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**ELASTOGRAPHIC APPROACHES IN THYROIDITIS: STRAIN  
AND SHEAR-WAVE TECHNIQUES IN PEDIATRIC AND  
ADULT POPULATIONS**

**ABSTRACT**

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## **GENERAL PART**

The importance of autoimmune thyroiditis in both adults and children is becoming more widely acknowledged. The younger generation is increasingly affected by this medical condition, which emphasizes how critical it is to recognize and treat it from an early age. As thyroid function is crucial for growth, development, and overall well-being, autoimmune thyroiditis can have important effects on a child's health.

Elastography, a relatively recent but extensively documented methodology, has been utilized to assess the stiffness of the thyroid gland by assessing tissue distortion under pressure, which can be applied externally through the transducer, as seen in strain elastography, or internally, as in the shear-wave technique, where controlled monoplane or biplane waves are generated by the transducer. The level of elasticity dictates the extent of compression or distortion, leading to alterations in shape that the ultrasound probe detects. This process generates either qualitative outcomes, represented through color-coded maps, or quantitative measurements.

## **SPECIFIC PART**

### **1. GENERAL OBJECTIVES**

Given the increasing prevalence of autoimmune thyroid diseases, there is a growing need for new diagnostic methods and approaches to monitor disease progression. Therefore, the objective of this thesis is to assess the efficacy of elastography in diagnosing autoimmune thyroiditis in both children and adults. Our research objectives were:

1. To analyze the predictive value of strain elastography for the presence of chronic autoimmune thyroiditis in adults;
2. To propose a prediction score to increase the diagnostic accuracy of chronic autoimmune thyroiditis;
3. To determine whether the results obtained in the adult population are replicated in the pediatric population;
4. To evaluate the diagnostic accuracy of Shear-Wave Elastography and to compare the thyroid elasticity levels of children and adults;
5. To make a comparative analysis of the two types of elastography to observe which is more appropriate in the evaluation of children with chronic autoimmune thyroiditis.

## **2. STUDY I: THE ROLE OF STRAIN ELASTOGRAPHY IN DETECTING AUTOIMMUNE THYROIDITIS IN ADULT POPULATION**

### **2.1. AIM OF THE STUDY**

This study is designed to assess the performance of strain elastography as a supplement to conventional ultrasound in identifying Hashimoto thyroiditis and to create a prediction score to improve diagnostic accuracy.

### **2.2. MATERIALS AND METHODS**

This prospective research was conducted on patients with HT between July 2019 and July 2020 at “Dr D” Medical Center. All subjects provided their written assent, which was obtained with their knowledge and consent. Two hundred and fifty participants were examined; 180 among them were diagnosed with CAT, confirmed by significantly elevated TPOAb and/or TGAb levels (10 men and 170 women, ages 18 to 72). The control group consisted of seventy healthy individuals (four men and sixty-six women between the ages of 19 and 68) with normal thyroid hormone levels, anti-thyroid antibody titres, and ultrasound appearance. Participants in the control group had a healthy thyroid, as indicated by normal TPOAb, TGAb, TSH, and FT4 values. Each study participant was euthyroid. Ninety-two of the 180 patients confirmed to have CAT were euthyroid while receiving substitution treatment. Patients with GD, nodular thyroid pathology, and known thyroid cancers were not included. Patients with lobectomy or subtotal thyroidectomy histories were additionally left out of the investigation group. Cases with a suggestive US aspect for HT, but normal TPOAb and TGAb were not considered as well. The following parameters were taken into account: TSH, FT4, TPOAb and TGAb. On a Hitachi Preirus device (Hitachi Medical Corporation, Tokyo, Japan) with a 5–15 multifrequency linear transducer, standard B-mode thyroid US and SE were carried out.

### **2.3. RESULTS**

When the SR mean was used, the optimal cut-off for predicting CAT was  $SR > 1.64$  (AUROC = 0.87, Se = 69%, Sp = 92%, PPV = 95.4%, and NPV = 54%). When the greatest SR (SR max) values were used, the following CAT prediction threshold was determined:  $SR > 1.9$  (AUROC = 0.80, Se = 70.5%, Sp = 75%, PPV = 78.8%, NPV = 54.5%), whereas when the minimum SR (SR min) values were used, the following values were obtained: cut-off value  $SR > 1.1$  (AUROC = 0.75, Se = 69.4%, Sp = 67.5%, PPV = 82.4%, NPV = 52.9%). The region below the AUROC score should be as close to 1 as possible to improve test predictiveness. The SR mean had the highest predictive value, followed by the SR maximum and SR minimum. For this reason, the SR mean will serve as the standard for further determinations. When compared to the control group, individuals with CAT showed a notable increase in thyroid stiffness ( $2.81 \pm 2.11$  versus  $1.03 \pm 0.51$ ;  $p < 0.0001$ ). For predicting the occurrence of CAT, the ideal threshold value was found to be  $>1.64$  (AUROC = 0.87, Se of 69%, Sp of 92%, PPV of 95.4%, and NPV of 54%). Elevated values are evident in individuals with

chronic autoimmune thyroiditis (CAT) when compared to healthy subjects in all age groups younger than 60 years. Among the 180 patients diagnosed with CAT, 92 individuals (51.1%) were already in the hypothyroidism phase and were undergoing thyroid hormone replacement therapy at the time of their examination. Notably, the mean thyroid stiffness measurements were markedly higher in patients with hypothyroidism when contrasted with those who had an asymptomatic disease ( $3.45 \pm 2.53$  versus  $2.15 \pm 1.27$ ,  $p < 0.0001$ ). An optimal threshold value of  $> 2.94$  was identified for predicting the presence of hypothyroid status in CAT patients, yielding a Se of 52.3%, Sp of 83.7%, PPV of 75.4%, NPV of 64.7%, and AUROC of 0.66. Subsequently, a multiple regression analysis was conducted using these predictors, resulting in the following predictive score for CAT:  $0.03 \times \text{thyroid stiffness values} + 0.x \text{ anti-TPO values} + 0.64$ . The optimal threshold value for this predictive score in identifying CAT was determined to be  $>0.7$ , yielding an AUROC of 0.97, Se of 95%, Sp of 95%, PPV of 99%, NPV of 68%, and a significance level of  $p < 0.001$ . When comparing the AUROCs, it was observed that the predictive score outperformed using thyroid stiffness values alone for the prediction of CAT ( $p = 0.0018$ ).

## **2.4. DISCUSSION**

Consistent with existing literature, our findings revealed significant disparities in the average strain ratio values between patients with thyroiditis and the control group. After conducting statistical analysis, we identified the optimal cut-off value as 1.64, exhibiting a specificity of 92% and a sensitivity of 69%. In a study involving 31 patients diagnosed with CAT and 21 healthy subjects, a distinct optimal cut-off of 0.677 was determined, demonstrating a sensitivity of 96% and a specificity of 67%. To establish the most suitable cut-off value for chronic autoimmune thyroiditis diagnosis, larger-scale studies are imperative, considering potential variations among populations and different ultrasound machines. Notably, in line with previous research, no correlation was discovered between thyroid stiffness and TSH values. A significantly elevated stiffness was evident in the treatment group compared to euthyroid CAT subjects. Considering the progression of CAT to hypothyroid status necessitating hormone replacement therapy, the notable fibrosis levels in the treatment group may be attributed to a prolonged course of the disease. This disparity in thyroid stiffness between euthyroid and hypothyroid patients has been previously investigated using SWE, yielding similar findings.

## **2.5. CONCLUSIONS**

Our findings affirm the substantial informative contribution that elastography can offer in the assessment of cases characterized by diffuse thyroid pathology. SE emerges as a promising predictor for identifying autoimmune thyroiditis, suggesting its potential to enhance the ultrasound diagnosis of this condition. The strength of our study lies in the substantial number of subjects involved, coupled with the novel exploration of distinctions in elasticity and functional status. The introduction of a prediction score for chronic autoimmune thyroiditis (CAT) also introduces a fresh diagnostic perspective.

### **3. STUDY II: THE ROLE OF STRAIN ELASTOGRAPHY IN DETECTING AUTOIMMUNE THYROIDITIS IN PEDIATRIC POPULATION**

#### **3.1. AIMS OF THE STUDY**

The purpose of this study is to investigate if there are any notable differences in the elasticity levels of the thyroid tissue between children diagnosed with CAT and children with no thyroid pathology. Additionally, we aim to establish a threshold value for diagnosing HT in children.

#### **3.2. MATERIAL AND METHODS**

The study included 52 children diagnosed with CAT, comprising 14 boys and 38 girls aged 7–18, and a control group of 22 children (5 boys and 17 girls) aged 6–18 without thyroid pathology. The CAT's group inclusion criteria included children diagnosed with CAT based on elevated levels of TPOAb and/or TGAb and ultrasound findings. The study comprised 52 children (14 boys, 38 girls, aged 7–18) diagnosed with chronic autoimmune thyroiditis and 22 children (5 boys, 17 girls, aged 6–18) without thyroid pathology, serving as the control group. The examinations were conducted at the "Dr. D" Medical Center in Timisoara, Romania. Exclusion criteria comprised patients with nodular thyroid pathology, malignancies, or a history of thyroid surgery. Patients with GD, acute or subacute thyroiditis, and children under the age of 6 were also excluded. Cases with suggestive ultrasound findings for CAT but normal anti-thyroid antibody titers were not considered. Each child underwent analysis of the following parameters: TSH, FT4, TGAb, and TPOAb. A Hitachi Preirus device with a 5–15 multi-frequency linear probe was utilized to conduct strain elastography in addition to conventional B-mode ultrasonography of the thyroid. Transverse diameters (two dimensions) and a longitudinal diameter (one dimension) were measured, and the thyroid volume was automatically computed by the device, expressed in milliliters (mL). Two distinct regions of interest (ROI) were designated for SR calculation, with ROI A representing the thyroid tissue and ROI B representing the sternocleidomastoid muscle in front of the ipsilateral thyroid parenchyma. Five successive measurements were taken for each lobe, and the mean value was employed for analysis. The SR was calculated for each lobe and automatically presented.

#### **3.3. RESULTS**

No discernible differences were observed between the two groups with respect to weight or height. The mean TSH value for the CAT group was  $2.65 \pm 1.17$ , whereas for the control group, it was  $3.28 \pm 1.08$  ( $p = 0.0901$ ). The mean Ft4 value for healthy children stood at  $13.58 \pm 1.56$ , while for the CAT group, it was  $14.20 \pm 1.53$  ( $p = 0.1175$ ). Children with CAT exhibited significantly higher mean thyroid stiffness (TS) values compared to their healthy counterparts



( $1.19 \pm 0.25$  vs.  $0.68 \pm 0.2$ ;  $p < 0.0001$ ). Within the CAT group, there was no observed difference in mean SR values based on gender ( $1.19 \pm 0.24$  for females vs.  $1.20 \pm 0.30$  for males;  $p = 0.9014$ ). The optimal cut-off value, determined as the highest sum of sensitivity and specificity using the mean RS values to predict the presence of CAT in children, was  $>0.9$  (AUROC—0.90, Se—84.62%, CI 95%: 71.9–93.2; Sp—95.45%, CI 95%: 77.2–99.9; PPV—97.8%, and NPV—72.4%). In terms of substitution therapy, 75% (39/52) of children in the CAT group were undergoing LT4 replacement therapy. No significant differences were observed in mean SR values between preexisting hypothyroid cases and euthyroid cases ( $1.24 \pm 0.26$  vs.  $1.18 \pm 0.25$ ;  $p = 0.4615$ ). In the control group, none of the children required treatment. A positive and noteworthy correlation was identified between SR mean values and TPOAb levels ( $r = 0.65$ ,  $p < 0.0001$ ), thyroid volume ( $r = 0.49$ ,  $p < 0.001$ ), body surface area ( $r = 0.32$ ,  $p = 0.0054$ ), and TGAAb levels ( $r = 0.29$ ,  $p = 0.0135$ ). However, no significant correlation was observed between SR mean values and TSH values ( $p = 0.8205$ ), FT4 values ( $p = 0.8232$ ), or age ( $p = 0.0840$ ).

### **3.4. DISCUSSION**

There are currently only two studies using strain elastography and another two studies using ARFI to assess children with CAT, the cut-off value identified for CAT presence was 0.31 (92.1% sensitivity, 66% specificity, AUROC 0.828), notably lower than the cut-off value we derived ( $>0.9$ ). In another study, the recommended cut-off value for CAT diagnosis was  $>0.98$  (83% se, 93% sp, AUROC 0.929), a finding consistent with our obtained cut-off value ( $>0.9$ ; AUROC 0.9, se 84.62%, sp 95.45%; ppv 97.8%; npv 72.4%). The mean SR values for children with CAT stood at  $1.2 \pm 0.2$ , significantly higher than the mean SR values for control subjects ( $-0.77 \pm 0.18$ ;  $p < 0.01$ ), mirroring our results. The distinctive aspect of our study lies in the examination of thyroid parenchyma elasticity in children undergoing hormone replacement therapy compared to those not receiving it. No discernible differences were observed between children undergoing levothyroxine treatment ( $1.24 \pm 0.26$ ) and those without treatment ( $1.18 \pm 0.25$ ;  $p = 0.4615$ ). This avenue of investigation merits further exploration, as existing studies on the adult population have identified differences between treated and untreated patients.

### **3.5. CONCLUSION**

Our findings indicate that SE is a valuable diagnostic technique for assessing children with CAT, demonstrating excellent sensitivity and specificity values (84.62% Se, 95.45% Sp, 97.8% PPV, and 72.4% NPV). These results align with similar studies conducted on adults. This research lays the groundwork for implementing elastographic examinations in pediatric cases. The obtained results hold significance, providing encouragement and opening avenues for broader studies in a population category with limited available data.

## **4. STUDY III: THE DIAGNOSTIC PERFORMANCE OF 2D-SWE IN THE EVALUATION OF CHILDREN WITH CHRONIC AUTOIMMUNE THYROIDITIS**

### **4.1. AIMS OF THE STUDY**

SWE demonstrated its utility as an adjunct diagnostic tool for assessing TS in adults with CAT. This research seeks to extend its applicability to the pediatric population for detecting CAT in children. Consequently, the objective of this study is to appraise the efficacy of SWE in diagnosing CAT in children while also conducting a comparative analysis of fibrosis levels between pediatric and adult cases. Furthermore, our aim includes establishing a threshold value for diagnosing HT in children.

### **4.2. MATERIAL AND METHODS**

We assessed a total of 150 participants, comprising 100 children and adolescents and 50 adults. Among the 100 children, 50 were diagnosed with CAT, while the remaining 50 served as the control group without thyroid pathology. The two groups of children were matched for age and gender. All adults included in the study were diagnosed with CAT. For inclusion, we considered children aged 5–18 years diagnosed with CAT based on clinical examination and ultrasound findings. Immunology assays confirming the diagnosis included elevated levels of TPOAb and/or TGAb. The control group consisted of 50 children (ages 5–18) without thyroid pathology, while the adult group comprised 50 individuals over the age of 20 diagnosed with CAT through similar examination methods. Exclusions were made for adults and children with GD, nodular thyroid pathology, or malignancies. Cases with a history of thyroid surgery (lobectomy or thyroidectomy) were also excluded. Adults without thyroid pathology were not part of the study. Furthermore, children under the age of 5 were excluded due to the challenges associated with their examination. The Aixplorer Mach 30 machine (Supersonic Imagine, Aix-en-Provence, France), equipped with an L 18-5 probe (linear, 5–18 MHz), was utilized to conduct conventional B-mode thyroid ultrasound, followed by SWE. Activating the SWE mode by placing the probe on one side of the neck resulted in a color map ranging from blue (indicating soft tissue) to red (indicating hard tissue). All images were captured in the longitudinal plane while the subject held their breath for approximately five seconds. The frozen image facilitated the measurement of tissue elasticity using the Q-BOX, recorded in kilopascas.

### **4.3. RESULTS**

No significant differences were found between the mean values obtained in the left lobe and the right lobe ( $15.47 \pm 4.77$  kPa vs.  $15.56 \pm 5.22$  kPa;  $p = 0.92$ ). The mean TS value for

children diagnosed with CAT was  $15.51 \pm 4.76$  kPa. A parallel approach was applied for adults, showing no notable differences between the mean values obtained in the left lobe and the right lobe, respectively ( $21.17 \pm 6.13$  kPa vs.  $20.76 \pm 7.07$  kPa;  $p = 0.75$ ). The mean TS value for adults with CAT was  $20.96 \pm 6.31$  kPa. Comparatively, the mean TS values were significantly lower for children in the CAT group compared to adults with CAT ( $15.51 \pm 4.76$  kPa vs.  $20.96 \pm 6.31$  kPa;  $p < 0.0001$ ). Additionally, in children, the mean TS values were significantly higher compared to the healthy age-matched controls ( $15.51 \pm 4.76$  kPa vs.  $10.41 \pm 2.01$  kPa;  $p < 0.0001$ ). The optimal cut-off value for predicting the presence of CAT in children, determined using mean TS values, was  $>12.2$  kPa (AUROC = 0.88, Se = 82%, Sp = 88%, PPV = 87.2%, NPV = 83%). In the same population, when analyzing the highest TS values, a cut-off value for predicting CAT ( $>13.13$  kPa) yielded an AUROC of 0.89, Se of 80%, Sp of 92%, PPV of 91%, and NPV of 82.1%. Using the lowest TS values, the cut-off value ( $>11.53$  kPa) resulted in an AUROC of 0.85, Se of 76%, Sp of 86%, PPV of 84.4%, and NPV of 78.2%. A weak correlation was observed between TPOAb levels and TS values ( $r = 0.43$ ) and between TS values and age ( $r = 0.30$ ). No correlation was evident between TS values and TGAb levels, TSH, FT4, or thyroid volume. Within the CAT group, 17 out of 50 children (34%) were undergoing LT4 replacement therapy. No discernible differences were identified in mean TS values between children undergoing therapy and those without therapy ( $16.29 \pm 4.75$  kPa vs.  $15.11 \pm 4.79$  kPa;  $p = 0.41$ ).

#### **4.4. DISCUSSIONS**

In the adult population, there are several studies demonstrating the utility of SWE in diagnosing and differentiating DTD. Regarding pediatric population, the studies are not so extensive. Our analysis identified higher values in healthy children, with a mean TS of  $10.41 \pm 2.01$  kPa. Similar values to those obtained in our study were reported in other studies regarding the control group, with no thyroid pathology, with TS values ranging from  $8.2 \pm 2.82$  kPa to  $11.24 \pm 1.99$  kPa. Some papers reported normal elasticity scores as  $10.9 \pm 1.78$  kPa,  $9.36 \pm 1.63$  kPa, or 10.6 kPa. Through the statistical analysis, this study established a cut-off value of 12.2 kPa for the mean SWE value in predicting CAT, demonstrating a Se of 82% and a Sp of 88%. Up until the publication of our study, only three existing publications had suggested a cut-off value for the diagnosing CAT in children using SWE. Recently, three additional studies have proposed the following cut-off values to distinguish normal thyroid tissue from that affected by thyroiditis: 13.217 kPa, 9.68 kPa and 13.41 kPa, with varying sensitivity and specificity values. We also investigated whether there is a disparity in TS among children diagnosed with CAT who are receiving hormone replacement therapy with levothyroxine compared to those who are not. However, we did not identify significant differences in elasticity between these two subgroups of pediatric patients. In our study, the mean TS values were notably lower in children within the CAT group in comparison to adults with CAT. Furthermore, in children, the mean TS values were significantly elevated in the CAT group compared to the healthy age-matched controls. As of now, there is no existing research that has comparatively examined the levels of thyroid fibrosis in children and adults.

## **4.5. CONSLUSIONS**

This study prompts important considerations regarding the application of elastography for detecting CAT in the pediatric population, showing promising results thus far. Notably, significant differences were observed between adults with CAT and children with the same condition. A crucial aspect of this study is the comparative analysis of values obtained in the group of children with CAT with two control groups: one comprising healthy children and the other consisting of adults with CAT. To the best of our knowledge, this comparative aspect has not been previously studied. The findings of this study support the utilization of elastography, when available, for the assessment of children suspected of autoimmune thyroiditis.

## **5. STUDY IV: THE COMPARATIVE ASSESSMENT OF STRAIN AND 2D SHEAR WAVE ELASTOGRAPHY FOR AUTOIMMUNE THYROIDITIS DIAGNOSIS IN CHILDREN**

### **5.1. AIMS OF THE RESEARCH**

The research aims to evaluate and compare the diagnostic efficacy of 2D SWE and SE in identifying pediatric patients with autoimmune thyroiditis. To shed light on these two elastographic methods' relative performances and their use in the diagnosis of autoimmune thyroiditis in younger patients, the study intends to examine how effective both are.

### **5.2. MATERIAL ANS METHODS**

The study cohort comprised 77 children aged 6 to 18 years. Among them, 45 were diagnosed with CAT, confirmed through clinical examination, ultrasound assessment, and elevated levels of TPOAb and TGAb. Nineteen of the CAT-diagnosed children received hormone replacement therapy. The control group consisted of 32 children without any thyroid pathology, exhibiting normal laboratory results and ultrasound characteristics indicative of a healthy thyroid. All assessments took place at the "Dr. D" Medical Center in Timisoara, Romania. Exclusion criteria encompassed patients with nodular thyroid pathology, malignancies, or a history of thyroid surgery. Individuals with GD or acute/subacute thyroiditis were also excluded. Minors under the age of six were omitted due to evaluation complexity. Utilizing a Hitachi Preirus machine equipped with a 5–15 multifrequency linear transducer, we conducted conventional B-mode thyroid ultrasound and SE. SWE was conducted in the same session using the Aixplorer Mach 30 machine (Supersonic Imagine, Aix-en-Provence, France) equipped with an L 18-5 probe (linear, 5–18 MHz).

### **5.3. RESULTS**

A total of 77 subjects underwent evaluation through both strain and shear-wave elastography measurements on the thyroid, resulting in a diagnosis of CAT for 45 out of 77 individuals (58.4%), while 32 out of 77 (41.55%) showed no signs of thyroid pathology. Accurate

measurements were obtained for all 77 subjects. In both diagnostic categories, the representation of women exceeded 75%, while men accounted for less than 25%.

In the analysis of strain evaluation, the median of three values was considered, and no significant differences were observed between the right and left thyroid lobes ( $U = 2864$ ;  $p = 0.716$ ). The obtained median SR was 1.2 (1.2–1.3) for CAT, contrasting with 0.7 (0.6–0.9) for healthy thyroid tissue ( $p < 0.0001$ ).

For the entire group, the median EI values for the left thyroid lobe were 13 kPa (10.7–14.7), and for the right thyroid lobe, they were 12.7 kPa (10.8–14.4) ( $U = 2958$ ;  $p = 0.981$ ), with no significant differences observed between these values. However, within the CAT group, the median thyroid EI was 13.8 (13.3–17) kPa, contrasting with 10.1 (9.3–11.2) kPa in healthy children ( $p < 0.0001$ ).

Upon conducting both 2D-SWE and SE on both thyroid lobes of each child, it was observed that there was no notable distinction between the median values obtained in the left lobe and those in the right lobe. The optimal cut-off value for predicting the presence of CAT in children using SWE was determined to be  $>12$  kPa (AUROC = 0.943, Se = 88.9%, Sp = 93.7%, PPV = 95.2%, and NPV = 85.5%) based on the median EI values. The optimal threshold for predicting the presence of CAT in children using SR was  $>1$  (AUROC = 0.850, Se = 82.2%, Sp = 87.5%, PPV = 90.2%, and NPV = 77.8%). Upon comparing these two methods, no significant differences were observed (difference =  $-0.093$ ; std error = 0.056;  $p = 0.101$ ).

Out of the CAT group, 19 out of 45 children (42.22%) were undergoing LT4 replacement therapy. There weren't any notable differences in the median values of EI and SR between children undergoing therapy and those without therapy.

## **5.4. DISCUSSION**

To the best of our knowledge, only three studies, including our previous research and two others, have investigated the use of SE in examining children with CAT. While there is a larger volume of studies on SWE compared to SE, the quantity of SWE studies conducted on children remains notably lower than the studies conducted on the adult population. While the current studies align relatively well regarding the cut-off values, discrepancies arise in terms of the correlations between the elasticity level determined by elastography and various variables. Another side of our study involved comparing thyroid elasticity in children diagnosed with CAT requiring treatment and euthyroid patients. However, we did not find any statistically significant differences. In studies involving the adult population, distinctions have been found between patients receiving treatment and those who are not. This suggests that elastography might have the potential to discern a more advanced stage of the disease associated with hypofunction, a significant finding. Currently, there are no additional ultrasound or ultrasound-based characteristics capable of differentiating between patients with euthyroid-state CAT and CAT patients with hypothyroidism. Therefore, further exploration of this research avenue is warranted.

## 5.5. CONCLUSIONS

Based on the outcome of our study comparing SE and SWE in children with CAT, both techniques demonstrate utility in assessing thyroid tissue elasticity. SWE exhibited greater sensitivity and specificity than SE, although no statistically significant differences were observed in the diagnostic accuracy and reliability between these two methods. Consequently, both strain elastography and shear-wave elastography hold potential as valuable tools for clinicians evaluating the thyroid health of children.

## FINAL CONCLUSIONS

### 1. Is Strain Elastography useful in diagnosing CAT in adults?

Our findings validate the significant and informative role that elastography can play in evaluating cases of CAT in adult population. We suggest the ideal threshold for predicting CAT as an SR greater than 1.64. A threshold value of greater than 2.94 was determined to be optimal for predicting the occurrence of hypothyroid status in patients with CAT.

### 2. Strain Elastography in assessing children with CAT.

We observed differences in thyroid elasticity between healthy children and those with CAT, and we propose an SR > 0.9 as the cut-off value for the diagnosis of autoimmune thyroiditis in children. Regarding the pediatric population, in comparison to adults, SE cannot differentiate between euthyroid and hypothyroid patients undergoing hormonal substitution therapy.

### 3. SWE in evaluating children with CAT

We obtained significant differences in thyroid elasticity between children with thyroiditis and healthy ones, and we propose the cut-off value of EI > 12.2 kPa for diagnosing thyroiditis in children. Although the values were significantly higher in children with thyroiditis compared to healthy ones, when compared to adults with thyroiditis, the values in children were significantly lower.

### 4. Comparison of Elastography Methods: Strain versus shear-wave elastography

Our investigation comparing SE and SWE in children with CAT showed that both methods are useful for determining the elasticity of thyroid tissue. Despite the fact that there were no statistically significant differences between the two approaches in terms of diagnostic accuracy and reliability, SWE showed higher sensitivity and specificity than SE. Accordingly, se and swe have the potential to be useful instruments for physicians assessing children's thyroid health.

***In conclusion, irrespective of the method used, elastography emerges as a promising tool for evaluating thyroiditis in both adults and children, enhancing diagnostic confidence in thyroid imaging.***