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CORRELATION BETWEEN THYROID FUNCTION TESTS AND DOPPLER INDICES IN PATIENTS WITH THYROIDITIS

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Abstract:
The integration of TFTs with imaging modalities and clinical parameters provides a comprehensive approach to evaluating thyroiditis. For instance, correlating TSH, FT3, and FT4 levels with Doppler ultrasound findings can help differentiate between hypervascular thyroid conditions like Graves' disease and inflammatory conditions like subacute thyroiditis. The study was conducted at the Department of Radio-Diagnosis. This setting was selected due to its accessibility to a large and diverse patient population, including both outpatient and inpatient referrals for USG of thyroid. The institution is equipped with state-of-the-art diagnostic facilities, including high-resolution ultrasound (HRUS), essential for this study. The medical sciences institute provided a well-controlled environment for imaging and clinical examinations, making it an ideal location for collecting accurate and reliable data. In this significant correlation was found between PSV and various other thyroid hormones ($p<0.001$). A very high significant positive correlation was found between PSV and T3 and T4, with a Pearson correlation coefficient of 0.988 and 0.982 respectively. In contrast PSV had a very high significant negative correlation with TSH values in this study (-0.872)

Keywords: Thyroid Function Tests, Doppler Indices , Thyroiditis

Introduction:

Thyroid function tests (TFTs) are the cornerstone for assessing thyroid gland functionality and play a critical role in diagnosing and managing thyroiditis. These biochemical tests evaluate key parameters, including Thyroid-Stimulating Hormone (TSH), Free Thyroxine (FT4), and Free Triiodothyronine (FT3), providing essential insights into thyroid hormone synthesis, regulation, and overall glandular activity. In thyroiditis, the interplay of inflammation, autoimmunity, and tissue damage significantly influences these biochemical markers, making TFTs invaluable in understanding the disease's underlying pathophysiology and guiding clinical decisions.[1,2]

The integration of TFTs with imaging modalities and clinical parameters provides a comprehensive approach to evaluating thyroiditis. For instance, correlating TSH, FT3, and FT4 levels with Doppler ultrasound findings can help differentiate between hypervascular thyroid conditions like

Graves' disease and inflammatory conditions like subacute thyroiditis. Similarly, combining autoantibody profiles with fine-needle aspiration cytology (FNAC) results enhances the diagnostic accuracy for autoimmune thyroiditis. This multidimensional approach not only facilitates precise diagnosis but also informs treatment decisions, such as the initiation of thyroid hormone replacement in hypothyroid states or the use of anti-inflammatory agents in subacute thyroiditis. By leveraging the complementary strengths of biochemical,
imaging, and clinical data, clinicians can achieve a more nuanced understanding of thyroiditis.[3,4]
Thyroid function tests and associated biochemical markers are indispensable in the evaluation and management of thyroiditis. Parameters such as TSH, FT3, and FT4 provide valuable insights into glandular function and disease dynamics, while autoantibodies, Tg, and inflammatory markers offer additional diagnostic and prognostic information. The integration of these biochemical findings with imaging and clinical assessments enhances diagnostic accuracy, enabling tailored treatment strategies. As our understanding of thyroiditis continues to evolve, the role of TFTs in elucidating disease mechanisms and guiding clinical practice remains central, underscoring their importance in modern endocrinology.[5,6]

Methodology:
Informed consent was obtained together with detailed history. All the ultrasounds were performed using the Mindray DC70 Ultrasound machine using a linear probe of frequency 7–12 MHz, along with a coupling agent (ultrasound gel). At first, using, a B-mode scan was used to look for echogenicity of the gland and any lesions. STA is the first branch of the external carotid artery that arises anteriorly at the level of the hyoid bone. In most cases, the vessel can be traced up to the upper pole of the thyroid gland and then the color Doppler mode was used. The spectral waveform was taken with a sample gate size of 1 mm and Doppler angles of 30–60. Peak systolic velocity (PSV), Pulsatility index (PI) and Resistance index (RI) of bilateral STAs calculated. The study was conducted at the Department of Radio-Diagnosis. This setting was selected due to its accessibility to a large and diverse patient population, including both outpatient and inpatient referrals for USG of thyroid. The institution is equipped with state-of-the-art diagnostic facilities, including high-resolution ultrasound (HRUS), essential for this study. The medical sciences institute provided a well-controlled environment for imaging and clinical examinations, making it an ideal location for collecting accurate and reliable data. The proximity to a wide demographic of patients also enhanced the generalizability of the study's findings, ensuring a representative sample from both rural and urban populations.

Inclusion Criteria: -
- All patients who are advised for USG neck and found to have thyroid abnormalities.
- Clinical suspicion of thyroiditis.
- Known case of thyroiditis.

Exclusion Criteria: -
- Patients in whom partial or total thyroidectomy was performed.
- Patients who underwent radioiodine therapy.
- Patients who underwent radio-isotope scans or procedures.

Study Sampling
Purposive sampling was used in this study, where participants were selected based on specific inclusion criteria. This non-random selection process was essential for targeting patients presenting with thyroiditis, as only these individuals would be relevant for the research objectives. This approach ensured that participants had the required conditions to make the study both feasible and focused on thyroid pathology. Purposive sampling allowed for the inclusion of a specific, yet diverse group of patients with varying causes of thyroid abnormalities, providing a representative cross-section of the population. The total number of participants was fixed,

ensuring adequate representation of different thyroid pathologies for the study's analytical purposes.

Study design: Prospective cross-sectional study.
Sample Size and sampling method: Purposive sampling, sample size =80

Study data collection

Data was collected through direct patient examination, imaging results and medical history. The data from USG,blood investigation and FNAC reports were stored and analyzed. During the examination, detailed notes on the size, PSV, RI, PI values of doppler of STA were recorded. The data was entered in M.S. Excel and represented in the form of percentages and frequencies in tables and diagrams. The data was analyzed using the software SPSS. Independent t-tests and paired t-tests was be used for the test of significance.

Results:

Table 1: Mean thyroid hormone values of the study population

Thyroid hormones	Mean	Standard deviation
T3 (ng/dL)	2.03	1.06
T4 (µg/dL)	9.27	4.63
TSH(µIU/mL)	3.98	5.45

The mean T3 in this study population was 2.03 ± 1.06 ng/dL, mean T4 was 9.27 ± 4.63 µg/dL and mean TSH was 3.98 ± 5.45 µIU/mL.

Table 2: Correlation between Thyroid hormones and PI

	Mean ± SD	Pearson correlation	P value
PI	1.20 ± 0.25		
T3	2.03 ± 1.06	0.970	<0.001
T4	9.27 ± 4.63	0.968	<0.001
TSH	3.98 ± 5.45	-0.833	<0.001

In this significant correlation was found between PI and various other thyroid hormones (p<0.001). A very high significant positive correlation was found between PI and T3 and T4, with a Pearson correlation coefficient of 0.970 and 0.968 respectively. In contrast PI had a very high significant negative correlation with TSH values in this study (-0.833)

Table 3: Correlation between Thyroid hormones and RI

	Mean ± SD	Pearson correlation	P value
RI	0.59 ± 0.08		
T3	2.03 ± 1.06	0.962	<0.001
T4	9.27 ± 4.63	0.958	<0.001
TSH	3.98 ± 5.45	-0.792	<0.001

In this significant correlation was found between RI and various other thyroid hormones (p<0.001). A very high significant positive correlation was found between RI and T3 and T4, with a Pearson correlation coefficient of 0.962 and 0.958 respectively. In contrast RI had a high significant negative correlation with TSH values in this study (-0.792)

Table 4: Correlation between Thyroid hormones and PSV

	Mean ± SD	Pearson correlation	P value
PSV (cm/s)	50.75 ± 21.22		
T3	2.03 ± 1.06	0.988	<0.001
T4	9.27 ± 4.63	0.982	<0.001
TSH	3.98 ± 5.45	-0.872	<0.001

In this significant correlation was found between PSV and various other thyroid hormones ($p<0.001$). A very high significant positive correlation was found between PSV and T3 and T4, with a Pearson correlation coefficient of 0.988 and 0.982 respectively. In contrast PSV had a very high significant negative correlation with TSH values in this study (-0.872)

Discussion:

Thyroid function tests (TFTs) are integral to the biochemical evaluation of thyroiditis, providing insights into thyroid hormone levels and glandular activity. Parameters such as TSH, FT4, and FT3 are measured to assess thyroid function, while autoantibodies like TPOAb and TgAb help confirm autoimmune thyroiditis. In subacute thyroiditis, TFTs typically reveal a transient hyperthyroid phase characterized by suppressed TSH and elevated FT4 and FT3 levels, followed by a hypothyroid phase as the disease progresses. Although highly sensitive, TFTs lack specificity for thyroiditis, as similar patterns may be observed in other thyroid conditions, such as Graves' disease or thyroid hormone resistance. Therefore, biochemical tests are most effective when used in conjunction with other diagnostic modalities.

Imaging studies, particularly ultrasound and Doppler ultrasound, play a pivotal role in the evaluation of thyroiditis by providing detailed information about glandular structure, vascularity, and inflammatory changes. Ultrasound findings in thyroiditis include diffuse hypoechogenicity, heterogeneity, and increased vascularity, which correlate with disease activity and severity. Doppler indices such as Peak Systolic Velocity (PSV), Pulsatility Index (PI), and Resistive Index (RI) offer additional insights into blood flow dynamics, aiding in the differentiation of thyroiditis from other conditions such as nodular goiter or thyroid malignancy. While imaging modalities are highly sensitive to structural and vascular changes, they are often unable to determine the underlying etiology of thyroiditis without corroborative biochemical or cytological evidence, limiting their standalone diagnostic value.

L. Sultan et al., 2015: This study evaluated vascularity metrics in 100 thyroid nodules using color Doppler ultrasound to differentiate between benign and malignant nodules. Results indicated that malignant nodules had significantly higher vascular fraction area and flow volume index compared to benign nodules. Specifically, the vascular fraction area of the central region achieved a sensitivity of 90% and a specificity of 88%, while other metrics like flow velocity index were less discriminatory. These findings support the role of Doppler vascularity measurements in enhancing the accuracy of thyroid nodule diagnosis.[7]

Rohan V et al., 2022: The study analyzed the Doppler indices of the inferior thyroid artery (ITA) to differentiate Graves' disease from Hashimoto's thyroiditis. Doppler evaluation revealed that the mean PSV was 36.2 cm/s in patients with Hashimoto's thyroiditis, significantly lower than 86.4 cm/s in Graves' disease patients and markedly higher than 16.4 cm/s in healthy controls. The differences between groups were statistically significant ($p < 0.001$), demonstrating the utility of ITA Doppler indices as reliable markers for distinguishing these conditions.[8]

Feyzi Gokosmanoglu et al., 2020: This study assessed Doppler parameters in distinguishing postpartum thyroiditis from Graves' disease. Forty-two participants were divided into postpartum thyroiditis (Group 1) and Graves' disease (Group 2). Peak systolic velocity (PSV) and end-diastolic velocity (EDV) were higher in Group 2, with a mean PSV of 86.7 cm/s compared to 36.5 cm/s in Group 1 ($p < 0.05$). Conversely, the resistive index (RI) was significantly elevated in Group 1. These findings underscore the efficacy of Doppler parameters in differentiating postpartum thyroid conditions.[9]

Pradosh Kumar Sarangi et al., 2021: This study focused on the role of the superior thyroid artery (STA) Doppler indices in distinguishing Graves' disease from thyroiditis. Among 111 patients with thyrotoxicosis, Graves' disease patients exhibited a significantly higher STA-PSV of 54.3 cm/s compared to 32.6 cm/s in thyroiditis patients. A sensitivity of 82.9% and specificity of 86.2% were achieved at a cutoff of
54.3 cm/s for Graves' disease diagnosis. These results validate the use of STA Doppler indices as a cost-effective alternative to nuclear imaging.[10]

Conclusion:
A significant correlation was found between PSV, PI, RI and various thyroid hormones in this study. A positive correlation was found to between T3 and T4, while a negative correlation was found between the indices and TSH.

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