for anovulation if the mid-luteal progesterone concentration is less than three nanograms per milliliter or if the cycles are severely irregular. The basic diagnostic procedure involves testing for serum prolactin, thyroid-stimulating hormone, follicle-stimulating hormone, and an evaluation for PCOS. The genesis of anovulation as well as its diagnostic assessment will each be discussed individually (51).

A reduced ovarian reserve may mean reduced oocyte quality, reduced oocyte quantity, or reduced reproductive potential. In individuals who are coming for diagnostic examination later in their reproductive age, the diagnosis of reduced ovarian reserve is an essential part of the first infertility evaluation. There are published guidelines for testing derived from several national organizations (22,54). On the other hand, there is no such thing as a perfect test for determining ovarian reserve. There are a few different screening tests that are performed, but none of them are very accurate in determining whether or not a woman will get pregnant. As a result, the coordination of testing results in the most accurate evaluation (51). We determine ovarian reserve by measuring the levels of both estradiol and FSH on day 3, in addition to the Anti-Mullerian hormone (AMH) level. In exceptional cases, further examinations such as the clomiphene citrate challenge test (CCCT) and the antral follicle count may be carried out. These tests have high specificity for determining whether or not an in vitro fertilization (IVF) cycle would have a poor response, but their utility in determining the outcome of an IVF cycle is much lower (51).

The preantral and early antral follicles, which are typically less than 8 millimeters in diameter, are the sites of MH expression. MH is a member of the TGF-beta family. The amount of AMH is a reflection of the size of the primordial follicle pool, and it may be the most accurate biochemical measure of ovarian function across a wide variety of clinical settings (55). AMH levels steadily decrease in adult women as the primordial follicle pool gradually decreases with age (56), and AMH levels are undetectable after women reach menopause (57).

Evaluation of the patency of the fallopian tubes

Because of the therapeutic as well as diagnostic advantages, hysterosalpingography (HSG) is the test that we begin with when attempting to determine whether or not the tubes are patent. The HyCoSy test is an acceptable replacement option. The availability of the test should be taken into consideration. Whenever the diagnosis is uncertain, more intrusive tests may be performed to establish the diagnosis and give an option for contemporaneous therapeutic action. These tests may however pose a greater risk to the patient. The laparoscopic procedure with chromotubation and fluoroscopic/hysteroscopic selective tubal cannulation are two of the tests that are included in this category (51,58).

To assess the uterus and tubes, we often do an HSG or hysterosalpingo-contrast sonography (HyCoSy). Nevertheless, in cases where endometriosis is suspected, a laparoscopy with chromotubation in addition to a hysteroscopy may be preferable. The chromotubation dye might be diluted methylene blue (51).

Hysterosalpingogram

Unless a laparoscopy is scheduled for the patient, the gold standard for diagnosing tubal blockage is HSG, which is performed on all patients (59,60). During an HSG, a contrast medium that is either water- or lipid-soluble is administered to fill the uterus and fallopian tubes; these structures are then examined using fluoroscopy (ionizing radiation). The use of HyCoSy is an acceptable substitute. In addition to this, HSG may offer information on the cavity of the uterus. It is recommended that women who have abnormalities detected by HSG be referred to a reproductive endocrinologist to explore their treatment options (51). HSG does not help identify peritubal adhesions or endometriosis (59).

Hysterosalpingo-contrast sonography (HyCoSy)

Before and after the transcervical injection of echogenic contrast material, hysterosalpingo-contrast sonography (HyCoSy) employs ultrasound to visualize the uterus, tubes, and adnexa (either microbubble contrast or agitated saline). Using conventional ultrasonography to gather information on the tubal state, the uterine cavity, the ovaries, and the myometrium is a procedure that is well-tolerated, safe, rapid, and simple (60,61). Both the HyCoSy and the HSG had high diagnostic accuracy when compared with laparoscopy, the reference standard, and there was no significant difference between the two tests, according to a systematic review of studies that were conducted in 2014 and compared HyCoSy and HSG for the diagnosis of tubal occlusion in infertile women (51).

Assessment of the uterine cavity

Sonohysterography with saline infusion, three-dimensional sonography, hysterosalpingography (HSG), and hysteroscopy are some of the diagnostic modalities that may be used to evaluate the uterine cavity. Since it gives information regarding the endometrial cavity, myometrium, and adnexa, saline infusion sonohysterography is the imaging modality of choice for assessing the uterine cavity. Saline infusion sonohysterography is the recommended imaging modality. Saline infusion sonohysterography is much better than routine ultrasonography for the diagnosis of intrauterine adhesions, polyps, and congenital uterine anomalies (62), and it performs similarly to hysteroscopy when it comes to detecting intrauterine pathology (63). While routine ultrasonography can be used to detect suspected leiomyomata, saline infusion sonohysterography is much better than routine ultrasonography for diagnosing One kind of sonohysterography, known as HyCoSy, is an easy-to-understand, time-saving, and reliable technique that can assess tubal patency, the uterine cavity, and the myometrium all in the same examination (61).

Even though HSG is most used to evaluate tubal patency, it can also be used to identify developmental as well as gained abnormalities of the uterine cavity that hurt fertility. These anomalies include submucous fibroids, a T-shaped cavity, polyps, synechiae, and congenital müllerian anomalies. Submucous fibroids are a type of uterine fibroids that grow below the surface of the Women who need a tubal examination often undergo HSG to evaluate not only the patency of the fallopian tubes but also the architecture of the uterine cavity (51). Three-dimensional ultrasonography or magnetic resonance imaging may discriminate between a uterine septum and a bicornuate uterus in women whose HSG suggests they may have one. The majority of abnormalities seen on HSG need a referral to a reproductive endocrinologist, further examination with other imaging modalities (such as three-dimensional sonography, sonohysterography, or magnetic resonance imaging), hysteroscopy, or laparoscopy (51).

When done in the operating room, hysteroscopy is the only approach that can be relied upon to evaluate disorders of the uterine cavity and provides the chance for therapy at the time of diagnosis. Lack of knowledge about the myometrium, fallopian tubes, and adnexal tissues is one of the hysteroscopy's limitations. The uterine cavity and pelvis structures may be assessed concurrently during hysteroscopy and laparoscopy, negating the necessity for a separate examination of the fallopian tubes. Hysteroscopy may not always be needed if an endometrial cavity is evaluated using another method. There were no changes in the live birth rates between the women allocated to regular hysteroscopy before IVF and the women who went straight to IVF without hysteroscopy in a multicenter study of 750 infertile women having normal transvaginal ultrasonography of the uterine cavity (64).

Laparoscopy

Laparoscopy's significance in the assessment of infertility is debatable. Whether the first infertility exam is normal or when it reveals severe male factor infertility, the results of the laparoscopy often do not change the initial therapy of the infertile couple. Nevertheless, since endometriosis may be present in up to 50% of women who complain of infertility, the physician must choose whether to include a surgical investigation for endometriosis and another disease in the workup for women who complain of infertility (65,66). To prevent possibly unsuccessful or needless empiric medical treatment, such as ovulation stimulation, laparoscopy should be performed early in the examination of women suspected of having endometriosis or pelvic adhesions. Pelvic adhesions may be lysed and endometriosis can be removed or abated if found at the time of the diagnostic procedure (51).

Test of limited clinical utility

Postcoital test

The postcoital test has limited diagnostic potential as well as low predictive value (67,68). This is in part owing to the lack of agreement on what constitutes a normal vs abnormal test result, as well as low inter- and intraobserver repeatability (69). In addition, interventions that were designed to improve infertility caused by cervical factors have not been successful. On the other hand, common infertility treatments, such as intrauterine insemination and in vitro fertilization, bypass the cervix, making it irrelevant to focus on improving cervical factors. It is important to note that the results of a randomized study that examined the outcome of infertility investigations with and without the postcoital test indicated no change in pregnancy rates at 24 months (70). Hence, using the postcoital test as part of conventional infertility assessments results in an increased number of tests and treatments but has no impact on the percentage of successful pregnancies achieved (51).

Endometrial biopsy

The American Society of Reproductive Medicine points out the absence of the advantage of an endometrial biopsy in analyses of the infertile female and therefore does not recommend using this test unless there is a strong suspicion of endometrial pathology. This is because the American Society of Reproductive Medicine believes that the endometrial biopsy provides no benefit (71,72).

Basal body temperature records

While the interpretation of the charts may be challenging and prone to significant interobserver variance, basal body temperature charts are the least costly way for diagnosing ovulation (73,74). For assessing ovulatory status in women with irregular cycles, experts choose serum or urine tests (51). Progesterone secreted from the corpus luteum during the time of ovulation has significant effects on the hypothalamus, one of which is elevating body temperature. Monitoring your temperature regularly may thus be used to provide evidence of progesterone production and, therefore, ovulation. The lady takes her temperature by placing the thermometer under her tongue every morning while she is still in the basal state (before she gets out of bed, uses the restroom, or has anything to eat or drink) and writes the temperature on a chart. The luteal phase of a woman's menstrual cycle is characterized by an increase in core body temperature of around 0.5 degrees Fahrenheit when compared to the preceding follicular phase of the cycle. This increase may be seen despite the daily fluctuations that are to be anticipated. The temperature increase typically starts one or two days after the LH surge and continues for at least ten days beyond that point in a normal cycle. Hence, temperature variations are adequate for identifying ovulation after the fact, but since they occur too late, they cannot be used to accurately time sexual activity (51).

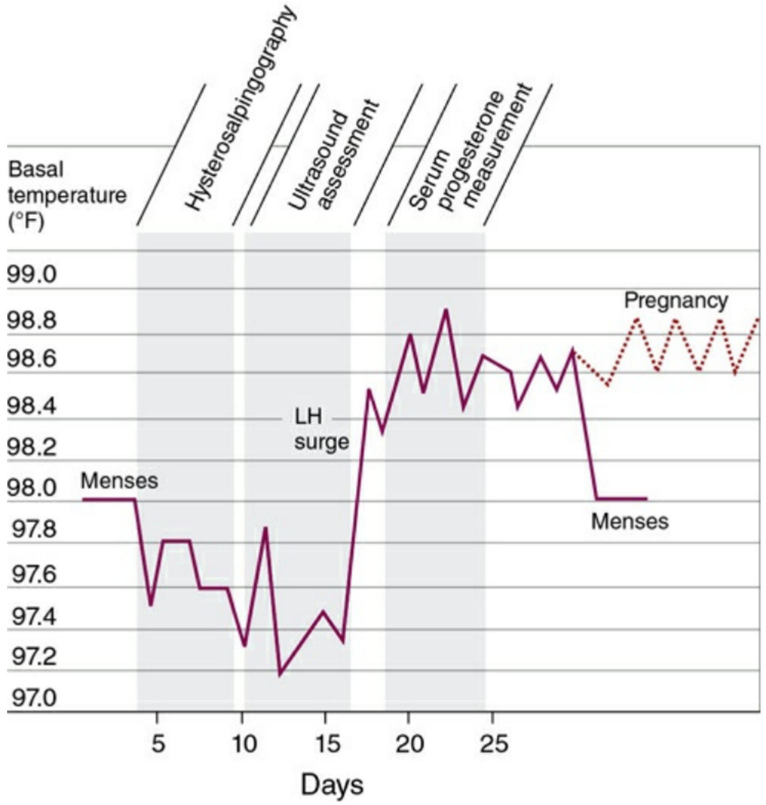

Figure 36. Biphasic basal body temperature pattern that occurs with an ovulatory cycle (6)

Mycoplasma cultures

Since there is little evidence implicating either Ureaplasma urealyticum or Mycoplasma hominis in the pathogenesis of female infertility, researchers do not recommend acquiring regular cultures of either of these organisms (75).

Testing for antibodies

Existing results do not support routine testing for antiphospholipid, antisperm, antinuclear, and antithyroid antibodies (76). While recurrent pregnancy loss and antiphospholipid antibodies have been linked, additional autoimmune variables are still being researched as potential indicators of infertility treatment failure (51).

Karyotype

There is a broad agreement that if there is significant oligospermia, advise the male spouse and offer to karyotype him since these individuals are more likely to have karyotypic anomalies. There may also be a separate test for Y chromosomal microdeletions available. If there have been repeated pregnancy losses, we advise karyotyping both spouses and women having premature ovarian deficiency or a genetic predisposition of early ovarian insufficiency (before age 40). Due to the low occurrence of anomalies in women with unexplained infertility, endometriosis, or tubal factor infertility, karyotyping is often not recommended as part of the first screening in other situations (77). While the cost-effectiveness of universal karyotype screening before IVF has not been shown, karyotype may be helpful for individuals with certain diseases who have tried other treatment options but have failed and want to undertake IVF (78).

Treatment Approaches

There are several medical, surgical, and assisted reproductive technology procedures available to help infertile couples. Empiric therapy may address one or more modest problems in couples with unexplained infertility (6).

Ovarian Stimulation

Ovulation induction is recommended for women who have anovulation or oligoovulation. Therefore, before beginning ovulation induction treatment, any recognized condition related to ovulatory abnormalities should be treated. Thyroid diseases, hyperprolactinemia, PCOS, and high amounts of stress (including psychological stress, hard exercise, and eating disorders) all contribute to hypothalamic dysfunction (6).

Clomiphene

Clomiphene citrate is the most often used drug for ovulation induction. Letrozole, an aromatase inhibitor, should be investigated as a first-line therapeutic option. Clomiphene is a selective estrogen receptor modulator that inhibits estrogen binding to the hypothalamic and pituitary estrogen receptors. Clomiphene's antiestrogen actions cause pituitary gonadotropin release, which increases follicle formation in the ovaries. Clomiphene is taken once a day for 5 days during the follicular phase of the menstrual cycle, between cycle days 3 and 5. If no ovulation occurs, the dosage is raised for the next month (6). Clomiphene usage is linked to a ten percent increased chance of multiple pregnancies, the vast majority of which are twin pregnancies, as well as a five percent increased risk of ovarian hyperstimulation and one percent increased risk of cyst development (6).

Controlled Ovarian Hyperstimulation

There is also the option of administering exogenous gonadotropins to encourage the growth of follicles. Controlled ovarian hyperstimulation is the term that is most generally used to refer to the process of using gonadotropins (COH). Ovulation of a single mature follicle is the goal of this treatment for anovulatory women (especially those who do not react to clomiphene), whereas ovulation of many mature follicles is the goal of treatment for other infertile women. Purified human menopausal gonadotropins are one of the available preparations. Other options include recombinant human FSH, FSH, and LH isolated from the urine of postmenopausal women, and recombinant human FSH (6). There is a one in four chance that you will have more than one baby as a result of this treatment, there is a 25 percent chance that you will have an ectopic pregnancy, and there is a 25 percent chance that you will experience several pregnancies (6).

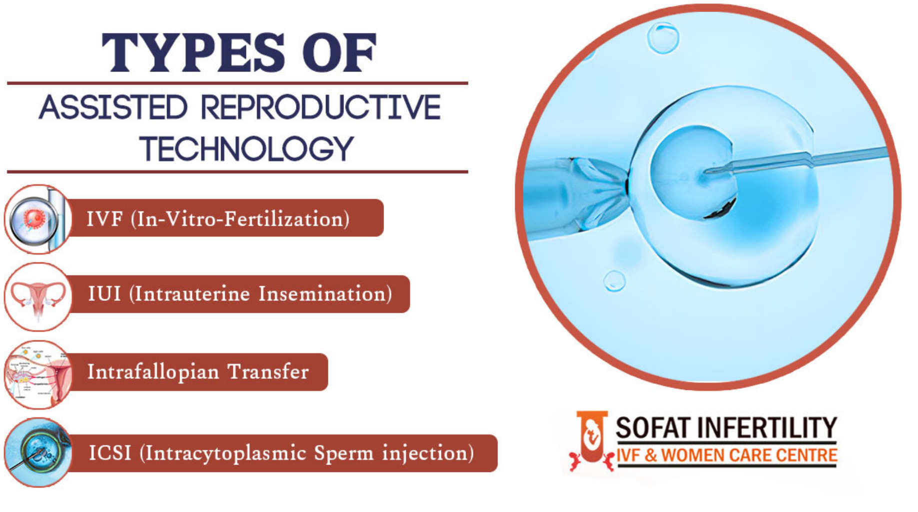

Figure 37. Types of assisted reproductive technology (79)

Intrauterine Insemination

An ejaculated semen specimen is cleaned to eliminate any prostaglandins, bacteria, or proteins before the in vitro fertilization procedure. After that, the sperm is put into a medium that has only a little bit of it. In vitro fertilization (IVF) is performed by first inserting a speculum into the vagina, then placing the specimen inside of a thin flexible catheter, and then advancing the catheter past the cervix and into the uterine cavity, which is where the specimen is left. Since pregnancy is so difficult to obtain with lower sperm counts, a total motile sperm count of at least one million must be present. This is calculated by multiplying the concentration by motility. IUI has been shown to enhance the likelihood of conception for infertile couples, especially those in whom the male partner has just minor reproductive issues. Yet, in cases of more severe male infertility, assisted reproductive technology may be required to conceive a child. IUI with sperm from an anonymous donor is an option that may be considered when a woman does not have a male partner, the male partner has been diagnosed with azoospermia, and a testicular biopsy has shown that there are no sperm present in the testicle (6).

It is believed that one in ten persons of reproductive age is subfertile or infertile and that modern procedures in assisted reproduction have become a frequent and acceptable type of treatment to aid these individuals. The amazing adaptability of mammalian gametes and the preimplantation embryo to both changes in their physical surroundings and changes in the chemicals they are exposed to is a critical factor in the success of the technologies being covered here. The confidence in the capability of these "germ cells" to precisely replicate the regular procedure of early growth under such settings may, however, be misguided, according to recent data from investigations involving both humans and animals. Even though there are known risk factors, such as increased maternal age and infertility in human-assisted reproductive technology subjects, as well as the transfer of supernumerary embryos, evidence from studies conducted on animals suggests that assisted reproductive technology procedures can directly contribute to the variable perinatal outcomes observed and the imprinting disorders that have only recently been discovered. The precise nature and scope of these contributions are a topic of debate; nonetheless, ovarian stimulation, in vitro maturation and embryo culture, intracytoplasmic sperm injection, and gamete and embryo cryopreservation have all been suggested as possible contributors (80).

In vitro fertilization (IVF), a procedure in which sperm and eggs are removed from bodies, allowed to fertilize in a petri dish, and then transferred as fertilized embryos back to the woman's uterus, resulted in the birth of Louise Brown, the first "test-tube baby," in the UK, in 1978. It has been 30 years since this reproductive technology was created to solve the issue of a woman's blocked or otherwise damaged fallopian tubes. Although there have been 30 years of IVF successes, nearly 5 million IVF babies have been born, and many other assisted reproductive technologies (ARTs) have advanced quickly, including some that combine assisted reproduction and human genomics, IVF is still out of reach for many infertile couples in low-resource nations. Following a rights-based approach to family planning, millions of infertile couples worldwide still do not have access to the reproductive "right" to ART (81).

During in vitro fertilization, (IVF) cycles, gonadotropins, clomiphene citrate, and aromatase inhibitors like letrozole are used to stimulate the ovaries or induce ovulation. Depending on the precise treatment, gonadotropins may cause multiple pregnancies in up to 36% of cycles and ovarian hyperstimulation syndrome, which includes ascites, electrolyte imbalance, and hypercoagulability, in 1% to 5% of cycles. Ovulation induction with scheduled sexual activity is often the best first line of therapy for those who come with anovulation. Couples with unexplained infertility, endometriosis, or moderate male factor infertility may pursue an initial 3 - 4 cycles of ovarian stimulation; if these methods fail to produce a pregnancy, IVF should be taken into consideration. Age-related decreases in female fertility should be taken into consideration while making decisions. For women who are older than 38 to 40 years old, immediate IVF may be a first-line therapeutic option. IVF is also recommended in situations of severe infertility due to the male sperm or untreated bilateral tubal factor (3).

Since they are a crucial factor in sperm membrane fluidity, polyunsaturated fatty acids, especially omega-3 fatty acids like docosahexaenoic acid, have been suggested for increasing in male diets (17).

Assisted Reproductive Technologies

Assisted reproductive technologies (ARTs) refer to any fertility methods that include the alteration of gametes, zygotes, or embryos to produce conception. IVF treatments make up more than 99% of all assisted reproductive technology (ART) operations performed in the United States. The process of in vitro fertilization (IVF) begins with the stimulation of the ovaries to produce multiple follicles, continues with the retrieval of oocytes from the ovaries, continues with the fertilization of oocytes in vitro in the laboratory, continues with the incubation of embryos in the laboratory, and then concludes with the transfer of embryos into the uterus of a woman through the cervix (6). The medications that are necessary for in vitro fertilization (IVF) include gonadotropins, which are used to stimulate the growth of follicles, a gonadotropin-releasing hormone analog (either an agonist or an antagonist), which is used to prevent premature ovulation during the process of follicle development, and hCG, which is used to initiate the final maturation of oocytes before they are retrieved from the body (6). A thorough monitoring of the ovarian response using transvaginal ultrasonography and serum estradiol levels is required throughout the IVF process, just as it is during the COH procedure. To retrieve oocytes, a needle is inserted via the vaginal apex and guided by ultrasonography to aspirate the fluid that is contained inside mature follicles. This procedure is done during in vitro fertilization. These fluids, which contain the oocytes, are then sent to the laboratory, where they are prepared for fertilization (6). It is possible to accomplish conception "naturally," by combining tens of thousands of sperm with a single egg, or by the use of Intracytoplasmic sperm injection, depending on the etiology of infertility. To prevent higher-order multiple fetal pregnancies, embryos are first assessed for their level of development and quality before having an acceptable number of them transplanted to the uterus to achieve pregnancy. IVF thereby makes it possible to circumvent the normally occurring processes of gamete transfer, fertilization, and embryo transport by supplying the essential instruments. After oocyte retrieval, it is necessary to take a daily progesterone supplement to ensure the appropriate secretory changes in the endometrium and to provide support for the potential pregnancy. If conception does take place, the supplementation is continued for at least the first ten weeks of the pregnancy (6).

Infertility caused by severe male factors, unexplained infertility, severe pelvic adhesions, severe endometriosis, poor ovarian response to stimulation, oligo-ovulation, absent or blocked fallopian tubes, tubal sterilization, failed surgery to achieve tubal patency, severe pelvic adhesions, severe endometriosis, poor ovarian response to stimulation, oligo-ovulation, severe male factor infertility IVF success rates are very variable and dependent on the underlying cause of infertility as well as the age of the woman undergoing the procedure. The likelihood of achieving pregnancy through a single round of in vitro fertilization is proportional to the quantity and quality of embryos that are implanted; it can range anywhere from 40 to 50 percent, with a 30 percent chance of carrying more than one baby at a time and a 15 percent chance of a miscarriage occurring on its own. Donor gametes may be used to increase the quality and quantity of embryos, and thus, the chances of becoming pregnant, under specific circumstances (6).

Emotional and Financial Considerations

Although infertility is not a life-threatening disease, receiving a diagnosis that one or both partners are unable to have children may be a traumatic event for couples. Both spouses may experience mental anguish, emotional strain, and financial challenges as a result of infertility's negative effects (82,83). Anger, guilt, despair, melancholy, anxiety, and a loss of self-confidence and self-esteem are some of the feelings that may be experienced by couples. In addition to this, the expense of the therapy for infertility may be very expensive, which is another big contributor to stress. Some couples are unable to seek therapy because it is so expensive, which leads to despondency (82).

In today's world, an increasing number of couples are confronted with challenges that are related to conceiving a child. The presence of psychological issues on both sides of a couple's relationship is linked to infertility. In vitro, fertilization is a method that may be used in the treatment of infertility. The use of this therapy has a substantial impact, psychologically speaking, not only on patients but also on their families (84).

After infertility treatments begin, partners commonly express concern that they will no longer have a fulfilling sexual life. "Sex on demand," which is planned according to cycles throughout the month, transforms what was once likely a spur-of-the-moment occurrence into something that is seen as a chore to be completed (85). The couple must choose whether or not they should notify their friends and family that they are undergoing IVF therapy. This is the most important choice that they need to make. It is not uncommon for a couple undergoing treatment for infertility to go through the cycle of having high hopes, only to have those hopes dashed by menstruation, sometimes month after month. Additionally, the couple must endure the ongoing stress of undergoing a variety of invasive physical procedures (85). Infertility may have a variety of consequences on a person's mental state, and the medications and hormones that are used to treat infertility can also have their own set of potential adverse effects. For instance, the synthetic estrogen clomiphene citrate (Clomid, Serophene), which is often recommended because it promotes ovulation and boosts the generation of sperm, may cause women to experience anxiety, sleep disruptions, and irritability (86).

Sadly, resource-poor and primarily rural countries of the low-income world cannot obtain successful infertility treatments and ARTs, creating a bleak situation of untreated and incurable infertility throughout significant areas of the globe (81,87,88).

Treatments that might be of assistance

Infertility Counseling

Those who are planning or already undergoing reproductive therapies may take use of the fertility counseling services provided by experienced medical health practitioners (MHPs) to better manage the psychological and social repercussions of infertility. Counseling services may be performed on an individual basis, for a couple, or in a group setting. It is designed to cater to the extraordinary situation-specific requirements of patients (such as in times of high distress, during pregnancy after infertility, during multiple pregnancies, while facing the end of medical treatment, while entering third-party donor programs), and it is carried out in a variety of settings, including individual, couple, and group settings (89). Infertility counseling, according to international guidelines, is thought to be distinct from disease-oriented gynecology and obstetrics consultations because it needs to focus on the emotional breakdown affiliated including an unaccomplished wish or living goal; the medical treatments required to meet this wish commonly consist of repetitive cycles of interventions which have a narrow success rate; the protracted wait creates frustration, disappointments, desperation, and adds stress to the situation; and the medical treatments required to meet this wish commonly consist (90).

Psychotherapy

The fact that each member of a couple undergoing therapy for infertility will have their own unique experience within the context of the treatment, as well as a shared one, is an essential consideration for the therapists. It's possible that the pair won't talk about their emotions with each other. It may be quite challenging for males to show their feelings and express themselves emotionally. Due to the very personal character of moving through the phases of rejection, rage, guilt, humiliation, and despair, many different kinds of difficulties may crop up in everyday life (85). For individuals or spouses who do not want to discuss their issues with other people, a therapist may provide a secure environment in which they can talk about their feelings. Couples struggling with any kind of infertility should strongly consider receiving psychotherapy since it is an effective treatment that should be advised. Patients should preferably start counseling before beginning any medical assistance to aid with infertility, if at all possible (91). Some individuals may need counseling to come to terms with the reality that they are unable to have children, and if this is the case, the therapist should discuss all of the possibilities that are open to them. The primary focus of therapy is communication, which, as a result, contributes to improved communication between couples. According to the findings of some studies, treating psychological issues including stress, anxiety, and depression may help boost a couple's chances of becoming pregnant (91). Throughout therapy, it's also been reported to facilitate the development of coping strategies and the making of decisions. In addition to individuals who suffer from anxiety and depression, those who struggle with a variety of sleep and eating problems may also find relief from it. Patients that fit this description need the assistance of an IVF clinical specialist who also has experience working in the field of mental health nursing. This individual is familiar with both reproductive treatments and psychotherapy. On the other hand, those who have specialized knowledge in fields such as psychology and social work have a solid grounding in mental health. But, they do not have the requisite medical knowledge of reproductive processes, which is an essential component for couples who are undergoing therapy for infertility (82).

Relaxation Techniques

In addition to psychological treatments, it has been shown over and again that practicing relaxation methods may help a broad variety of medical patients feel less anxious and depressed (92). Particularly, research indicated that participants who participated in a yoga intervention had a better quality of life and had a reduction in the number of negative sensations and thoughts linked with infertility (93). Meditation, deep breathing, guided visualization, and yoga are just a few of the many relaxation practices that are advised by professionals (94).

Figure 38. Some yoga positions (95)

References to the fourth chapter

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The Complexities of Menopause: A Comprehensive Examination of Treatment Options and Risks

Definition of menopause

The age at which a woman reaches menarche, the age at which she gives birth to her first child, and the age at which she goes through menopause are all significant milestones in a woman's life. There is a dearth of comparative information on this general pattern of the ages at which certain occurrences occur and the intervals of time in between them among the various people of the globe (1). Menopause is considered the absence of spontaneous menstruation for at least one year before diagnosis. Most women experience menopause between the ages of 49 and 52 in all parts of the world (1). Menopause typically occurs at a mean age of 51 years old in the United States. It is predicted that 6,000 women in the United States approach menopause every single day, and due to rising life expectancy rates, these women will spend about forty percent of their lives in the postmenopausal period of their lives. Smoking, having a lower body mass index, not having children, and having a lower educational attainment are all factors that have been linked to an earlier onset of menopause (2,3).

Generally, the menopausal transition occurs between the ages of 45 and 55. Midlife often coincides with other important changes, such as physical health issues, changes in family and career duties, changes in relationships and sexual functioning, or new caregiving responsibilities for elderly parents or ailing spouses (4,5).

While the menopausal transition is generally thought of as occurring at a single moment in time, coinciding with the end of ovarian egg production, it spans many years and is a dynamic time when women undergo predictable changes to their menstrual cycle. The staging method developed by the Stages of Reproductive Ageing Workshop is regarded as the industry standard for describing the alterations brought on by reproductive aging. This staging approach comprises seven stages total, divided into three periods (reproductive, menopausal transition, and postmenopausal). It details each stage's normal length, menstrual cycle features, hormonal makeup, number of antral follicles, and symptoms (6).

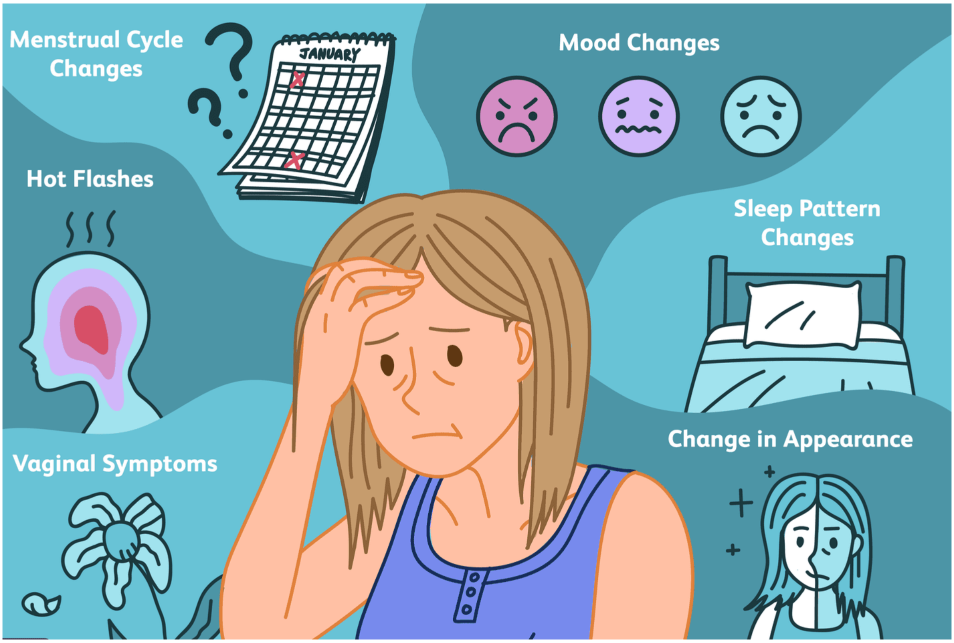

Figure 1. Menstrual transition syndrome (7)

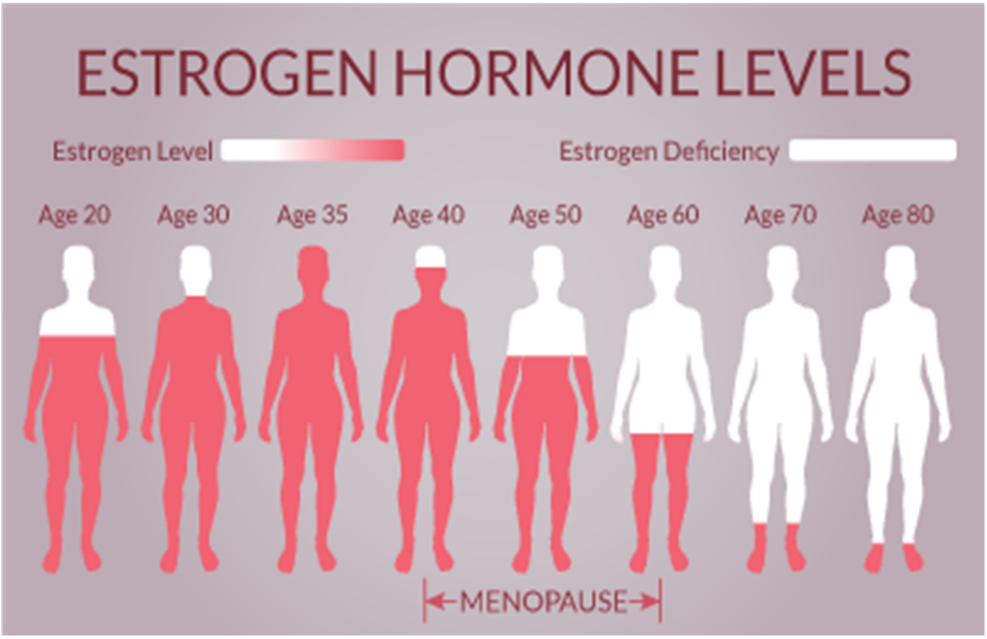

Figure 2. Fluctuation of estrogen levels (8)

Physiology of menopause

There are 7 phases of reproductive aging: 5 occur before and 2 occur after the last menstrual cycle. Not every woman will go through all seven of these phases. The length of each of these phases varies from woman to woman, and each stage is marked by varying changes in the menstrual cycle, hormone levels, and menopause-related symptomatology, highlighting the difficulty of researching the menopausal transition (MT) and its potential for health-related consequences (9–11). Women are born with a complete complement of oocytes, which progressively decrease over their reproductive years due to ovulation and atresia. Reduced inhibin B is produced by fewer oocytes, which reduces the ovarian response to follicle-stimulating hormone (FSH). As a consequence, the amount of FSH rises, increasing follicular recruitment and speeding up follicular atrophy while maintaining estradiol levels throughout the early menopausal transition**.** Eventually, the loss of follicles leads to a broad range in estrogen levels, unpredictability in the ovarian responsiveness to FSH, and disruption of the regular reproductive cycle. The ovary cannot react to even very high levels of FSH, and estrogen levels fall after all the ovarian follicles have been lost. Hormonally, the postmenopausal era is characterized by decreased estradiol levels and high FSH (>30 mIU/mL) (12).

Factors Affecting the Timing of Natural Menopause

The age of natural menopause is seen as a marker for not only physical and general health aging but also reproductive aging. A later age of natural menopause has been associated with a larger risk of ovarian and breast cancer in obese women, as well as a longer life expectancy, better bone mineral density, and decreased fracture risk (13 - 19).

Factors that affect menopause are the next:

- Race/Ethnicity
- Reproductive History Factors
- Body mass index
- Cardiovascular Health Before Menopause
- Exercise, eating, and drinking habits
- Smoking
- Genetics (20).

Menopause symptoms and signs

Women who are traveling the MT may encounter a variety of signs and symptoms, including hot flashes and night sweats (also known as vasomotor symptoms), mood swings (such as despair and anxiety), sleep and cognitive problems, as well as abnormalities in genitourinary and sexual function (21). It also includes irregular menstruation, postmenopausal vaginal dryness, and symptoms of the lower urinary tract (12).

Vasomotor symptoms

Most middle-aged women have vasomotor symptoms, which may lower a woman's quality of life and need medical attention. Vasomotor symptoms may persist for up to 10 years, with women whose symptoms start early in the treatment experiencing issues for a longer period (21,22). Reproductive hormones seem to be a major element in the multifactorial causes of vasomotor symptoms. More elements that have been linked to a greater frequency and intensity of vasomotor symptoms include premenopausal symptoms, increased anxiety and depression, obesity before menopause, and smoking. Data on food, alcohol use, and physical activity and their correlations with the development of vasomotor symptoms are inconsistent (21).

Around 65% of women experience hot flashes and nocturnal sweats regularly. Hot flashes are sudden feelings of warmth that often affect a woman's chest, neck, and face. They are sometimes accompanied by sweat followed by a cold, and occasionally by palpitations and anxiety. They could last as long as thirty minutes but often last less than five min. They may sometimes be brought on by hot conditions, stress, or hot foods and drinks (23). Hot flashes known as night sweats sometimes keep people up at night and disrupt their sleep. While the exact etiology of menopause symptoms is unknown, it is believed that reduced estrogen as well as potential alterations in FSH and inhibin B have an impact on endorphin levels in the hypothalamus (24).

Menopause seems to shrink the hypothalamic thermoregulatory zone, which is the core temperature spectrum within which a person may regulate the temperature of the body without reverting to symptomatic vasodilation or sweating. As a result, vasodilation and sweating are induced at a lower temperature (24). It is usual for vasomotor symptoms to last for four years; however, this duration might vary (25). Women who are 60 years old and older are more likely to suffer from continuous hot flashes. According to the findings of a meta-analysis that included two longitudinal studies and many cross-sectional investigations, vasomotor symptoms typically begin two years before menopause, reach their highest point one-year following menopause, and then gradually improve over the subsequent ten years (23,25).

Evaluations of vasomotor symptoms

Laboratory testing is not necessary to confirm vasomotor disturbances for a woman in their late forties to mid - fifties unless another cause is suspected. In general, a thorough history can rule out other explanations. More factors that might bring on hot flashes include intake of alcoholic beverages, carcinoid syndrome, dumping syndrome, hyperthyroidism, withdrawal from narcotics, panic attacks and high levels of stress, and drugs. Hot flashes are one of the many symptoms that may be brought on by anxiety and excessive levels of stress. It is interesting to note that in a large longitudinal research, anxiety symptoms at the beginning of the investigation were shown to have a high association with subsequent vasomotor symptoms (26).

Treatment of vasomotor symptoms

The breadth of treatment options includes everything from lifestyle evaluation and intervention to hormonal and non-hormonal medication, each of which has unique advantages and disadvantages. Women who are perimenopausal or postmenopausal must consider their symptoms, health condition, short- and long-term health concerns, personal life expectations, and the accessibility and price of various treatments before choosing a course of treatment (9). Studies have repeatedly shown the existence of a highly powerful placebo effect; consequently, placebo-controlled randomized trials are essential to evaluate the effectiveness of any therapy (24).

Lifestyle adjustments

To relieve the symptoms of hot flashes, try lowering the room temperature, layering your clothing, having a fan nearby, and staying away from hot beverages, caffeine, and hot or spicy meals. Another factor supporting the recommendation for perimenopausal women to stop smoking is the association between smoking and the frequency of vasomotor symptoms (26,27).

Hormonal Treatment

The best treatment for menopausal hot flashes and symptoms of atrophic vaginal and urogenital tissues is estrogen therapy (ET). In comparison to a placebo, oral estrogen reduces the frequency of hot flashes by 75% (28). While vaginal tablets and rings may have fewer side effects and greater rates of adherence than vaginal creams, all types of vaginal estrogen treatment are efficient and well-tolerated (9).

For vasomotor symptoms, estrogen may be administered orally, topically, or intravaginally. Unless the patient has undergone a hysterectomy, progestin must be administered to avoid endometrial hyperplasia and cancer. In the form of a pill, a levonorgestrel-releasing intrauterine device, or in combination with the estrogen in a tablet or patch, progesterone is administered. Either continuously (daily, as in the conjugated equine estrogen 1 medroxyprogesterone acetate pill or the estradiol 1 norethindrone patch) or sequentially (as in the CEE 1 MPE dosage pack, where the progesterone is contained in the tablets for days 14–28) may be used to administer it. In addition to being useful for hot flashes, low-dose oral contraceptive tablets that only contain 20 mg of ethinyl estradiol with progesterone also provide perimenopausal women contraception and cycle management. They are four times as potent as conventional hormone-replacement therapy (HRT) and should not be used by women who smoke, are obese, suffer from migraines, or have hypertension since 5 mg of ethinyl estradiol is comparable to 0.625 mg of CEE. The only medication included in Table 1 that is effective for contraception outside oral contraceptives is the levonorgestrel intrauterine device. Oral HRT is metabolized in the liver's first pass, which encourages prothrombotic hemostatic alterations (24,29). As compared to an equal dosage of oral estrogen, case-control studies have shown that transdermal estrogen is linked with a much-reduced incidence of deep venous thrombosis (30). There are also ultra-low-dose estrogen formulations that some women may use to alleviate their hot flashes. Transdermal gels, emulsions, patches, and sprays are the available forms (24).

Treatment duration, patient care, risks factors, and complications

Short-term HRT (up to 5 years) is appropriate for the majority of people with debilitating hot flashes. Many women have a reduction in vasomotor symptoms after menopause, thus it is proper to discontinue hormone treatment for 6 to 12 months and then resume if required. Tapering as opposed to suddenly ceasing does not prevent the recurrence of hot flashes. Yet, some women may like tapering. It is debatable whether HRT should be withheld before surgery to prevent perioperative venous thromboembolism (VTE) due to the lack of strong evidence that HRT raises the risk of VTE more than surgery. Others propose discontinuing HRT 4 to 6 weeks before surgery for women having procedures linked with a high or moderate risk for VTE (30,31). Breast soreness, vaginal bleeding, and sickness are side effects of estrogen therapy, and some women report mood problems and bloating with progestin medication. Aggressive breast cancer and coronary artery disease were also related to hormonal therapy. Once these findings were made public, the majority of women stopped using hormonal therapy for disease prevention and were hesitant to use it even for severe vasomotor symptoms (24,32).

Estrogen was used for many years to alleviate vasomotor symptoms, and millions of women also took it to avoid chronic diseases, such as osteoporosis and cardiovascular disease. In 2002, preliminary data from the Women's Health Initiative (WHI) indicated that the overall risks of estrogen for illness prevention outweighed its advantages (24).

Contraindications for hormone replacement therapy:

- Breast or endometrial cancer history
- Breast ductal hyperplasia is atypical
- Histories of thromboembolic illness of the veins
- Coronary artery disease or stroke history
- Undiagnosed uterine hemorrhage
- Unregulated hypertension
- Migraine-related headaches (may increase the risk of stroke)
- Chronic liver disease (decreases estrogen metabolism)
- Immobilization
- Active gallbladder condition
- Porphyria (may be exacerbated)
- High triglyceride levels (may increase venous thromboembolic disease) (24).

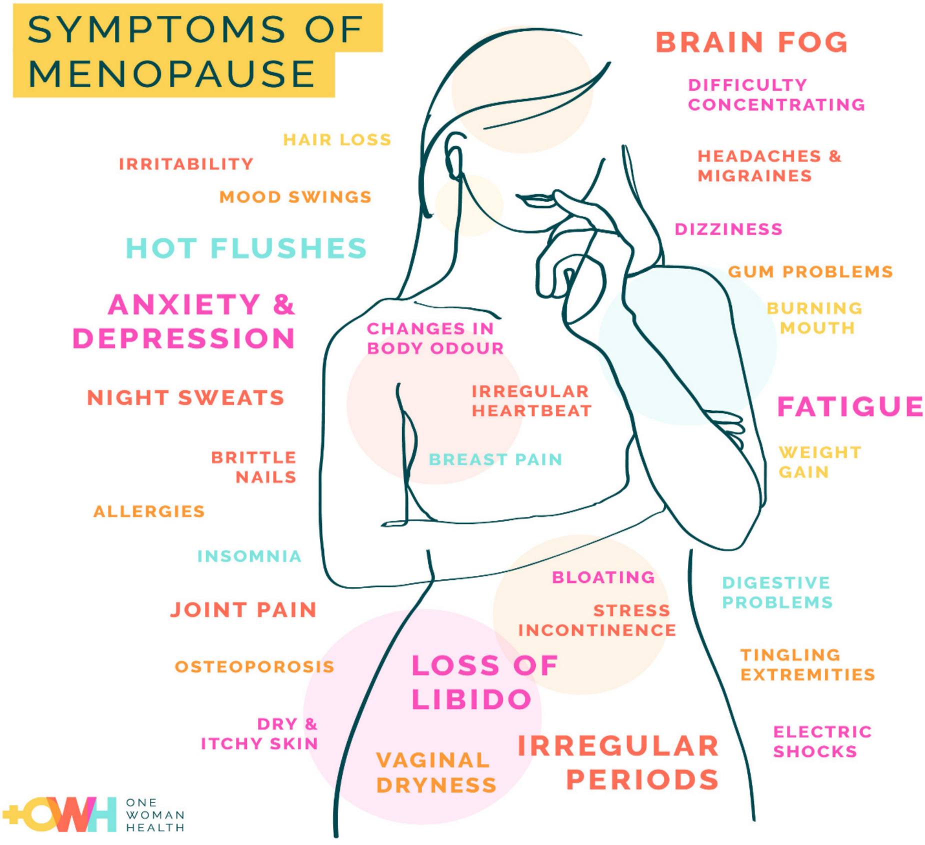

Figure 3. Symptoms of menopause (33)

Treating Hot Flashes with a Nonhormonal Medication

While less effective than estrogen, it has been proven that the selective serotonin reuptake inhibitors paroxetine (10–20 mg per day) and fluoxetine (20 mg per day), and the serotonin-norepinephrine reuptake inhibitor venlafaxine (75 or 150 mg per day) reduce the hot flash frequency (29). Gabapentin, 900 mg per day, also reduces the frequency and intensity of hot flashes, as well as its sedative properties may make it effective at sleep. Clonidine has modest effectiveness but intolerable adverse effects (dry mouth, insomnia, drowsiness) (34).

Treating Hot Flashes with a Non-Prescription Medicine

In the postmenopausal population, 50% to 75% of women use an alternative therapy. They are poorly researched and not subject to Food and Drug Administration regulations. Most of the research indicates that complementary treatments for hot flashes, such as soy, black cohosh, and acupuncture, do not prove more beneficial than a placebo (35,36). Phytoestrogens are nonsteroidal substances generated from plants that bind to estrogen receptors, such as isoflavones found in red clover and soy. Red clover isoflavone extracts are not effective in random studies, while soy isoflavone extract has had inconsistent results (37). Soy-based therapies should not be used by women with a strong personal or family history of thromboembolic events, cardiovascular events, or hormone-dependent cancers (of the breast, uterus, or ovary) (38).

Sleep disturbance

During the MT, insomnia is a typical issue. Independent of chronological aging or changes in body habitus, women report sleeping worse during the perimenopause period than they did during the late reproductive age, with the severity of sleep-disordered breathing rising as women go from premenopausal to postmenopausal (39,40). Only 15% of midlife women report increasing sleep complaints (waking up frequently) during perimenopause, according to recent analyses. The remaining midlife women experience a stable increase in sleep complaints consistent with an aging-related increase in sleep problems that are not specific to menopause (41). Obesity, concomitant diseases, hormonal changes, vasomotor symptoms, and psychological variables have all been connected to a rise in sleep disruptions throughout the MT (22,39).

Menopausal genitourinary syndrome

The menopausal genitourinary syndrome includes Vulvovaginal atrophy (VVA) and lower urinary tract symptoms (42).

Vulvovaginal Atrophy

Premenopausal vaginal linings are thicker, rugate, well-vascularized, and lubricated. The vaginal lining gets thinner and may become dry and pallid after menopause when estrogen levels drop. The vagina loses elasticity and narrows. Atrophic vaginitis causes the brown or yellow discharge. A change to fewer acid-producing vaginal bacteria raises pH over 5.0. Wet mount microscopy shows white blood cells outnumbering epithelial cells, parabasal cells (immature epithelial cells with big nuclei), and few or no lactobacilli (43). Those vaginal and vulvar alterations may cause several symptoms that might lower a woman's life satisfaction and sexual function. Vaginal Symptoms include dryness, Itching, Irritation, Discharge, and Dyspareunia. Lower urinary tract symptoms include burning, dysuria, recurrent infections, and nocturia (24).

Dryness in the vaginal area is the symptom of VVA that is reported the most often, accompanied by dyspareunia and discomfort. On the other hand, 44 percent of postmenopausal women may not consult a doctor for their symptoms, and just a minority of health care practitioners begin conversations about patients' vaginal complaints. While screening post-menopausal women that report symptoms of vaginal or vulvar itching, discomfort, and vaginal discharge, doctors should think about other illnesses that might explain similar symptoms and rule out those disorders first (44–46). If any of these symptoms go untreated, they might lead to vaginal discomfort, pain, and sexual dysfunction, which could reduce the quality of life (47).

Atrophy of the vaginal tissue often progresses and is not likely to spontaneously improve (48). Women typically report having little sexual interest or desire. Clinically, it is obvious when there is a lack of subjective arousal during a sexual engagement, yet this deficit has not been the focus of a conventional sexual investigation, definitions of dysfunction, or treatment. Assessment, diagnosis, and treatment have not considered the often-poor association between women's subjective sexual excitement and palpable increases in vaginal congestion in response to sexual stimulation (48). In contrast to the effects of dyspareunia, nonsexual and urologic elements of vaginal atrophy have a substantial emotional impact (49,50).

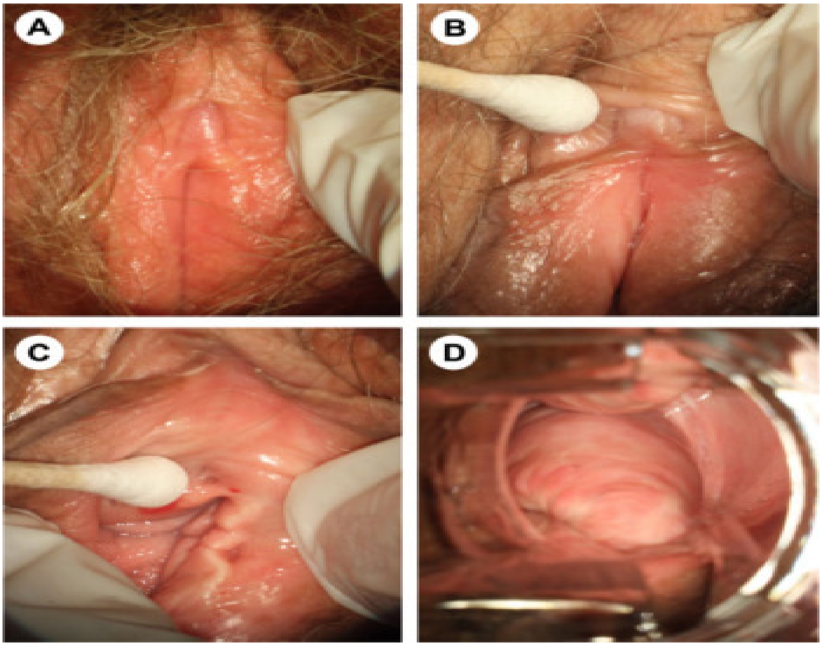

Figure 4. Multidisciplinary overview of vaginal atrophy (51)

Vulvovaginal Atrophy Care and Therapy

Longer-term estrogen depletion increases the risk of developing urogenital symptoms because maintaining vaginal health requires substantially less estrogen than preventing vasomotor and other symptoms (52).

Moisturizers may be used more often to treat vaginal dryness, although lubricants are typically used before intercourse to lessen friction and discomfort. There are many water-based, silicone-based, and oil-based formulas available. Women should be informed about the decreased efficacy of condoms in preventing pregnancy and STDs since oil-based lubricants may induce condom degradation (24,53,54).

In symptomatic postmenopausal women, local estrogen, either by itself or in combination with androgen, is very successful in reducing urogenital atrophy symptoms and enhancing sexual function (52). When it comes to relieving the symptoms of VVA, the local administration of estrogen is more beneficial than the use of systemic estrogen (oral or transdermal); in fact, up to eighty percent of women report an improvement in their symptoms (55,56).

Ospemifene is a selective estrogen receptor modulator that was given the green light by the Food and Drug Administration in 2013 for use in the treatment of moderate to severe dyspareunia brought on by VVA. In the vaginal epithelium, it has the action of an estrogen agonist, while on breast tissue and endometrial, it has a negligible or nonexistent estrogenic impact. Dyspareunia and vaginal dryness were considerably improved in women with VVA when they took ospemifene at a dose of 60 mg daily. In the group that was given a placebo, just 2% of the participants had hot flushes, while 7.2% of those who took ospemifene reported experiencing them. While there was no increase in the incidence of VTE, it is possible that the trials did not have enough participants to detect the difference (57–59).

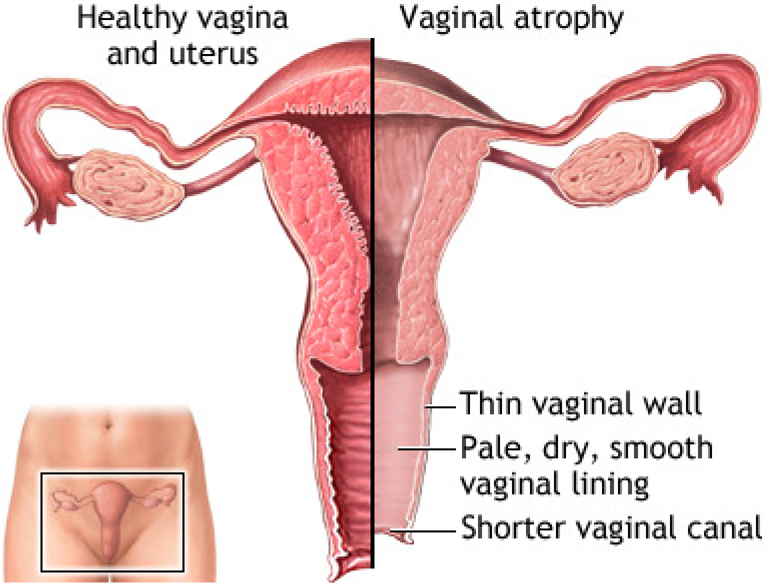

Figure 5. Vaginal atrophy in a menopausal woman (60)

Vulvovaginal atrophy is a differential diagnosis for the following symptoms:

- Infections of the vaginal cavity (bacterial vaginosis, Candida, Trichomonas);
- Lubricants, moisturizers, soaps, and condoms may all cause contact dermatitis and irritation;
- Lichen sclerosis;
- Malignancy, sometimes known as vulvar cancer or vulvar intraepithelial tumor;
- Paget disease;
- Vaginitis with desquamative and inflammatory lesions;
- Trauma;
- Foreign body;

Severe Vulvar Atrophy

Labia minora atrophied and no longer existent. Fusion of superior labia obscuring clitoris.

Figure 6. Severe vulvar atrophy in a menopausal woman (61)

Urinary Symptoms

Women who have gone through menopause may have symptoms of the lower urinary tract, including irritability, incontinence, dysuria, and nocturia. It is not known for certain whether these symptoms of the lower urinary tract are brought on by aging or by a lack of estrogen (24).

Urinary tract infections, more often known as UTIs, are the most prevalent kind of bacterial infection that affects women, in general, and postmenopausal women. It is important to differentiate between two groups of elderly women who suffer from recurrent UTIs based on their ages and general conditions. The first group should consist of healthy, young postmenopausal women aged 50 to 70 years who are neither institutionalized nor catheterized. The second group should consist of elderly women who are confined to an institution, with or without a catheter (62).

Bacteriuria is more common in older women who have some degree of functional impairment, yet the condition is often asymptomatic. Notwithstanding, there is not a lot of information available on the risk factors related to recurrent UTIs in older women. Urinary incontinence, a history of UTI before menopause, and nonsecretor status were revealed to be highly linked with recurrent UTI in young postmenopausal women when multivariate analysis was conducted. Another research looked at the incidence of acute cystitis in postmenopausal women with and without diabetes and compared the risk factors for developing the condition (62).

In yet another study, researchers looked at the incidence of acute cystitis in diabetes and non-diabetic postmenopausal women and compared the two groups' risk variables. Those who were using insulin and had a history of urinary infections at any point in their lives were both independent predictors of infection. A history of using vaginal estrogen cream within the last month, kidney stones, and asymptomatic bacteriuria at baseline were all considered to be associated with a borderline level of significance. In postmenopausal women, the probable function that estrogen insufficiency has in the development of bacteriuria is another significant aspect that must be taken into consideration (62).

At least two studies show that estrogen has a favorable impact on the therapy of recurrent bacteriuria in older women (62).

A patient is considered to have recurrent urinary tract infection (RUTI) if they have had at least three episodes of urinary tract infection (UTI) in the preceding 12 months or at least two episodes in the most recent six months. Vesical prolapse, cystocele, post-void residue, and urine incontinence are the primary variables related to RUTI in postmenopausal women. These characteristics are all connected with a drop in estrogen, which also has a role in RUTI. Estrogens have been suggested as a potential method of RUTI prevention (63). There is a potential for approximately 10 percent of postmenopausal women to have experienced an infection of the urinary tract in the preceding 12 months (64,65). It has been speculated that decreased estrogen levels cause changes in the vaginal flora and pH, making it simpler for enteric coliforms to colonize and making a person more prone to urinary tract infections. While it has not been shown that estrogen administered systemically may lower the risk of recurrent urinary tract infections, vaginal estrogen has been proven in a few trials to do so (63).

Other frequent disorders that are associated with the menopause

Depression

Anxiety and depression are two very common affective diseases that have a significant impact on morbidity and death (66). Mood disorders comprise a range of symptoms ranging from modest changes in mood to severe serious depression. Nonetheless, perimenopausal women's quality of life may be considerably influenced by dysphoric disorder, sub-threshold depression (minor depression), or a depressive disorder related to a general medical condition, all of which have been proven to be more frequent than a major depressive disorder in the community-dwelling older adult population (67).

Menopause is considered a "window of susceptibility" for mental disorders. Nonetheless, there is still disagreement about the fluctuation/loss of estrogen as a distinct etiologic component leading to depression throughout perimenopause and beyond (67).

According to findings from studies that followed participants over time, women are two to four times more likely to develop depressive symptoms throughout the transition from premenopausal to menopause than they were before menopause. There is a correlation between hormonal variations and the existence of vasomotor symptoms, which has led to the diagnosis of depression (68,69). Compared to males, women are more susceptible to depressive illnesses. While endocrine factors have been suggested, variations in coping mechanisms and stress responses, for instance, may also play a role in the gender gap in the frequency of depressive disorders. Women may have a greater incidence of depression because of gender variations in socialization. Despite the lack of a single, obvious cause, studies point to a connection between menopause and sadness. Hot flushes, nocturnal sweats, vaginal dryness, and dyspareunia are climacteric symptoms that are more often reported by women with anxiety and/or depressive symptoms. Uncomfortable vasomotor sensations may be linked to sleep problems, which may in turn lead to more reports of sad and anxious feelings. Middle-aged women's sexuality and depressive disorders are significantly influenced by biopsychosocial and relationship characteristics, and the majority of antidepressants may negatively impact sexual responsiveness. Last but not least, research has repeatedly shown that women with high degrees of depressive symptoms have worse cognitive performance and are at higher cardiovascular risk. At this time, a definite link between mental symptoms and hormonal changes such as a drop in estrogen levels has not been established. The incidence and clinical progression of both menopausal symptoms and depressive disorders may be influenced by stress, educational attainment, ethnicity, socioeconomic circumstances, and relationship status. Further research is required to improve the early diagnosis of depression because it is frequently a lifelong condition and is often accompanied by severe comorbid conditions. It may also be prudent to monitor a woman's mental health during the menopause transition to prevent a depressive disorder from having long-term negative effects (70).

Accumulated data reveals that ovarian hormones affect serotonin and noradrenaline neurotransmission, a mechanism that may relate to the pathophysiological processes underpinning the onset of depression symptoms during hormonal fluctuations in biologically susceptible subpopulations. Midlife women with depression and vasomotor symptoms may be effectively treated with transdermal estradiol and serotonergic and noradrenergic antidepressants, respectively. The identification of patients who may be at a higher risk of depressive disorders during the menopausal transition might aid in the development of preventative measures for this group (5).

Sexual hormones and neuronal functioning

Evidence suggests that ovarian hormones interact with several molecular and cellular processes in the brain to control a vast array of non-reproductive activities (71). Through influencing homeostasis, synaptic plasticity, and neuronal protection, estrogens exert a variety of effects on the brain (72,73). Estrogens exert their effects through a slower genomic method involving estrogen binding to nuclear estrogen receptors and subsequent control of transcription, and by a more fast nongenomic membrane route involving calcium, ion channel, and kinase signaling. Estrogens have been shown to have a powerful neurotrophic effect: they enhance the repair of neuronal membranes, promote dendritic sprouting, and enhance the synthesis, release, and action of neurotransmitters. In addition, there is evidence of a unique anti-inflammatory effect on the brain (73–76). There is a growing interest in the rapid nongenomic effects of estrogen and the role they may play in estrogen's neural actions, even though many of these actions are undoubtedly mediated by the classical genomic mechanism of regulation of transcription of genes by estrogen nuclear receptors (73).

Androgens are produced in the brain, testes, and adrenal glands of both sexes, influencing the formation and function of the central nervous system in significant ways. These impacts may contribute to the occurrence and development of neurological illnesses such as autism spectrum disorder, schizophrenia, and Alzheimer's disease, which affect men and women at different rates (77). Like other steroid hormones, androgens are produced from the breakdown of cholesterol. The first rate-determining step in steroidogenesis is the cleavage of the cholesterol side chain by the P450scc enzyme, which is connected with the inner mitochondrial membrane, to generate pregnenolone. Pregnenolone serves as a substrate for the manufacture of additional steroid hormones by its conversion to 17-hydroxypregnenolone or progesterone (77).

These steroids are precursors to produce dehydroepiandrosterone (DHEA), androstenediol, and androstenedione, which are low androgens that are substrates for conversion to testosterone, the major circulating androgen in the blood. In androgen target tissues, testosterone is converted to a variety of physiologically active metabolites, including 5 dihydrotestosterone (DHT) and estradiol through 5-reductase and cytochrome P450-aromatase, respectively (77).

Since multiple different neuronal and glial cell types may be involved in mediating the effects of testosterone on the brain, as well as potential contributions from multiple receptor systems, this pattern of local tissue metabolism makes it more difficult to understand the mechanisms by which testosterone affects the brain (78,79).

Persistent estrogen insufficiency is harmful to the neuro vegetative, emotional/affective, cognitive, motor, and major systems of the brain. According to the kind of neuronal damage that the gradual loss of estrogen produces, the symptoms that women experience throughout menopause and beyond have varied beginning and temporal patterns. Early affective symptoms, such as depression and anxiety, are caused by the impact of estrogenic fluctuations on the limbic system, resulting in a reduction of key neurotransmitters such as serotonin, dopamine, and endorphins. Early neuro vegetative symptoms, such as hot flushes, insomnia, and night tachycardia, are consequent to the rapid dysregulation of the hypothalamic set-points secondary to the impact of estrogenic fluctuations on neuronal functioning in 5\s. The majority of cholinergic and dopaminergic neurons, respectively, must have been killed for these symptoms to manifest (80–84).

Treatment of menopausal mood disorders

According to what is known right now, estrogen therapy for emotional disorders may be effective in two circumstances:

- To maintain and restore disturbed homeostasis, such as that which happens in premenstrual, postpartum, or perimenopausal conditions (85);
- To operate as a psych modulator during times when estrogen levels are low and people are more susceptible to dysphoria, as is the case for postmenopausal women. There is mounting data that suggests estrogen may be effective for depressed perimenopausal women as their only antidepressant (86,87).

Particularly, compared to premenopausal women, postmenopausal women have more severe depression, progress more slowly, and are more resistant to standard antidepressants. Postmenopausal women also get greater results from antidepressants when paired with hormone treatment (88).

A persistent hypoestrogenic condition may lessen an antidepressant's effectiveness, according to some research. To prospectively assess the impact of menopausal status and its hormonal correlates on the efficacy of antidepressant treatment for 6 weeks, 39 female patients (n17 in pre-menopause; n22 in post-menopause) with major depressive disorder based on DSM-IV criteria and who were not on HRT has taken part in the study. Post-menopausal women showed a poorer response to antidepressants over 6 weeks of treatment compared to pre-menopausal women, even after controlling for age, age at onset, baseline symptom severity, antidepressant dosage, and hormonal levels of follicle-stimulating hormone (FSH), luteinizing hormone (LH), and estradiol (E2). The effectiveness of antidepressants in post-menopausal women was likewise correlated with old age and high FSH levels. Age and menopausal status are indicators of poor antidepressant medication response. Moreover, the FSH may disrupt the antidepressant drugs' ability to work (88).

Because antidepressants work on shared neuro-biological common denominators, they help lessen certain menopausal symptoms. Soares and Coll discovered that HT and escitalopram had comparable effectiveness in treating depression symptoms and menopausal symptoms such as vasomotor symptoms and sleeplessness (89).

Cognitive Function

Although up to forty percent of women say that they experience forgetfulness during the perimenopausal era, any cognitive deterioration that has been seen in observational studies has been mild and temporary (90,91). When hormone therapy is started during menopause, the impact that it has on a woman's cognitive performance may change, depending on the timing of the treatment. The use of hormone treatment in women aged 65 and older was shown to raise the probability of acquiring probable dementia, as well as result in more cognitive decline and higher brain shrinkage, according to analyses of pooled data from both the ET and EPT arms of the WHI study. The decline in cognitive function was marginal, and its implications for therapeutic practice are not entirely evident (92–96).

There is evidence to suggest that ovarian steroids impact both the maturation of reproductive cells and the development of brain pathways. There is a correlation between the date of natural menopause and cognitive performance in childhood. Ovarian steroids may influence both of these factors throughout a person's life (97).

Both premature surgical menopause and premature ovarian failure were associated with long-term negative effects on cognitive function, which are not entirely offset by menopausal HT. In terms of surgical menopause, these results suggest that the potential long-term effects on cognitive function should form part of the risk/benefit ratio when considering ovariectomy in younger women (98).

The studies that have been conducted to investigate the effects of estrogen replacement on cognitive performance in healthy older women have produced contradictory findings. Researchers investigated whether there was a correlation between a history of estrogen usage and the level of cognitive ability shown by 727 women who took part in major community-based research. Participants were monitored continuously for about 2.5 years on average. At the baseline, information on estrogen usage was collected. At both the beginning of the study and throughout the subsequent follow-up, participants were given standardized assessments of their memory, language, and ability to think abstractly. According to the findings, women who had used estrogen replacement therapy scored considerably higher on cognitive tests at the beginning of the study compared to women who had not used the therapy, and their performance on verbal memory tests increased marginally during the study. There was no correlation between age, education, ethnicity, or APOE genotype and the influence estrogen had on cognitive ability. According to the findings, estrogen replacement treatment may be beneficial for maintaining cognitive function in postmenopausal women who do not have dementia (99).

Cardiovascular Disease, Osteoporosis, and Malignancy

Osteoporosis (OP), breast cancer (BrCa), and cardiovascular disease are among the chronic diseases that postmenopausal women are at a high risk of acquiring. Significant direct (medical care) and indirect (workplace) expenditures may arise from these illnesses (100).

Women are more at risk for cardiovascular disease (CVD) after menopause than men are, and they often get coronary heart disease many years later than men do. CVD is the primary cause of mortality in women. This finding gave rise to the theory that the menopausal transition (MT) is partly responsible for the rise in the risk of coronary heart disease. Our knowledge of the connection between MT and CVD risk has greatly improved over the last 20 years because of longitudinal research on menopausal women (20).

Growing children and teenagers see a fast rise in bone mass, which reaches its maximum in adults in their 20s and 30s years of age. When a person is between the ages of 35 and 45, their bone mass starts to gradually decrease (101).

Osteoporosis is a condition that causes a reduction in bone mass as well as a degradation of the skeleton's microarchitecture. This leads to an increased risk of fractures. Osteoporosis comes with significant financial and human expenses, both of which are expected to rise as the population continues to age. The primary risk factor for osteoporosis is the reduction in ovarian hormone production that occurs with menopause. This results in an increased rate of skeletal resorption and a significantly lower rate of bone growth. While estrogen therapy protects against the loss of bone mass and lowers the risk of vertebral and hip fractures, estrogen therapy must be continuously administered for the favorable benefits to be maintained. It makes no difference how the drug is taken or whether a progestin is taken at the same time for it to have these effects. Calcitonin, bisphosphonates, and tissue-specific estrogen are some of the estrogen replacement therapies that are now in the research and development stage (102).

The rates of bone synthesis and bone resorption are roughly equal in adult women before the start of menopause. Calcium balance is maintained, and no loss of bone mass happens during this time. However, following menopause, even though both bone synthesis and bone resorption rates rise, the rate of bone resorption increases more quickly, which results in calcium imbalance and a net loss of bone. Hence, the first objective of treatment for osteoporosis is to return levels of bone resorption and bone production to what they were before the onset of menopause. In an ideal scenario, the rate of bone production would be maintained at a level that was slightly greater than the rate of bone resorption, which would result in a calcium surplus (101).

It is recommended that hormone replacement therapy (HRT) be started as soon as possible following menopause. On the other hand, there is abundant evidence in the published research that hormone replacement therapy stops bone loss throughout all phases of postmenopausal life. In addition, recent research on hormone replacement treatment in women with symptomatic osteoporosis found that there was a considerable reduction in the incidence of fractures while the medication was being administered (103).

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Annex III Personal archive
Prof. Univ. Dr. Pirtea Laurențiu Cornel

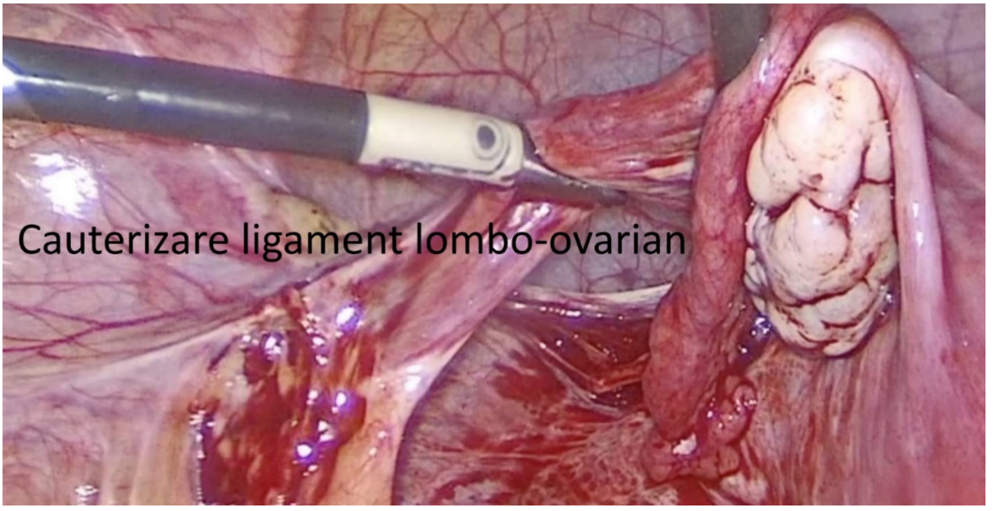

Figure 39. Cauterization of the lumbo-ovarian ligament

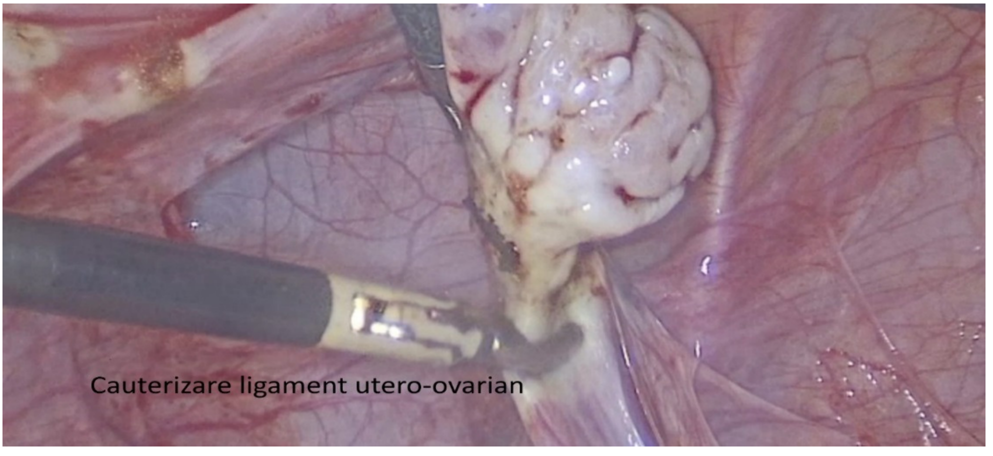

Figure 40. Utero-ovarian ligament cauterization

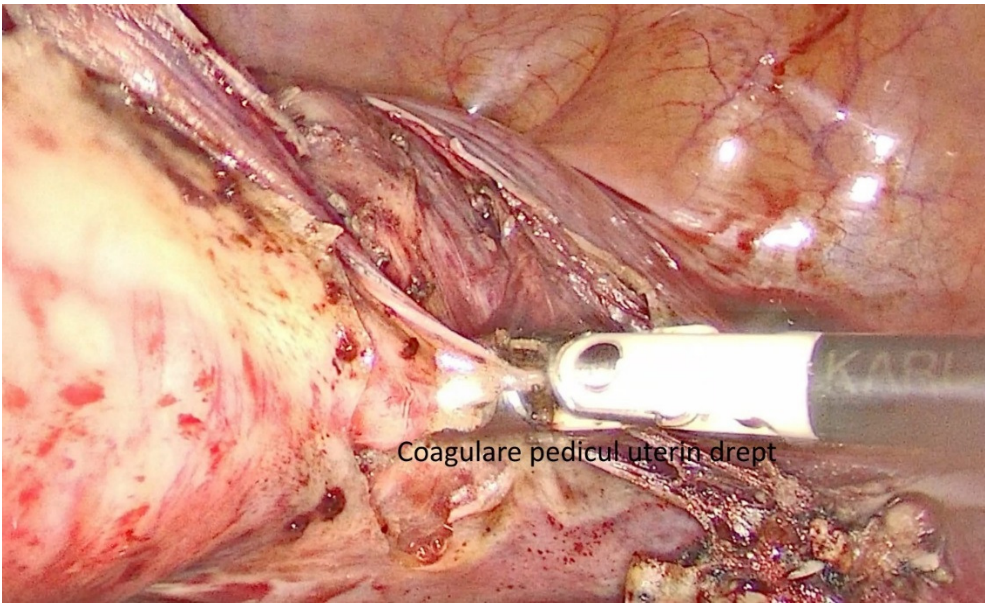

Figure 41.Coagulation of the right uterine pedicle

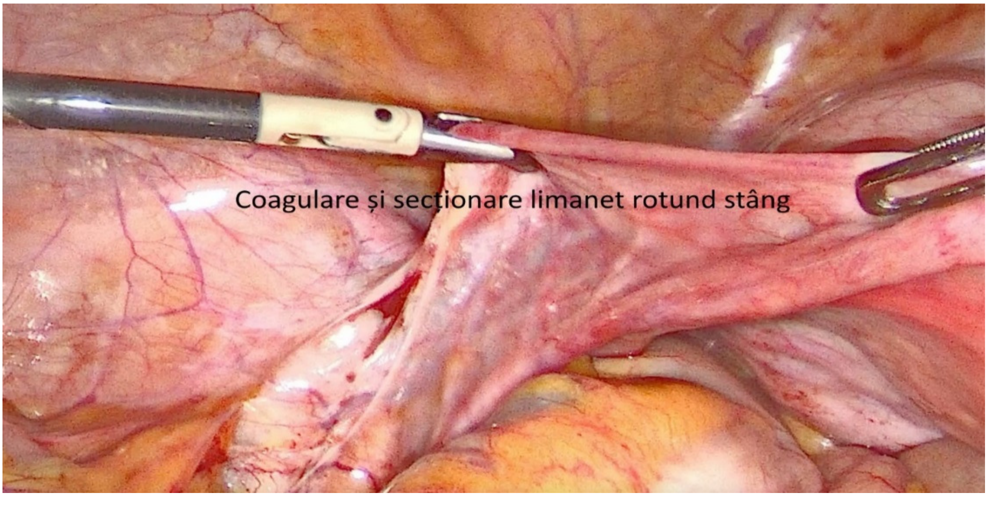

Figure 42. Coagulation and sectioning of the left round ligament

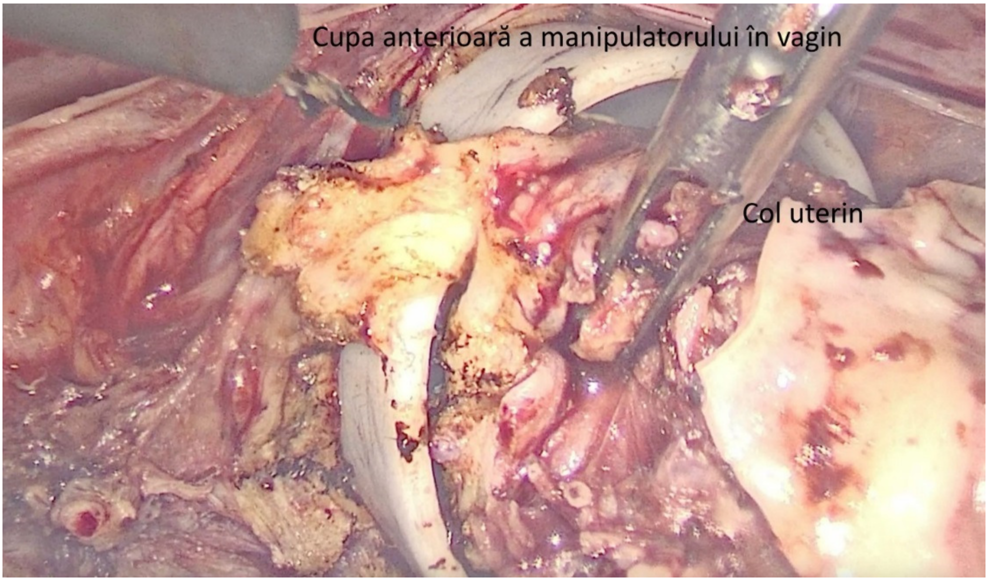

Figure 43. Anterior cup of manipulator in vagina, cervix

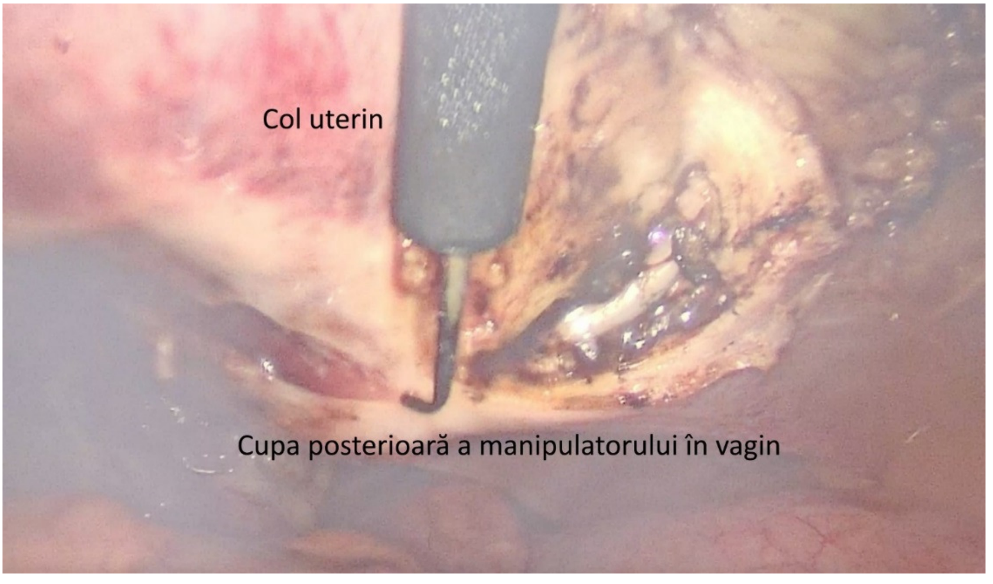

Figure 44. Posterior cup of a manipulator in the vagina, cervix

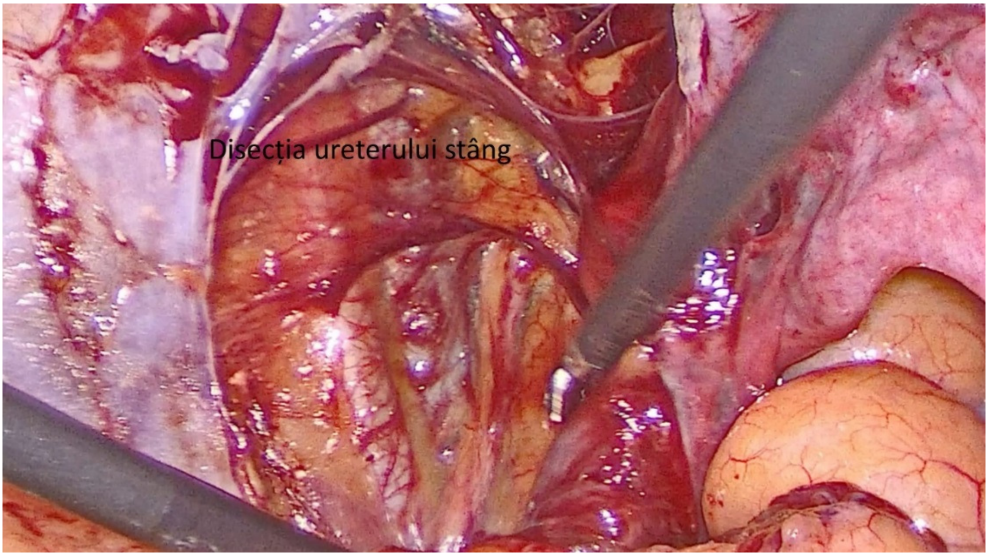

Figure 45. Dissection of the left ureter

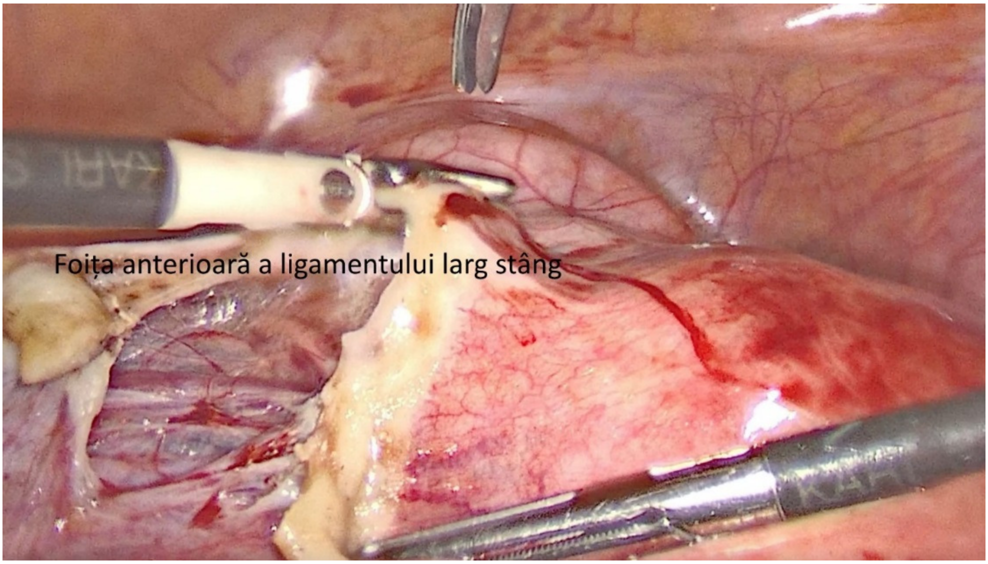

Figure 46. anterior leaflet of the left broad ligament

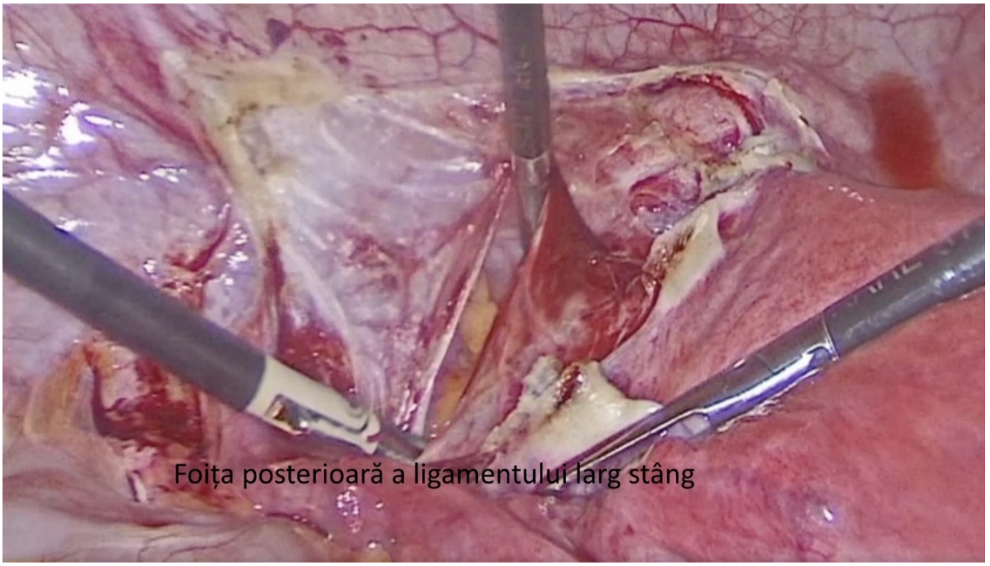

Figure 47. posterior leaflet of the left broad ligament

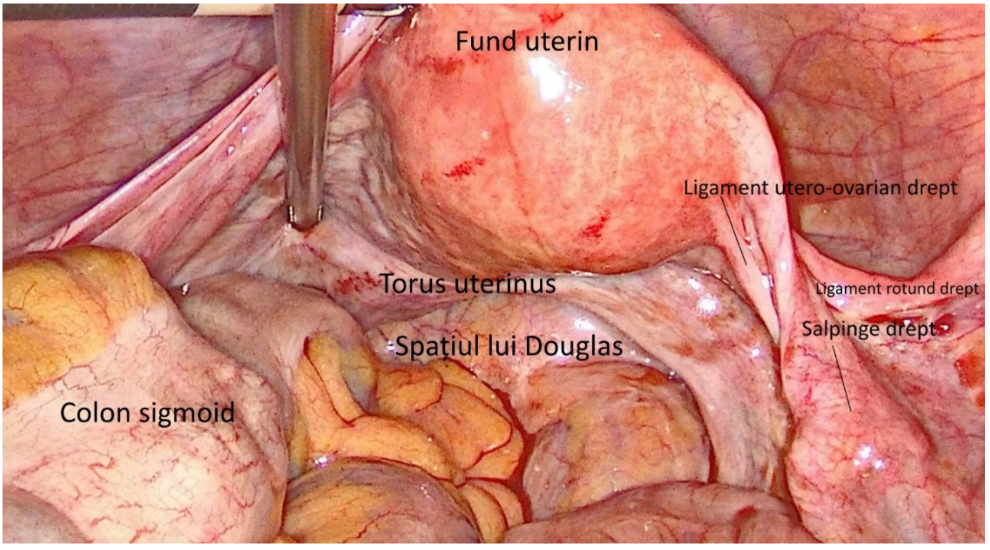

Figure 48. Inspection of the pelvic cavity

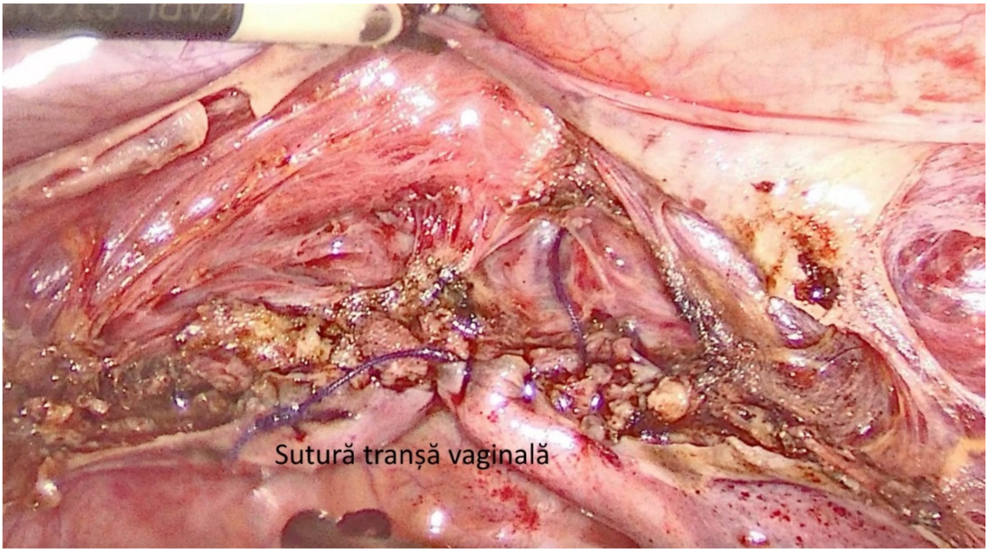

Figure 49. Vaginal suture

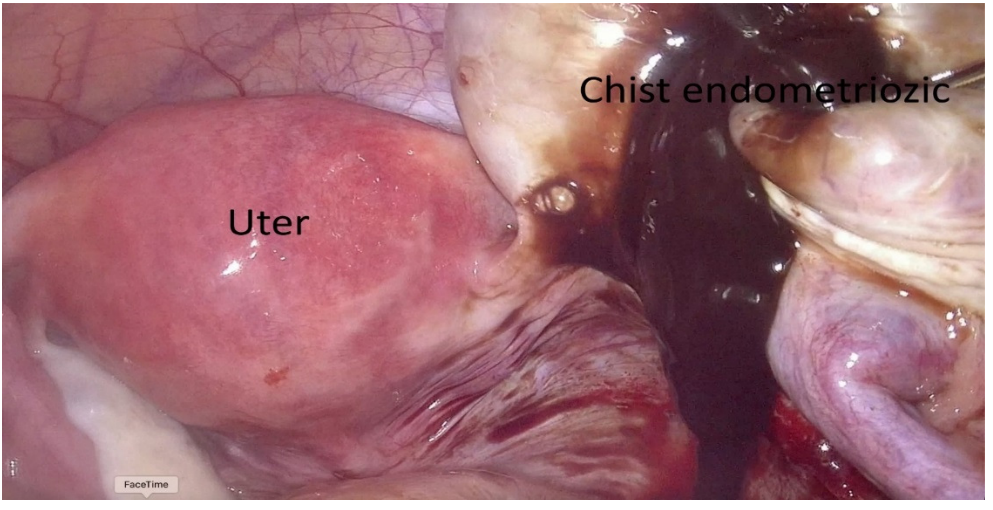

Figure 50. Uterus, endometriotic cyst

Vaginal Hysterectomy: Step-by-Step Surgical Technique, Indications, and Historical Overview

> "It is interesting to note that those who persist in perfecting themselves in the technique of vaginal hysterectomy gradually disregard more and more of the contraindications so intensely laid down by those Awith little to no familiarity with the operation ".
>
> **N. Sproat Heaney**

Introduction

A hysterectomy is a surgical procedure that involves the removal of all or part of the uterus. This is done to alleviate the symptoms that are brought on by the various maladies that damage the womb. It is a significant surgical operation that comes with its own set of dangers and potential adverse consequences. Because of this, it is often only explored after other therapies are insufficiently successful. If a woman has cancer that has spread to either the uterus or the ovary, a hysterectomy may be required to remove the tumor (1).

Based on the organs and tissues that are removed during the procedure, there are three distinct kinds of hysterectomy:

- A partial hysterectomy (also known as a supracervical hysterectomy). It is necessary to remove the primary part of the womb. The cervix, fallopian tubes, and ovaries will all still be there after the procedure (1).
- A total hysterectomy involves the removal of both the uterus and the cervix. The ovaries and fallopian tubes are not removed during this procedure (1).
- The radical hysterectomy. During a radical hysterectomy, the patient's womb, cervix, a portion of the adjacent vagina, and sections of the vaginal and pelvic supporting tissues are removed. In certain cases, the patient's ovaries, fallopian tubes, and pelvic lymph nodes are also removed (1).

There are a few distinct approaches to performing a hysterectomy, including the following:

- In a vaginal hysterectomy, the removal of the uterus takes place via the vaginal canal. To do the procedure, the surgeon will not need to create any incisions (cuts) in the abdomen (1).
- Laparoscopy, often known as "keyhole surgery," is when the physician operates by making very tiny incisions in the patient's abdomen and inserting very thin tubes that have a camera and surgical equipment connected to them. Within the abdominal cavity, the womb is dissected into smaller pieces, and the tissue that is removed is removed by suction (1).
- In a procedure known as an abdominal hysterectomy, the uterus is excised through an incision that is made horizontally across the abdominal wall (1).

As a general rule, hysterectomies are performed via the vagina or by keyhole surgery since these methods are less intrusive than traditional abdominal surgery. Many women would rather have a vaginal hysterectomy if one is an option. Laparoscopy is another option that may be coupled with it (1).

The medical condition, as well as other relevant criteria such as the woman's age, weight, and general health, have a role in determining the sort of operation that may be recommended. Because a hysterectomy is a significant surgery, it must be performed in a medical facility. In most cases, patients can leave the hospital within seven days of their admission. It may take anywhere from three to six weeks before you can return to your regular, daily activities, depending on the extent of the treatment (1).

A hysterectomy, like any other kind of surgical treatment, carries with it the risk of injuring blood vessels, nerves, or organs, as well as the possibility of developing infections or having trouble healing wounds. These sorts of issues affect around 5 out of every 100 women. In the days immediately after surgery, it is not uncommon for female patients to have transient discomfort in the form of pain, constipation, or difficulty passing urine. In addition, as is the case with any operation that takes place inside the abdominal cavity, scar tissue may develop, which may cause the various portions of the abdominal tissue to adhere to each other. This condition, also known as adhesion, may cause discomfort as well as digestive issues (1).

It is not feasible to bear children after having a hysterectomy since the uterus is removed. In addition, menstrual cycles will cease. However, even if the cervix and the ovaries are not removed, a woman may still have some light bleeding (1). If both ovaries are removed during the procedure, menopause will begin immediately after the procedure. This might result in issues such as hot flashes, mood swings, and dryness in the vaginal area (1). The symptoms that a woman was experiencing before having her womb removed will determine how the removal of the womb will influence her sexual life after the surgery. For instance, if the pain was a concern in the past, this may become less of an issue. But some women suffer a decline in sexual enjoyment (1).

Trans-vaginal hysterectomy (TVH) was the first minimally invasive surgical treatment for more than a century. Even though TVH does not need any incisions on the anterior abdominal wall or its tissues, many people nowadays associate "minimally invasive hysterectomy" with laparoscopic and robotic-assisted procedures (2).

So maybe the "non-invasive hysterectomy" should be used instead. Through position statements and other commentary reports, the American College of Obstetricians and Gynecologists (ACOG), the American Association of Gynecologic Laparoscopists (AAGL), and committees on behalf of the Society of Gynecologic Surgeons (SGS) all express their support for vaginal hysterectomy as the preferred treatment for benign disease. There is a wealth of information in the literature that solidly supports these organizations' claims that vaginal hysterectomy benefits patients the most with much-reduced rates of morbidity and death and society as a whole with less expense. This article will examine the development of hysterectomy historically and the evidence in favor of vaginal hysterectomy for benign illness while highlighting the critical need for continuing to expand residency and post-graduate training in the procedures (2).

An estimated 600,000 hysterectomies are conducted yearly in the United States. The incidence of abdominal and vaginal hysterectomies has exhibited a consistent decline between 1997 and 2005. In contrast, laparoscopic and robotic-assisted hysterectomies have demonstrated a rise in numbers during the same period (3,4).

The surgical procedure of abdominal hysterectomy remains the predominant method for conducting hysterectomies, constituting roughly 66% of the total number of hysterectomies carried out each year (5). The persistent decline in the proficiency of recent graduates in the requisite competencies for conducting vaginal hysterectomy is anticipated to result in a subsequent reduction in the frequency of vaginal hysterectomy procedures carried out in clinical settings. The vaginal approach to hysterectomy is comparatively less invasive when compared to the abdominal method (6). The study findings suggest that there are no significant differences in postoperative pain and outcomes among patients who underwent a vaginal hysterectomy, laparoscopic-assisted vaginal hysterectomy, and total laparoscopic hysterectomy. Regardless of the benefits associated with laparoscopic and robotic techniques, the expenses associated with these procedures remain notably greater than those for conventional vaginal hysterectomy (7).

A brief overview of the history of vaginal hysterectomy

The hysterectomy, one of the most frequent operations on women, has been practiced since antiquity. The stories of many unassuming individuals who made important individual attempts to overcome the mistrust of the medical establishments of their eras are included in the history of hysterectomy. The pioneers were often disregarded. Hysterectomy is one of the most often carried out gynecological procedures although there are many alternatives. Hysterectomy became a safe surgery with the development of antisepsis, anesthesia, antibiotics, and blood transfusion. The three surgical methods used now for hysterectomy are vaginal, abdominal, and laparoscopic. Due to the drawbacks of traditional laparoscopy, robotic surgery has been developed. Over the last ten years, it has progressed from basic adjustable arms to support cameras in laparoscopic surgery to more complex four-armed robots that are now in use all over the globe (8).

Although hysterectomy was discussed in Greek writings from 2000 years ago, there is no evidence that it was ever carried out. Early vaginal hysterectomy efforts, which were often deadly, date back to the 16th century. Following the groundbreaking work of Langenbeck and Clay, the history of vaginal and abdominal hysterectomy may be traced back to the 19th century. The hysterectomy became the second most prevalent procedure for women as a result of developments in anesthesia, blood transfusion, antibiotics, and surgical skill. Subtotal abdominal hysterectomy was the norm in the early 20th century, but total abdominal hysterectomy took its place by the 1950s. Subtotal hysterectomy has recently had a little return in popularity. Ironically, traditional vaginal hysterectomy has now again replaced laparoscopic assisted hysterectomy as the preferred technique for many benign gynecological diseases needing a hysterectomy. There are indications that hysterectomy alternatives, such as hysteroscopic surgery, uterine fibroid embolization, and the levonorgestrel intrauterine device, are causing a decline in hysterectomy rates at the beginning of the twenty-first century (9).

Trans-abdominal hysterectomy (TAH) and trans-vaginal hysterectomy (TVH) were the two techniques used to remove the uterus surgically during the majority of the 20th century. The data highlighting the variations in patient experience between these two strategies was noteworthy. TVH remained the favored treatment option due to its much-reduced rates of morbidity and death, which included outcomes like fever episodes, surgical blood loss, and duration of hospital stay (10).

Langenbeck successfully removed a prolapsed uterus from a 50-year-old lady who had an ulcerated cervix in Gottingen, Germany in the year 1813. This was the first time a hysterectomy was done as a vaginal surgery. Although it has been recorded that Heath conducted an abdominal subtotal hysterectomy sometime earlier when a suspected huge adnexal tumor was determined to be uterine in origin, an abdominal hysterectomy (AH) was not done until some years later by Clay of Manchester, England in 1843 (11). Kurt Semm reported the first laparoscopic-assisted vaginal hysterectomy (LAVH) in Germany in 1984, ushering in a new age of hysterectomy (8).

Subtotal abdominal hysterectomy was the norm up until the late 1930s, keeping the cervix in place to reduce the danger of peritonitis and the high mortality that comes with it. This method was gradually replaced by total abdominal hysterectomy in the United States and the United Kingdom because of the development of antibiotics, careful attention to antisepsis, and other medical and surgical advancements; however, the subtotal approach continued to be widely used, particularly in Scandinavian nations. Many surgeons have resumed doing subtotal hysterectomies after the introduction of laparoscopic hysterectomy for some reasons, including a desire for a more straightforward procedure. The purpose of this article is to evaluate the history of the procedure's evolution and, to the extent that it is feasible, to resolve some of the conflicts that arise when deciding between a total and subtotal process, to examine the historical development of the operation from a historical viewpoint (12).

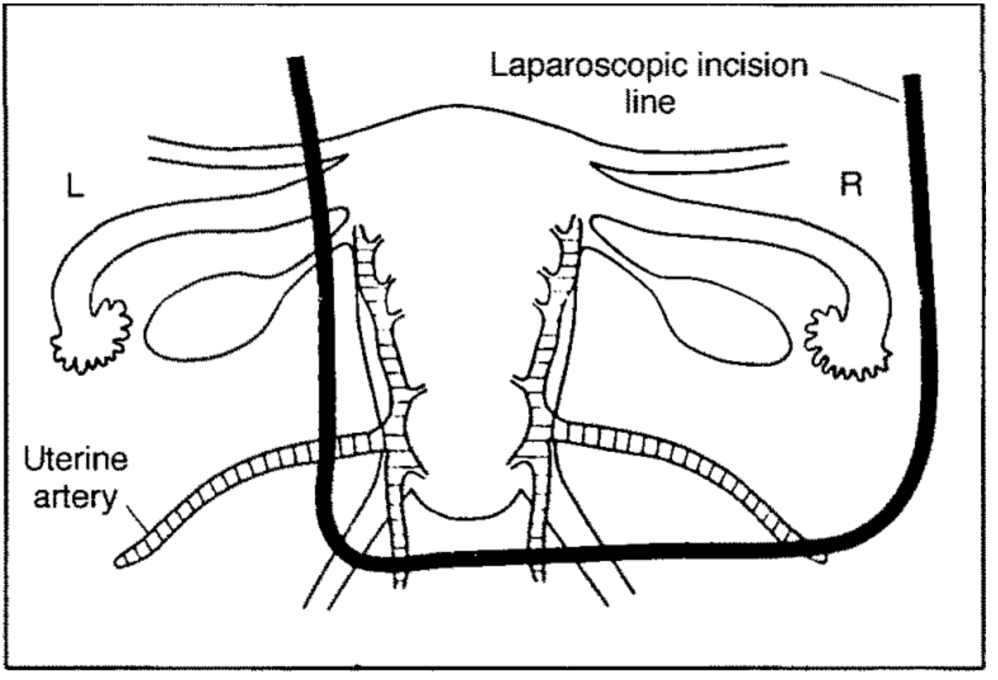

Figure 51. Completely laparoscopic hysterectomy (13)

Indications for Vaginal Hysterectomy

Having a hysterectomy is performed for a variety of reasons, the most prevalent of which are as follows:

- Fibroids
- Pelvic organ prolapse
- Periods that are very painful or burdensome
- Endometriosis
- Cancer of the uterus, the cervix, or the ovaries
- Benign ovarian mass
- Adenomyosis (1,14).

In very unusual cases, prompt removal of the womb may be necessary. You may need to do that to prevent significant difficulties during labor and delivery caused by things like severe injuries, severe infections, or excessive bleeding (1).

Contraindications for Vaginal Hysterectomy

There exist a limited number of absolute contraindications to vaginal hysterectomy, which encompasses:

- Severe endometriosis,
- Uterine size exceeding 16 to 18 weeks
- Advanced pelvic malignancy (15–19).

Vaginal hysterectomy is associated with a certain relative contraindication, such as:

- Pelvic radiation therapy is a medical treatment that involves the use of high-energy radiation to target and destroy cancer cells in the pelvic region.
- The uterus exhibits a significant increase in size.
- Previous surgical interventions in the pelvic region.
- There is a possibility of severe pelvic adhesion and anatomical distortion resulting from either pelvic inflammatory disease (PID) or endometriosis.
- The condition of being morbidly obese.
- Nulliparity
- Uterine descent deficiency (17,18,20).

Numerous studies have demonstrated that several of these relative contraindications can be surmounted and that vaginal hysterectomy can be executed securely in patients with the aforementioned preoperative discoveries (15,17).

Clinical Significance

The vaginal approach to hysterectomy is regarded as a type of minimally invasive hysterectomy that yields superior results and fewer adverse events. Whenever feasible, laparoscopic hysterectomy should be considered as the optimal approach. Vaginal hysterectomy offers several benefits, such as reduced pain, expedited recovery, quicker resumption of work, decreased expenses, and diminished morbidity. Typically, it is carried out for non-malignant purposes (10). The surgical procedure of hysterectomy can significantly affect the quality of life of a patient and result in enduring physical, psychological, and mental health consequences. Healthcare professionals must provide comprehensive counseling to patients before a hysterectomy to facilitate informed decision-making regarding their treatment (21).

Interventions Provided by Nursing, Allied Health Professionals, and Other Interprofessional Teams

The importance of interprofessional collaboration cannot be overstated in the context of hysterectomy, both during and post-operation. The objective of nursing intervention is to prevent or reduce the occurrence of complications, manage pain, provide support, and facilitate optimal recovery. The provision of nursing care is crucial throughout the patient's hospitalization period, starting from the day of admission until the day of discharge. The main duties encompassed within this role comprise preoperative preparation, intraoperative coordination of the surgical procedure, and postoperative management of pain, diet, bladder and bowel care, mobility and physical therapy, breathing exercises, wound care, personal hygiene, and monitoring of vaginal bleeding. The implementation of nursing actions and interventions constitutes a crucial component of hysterectomy procedures (21).

The use of simulation-based training is a highly efficacious approach to enhancing the proficiency and expertise of healthcare providers. The simulation model exhibits the potential for imparting vaginal and uterine morcellation proficiency through educational means. According to providers, the simulation serves as a suitable initial step for residents undergoing training and offers a comprehensive approximation of vaginal morcellation (22).

Factors that determine if a patient is a candidate for vaginal hysterectomy

Despite the well-documented evidence that vaginal hysterectomy offers distinct health and economic benefits such as fewer complications, better postoperative quality-of-life outcomes, and reduced hospital charges, gynecologic surgeons in the United States persist in utilizing the abdominal approach for most hysterectomies that could be performed vaginally (23). The American College of Obstetricians and Gynecologists (ACOG) has recommended vaginal hysterectomy as the preferred method for hysterectomy. According to medical professionals, several primary obstacles impede the execution of minimally invasive hysterectomies, including the dimensions and configuration of the uterus, limited accessibility to the uterus, and insufficient training and expertise among surgeons (22).

The guidelines established by the American College of Obstetricians and Gynecologists pertain to the approach employed for hysterectomy:

- The indication for surgery;
- The patient's anatomical condition;
- Empirical evidence substantiating the selected methodology;
- Patient preference based on informed decision-making;
- The proficiency and education of a surgeon (23).

Traditional guidelines for hysterectomy:

- Abdominal hysterectomy for a graver condition:

  - Uterus is "too large"
  - Vagina "too slender"
  - One's pubic arch is 90 degrees
  - Bituberous in diameter shows that uterus is "too elevated" or "will not descend" at 8.0 cm (23)
  - Intra-abdominal conditions contraindicate vaginal approaches such as:

  - Adherences
  - Endometriosis
  - Genital ailment
  - A history of pelvic surgery
  - Persistent pelvic discomfort
  - Previous cesarean birth (23).

- Vaginal hysterectomy for less severe conditions, primarily prolapse (23).

Preparation for Vaginal Hysterectomy

Preoperative evaluation and testing

The initial assessment of a patient ought to commence with a comprehensive overview of any prevailing medical conditions, followed by a meticulous account of the individual's obstetric and gynecologic history. It is recommended to gather medical and surgical histories, as well as family history of the gynecologic, gastrointestinal tract, or breast malignancies (15).

Before surgery, it is imperative to gather a comprehensive sexual history, with particular attention paid to any indications of dyspareunia. This could be particularly significant for preoperative consultation (15).

It is recommended that a comprehensive physical examination should encompass thorough evaluations of the abdominal and pelvic regions. The pelvic examination necessitates careful observation of the uterus' size and mobility, associated pelvic relaxation, adnexal masses, uterosacral tenderness, and any areas of pelvic discomfort during the examination (15).

Diagnostic imaging and laboratory analyses may be conducted as necessary to enhance patient evaluation. To proceed with a hysterectomy, precise indications for the procedure must be thoroughly documented (15).

At the outset of the discourse on hysterectomy, the surgeon must provide the patient with comprehensive information regarding the procedure and potential consequences, before deciding upon the surgical approach. Assessing the patient's preference for ovarian removal is a crucial aspect to consider. Upon establishing the patient's preference for hysterectomy and ensuring the presence of suitable indications, the surgeon and patient must collaborate to select the optimal approach for the procedure (15).

It is recommended that the patient undergoes an examination in the operating room while under anesthesia before preparation and draping. This enables a comprehensive assessment of the uterus and its surrounding structures. The use of this technique provides the surgeon with an improved evaluation of the dimensions, descent, and maneuverability of the uterus. The initial impression of an abdominal case during a clinic examination may potentially transform into a feasible vaginal case upon reevaluation of the patient in the operating room while under anesthesia. The patient should provide prior consent for these potentialities (15).

It is recommended that a pregnancy test be taken into consideration for any woman who is of reproductive age before undergoing gynecologic surgery. This omission may be considered in cases where the woman has been utilizing dependable contraception or has undergone previous surgical sterilization (15).

The process of preparing the gastrointestinal tract

The routine vaginal hysterectomy may not require full mechanical bowel preparation as the probability of fecal spillage during surgery is low. Bowel preparations have lost favor in the context of colorectal surgery, as some evidence indicates that they may elevate the risk of spillage during bowel surgery (24). In the preoperative setting, surgeons may contemplate the utilization of two enemas, namely a saline laxative or tap water, to effectively eliminate any fecal matter present in the rectal region. This could potentially result in a reduction of exogenous fecal material leakage during the aforementioned procedure. If this procedure is executed, the rectal vault will be devoid of any stool, thereby eliminating any pressure exerted on the posterior vaginal wall. This, in turn, facilitates a more comprehensive retraction of the posterior vagina downwards, leading to improved visualization (15).

Preoperative vaginal irrigation

Although the administration of Betadine is a controversial procedure, it has been a longstanding policy at our institution to implement it. If the patient does not exhibit an iodine allergy, it is recommended to perform a douche on the morning of the surgery. The intervention results in a reduction of microbial populations and does not produce any negative consequences. Furthermore, the intravaginal administration of topical Betadine preparation is conducted in the operating room directly before the procedure (15).

The topic of interest pertains to the measurement of the volume of the bladder

There is a divergence of viewpoints regarding the optimal quantity of fluid that ought to be present in the bladder at the commencement of a vaginal hysterectomy. It is our preference to perform in-and-out catheterization to fully empty the bladder before surgical procedures. The decompression of the bladder is intended to reduce the incidence of inadvertent cystotomies. On the other hand, some individuals hold the belief that retaining a certain amount of fluid in the bladder would enhance their ability to detect cystotomy, as the release of urine into the operative field would serve as an indicator. The use of a full or distended bladder can aid in the identification of suitable surgical planes during dissection. Nonetheless, it is important to note that this technique may increase the surface volume of the bladder, thereby elevating the probability of cystotomy (15).

Equipment

The necessary equipment for performing a vaginal hysterectomy includes the following instruments:

- The object in question possesses a considerable length and weight. Mayo scissors are a type of surgical scissors commonly used in medical procedures.
- Vaginal speculums of varying lengths and weights, including those with extended blades.
- The Heaney right-angle retractors are surgical instruments commonly used in medical procedures.
- The Jorgenson scissors are a type of cutting instrument commonly used in various fields, including medicine, crafting, and household tasks.
- Allis clamps of extended length.
- Deaver retractors are surgical instruments commonly used in medical procedures to hold back soft tissue and organs, allowing for better visualization and access to the surgical site.
- A tool used for grasping and manipulating long needles.
- Heany clamps.
- The single-tooth tenaculum is a medical instrument commonly used in gynecological procedures to grasp and hold the cervix in place during various diagnostic or therapeutic interventions.

- The Bovie extender and suction apparatus are two medical devices commonly used in surgical procedures.
- A device utilized in the field of neurosurgery to provide illumination during surgical procedures (21).

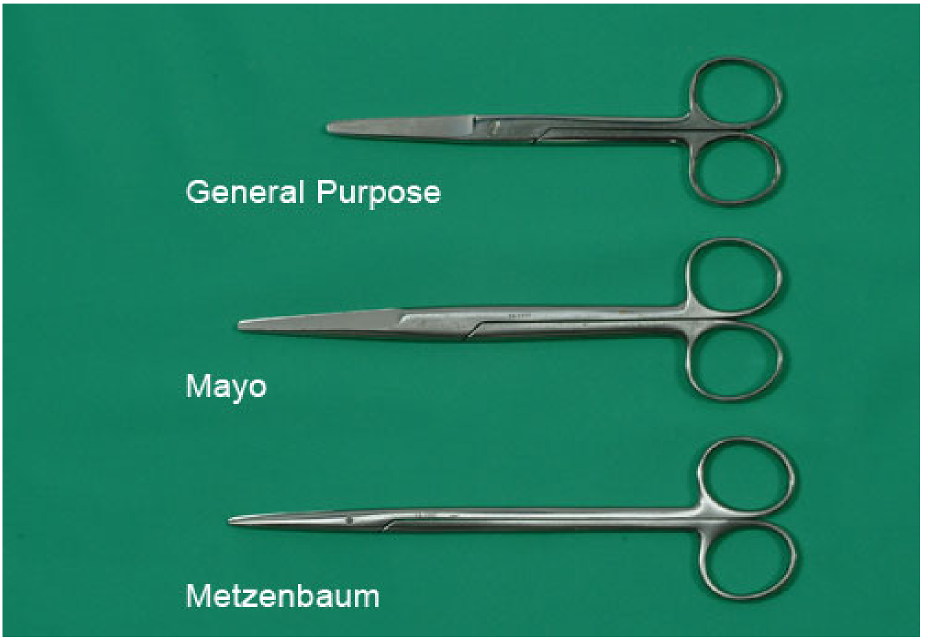

Figure 52. Scissors (25)

Figure 53. Skene Single Tooth Tenaculum (26)

Figure 54. Vaginal Speculum (27)

Step-by-Step Surgical Technique for Vaginal Hysterectomy

Patient preparation

Patient preparation encompasses the subsequent measures:

- The right positioning of the patient is crucial during a vaginal hysterectomy, and it is commonly executed with the patient placed in a dorsal lithotomy position. This is achieved with the assistance of either candy cane or boot-type stirrups. Stirrups designed in the shape of candy canes have been observed to provide greater room and enhanced entry to the patient for medical assistants. This leads to enhanced retraction and improved outcomes. The use of visualization techniques is beneficial for the surgeon. To ensure proper positioning, it is recommended that the patient's gluteal region be positioned at the table's edge following the removal of the bed's foot. It is recommended that the thighs of the patient be flexed and abducted, while the knees should be flexed with minimal external rotation. It is imperative to exercise caution when considering the padding of the lateral aspect of the lower extremity, as this area is susceptible to compression against the stirrup, leading to potential lower extremity neuropathy.

- The use of sequential compression devices or the administration of anticoagulants for prophylaxis against venous thromboembolism.
- The administration of antibiotic prophylaxis is a common practice in surgical procedures. The recommended antibiotic of choice is cefazolin, which is typically administered intravenously at a dose of 1 to 2 grams. It is important to note that the administration of the antibiotic should occur within 60 minutes of the incision.
- The pre-procedure verification checklist, known as time out, is a standard hospital protocol that is consistently executed before the initiation of surgery. Its purpose is to verify the accuracy of critical information, such as the identity of the patient, the type of operation, the equipment used, and the surgeon responsible for performing the procedure.
- Under anesthesia, the patient undergoes an examination to evaluate the size, shape, and mobility of the uterus, as well as to assess the adnexa and other pelvic structures. The assessment includes the evaluation of the degree of descent of the uterus, the caliber of the vaginal wall, and the presence of pelvic organ prolapse, cystocele, and rectocele.
- Betadine scrub is used as a means of vaginal preparation before a medical procedure.
- To maintain the aseptic conditions throughout the procedure, a sterile surgical drape is employed to cover the patient (15,21,28).

Figure 55. Two views of dorsal lithotomy position (15)

Figure 56. Narrow arch (15)

The procedural steps for conducting a hysterectomy

The procedural steps for conducting a hysterectomy are as follows:

- The process of decompressing the bladder involves the utilization of a Foley catheter for urinary drainage (21).
- The administration of vasoconstricting agents involves the injection of diluted vasopressin, specifically 20 units in 100 ml of normal saline, into the proper planes of the cervicovaginal junction. The objective of this is to achieve hemostasis and hydro-dissection (21).
- A surgical procedure involves creating a circular cut surrounding the cervix at the point where the cervix meets the vagina, utilizing either a scalpel or diathermy (21).
- The procedure of dissection and deflection of the bladder, referred to as anterior colpotomy, involves the initial creation of a circumferential incision. Following this, the anterior aspect of the vaginal mucosa is carefully grasped and elevated, and a combination of sharp and blunt dissection techniques is employed to effectively separate the vaginal mucosa from the cervical stroma (21).
- The peritoneum is discerned and subsequently penetrated with a sharp instrument to access the peritoneal cavity. Subsequently, a

Deaver retractor or right angle is introduced into the peritoneal cavity, while ensuring the safeguarding of the bladder (21).

- The technique of posterior cul-de-sac entry involves the grasping of the posterior vaginal epithelium using Allis clamps at the site of the previous circumferential incision, followed by gentle elevation (21).
- Mayo scissors are used to cut precisely through the peritoneum. Upon opening the peritoneal cavity, the vaginal mucosa is either laterally stretched or incised, followed by the reinsertion of a long-weighted vaginal speculum into the peritoneal cavity (21).
- The Uterosacral and Cardinal Ligament Complex can be assessed through manual palpation of the Uterosacral Ligaments using the index finger. To achieve the right exposure of the ligament, the medial aspect of the vagina is fitted with a right-angle retractor. The Heaney clamp is then utilized to clamp and sever the ligament. Subsequently, the wound is sutured, and the remaining end of the suture is secured and preserved for potential utilization in McCall's culdoplasty at a later time. The cardinal ligaments are located and subsequently subjected to clamping, cutting, and suture ligation. It is imperative to exercise caution while clamping due to the proximity of the ureters to the uterosacral ligaments. It is imperative to position clamps close to the cervical stump. To prevent bleeding from collateral blood vessels, clamps must include both the anterior and posterior peritoneum (21).
- The Heaney clamp is utilized to incorporate all vasculature into the clamp, and subsequently, the uterine vessels are excised and ligated using a suture. According to the author, the use of Heaney stitch is not advisable due to its potential to cause harm to the vascular pedicle and result in bleeding. A notable descent of the uterus is observed after the dissection of the uterine vessels (21).
- The broad ligament is a ligament that is mainly composed of peritoneum and minor blood vessels and is devoid of vascularization. The medial clamping, cutting, and suturing of this ligament are performed (21).
- The utero-ovarian, round ligament complex and cornual end of the Fallopian tube are anatomical structures found within the female reproductive system.- Both the upper and final pedicles have the option of being clamped either together or independently. In cases where the pedicles exhibit excessive dimensions, it is possible to apply individual clamping to the round ligament. Due to the

significant size of the pedicle, the author suggests implementing a dual clamping technique and utilizing two sutures for closure. Initially, a suture tie is performed, which is then followed by a suture ligation located medially to the first. Upon completion of the necessary procedures to cut, ligate, and secure all ligaments and vessels, the uterus is extracted (21).

- Systematically assess each pedicle in a clockwise manner to ensure sufficient hemostasis.
- Closure of the cuff and McCall's culdoplasty are commonly employed techniques during a vaginal hysterectomy to manage bleeding from the vaginal edges, which often occurs at the vaginal apex. The closure is performed in a running and locking fashion to effectively control the bleeding (29).
- The customary practice of the author is to perform a horizontal closure of the cuff, unless there exists a concern regarding the vaginal length, in which case a vertical closure of the wound is preferred (30).
- The uterosacral ligaments should be integrated into the vaginal cuff angle during the closure of the cuff to supply suspensory support for the vagina. This technique serves to prevent potential prolapse of the vaginal wall in the future (21).
- There is currently no evidence to support the practice of packing the vagina as a means of improving bleeding or other outcomes (21).
- The Foley catheter remains in situ until the patient can ambulate (21).
- The diet is progressed based on the patient's ability to tolerate it (21).

Challenges Experienced During a Challenging Vaginal Hysterectomy and Approaches to Mitigate Them

- **Prominent buttocks**

The prevalence of obesity is on the rise, resulting in a greater number of overweight and obese individuals seeking medical attention in clinical settings. A significant number of these females exhibit noticeable gluteal regions, thereby rendering surgical procedures involving the vaginal area more challenging. Sufficient exposure holds paramount significance in such circumstances, and the utilization of comparatively larger or broader retractors intravaginally may prove advantageous. The use of a self-retaining vaginal retractor has the potential to enhance visualization during medical procedures, without necessitating the involvement of an assistant's hand.

During a complex surgical procedure, a surgeon may greatly benefit from the assistance of individuals who possess a thorough understanding of both the relevant anatomical structures and the procedural steps involved (15).

- **History of prior pelvic surgery or cesarean delivery**

Certain clinicians hold the belief that females who have undergone previous pelvic surgery or cesarean delivery are not suitable candidates for vaginal hysterectomy. Nevertheless, a multitude of research has challenged this assertion. The incidence of cystotomy in women undergoing hysterectomy who had a prior cesarean delivery was investigated by Rooney et al17 and Unger and Meeks18. There was no significant difference observed in the incidence of incidental cystotomies between women who had undergone a previous cesarean delivery and those who had not. A thorough understanding and precise identification of surgical planes can mitigate the risk of unintended harm and promote favorable surgical outcomes (16–18,31–34).

- **A narrow pubic arch or narrow vagina**

A narrow pubic arch or narrow vagina is a condition characterized by a reduced width of either the bony structure of the pelvis or the vaginal canal. A reduced pubic arch or a constricted vaginal canal can pose difficulties during vaginal surgical procedures. It is crucial to have sufficient support during the process to aid in the exposure. When faced with a narrow introitus, a midline or mediolateral episiotomy may be performed to facilitate the opening of the vaginal lumen and improve visualization. In cases where a patient presents with a narrow vaginal opening, a Schuchardt incision may be performed. The procedure involves making a surgical cut in the posterior, lateral vaginal wall to expand the vulvovaginal outlet, thereby facilitating unobstructed entry to the vagina and uterus. Having knowledge of the perineal anatomy and taking measures to prevent harm to the anal sphincter is crucial in such cases (15).

- **Cervical elongation**

Cervical elongation refers to the process of lengthening or stretching the cervix, which is the lower part of the uterus that connects to the vagina. The identification of cervical elongation is typically not established before surgical intervention and is commonly detected during the intraoperative period. In many instances, the execution of a vaginal hysterectomy on a patient with cervical elongation may present a formidable challenge, thereby necessitating the exercise of great patience. The surgeon is recommended to proceed with the procedure systematically while being mindful of the anatomy of the vagina and pelvis, as well as the location of the ureter. Patients with cervical elongation exhibit a higher occurrence of entry into the anterior and posterior cul-de-sacs, as compared to those without this condition. In cases where there is a persistent challenge in discerning the peritoneal reflection, it may be necessary to divide the uterus into two sections after the ligation of the uterine arteries. The act of dividing the uterus in the midline can lead to the identification of the peritoneal reflection (15).

Prolapsed uterus

A prolapsed uterus is a medical condition characterized by the descent of the uterus from its normal anatomical position in the pelvis into the vaginal canal. While one may assume that a uterus that has prolapsed would be simpler to extract than one that is upheld, this is often not the scenario. The identification of accurate surgical planes may pose a challenge due to the presence of distorted anatomy in the context of pelvic organ prolapse. The surgeon must possess knowledge regarding the positioning of the bladder, ureters, and rectum, as they typically undergo prolapse in conjunction with the uterus (15). The use of transvaginal palpation for identification of the ureters can provide the surgeon with precise knowledge of their location, thereby reducing the likelihood of intraoperative injury. The ureters can be palpated transvaginal with the aid of the surgeon's index finger. It is our preference to perform this procedure after the ligation of the uterosacral ligament and the entry into the anterior peritoneal cavity. The medical professional applies a strong grip on the uterine tenaculum in a direction opposite to the side where the ureter is to be examined. The application of tension on the ureter helps its palpability. Subsequently, the surgeon employs a Deaver retractor at the 2 o’clock position while examining the left ureter or at the 10 o'clock position while examining the right ureter. The use of a Deaver retractor positioned at 12 o'clock aids in superior retraction of the bladder (15).

The condition of having an enlarged uterus

The data indicate that vaginal hysterectomy is a safe and efficacious procedure, even in cases where the uterus is enlarged (35). Consequently, the excision of a hypertrophied uterus can typically be performed through the vaginal route. The preoperative assessment of the pelvic region can provide valuable insights into the dimensions and motility of the uterus. The transvaginal method of uterus removal is feasible for uteri ranging from 16 to 20 weeks in size. Uterine morcellation is a crucial factor in achieving a successful vaginal hysterectomy when dealing with an enlarged uterus (15). Other crucial elements to consider are uterine mobility and the potential to induce mobility through the transection and ligation of the uterosacral and cardinal pedicles. The practice of uterine morcellation is contraindicated in cases where there is a suspected presence of uterine or endometrial malignancy in women. In instances of this nature, an endometrial biopsy is conducted in the office before surgery, or a preliminary dilatation and curettage are performed, followed by frozen section analysis, as deemed appropriate (15). Before performing morcellation, it is imperative to isolate and ligate the uterine vessels to prevent substantial hemorrhage. Subsequently, the uterine tenaculum is utilized to grasp each side of the cervix. Subsequently, a vertical incision is made on the cervix until it reaches the cervicouterine junction. The procedure involves the excision of uterine tissue in a sequential manner, one piece at a time. The excision of any discernible uterine fibroids involves the separation of their capsules and subsequent removal. A supplementary double-toothed tenaculum is employed, featuring a set of teeth situated within the endometrial cavity and another set on the serosal surface of the uterus (15). The excision of the tissue can be performed using a knife while ensuring consistent and stable traction is sustained on the tenaculum. The procedure is performed until the uterus can be extracted via the vaginal introitus, allowing access to the utero-ovarian ligaments (15).

Strategies for Achieving a Successful Vaginal Hysterectomy

The use of a self-retaining retractor can aid in enhancing visualization in situations where supplementary assistance is not accessible. Two distinct categories are currently accessible. The Lone Star Retractor System, manufactured by CooperSurgical, Inc. in Trumbull, CT, comprises a plastic ring and elastic stays that serve to facilitate retraction. This procedure is particularly beneficial for the removal of excess labia or vaginal tissue. The Magrina-Bookwalter Vaginal Retractor, manufactured by Codman in Raynham, MA, is a retractor that is affixed to a table. It utilizes Deaver-type retractors that are connected to a stationary ring through ratchet connectors. This facilitates deep retraction within the vaginal canal (15). In cases where women exhibit considerable posterior vaginal wall prolapse, possess a short vagina, or have a narrow introitus, maintaining the position of the weighted speculum can prove challenging, often resulting in its displacement (15). One potential method involves inserting the weighted speculum into the vaginal canal and subsequently encircling the neck of the speculum with the drape. Subsequently, the fabric is folded and secured onto itself with the aid of a towel clamp. The application of pressure will serve to maintain the position of the speculum (15). Adequate illumination is crucial when performing procedures within a constricted or profound vaginal cavity. At times, the overhead lighting may prove inadequate in supplying ample illumination to specific regions. In such circumstances, the use of a surgical headlight could potentially assist. The necessity of a headlight is not deemed imperative in the majority of cases; however, it is advisable to possess adequate knowledge regarding the available alternatives and strategize accordingly. There are multiple types of illuminated retractors available that can offer benefits in terms of providing sufficient visibility and lighting (15). During a challenging surgical procedure, such as a vaginal or abdominal hysterectomy, it is imperative to consistently adjust to ensure sufficient illumination and visibility. If deemed necessary, make appropriate adjustments to the retractors of your assistant following the established protocol. Each procedural stage is executed to optimize the subsequent surgical step's exposure (15).

Complications

A hysterectomy is commonly performed as a voluntary surgical procedure aimed at treating a medical condition that does not pose an immediate threat to the patient's life. The intended outcome is to achieve a low mortality rate and minimize the risk of complications during both the perioperative and postoperative periods. The surgical procedure ought to exhibit substantial efficacy in remedying the symptom(s) that prompted the decision to operate, while refraining from inducing any additional complications in the patient. Presently, hysterectomy is considered a safe medical procedure, irrespective of the surgical technique employed, and is associated with minimal risk of complications. Observational studies serve as a valuable supplement to the randomized trials on hysterectomies due to the limited duration of follow-up in the latter (36).

Intraoperative Complications

- Hemorrhage. The predominant areas of hemorrhage during vaginal hysterectomy are the uterine vessels, utero-ovarian ligament, and vaginal cuff (29).
- Ureteral injury (37).
- Bladder injury. The likelihood of occurrence escalates in the presence of risk factors such as previous pelvic surgeries and simultaneous bladder surgery (38).
- Bowel injury (21).
- Nerve injuries are a common occurrence during surgical procedures, particularly in cases where retractors or improper positioning of the legs on stirrups are utilized. The femoral nerve, peroneal nerve, and tibial nerves are among the most frequently affected in such instances (21).
- The likelihood of conversion to abdominal hysterectomy may be heightened in cases where there are unanticipated large pelvic masses, adhesions, and uncontrollable hemorrhage, necessitating conversion to laparotomy (21).
- Adverse reactions associated with the administration of anesthetics (21).

Postoperative Complications

- Ileus refers to a condition of intestinal obstruction.
- Vaginal cuff dehiscence refers to the separation or opening of the surgical incision made during a hysterectomy at the top of the vagina.
- Infections such as vaginal cuff cellulitis and pelvic abscess are commonly encountered in clinical practice.
- Fistulas that occur in the vesicovaginal, ureterovaginal, and rectovaginal regions.
- Pelvic organ prolapse, such as that of a Fallopian tube, is a medical condition characterized by the descent or herniation of pelvic structures (21).

The incidence of infectious complications following hysterectomy persists despite the administration of prophylactic antibiotics. The majority of surgical site infections are attributed to the presence of vaginal bacteria, which cannot be effectively managed through existing pre-operative antisepsis techniques (39).

Significant complications included deep venous thrombosis, pulmonary embolism, myocardial infarction, renal failure, cerebrovascular accident, septicemia, necrotizing fasciitis, secondary hemorrhage, fistula, ureteric obstruction, visceral injury (36).

Bladder injury

Bladder injury is a medical condition that involves damage to the urinary bladder. During a vaginal hysterectomy, there is a possibility of an incidental cystotomy. The crucial aspect during surgery is the detection of any injuries, as overlooking a cystotomy can result in the formation of a vesicovaginal fistula. Upon detection of the cystotomy, it is recommended to label or designate its position using a provisional suture and finalize the hysterectomy procedure. This practice is implemented to facilitate the identification and repair of any supplementary cystotomies that may be performed concurrently. In addition, the excision of the uterus serves to eliminate a cumbersome hindrance that could potentially complicate the closure of cystotomy from a technical standpoint (15). After the hysterectomy is complete, the cystotomy is located by looking for the previously put suture. The bladder should be examined to make sure no hidden injuries have occurred and to pinpoint the defect's location concerning the ureteral orifices. The cystotomy is closed in a two-layer method (either vertically or horizontally) after the edges are determined. With a 2-0 chromic suture applied in a running, through-and-through motion that incorporates the bladder epithelium, the first layer is sealed off. The second layer uses a 2-0 chromic suture to imbricate the prior layer. To create an additional barrier to fistula formation, we prefer to mobilize and fasten the anterior peritoneum over the closed cystotomy. When doing a cystoscopy to check for a watertight seal, care must be taken not to overstrain the bladder and jeopardize the repair. To ensure ureteral patency, the ureteral spill should be recognized during cystoscopy if the injury was close to one or both ureteral orifices (15).

Ureteral damage

The most frequent cause of iatrogenic ureteral damage is benign gynecologic surgery. It can happen because of the ureter being ligated, transaction, crushed, having sutures entrapped, or being thermally damaged. The infundibulopelvic ligament and gonadal vessels, the place where the ureter passes below the uterine artery, and the area close to the vaginal cuff, when the vaginal cuff is suspended to the uterosacral ligaments, are the most vulnerable locations to injury. To assist prevent injury and treat it when it does occur, the ureters must be identified during vaginal hysterectomy at specific sites of risk (15). There are several methods for determining ureteral damage. All vaginal hysterectomies undergo the routine cystoscopic examination of the ureters since most ureteral injuries occur in women who do not have ureteral injury risk factors. However, if the ureteral injury is suspected and cystoscopy is not usually performed, it should be taken into consideration. To help identify ureteral jets and ensure ureteral patency, indigo carmine (5 mL) can be given intravenously. The site and kind of the ureteral injury should be determined when it has been detected. Different repair methods may be performed depending on the type and location of the ureteral lesion, including but not limited to the removal of offending sutures, implantation of a ureteral stent, direct ureteral repair, or ureteroneocystostomy (15).

Living after a hysterectomy. Sexual and reproductive health

The primary factors proposed for a decrease in sexual desire after hysterectomy is of a hormonal and psychological nature. It has been observed that nearly 50% of patients who undergo hysterectomy also undergo oophorectomy, which leads to the onset of surgical menopause (3). The removal of the uterus without the removal of the ovaries, also known as hysterectomy without oophorectomy, has been found to accelerate ovarian failure, ultimately resulting in premature menopause. This has been supported by various studies (40–43). It has been posited that the reduction in ovarian hormones may contribute to diminished sexual desire and a state of depression. Apart from hormonal factors, diminished sexual desire following hysterectomy has been ascribed to psychological factors such as depression and negative body image (44).

The dimensions of quality of life (QoL) encompass interpersonal connections, communal assistance, and intimate interactions (45). In recent times, there has been a growing interest in investigating the impact of hysterectomy on sexual function and quality of life (46). The concept of Quality of Life encompasses a wide range of factors that are believed to affect an individual's overall well-being. The concept of Quality of Life lacks a universally agreed-upon definition. However, as per the literature in medical and nursing sciences, QoL can be succinctly described as encompassing physical, psychological, social, and financial well-being. This aligns with the definition utilized by the World Health Organisation's Quality of Life Group in 1995. Given that hysterectomy is primarily conducted for non-malignant indications to enhance the quality of life, evaluating these dimensions is of significance. The assessment of psychological well-being encompasses broad measures that encompass various aspects of general psychological well-being, as well as specialized measures that have been designed to identify alterations in a particular domain of psychological well-being or to serve as diagnostic instruments. Within the framework of the current thesis, measures are employed to identify alterations in various states of psychological well-being, rather than serving as diagnostic instruments for psychiatric disorders. The terms anxiety and depression are commonly used to describe a range of emotional states, including feelings of anxiety, nervousness, tenseness, depression, moodiness, and downheartedness (36).

The procedure of hysterectomy has gained recognition for its potential impact on various dimensions of women's health. The pertinent outcomes for a female contemplating a hysterectomy encompass its efficacy in mitigating symptoms, length of hospital stay and recovery period, and enduring impact on quality of life, encompassing psychological well-being and sexual functionality (47).

Females who have undergone a hysterectomy encounter challenges in their sexual and reproductive well-being. Women often experience a decrease in their self-esteem as a result of sexual dysfunction and the incapacity to bear children, in addition to the quality of their recuperation. The objective of this investigation is to delineate the associations between recuperation duration and the constituents of the standard of living after a hysterectomy (45).

Women who have had hysterectomies may experience anxiety and fear due to the loss of their fertility. These difficulties include changes in their relationship with their husband, changes in their body image, the consequences of menopause, and a physical lack of energy. Patients with uterine issues report a wide range of challenges, including physical and menstrual symptoms, discomfort, emotional and sexual dysfunctions, and a decline in the overall feeling of health. The severity of these issues has generally decreased, which harms the quality of life. Serious symptoms prompt women to seek surgical therapy (48).

Studies show that the vast majority of women who had hysterectomies say that their quality of life increased as a result of the difficulties that were resolved following the procedure, that their assessment of their general health improved, and that their discomfort and physical symptoms lessened (48). As per the clinical guidelines for hysterectomy established by the Society of Obstetricians and Gynaecologists of Canada (SOGC), the surgery should lead to an enhancement in the patient's quality of life, provided that the patient is appropriately selected (49).

It has been observed that complications such as hemorrhage, urinary system injuries, bowel perforation, and infections may occur in the early post-operative period in approximately 40-50% of women who have undergone hysterectomies. Furthermore, scholarly literature highlights that women are encountering various physical, social, and sexual challenges after undergoing surgery. These challenges include post-operative fatigue, weight fluctuations, irritability, insomnia, diminished concentration or memory, episodes of crying, reduced appetite, and gastrointestinal issues such as diarrhea or constipation. Additionally, women may experience feelings of sadness and changes in their sexual behavior (48).

The impact of varying hysterectomy procedures on the postoperative total vaginal length and sexual function is yet to be definitively established. A prospective study revealed that the postoperative total vaginal length was comparatively shorter and the incidence of dyspareunia was higher in the group that underwent vaginal hysterectomy as opposed to the group that underwent total abdominal hysterectomy (50). The aforementioned phenomenon could potentially be ascribed to a reduction in the length of the vagina after surgical intervention, specifically in cases where excessive excision of the vaginal walls has occurred, particularly in instances where vaginal hysterectomy was performed to address uterine prolapse (50).

The following factors are identified as potential influences on psychosexual adaptation after a hysterectomy:

- Age. Hysterectomy is commonly conducted either toward the conclusion of the reproductive phase or during the postmenopausal phase. During the postmenopausal phase, anatomical alterations associated with aging are evident. These include the reduction in vaginal length, thinning of vaginal tissue, decreased elasticity of vaginal tissue, shrinkage of labia majora and minora, loss of clitoral sensitivity and shrinkage, a decline in perineal muscle tone, and compromised orgasmic platform (51,52). The reported effects of this period on sexual physiology are as follows: The sexual arousal phase and lubrication process may require an extended duration, accompanied by a reduction in vaginal lubrication and a decrease in the frequency of achieving orgasm (53).
- The topic of discussion pertains to hormones and their related treatments such as hormone therapy and oophorectomy. The procedure of oophorectomy, commonly performed in conjunction with hysterectomy, results in the cessation of ovarian activity and may lead to symptoms such as vaginal dryness and dyspareunia in affected women. The administration of hormone replacement therapy following a surgical procedure is a crucial element that impacts the psychosexual adjustment of an individual (44,54).
- Variety of hysterectomies. The psychosexual adaptation following a hysterectomy is influenced by various factors such as the type of surgery performed (abdominal, vaginal, or laparoscopic) and whether the hysterectomy is total or subtotal (48).
- Culture. Certain ethnic groups encounter challenges in embracing the practice of hysterectomy. In certain regions of West India, there exists a belief among women that menstruation serves a purifying function, ridding the body of impurities. As a result, there is hesitancy among these women to undergo hysterectomy procedures. The women express apprehension regarding being labeled as "disabled" by their spouses and instead aspire to be recognized as complete individuals (55).
- Factors Associated with Sexual Partners. Several factors have been identified as potentially influencing psychosexual adaptation following a hysterectomy. These include a woman's satisfaction level with her partner, the age of her sexual partner, the presence of erectile dysfunction or premature ejaculation, and any chronic diseases or medications used by the partner (53,55–57).

- The Significance of the Uterus in Women. The uterus is perceived by women as a multifunctional organ that serves as a site for fertility, sexual activity, secretion, regulation of bodily functions, and a source of energy, vitality, youthfulness, beauty, attractiveness, and power.
- Individuals may view hysterectomy as a significant event that marks the end of their life, perceiving the procedure as a loss of their youth, femininity, and overall health. The excision of the uterus in women can result in psychosocial challenges, including emotions of vulnerability, anxiety regarding the loss of physical appeal and sexual identity, despair, and depressive symptoms (56,57).
- Mitigation of Symptoms Associated with Hysterectomy. A significant correlation was observed between the sexual function after the hysterectomy and the complaints that led to the surgical removal of the uterus. The alleviation of myoma uteri-related pain or heavy bleeding in women has a favorable impact on postoperative sexual function (58,59). According to reports, women who have undergone hysterectomy as a result of fibroid or endometriosis experience less painful and improved sexual intercourse compared to the preoperative period. The study reveals that there are positive outcomes associated with hysterectomy. The cessation of atypical uterine bleeding and alleviation of menstrual symptoms and pelvic pain, as well as a reduction in symptoms of depression and anxiety (55).
- Psychological Responses of Women to Surgical Procedures. According to the literature, there exists a correlation between the psychological reactions that arise following a hysterectomy and a woman's perception of the organ and the surgical procedure (55).

The physical, psychiatric, and cultural dimensions of hysterectomy necessitate consideration of psychological responses. Hysterectomy is a surgical procedure that may provide certain benefits to women, such as reducing the risk of developing malignant diseases, preventing unwanted pregnancy, increasing sexual autonomy, and alleviating painful menstrual periods. However, some individuals perceive it as a deprivation of their feminine identity and sexual expression. Individuals who express a desire to avoid additional pregnancies or experience apprehension towards pregnancy may find a sense of relief through undergoing a hysterectomy. However, younger individuals who have aspirations of parenthood may exhibit a negative response to this procedure. According to reports, women who believe that undergoing a hysterectomy results in a reduction of sexual arousal and contentment have reported a decrease in their libido (55).

Post-Hysterectomy Psychological and Biophysical Health Issues

According to reports, a significant proportion of women may experience psychological symptoms, such as depression, fatigue, and anxiety, as well as new physical symptoms, including urinary incontinence, constipation, premature ovarian failure, and sexual dysfunction, following a hysterectomy (54,55,60,61).

Adherents of Freudian theories posited that the decline in sexual responses after hysterectomy was attributable to a form of castration resulting from the loss of sexual organs. Historically, it was commonly held that hysterectomy-induced sexual dysfunction was not due to physiological changes, but rather a result of psychological stress. This belief was based on the assumption that all women would exhibit identical symptoms following the procedure. Currently, it is widely acknowledged that not all females who have undergone a hysterectomy will encounter these physiological alterations, and the degree of their manifestation differs (54,59,62).

Women who experience concerns regarding their femininity may encounter greater challenges in their postoperative psychosexual adjustment. Male partners of women who have undergone hysterectomy may experience anxiety during sexual intercourse due to concerns about causing harm to their partner. The degree of depression is intricately linked to cultural norms and the distribution of responsibilities among family members. Insufficient cohesion between partners may result in crises during this period (62).

The following factors are identified as potential contributors to psychological issues following a hysterectomy:

- Issues related to sexual identity;
- A personal history of depression;
- A family history of mental illness or depression;
- Being under the age of 35;
- A desire to conceive a child;
- Concerns about losing sexual appeal;
- A partner's negative attitude or unemployment status (63).

Arousal and sexual activity

There exists a theoretical proposition that hysterectomy may lead to a decrease in sexual arousal, which can be attributed to various mechanisms. The diminished amount of tissue that arises from the excision of the uterus, cervix, and/or upper segments of the vagina leads to a reduction in pelvic vasocongestion (54). Furthermore, the interference with the blood flow to the pelvic region can hinder the appropriate response of lubrication and swelling (64). The development of fibrous tissue in the superior region of the vaginal canal may impede complete vaginal distension, consequently restricting sexual arousal. Moreover, it is believed that cervical mucus plays a significant role in providing lubrication during sexual stimulation (65). The cessation of estrogen and androgen production after hysterectomy-oophorectomy and ovarian failure can result in vaginal atrophy, reduced lubrication, dryness, and challenges with arousal (54,66). There has been a suggestion posited that the presence of the uterus and cervix may not be essential for the attainment of orgasmic functioning (67). Certain researchers have posited that the presence of uterine pathology may lead to a decrease in coital frequency, while the removal of the uterus through hysterectomy may result in a significant increase in the frequency of sexual intercourse. There has been a proposal suggesting that heightened sexual activity could serve as the most compelling indication of enhancement in women's sexual functioning and pleasure (68). Nonetheless, the frequency of sexual activity may be associated with the lack of pelvic discomfort, hemorrhaging, and the sexual drive of the partner (56). A hysterectomy has the potential to cause alterations in various stages of the sexual response cycle, including sexual desire, arousal, and orgasm. The literature on hysterectomy commonly groups the various components of the sexual response cycle and categorizes them collectively as "sexual functioning" and "sexual well-being," among other terms (56).

Depression

Hysterectomy is associated with a high risk of depression, which is considered to be the most prevalent psychiatric complication (69). The potential link between hysterectomy and depression has been postulated to stem from the perceived impact on feminine self-image, strength, and self-esteem, as well as the emotional experience of deformation, mutilation, and grief associated with the loss of child-bearing capacity (70,71).

A significant contributing factor to depression is the perception of hysterectomy as a loss of fertility function and subsequent infertility following the procedure. Complications following a hysterectomy, such as a reduction in sexual desire, a loss of sexual identity, and alterations in body image, have been found to frequently result in depressive symptoms (55,56,62).

Psychiatric issues are infrequently observed during the initial weeks following a hysterectomy. However, psychological difficulties may arise during the period of adjustment to a new way of life once the trauma of the surgical intervention has been fully overcome (72).

Recent prospective studies have indicated that the prevalence of psychological morbidity is elevated before a hysterectomy due to the emotional response to distressing gynecological symptoms (73).

The phrase "mirth" is used to describe the symbolic meanings of the uterus, such as femininity, childbearing, sexuality, strength, vitality, youth, attractiveness, competence, regulation of body processes, and control of the rhythm of life. Post-hysterectomy depression is a wish for future children, independent of the mother's pregnancy (74–77).

Self-perception, femininity, and body image

The presence of scars after an abdominal hysterectomy can be perceived as a type of disfigurement and has the potential to negatively impact one's body image. The removal of the uterus may also be interpreted as a depletion of feminine identity and energy (76).

The significance of these psychological concerns lies in their association with the sexual and pain-related consequences of hysterectomy. Despite the existence of these ideas for several decades, there has been limited empirical research conducted on the relationship between hysterectomy and concepts such as body image, femininity, and self-perception (56,71,74).

According to a retrospective controlled study, women who underwent hysterectomy exhibited a compromised body image as compared to women who had not undergone the procedure (66). However, other prospective controlled studies have reported no significant difference in body image between women who underwent hysterectomies and those who received conservative treatment (47,78).

The outcomes related to pain

The prevalence of pelvic pain and dyspareunia among patients with uterine issues is estimated to be between 40% and 75%. However, it should be noted that only a portion of these patients report experiencing painful intercourse and subsequently receive a diagnosis (68,79–81). Theoretically, the excision of an afflicted uterus ought to alleviate dyspareunia and pelvic pain (82). Postoperative pain may also occur as a consequence of scarring in the pelvic region. Furthermore, the excision of a painful organ does not necessarily result in a decrease in pain perception, as evidenced by the occurrence of phantom limb pain. The surgical procedure of hysterectomy accompanied by oophorectomy and subsequent ovarian failure can result in the manifestation of postmenopausal symptoms, such as vaginal dryness. These symptoms have been associated with dyspareunia. Dyspareunia can occur due to potential vaginal scarring, constriction, and reduction in length following the complete removal of the cervix and uterus during a total hysterectomy (42,74,83–89).

Regarding pelvic pain, previous uncontrolled retrospective studies indicate that hysterectomy is typically effective in alleviating pelvic pain. Nonetheless, in approximately 22% of cases, the pain persists (90).

Patient education regarding recovery and return to activities

The postoperative recommendations and limitations following a hysterectomy exhibit notable variations across nations, medical departments, and individual practitioners. Furthermore, there is a dearth of evidence-based guidelines on this matter (91).

The literature reports that the recovery period following a hysterectomy is frequently evaluated in terms of the duration of hospitalization or the duration until resuming work and is regarded as a measure of short-term outcomes. The duration of hospitalization and the time needed to resume work are subject to various factors, including postoperative pain, the incidence of complications, local customs, and the physician's discretion. Therefore, it is crucial to conduct a thorough evaluation of the recovery process (36).

Comparison with other surgical approaches for hysterectomy

There is a perception that the surgical approach employed during hysterectomy impacts the degree of postoperative recuperation, psychological state, and overall health and wellness of female patients. Both LH and SH are regarded as less intrusive in comparison to TH. It is believed that surgical methods with lower invasiveness tend to yield better outcomes in the areas of psychological and overall well-being (36). Based on the aforementioned considerations, a set of hypotheses were formulated. The use of laparoscopic hysterectomy has been shown to result in improved psychological well-being and more rapid short-term recovery when compared to abdominal hysterectomy. Having a strong ability to cope with stress is advantageous for achieving positive psychological well-being following a hysterectomy procedure (36). The findings suggest that subtotal abdominal hysterectomy may be associated with improved psychological well-being compared to total abdominal hysterectomy. The subtotal hysterectomy procedure has been found to have a lower incidence of complications and a quicker recovery time for overall well-being compared to a total hysterectomy. It is anticipated that psychological well-being will experience a positive change after hysterectomy, irrespective of the surgical approach employed (36).

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Annex IV Personal archive
Prof. Univ. Dr. Pirtea Laurențiu Cornel

Figure 57. Pre-op preparation. Fixing the labia majora. Toilet with betadine

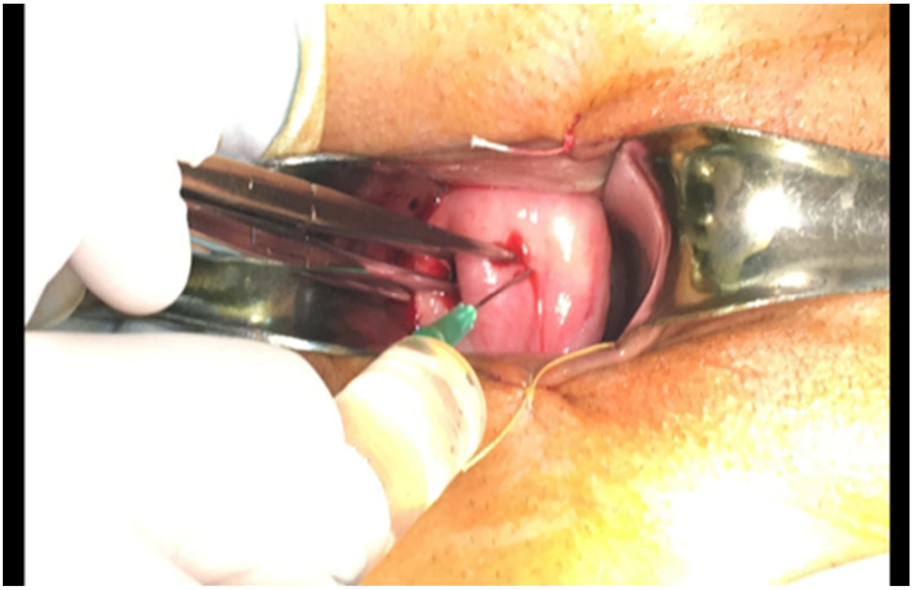

Figure 58. Hidrodisectia spatiului vezico-vaginal

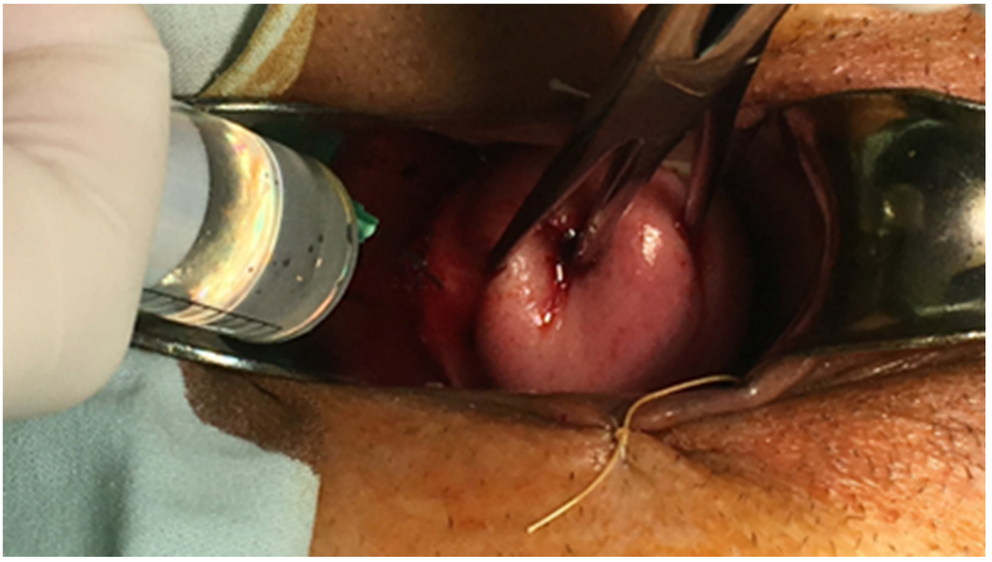

Figure 59. Hydro-dissection of the recto-vaginal space

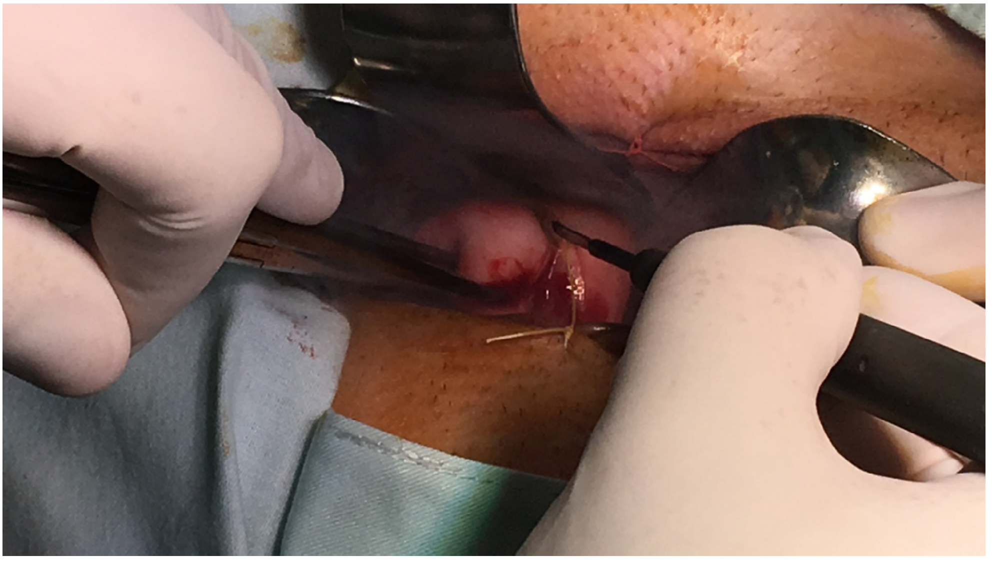

Figure 60.Continuous traction on the cervix using Pozzi forceps and incision of the anterior fold of the vaginal mucosa

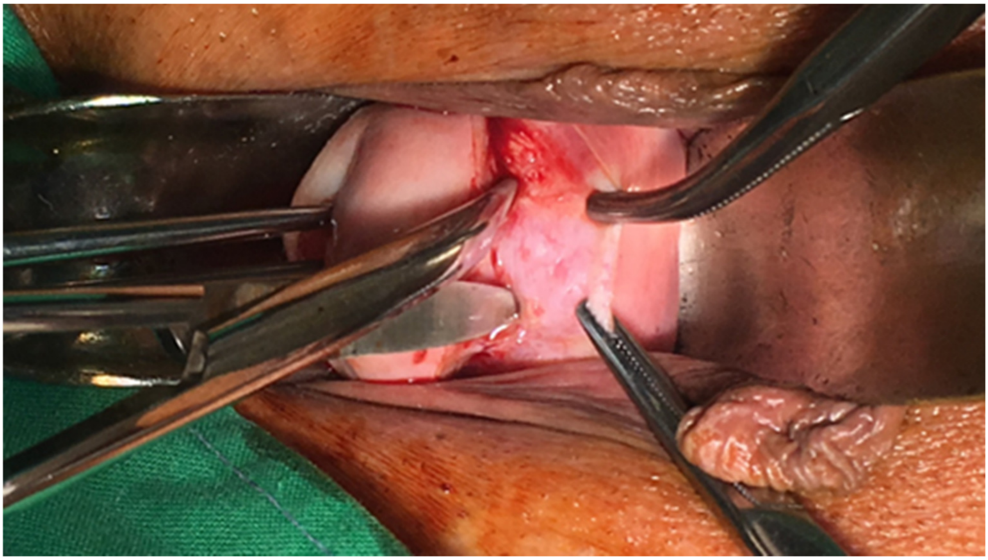

Figure 61. Sectioning of the vesicouterine septum

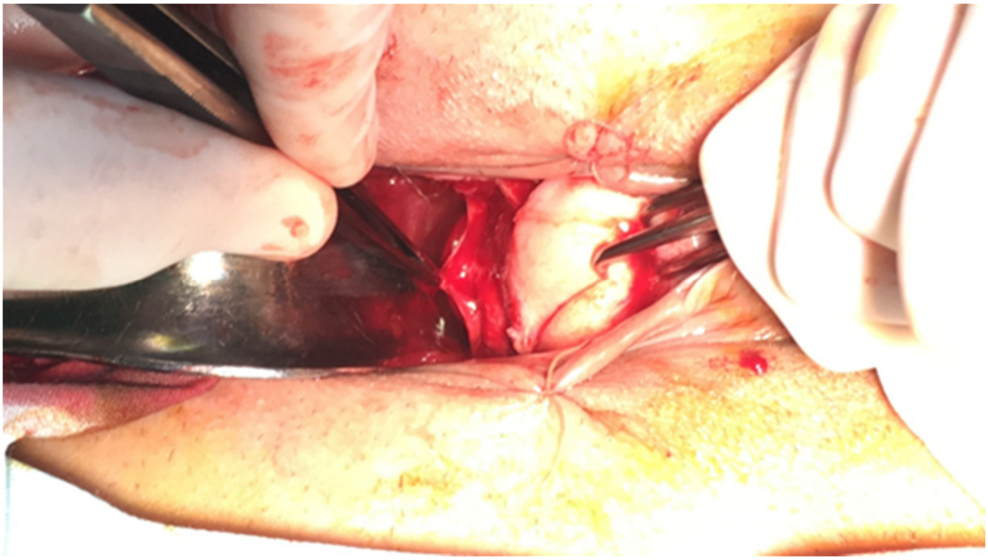

Figure 62. Dissection of the recto-vaginal space using a valve; incision of the posterior peritoneum using scissors

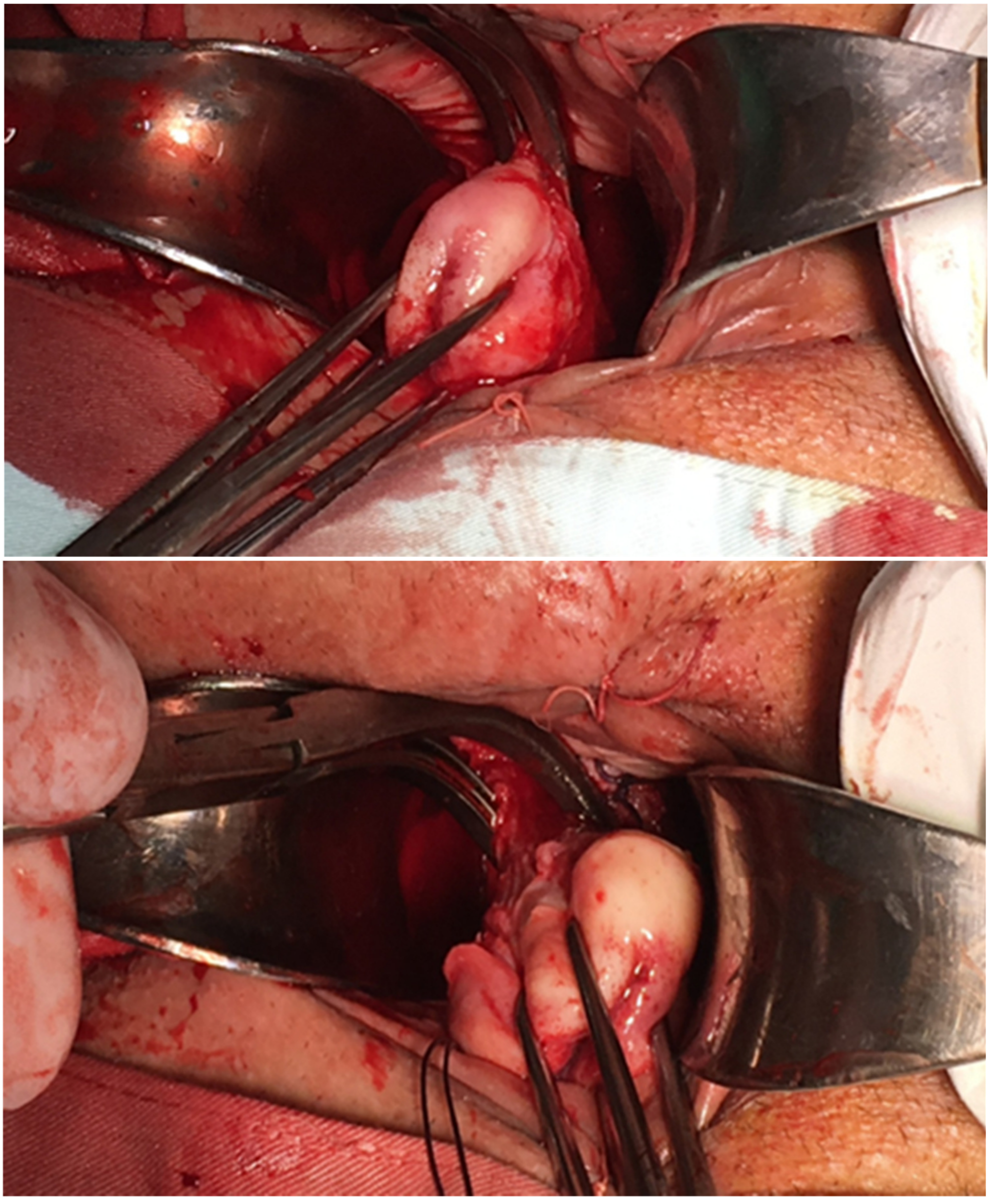

Figure 63. Sectioning and ligation of the lower uterine pedicle:
lig. Cardinal Mackenrot and lig. Utero-sacral ligaments (in 2 steps)

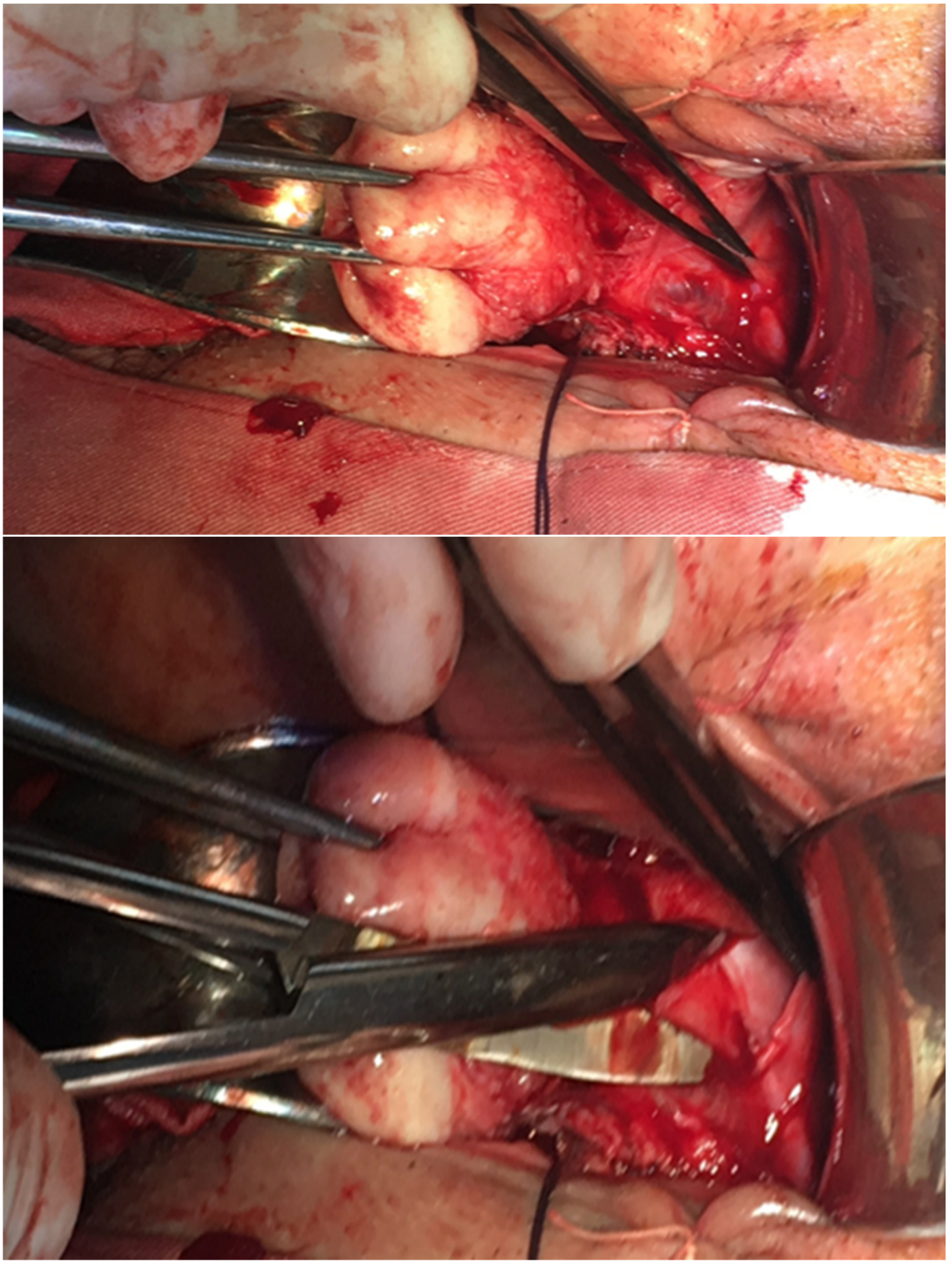

Figure 64. Opening of the anterior peritoneal sac fundus

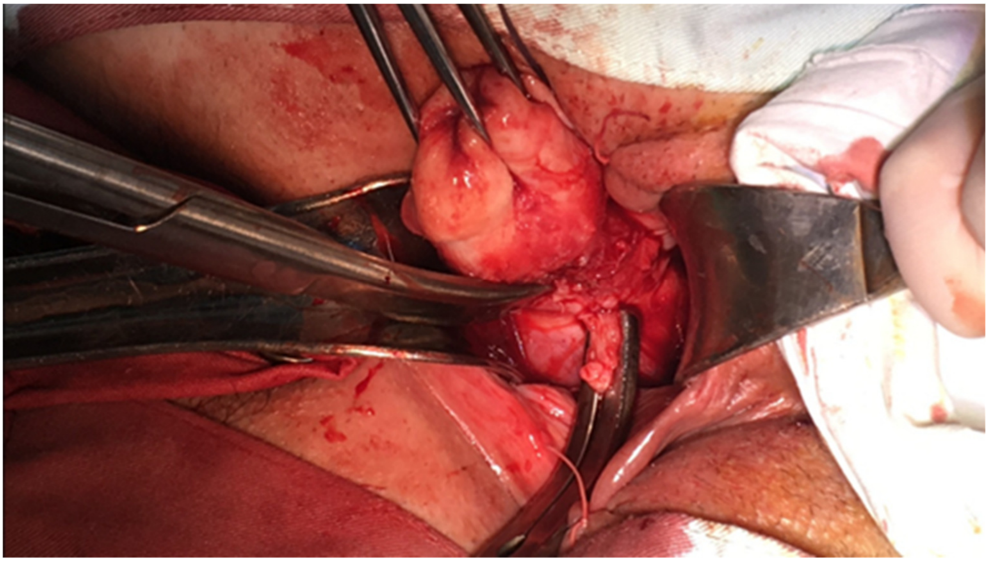

Figure 65. Sectioning and ligation of the middle uterine pedicle: uterine artery and vein

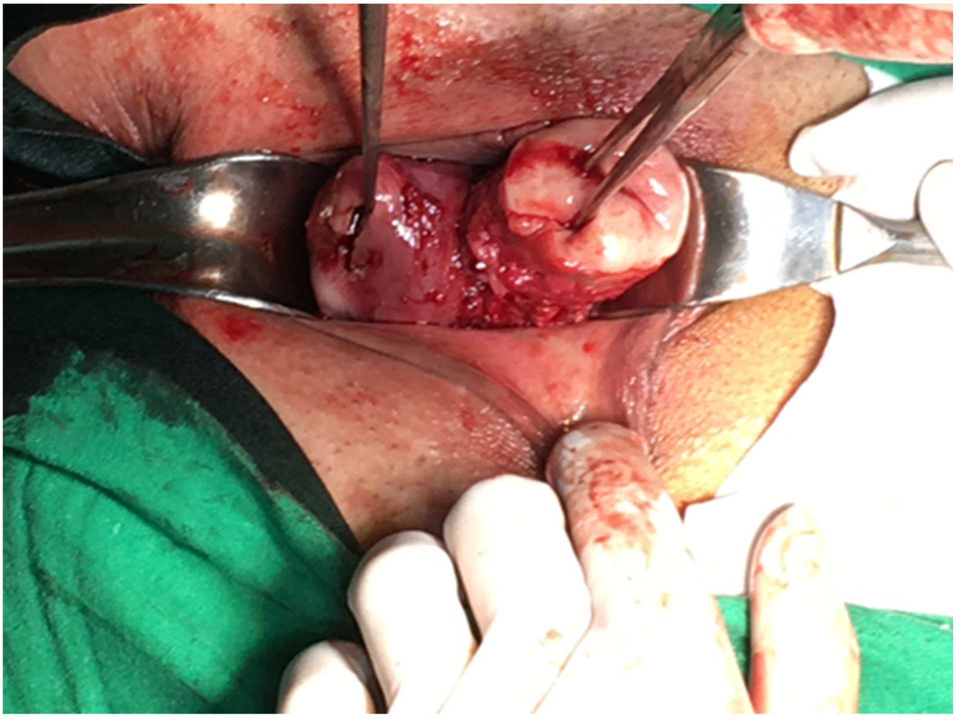

Figure 66. Removal of the uterine fundus through the posterior fundus to gain access to the upper pedicles (in the case of small-sized uteruses).

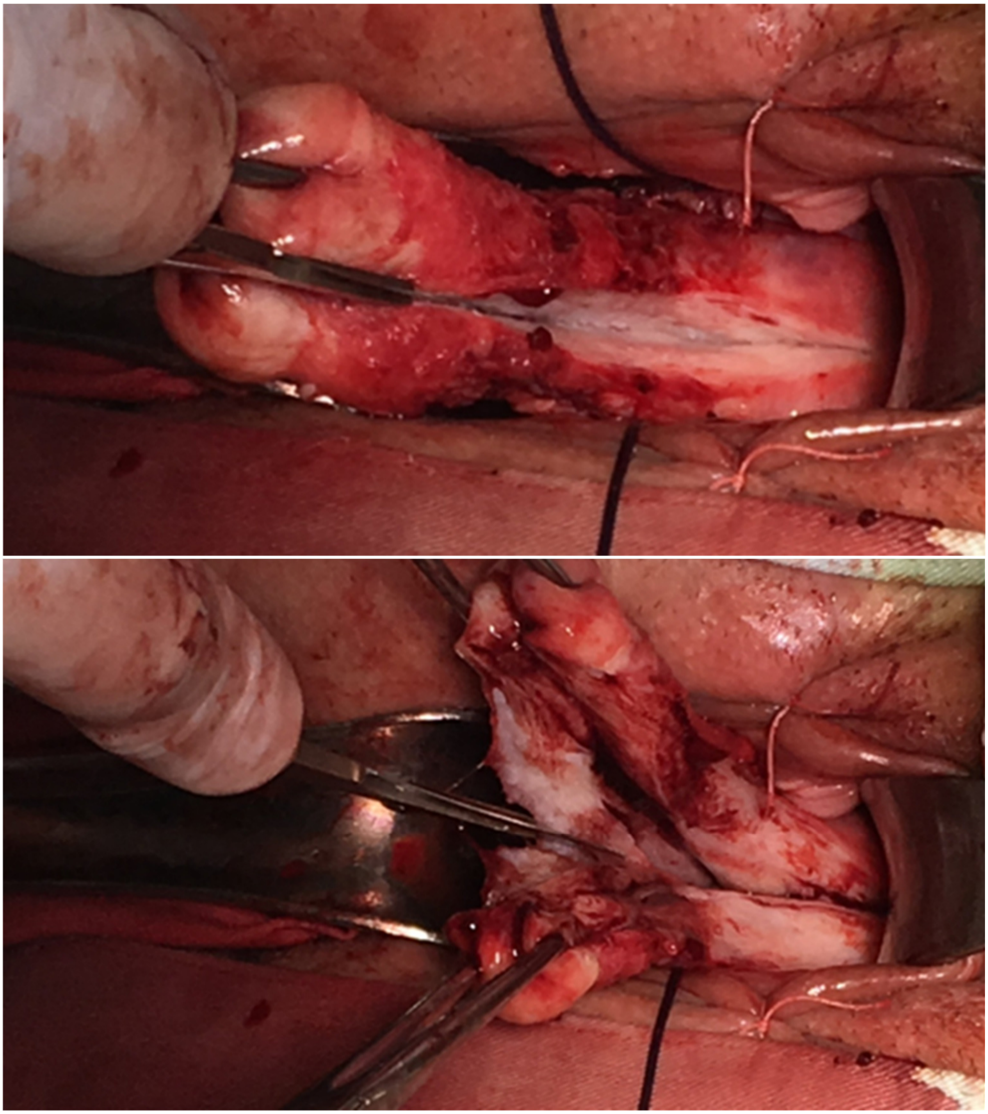

Figure 67. Hemisection of the uterus to gain access to the upper pedicle (in the case of large uteruses)

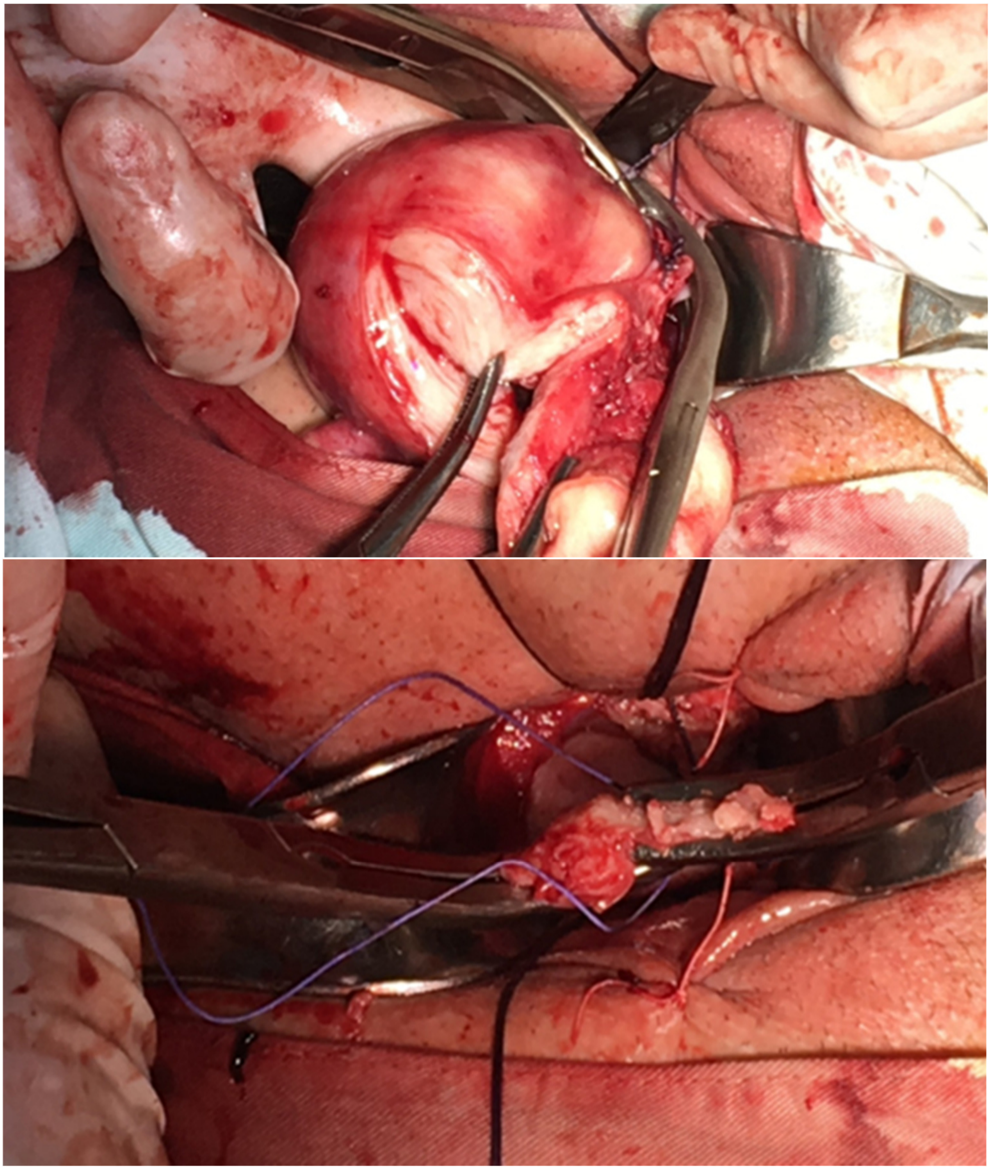

Figure 68. Upper uterine pedicle sectioning and ligation:
lig. Utero-ovarian, fallopian tube, and round ligament

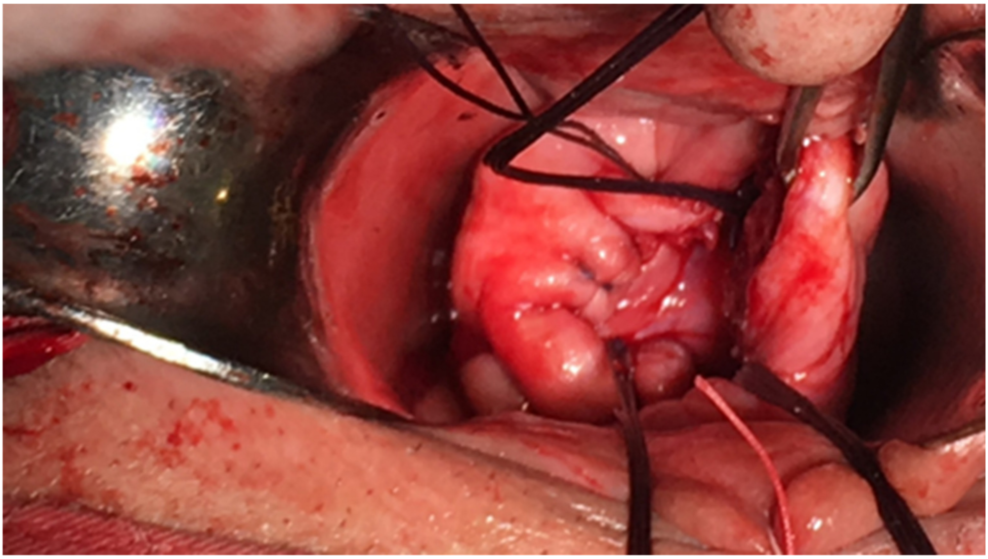

Figure 69.Removal of the pelvisubperitoneal space by continuous suture suturing of the posterior peritoneal lining and posterior vaginal mucosa

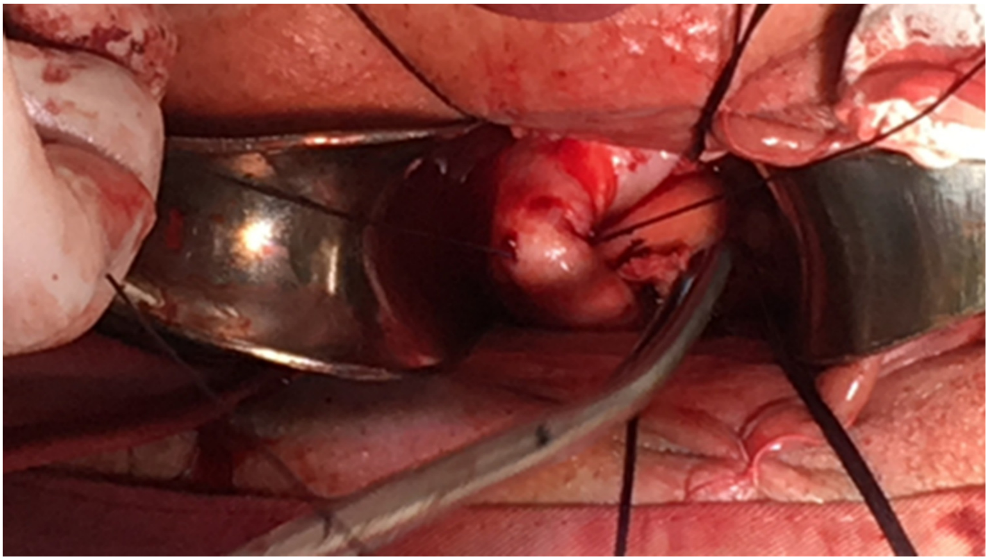

Figure 70. Vaginal suture