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EVALUATION OF DOPPLER INDICES IN SUPERIOR THYROID ARTERY AMONG CLINICALLY EUTHYROID ADULTS: A CROSS-SECTIONAL STUDY

Dr. Sathish babu [1], Dr. Revanth P [2], Dr. Rohit R.C [3]

1. *HOD, Department of Radiodiagnosis, Sree Mookambika Institute of Medical Sciences, Kulasekharam, Kanyakumari District, Tamil Nadu, India.*

2. Postgraduate, Department of Radiodiagnosis, Sree Mookambika Institute of Medical Sciences, Kulasekharam, Kanyakumari District, Tamil Nadu, India.

3. Assistant Professor, Department of Radiodiagnosis, Sree Mookambika Institute of Medical Sciences, Kulasekharam, Kanyakumari District, Tamil Nadu, India.

Corresponding Author:

Dr. Revanth P, Postgraduate, Department of Radiodiagnosis, Sree Mookambika Institute of Medical Sciences, Kulasekharam, Kanyakumari District, Tamil Nadu.

ABSTRACT

Introduction:

The superior thyroid artery (STA) plays a critical role in the vascular supply of the thyroid gland. Doppler ultrasonography provides non-invasive evaluation of STA blood flow dynamics, crucial for assessing thyroid physiology and pathology. Despite extensive research on thyroid vascularity in disease states, limited data exist on the normal Doppler indices of STA in clinically euthyroid populations. Establishing these normative values and analyzing their correlation with demographic factors such as age and gender is essential for accurate diagnosis and early detection of thyroid dysfunction.

Materials and Methods:

This cross-sectional study was conducted at a tertiary care center in Kanyakumari, involving 150 clinically euthyroid participants. Doppler ultrasonography was performed using standardized protocols to measure STA Doppler indices. Demographic variables, including age and gender, were recorded. Statistical analysis was conducted to evaluate mean values, gender differences, and age-related correlations.

Results:

The mean values of PSV, EDV, and RI were established for the study population. Significant

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differences in Doppler indices were observed between male and female participants, and age demonstrated a moderate negative correlation with PSV and EDV.

Conclusion:
This study establishes normative Doppler indices of the STA in a euthyroid population and highlights their variation with demographic factors. These findings provide a valuable reference for distinguishing normal from pathological thyroid vascularity.

Keywords:
Superior thyroid artery, Doppler ultrasonography, euthyroid, Doppler indices, thyroid vascularity.

INTRODUCTION

The thyroid gland regulates metabolic functions through hormone secretion and is vascularized, receiving blood from the superior and inferior thyroid arteries. Doppler ultrasonography is a non-invasive imaging technique that helps evaluate thyroid vascular dynamics, providing detailed insights into blood flow patterns and vascular resistance. Understanding normal Doppler parameters of the STA is crucial for distinguishing physiological variations from pathological changes. Doppler indices like Peak Systolic Velocity, End-Diastolic Velocity, and Resistive Index are used to evaluate thyroid blood flow in conditions like hyperthyroidism, hypothyroidism, and thyroiditis. However, limited data exists on the normative values of these indices in euthyroid populations and their potential variations based on demographic factors.

Globally, thyroid disorders are among the most prevalent endocrine abnormalities, affecting an estimated 750 million individuals. Hypothyroidism and hyperthyroidism, the two primary dysfunctions, are more common in women and often remain undiagnosed in their subclinical forms. Studies report that approximately 5%–10% of the global population suffers from overt thyroid disorders, with a higher prevalence observed in iodine-deficient regions. In India, thyroid dysfunction is a significant public health issue, affecting nearly 42 million people, as estimated by the Indian Thyroid Society. Although this study focuses on a euthyroid population, understanding thyroid vascularity is relevant for early identification and management of subclinical or impending thyroid disorders.

Numerous studies have evaluated the Doppler parameters of thyroid arteries in diseased states, particularly in hyperthyroidism and autoimmune thyroiditis. A landmark study by

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Ralls et al. (1992) highlighted the use of Doppler imaging to assess thyroid vascularity in Graves' disease, demonstrating significantly elevated PSV and RI in hyperthyroid states. Similarly, Dönmez et al. (2002) emphasized the diagnostic utility of Doppler ultrasonography in differentiating subacute thyroiditis from other inflammatory thyroid conditions based on vascular indices.

However, the data on Doppler indices in euthyroid individuals remain sparse. El-Desouky et al. (2018) conducted a study on a small cohort of euthyroid individuals, reporting mean PSV and RI values of the STA. The study also noted subtle gender-based differences, with males exhibiting slightly higher resistive indices. Another study by Zaletel et al. (2001) suggested an age-related decline in PSV and EDV values, reflecting physiological vascular changes. Nevertheless, the sample sizes in these studies were limited, and their findings were not generalizable across diverse populations.

Additionally, the majority of existing literature focuses on the pathological spectrum, overlooking the importance of normative Doppler values in euthyroid individuals as a reference point. Establishing baseline Doppler indices can aid clinicians in detecting deviations indicative of early thyroid dysfunction, particularly in asymptomatic individuals with subclinical conditions.

The study aims to provide comprehensive data on the normative values of STA Doppler indices in euthyroid individuals, particularly in the Indian population. This is crucial for distinguishing normal vascular patterns from pathological ones, and assessing demographic factors like age and gender's impact on STA Doppler indices in euthyroid individuals. The study evaluates mean Doppler indices (PSV, EDV, and RI) in a clinically euthyroid population and analyzes their correlation with age and gender. The findings will enhance diagnostic accuracy and aid in early detection of thyroid abnormalities. This is the first of its kind in Kanyakumari, offering region-specific insights.

AIMS AND OBJECTIVES

Aim

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To evaluate the Doppler indices of the superior thyroid artery in a clinically euthyroid population and analyze their correlation with demographic variables such as age and gender.

Objectives

1. To determine the mean Doppler indices (Peak Systolic Velocity, End-Diastolic Velocity, and Resistive Index) of the superior thyroid artery in a clinically euthyroid population.
2. To compare the Doppler indices of the superior thyroid artery between male and female participants.
3. To assess the correlation between Doppler indices of the superior thyroid artery and age among the study population.

MATERIALS AND METHODS

Study Design

A cross-sectional observational study conducted at a tertiary care center in Kanyakumari.

Study Period

The study was carried out over a period of 12 months, from July 2023 to Jun 2024.

Study Setting

The study was conducted in the Department of Radiology and Imaging at a Tertiary Care Center, Kanyakumari, catering to a diverse patient population.

Study Population

The study included clinically euthyroid individuals who were referred for ultrasound and Doppler evaluation of the neck as part of routine or diagnostic investigations.

Sample Size

A total of 150 participants were included in the study.

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Inclusion Criteria

1. Adults aged 18 years and above.
2. Clinically euthyroid individuals confirmed by normal thyroid function tests (TSH, T3, T4).
3. Participants providing written informed consent.

Exclusion Criteria

1. Individuals with diagnosed thyroid disorders (e.g., hypothyroidism, hyperthyroidism, thyroiditis).
2. History of thyroid surgery or radiotherapy.
3. Presence of thyroid nodules, goiter, or other thyroid abnormalities detected on ultrasonography.
4. Pregnant women.
5. Patients with significant cardiovascular or systemic diseases affecting vascular dynamics.

Methodology

1. **Participant Recruitment:**
    - Eligible participants were identified based on inclusion and exclusion criteria.
    - Written informed consent was obtained before enrollment in the study.
2. **Clinical Examination:**
    - A detailed history was taken, including demographic data such as age and gender.
    - Physical examination was performed to rule out any overt thyroid abnormalities.
3. **Thyroid Function Test:**
    - Thyroid function was assessed using serum TSH, T3, and T4 levels. Participants with normal thyroid profiles were included in the study.
4. **Doppler Ultrasonography:**

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- Doppler evaluation was performed using a high-resolution ultrasound machine with a linear transducer (7–12 MHz).
- Participants were placed in a supine position with the neck slightly hyperextended for optimal visualization of the thyroid gland and superior thyroid artery (STA).
- The Doppler indices of the STA, including Peak Systolic Velocity (PSV), End-Diastolic Velocity (EDV), and Resistive Index (RI), were measured bilaterally.
- Care was taken to avoid excessive probe pressure, which might alter vascular flow.
- Measurements were taken during mid-inspiration to ensure consistent results.

5. **Data Collection:**
   - Doppler indices were recorded and averaged for both sides.
   - Demographic variables (age and gender) were documented for analysis.

Statistical Analysis

1. Data were entered into Microsoft Excel and analyzed using statistical software.
2. Continuous variables (e.g., Doppler indices) were expressed as mean ± standard deviation.
3. Comparisons between groups (e.g., males vs. females) were made using the Student's t-test or Mann-Whitney U test, as appropriate.
4. Correlation between Doppler indices and age was assessed using Pearson's or Spearman's correlation coefficient.
5. A p-value <0.05 was considered statistically significant.

Ethical Considerations

The study was approved by the Institutional Ethics Committee of the institution. Confidentiality of participant information was maintained throughout the study. Participants were free to withdraw from the study at any point without any impact on their medical care.

RESULTS

Table 1: Demographic Characteristics of the Study Population (n = 150)

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Variable	Mean ± SD	Range	Frequency (n)	Percentage (%)
Age (years)	35.6 ± 10.2	18–65	-	-
Gender				
Male	-		70	46.7
Female	-		80	53.3
BMI (kg/m²)	24.2 ± 3.5	18–30	-	-

This table summarizes the baseline demographic characteristics of the 150 study participants. It includes data on the mean age, gender distribution, and BMI. The majority of the participants were evenly distributed between males (46.7%) and females (53.3%), with a mean age of approximately 35.6 years. BMI values indicate a relatively homogenous sample in terms of nutritional status.

Table 2: Doppler Indices of Superior Thyroid Artery (n = 150)

Parameter	Mean ± SD	Range
Peak Systolic Velocity (PSV) (cm/s)	21.4 ± 3.2	15–28
End-Diastolic Velocity (EDV) (cm/s)	6.5 ± 1.5	4–10
Resistive Index (RI)	0.72 ± 0.05	0.65–0.80

Table 2 presents the mean values and ranges of the primary Doppler indices of the superior thyroid artery, including Peak Systolic Velocity (PSV), End-Diastolic Velocity (EDV), and Resistive Index (RI). These indices provide an overview of the vascular flow characteristics in the clinically euthyroid population, with PSV averaging 21.4 cm/s and RI showing a mean of 0.72.

Table 3: Comparison of Doppler Indices Between Genders

Parameter	Male (n=70)	Female (n=80)	p-value

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Peak Systolic Velocity (PSV) (cm/s)	22.0 ± 3.1	20.8 ± 3.2	0.03*
End-Diastolic Velocity (EDV) (cm/s)	6.8 ± 1.4	6.2 ± 1.5	0.05*
Resistive Index (RI)	0.73 ± 0.04	0.71 ± 0.05	0.08

*Statistically significant ($p < 0.05$)

This table highlights the differences in Doppler indices between male and female participants. Statistically significant differences were observed in PSV ($p = 0.03$) and EDV ($p = 0.05$), with males showing slightly higher mean values. However, the Resistive Index (RI) did not show a significant gender-based variation ($p = 0.08$).

Table 4: Correlation of Doppler Indices with Age

Parameter	Correlation Coefficient (r)	p-value
Peak Systolic Velocity (PSV) (cm/s)	-0.25	0.001*
End-Diastolic Velocity (EDV) (cm/s)	-0.22	0.005*
Resistive Index (RI)	0.15	0.09

*Statistically significant ($p < 0.05$)

Table 4 illustrates the correlation of Doppler parameters with age. Both PSV and EDV showed a weak negative correlation with age, which was statistically significant ($p < 0.05$). RI exhibited a weak positive correlation with age, but this finding was not statistically significant ($p = 0.09$). These results suggest a slight decline in blood flow velocities with advancing age in the superior thyroid artery.

Table 5: Distribution of Doppler Indices Across Age Groups

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Age Group (years)	PSV (Mean ± SD)	EDV (Mean ± SD)	RI (Mean ± SD)
18–30	22.3 ± 3.1	6.9 ± 1.4	0.70 ± 0.04
31–45	21.0 ± 3.3	6.4 ± 1.5	0.72 ± 0.05
46–65	20.0 ± 2.9	6.1 ± 1.3	0.74 ± 0.04

This table examines how Doppler indices vary across three predefined age groups (18–30, 31–45, and 46–65 years). Younger participants (18–30 years) exhibited higher mean PSV and EDV compared to older groups, while RI values tended to increase with age. These findings indicate age-related changes in vascular flow dynamics, potentially influenced by physiological aging.

DISCUSSION

CONCLUSION

This study provides normative data on the Doppler indices of the superior thyroid artery in a clinically euthyroid population. The findings reveal that gender and age have a modest yet significant influence on Doppler parameters such as Peak Systolic Velocity (PSV) and End-Diastolic Velocity (EDV). Specifically, males exhibited higher PSV and EDV values compared to females, while an age-related decline in blood flow velocities was observed. The Resistive Index (RI) remained relatively stable across genders and showed minimal variation with age.

These results underline the importance of considering demographic factors, including age and gender, when interpreting thyroid Doppler ultrasonography. The normative values established in this study can serve as a reference for clinicians in differentiating normal from pathological vascular flow patterns in thyroid diseases. Further research with larger and more diverse populations is recommended to validate and expand upon these findings.

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