International Journal of Medical Science and Education

An official Publication of Association for Scientific and Medical Education (ASME)

Original research Article

QUANTITATIVE SPECTRAL DOPPLER PARAMETERS FOR DIFFERENTIAL DIAGNOSIS OF PARENCHYMAL THYROID DISEASES

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Received: 20/03/2018 ***Revised: 02/04/2018*** ***Accepted: 16/04/2018***

ABSTRACT

Background: Thyroid diseases, encompassing a wide array of disorders affecting the thyroid gland, present a significant challenge for radiologists due to their often subtle and overlapping clinical manifestations. The use of quantitative spectral Doppler parameters, such as resistivity index (RI) and acceleration time (AT) has emerged as a promising approach for the differential diagnosis of parenchymal thyroid diseases. The present study aims to evaluate the efficacy of RI and AT in distinguishing between various thyroid pathologies, including Hashimoto's disease, multinodular goiter, and nodular hyperplasia. **Methods:** A total of 200 adult participants, aged between 18 and 58 years and representing both genders, were enrolled after receiving comprehensive information regarding the study's procedures, associated risks, and potential outcomes. The participants were categorized into five groups based on their clinical presentation and thyroid pathology: normal thyroid function (Group I), newly detected untreated hashimotos disease (Group II), chronic hashitosis under treatment or follow-up (Group III), thyroid cystic lesions (Group IV), and thyroid nodules coexisting with hashiosis (Group V). **Results:** These differences were statistically significant for both RI ($p=0.02$) and AT ($p = 0.003$), indicating distinct thyroid function profiles among patients with different thyroid disorders. **Conclusion:** The combined assessment of resistivity indices, RI, and AT, proves to be a dependable approach for distinguishing among various thyroid diseases, offering insights that contribute to more effective patient care and outcomes.

Keywords: Thyroid Diseases, Spectral Doppler Parameters, Resistivity Index (RI), Acceleration Time (AT), Hashimoto's Disease, Multinodular Goiter.

INTRODUCTION:

Thyroid diseases, encompassing a wide array of disorders affecting the thyroid gland, present a significant challenge for radiologists due to their often subtle and overlapping clinical manifestations. Among these, parenchymal thyroid diseases stand out, characterized by alterations in the thyroid tissue itself, ranging from benign nodules to autoimmune conditions such as Hashimoto's disease **(1).** Accurate diagnosis and differentiation of these conditions are crucial for appropriate management and patient care. In recent years, advances in medical imaging techniques have revolutionized the field of radiology, providing radiologists with

powerful tools for non-invasive assessment and diagnosis. One such technique gaining prominence in the evaluation of thyroid disorders is spectral Doppler ultrasound **(2).** This modality enables the assessment of blood flow within the thyroid gland, offering valuable insights into its vascular architecture and hemodynamic characteristics.

The use of quantitative spectral Doppler parameters, such as resistivity index (RI) and acceleration time (AT) has emerged as a promising approach for the differential diagnosis of parenchymal thyroid diseases **(3).** RI, a measure of vascular resistance, reflects the degree of impedance to blood flow within the thyroid vasculature. AT, on the other hand, represents the time interval from the onset of systole to the peak systolic velocity, providing information about arterial compliance and dispensability.

The significance of RI and AT lies in their potential to discriminate between various thyroid pathologies based on distinct hemodynamic patterns. For instance, in conditions characterized by thyroid inflammation and fibrosis, such as Hashimoto's disease, alterations in vascular resistance and compliance are expected, leading to changes in RI and AT values. Similarly, nodular hyperplasia and multinodular goiter may exhibit different hemodynamic profiles, reflecting variations in vascularity and perfusion dynamics.

Despite the promise offered by quantitative spectral Doppler parameters, their clinical utility in the differential diagnosis of parenchymal thyroid diseases remains an ongoing challenge for radiologists **(4).** The complexity arises from the subtle nature of these hemodynamic changes and the overlap in Doppler findings among different thyroid pathologies. Moreover, factors such as patient demographics, coexisting medical conditions, and technical nuances in ultrasound acquisition can further confound the interpretation of spectral Doppler data.

To address this challenge, comprehensive studies assessing the reliability and diagnostic accuracy of RI and AT in differentiating parenchymal thyroid diseases are essential **(5).** Such investigations require meticulous patient selection, standardized imaging protocols, and rigorous statistical analysis to ensure robust and reproducible results. Moreover, collaborative efforts between radiologists, endocrinologists, and pathologists are vital for integrating imaging findings with clinical and histopathological data, thereby enhancing diagnostic confidence and patient management.

The study aims to assess spectral Doppler parameters' effectiveness in diagnosing thyroid diseases, including Hashimoto's disease, multinodular goiter, and nodular hyperplasia. Results could improve diagnostic accuracy and guide patient management

MATERIAL AND METHODS

The study was conducted at the Department of Radiology, of our tertiary care hospital, over a period of 18 months, following approval from the protocol review and institutional ethics committees. A total of 200 adult participants, aged between 18 and 58 years and representing both genders, were enrolled after receiving comprehensive information regarding the study's procedures, associated risks, and potential outcomes. Consent was obtained from all participants prior to their inclusion. Detailed demographic and clinical data, including name, age, and gender, were recorded using standardized case history forms, alongside a thorough clinical examination to assess overall health status and identify specific symptoms

related to thyroid disorders. Participants were categorized into five groups based on their clinical presentation and thyroid pathology: normal thyroid function (Group I), newly detected untreated Hashimoto's disease (Group II), chronic Hashimoto's disease under treatment or follow-up (Group III), multinodular parenchymal hyperplasia (Group IV), and nodular hyperplasia coexisting with Hashimoto's disease (Group V). Imaging techniques, including spectral Doppler ultrasound and acoustic radiation force impulse (ARFI) imaging, were employed to assess thyroid vasculature and hemodynamic characteristics, with the recording of quantitative spectral Doppler parameters such as resistivity index (RI) and acceleration time (AT). Subsequent statistical analysis of the collected data facilitated the identification of significant correlations and distinctions among the various thyroid pathologies, employing a significance level of $P < 0.05$ for statistical inference.

RESULTS

In our study involving the 200 participants, 45% were male and 55% were female. The age distribution showed that the majority fell within the 30-40 years range, representing 35% of the total, followed by the 40-50 years age group, comprising 27.5% of the population (Table 1).

The distribution of thyroid parameters varied significantly among the different patient groups. Specifically, Group III (H) exhibited the lowest RI (0.47) compared to other groups, while Group III (H) showed the highest AT (67.8). Conversely, Group I (Normal) had the highest RI (0.56) and the lowest AT (27.2). These differences were statistically significant for both RI ($p = 0.02$) and AT ($p = 0.003$), indicating distinct thyroid function profiles among patients with different thyroid disorders. These findings emphasize the efficacy of spectral Doppler parameters in distinguishing between various parenchymal thyroid diseases.(Table 2)

Table 1: Age and Gender Distribution of Patients

Gender	**N=200**	**%**
Male	90	45
Female	110	55
Age		
Below 30	25	12.5
30-40	70	35
40-50	55	27.5
Above 50	50	25

Table 2: Distribution of Patients and **Assessment of spectral Doppler parameters group**

Parameters	**Group I Normal N= 40**	**Group II Early untreated Hashimoto disease (EH) N=40**	**Group III Chronic Hashimoto (H) N=40**	**Group IV Multinodular parenchymal hyperplasia (M) N=40**	**Group V Nodular hyperplasia with Hashimoto (HM) N=40**	**P-value**
RI	0.56	0.61	0.47	0.52	0.55	0.02
AT	27.2	24.6	67.8	45.9	43.6	0.003

DISCUSSION

The utilization of color and power Doppler modes presents significant advantages in assessing thyroid gland vascularity, aiding in the evaluation of disease progression, particularly in conditions like Graves' disease and thyroiditis.**(6)** Additionally, it facilitates the assessment of vascularity within septations in thyroid cystic lesions, as demonstrated by the resistivity index (RI) values observed in different groups.**(7)** Ultrasonography (USG) remains invaluable for post-operative follow-up, fine needle aspiration (FNA), and True cut needle biopsy guidance. However, its operator-dependent nature, limitations in identifying retrosternal and laryngeal extensions, and varying sensitivity and specificity in certain cases persist **(8)** Thyroid USG serves multifaceted purposes including measuring parenchymal volume, assessing gland vascular characteristics, screening, and distinguishing nodules **(9).** With advancements in transducer technology and high-resolution screens, gray scale and Doppler examinations have become more accessible **(10, 11).**

Furthermore, our study sheds light on the gender-based differences in thyroid disease patterns. Contrary to previous findings by Yildirim et al. **(12),** which reported no significant effect of gender on disease pattern differentiation, our data suggests a potential influence of gender on spectral Doppler parameters. While our study included a higher proportion of female participants, reflecting the higher incidence of thyroid disorders among women, it is noteworthy that gender-based variations in spectral Doppler parameters warrant further investigation. Understanding these nuances can potentially refine diagnostic approaches and treatment strategies tailored to specific demographic profiles. Corroborating our findings, Popoveniuc et al. **(13)** conducted a study involving 167 patients, categorizing them into nine groups to assess thyroid diseases via ultrasound. Their results further underscored the crucial role of thyroid USG in disease assessment and follow-up.

Moreover, the assessment of shear wave velocity (SWV) in our study provides additional insights into tissue stiffness, complementing the information obtained from spectral Doppler parameters. The observed differences in SWV across the various disease groups underscore the heterogeneity of thyroid pathologies and highlight the potential utility of elastography techniques in characterizing thyroid lesions. Future studies exploring the integration of spectral Doppler ultrasound with elastography may offer a comprehensive diagnostic approach, enhancing our ability to differentiate between benign and malignant thyroid nodules and guiding optimal patient management strategies.

The study's limitations encompass a small sample size and the reliance on a single radiologist for image interpretation, which may introduce radiologist-specific errors. This could potentially affect the study's generalizability and increase the risk of bias in the findings. Additionally, the study's duration and setting, conducted within a specific medical institution, may limit the extrapolation of results to broader populations or clinical settings. Future studies with larger sample sizes, multiple radiologists for image analysis, and diverse patient cohorts are warranted to validate and extend the findings of this study.

CONCLUSION

In conclusion, the combined assessment of resistivity index (RI) and acceleration time (AT) proves to be a dependable approach for distinguishing between various parenchymal

thyroid diseases. Our findings underscore the utility of spectral Doppler parameters in enhancing the differential diagnosis of thyroid pathologies.

By leveraging RI and AT measurements, clinicians can improve diagnostic accuracy and refine treatment strategies tailored to individual patient needs. These results reaffirm the significance of spectral Doppler ultrasound as a valuable tool in the management of thyroid disorders, offering insights that contribute to more effective patient care and outcomes.

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