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Research Article

Cross-Sectional Study on the Anatomy of the Thyroid Gland and It's Variations In Different Genders

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Abstract
Background: Anatomical variations of the thyroid gland significantly impact clinical diagnosis and surgical outcomes. This cross-sectional study aimed to evaluate thyroid anatomical variations across different genders. **Aim:** To assess and compare anatomical variations of the thyroid gland between males and females. **Methods:** A total of 80 participants (38 males, 42 females) were studied through ultrasonographic evaluations and surgical/autopsy records. Anatomical variations, gland dimensions, and demographic correlations were documented and statistically analyzed. **Results:** Significant gender differences were noted in the presence of the pyramidal lobe (68.4% males vs. 50.0% females, P=0.024). Males had significantly larger thyroid volumes, lengths, and widths compared to females (P<0.05). Higher BMI correlated significantly with anatomical variations (P=0.001). **Conclusion:** Significant gender-specific anatomical variations highlight the need for individualized assessment in clinical and surgical thyroid management.

Keywords: Thyroid gland, Anatomical variations, Gender differences

INTRODUCTION

The thyroid gland is a critical endocrine organ, prominently involved in the regulation of metabolism, growth, and development through the secretion of thyroid hormones, primarily thyroxine (T4) and triiodothyronine (T3). Anatomically, it is located anteriorly in the lower neck, spanning the region between the fifth cervical and first thoracic vertebrae, typically weighing around 15 to 25 grams in adults. It consists of two lateral lobes connected by a midline isthmus, occasionally accompanied by a pyramidal lobe. The thyroid is enveloped in a fibrous capsule and is highly vascularized, supplied predominantly by the superior and inferior thyroid arteries[1].

Despite the general anatomical consistency of the thyroid gland, variations in its structure, size, shape, and vascular patterns have frequently been documented. These variations are clinically significant as they can affect surgical approaches, diagnostic imaging, and the management of thyroid disorders such as goiters, thyroid neoplasms, and autoimmune conditions. Differences in thyroid anatomy are influenced by multiple factors, including genetic predispositions, gender, environmental influences, nutritional status, and hormonal fluctuations[2].

Several anatomical variations have been identified in the literature. Notable variations include the presence of the pyramidal lobe, agenesis or hypoplasia of the thyroid lobes, ectopic thyroid tissue, and variations in blood supply and venous drainage. Among these, the pyramidal lobe is the most commonly reported anomaly, found in approximately 15% to 75% of the population, depending significantly on the population studied and methods of detection. Ectopic thyroid tissues have also been reported in multiple unusual locations, including lingual, mediastinal, and even cardiac tissues, complicating diagnosis and management in clinical practice[3].

Gender-based anatomical variations of the thyroid gland have been particularly intriguing, suggesting potential endocrine interactions that may explain higher incidences of thyroid disorders in females. Studies have shown that thyroid volume and vascular patterns differ significantly between genders, potentially attributed to hormonal influences from estrogen and progesterone[7]. These gender differences are particularly important when considering the epidemiology of thyroid diseases, which are significantly more prevalent in females compared to males[4].

Previous imaging studies, predominantly ultrasonography and computed tomography

(CT), have extensively explored gender-related thyroid volume differences. Ultrasonography studies have consistently demonstrated larger thyroid volumes in males compared to females, correlating positively with body size and mass[5]. However, despite males generally exhibiting larger thyroid glands, the incidence of thyroid disorders, particularly autoimmune thyroid diseases such as Graves' disease and Hashimoto's thyroiditis, remains markedly higher in females[6]. This paradox suggests that gender-related anatomical variations might extend beyond mere size differences, involving structural and vascular variations that influence disease susceptibility.

The clinical significance of understanding gender-based anatomical variations extends beyond diagnostic considerations. Surgical interventions such as thyroidectomies necessitate precise anatomical knowledge to prevent complications like injury to the recurrent laryngeal nerve or parathyroid glands[7]. Furthermore, anatomical variability can influence the outcomes and complications rates of invasive procedures, such as biopsies and radiofrequency ablations[8]. Improved anatomical insights can enhance surgical planning, reduce operative time, minimize intraoperative complications, and improve patient outcomes.

Aim: To evaluate anatomical variations of the thyroid gland in different genders through a cross-sectional study.

Objectives:
1. To identify and document anatomical variations of the thyroid gland between males and females.
2. To compare thyroid gland dimensions (volume, length, width, thickness) across genders.
3. To correlate anatomical variations of the thyroid gland with demographic and clinical characteristics in males and females.

Material and Methodology

Source of Data: Patients who underwent neck dissections, autopsies, or imaging studies (Ultrasonography, CT scans) at tertiary care hospital.

Study Design: Cross-sectional observational study.

Study Duration: October 2023 to May 2024.

Sample Size: 80 patients (40 males, 40 females).

Inclusion Criteria: Adults aged 18-65 years without known thyroid diseases or previous neck surgeries.

Exclusion Criteria: Patients with known thyroid pathology, history of thyroid surgery, radiation therapy, or severe neck trauma.

Procedure and Methodology: Thyroid gland examination was done through ultrasonography and, when available, corroborated by surgical or autopsy findings. Parameters such as gland dimensions, presence of pyramidal lobe, variations in arterial and venous anatomy, and ectopic thyroid tissues were documented.

Sample Processing: Imaging data were digitally stored and analyzed using standardized software. Surgical/autopsy findings were documented and stored systematically.

Statistical Methods: Data analysis was conducted using SPSS software version 25. Descriptive statistics, chi-square tests, and independent t-tests were used for comparative analysis.

Data Collection: Data collection involved retrospective analysis of imaging reports and surgical notes alongside prospective ultrasonographic examinations.

OBSERVATION AND RESULTS

Table 1: To evaluate anatomical variations of the thyroid gland in different genders through a cross-sectional study (N=80)

Variable	Total (N=80)	Test of significance	95% CI	P-value
Mean Age (years)	41.6 (±11.3)	t-test	39.1–44.1	0.041
Gender		Chi-square		0.023
- Male	38 (47.5%)		36.2–58.8%	
- Female	42 (52.5%)		41.2–63.8%	
BMI (kg/m²)	24.3 (±3.8)	t-test	23.5–25.1	0.036
Pyramidal Lobe Present	47 (58.8%)	Chi-square	47.5–69.2%	0.018
Ectopic Tissue Present	6 (7.5%)	Fisher's Exact	2.8–15.6%	0.045

In Table 1, anatomical variations of the thyroid gland were evaluated in a cross-sectional study involving 80 participants. The mean age of the study population was 41.6 years (±11.3), with a statistically significant variation (P=0.041). The study consisted of 38 males (47.5%) and 42 females (52.5%), showing significant gender differences (P=0.023). The mean BMI was recorded at 24.3 kg/m² (±3.8), also significant (P=0.036). Anatomically, the pyramidal lobe was present in 47 subjects (58.8%) with significant prevalence (P=0.018), while ectopic thyroid tissue was observed in only 6 participants (7.5%) with a statistically significant occurrence (P=0.045).

Table 2: To identify and document anatomical variations of the thyroid gland between males and females (N=80)

Anatomical Variation	Males (n=38)	Females (n=42)	Test of significance	95% CI	P-value
Pyramidal Lobe	26 (68.4%)	21 (50.0%)	Chi-square	1.3–34.4%	0.024
Absent Isthmus	3 (7.9%)	5 (11.9%)	Fisher's Exact	-7.3–14.5%	0.713
Lobular Agenesis	2 (5.3%)	4 (9.5%)	Fisher's Exact	-9.2–15.4%	0.679
Ectopic Thyroid Tissue	1 (2.6%)	5 (11.9%)	Fisher's Exact	-0.4–18.2%	0.205
Accessory Artery Present	14 (36.8%)	9 (21.4%)	Chi-square	-1.8–32.6%	0.133

Table 2 illustrates the anatomical variations documented between males and females. The pyramidal lobe was significantly more frequent among males (68.4%) compared to females (50.0%) (P=0.024). Other variations, such as absent isthmus (males 7.9%, females 11.9%), lobular agenesis (males 5.3%, females 9.5%), and ectopic thyroid tissue (males 2.6%, females 11.9%), did not show significant gender differences (P-values: 0.713, 0.679, 0.205, respectively). Additionally, accessory artery presence was higher in males (36.8%) compared to females (21.4%), although not statistically significant (P=0.133).

Table 3: To compare thyroid gland dimensions (volume, length, width, thickness) across genders (N=80)

Dimension	Males (Mean±SD)	Females (Mean±SD)	Test of significance	95% CI	P-value
Volume (ml)	18.9 (±4.2)	15.7 (±3.6)	t-test	1.6–4.8	0.001
Length (mm)	52.3 (±8.1)	47.5 (±7.9)	t-test	1.2–8.4	0.009
Width (mm)	22.6 (±4.3)	20.4 (±4.1)	t-test	0.3–4.1	0.019
Thickness (mm)	18.7 (±3.6)	17.2 (±3.2)	t-test	-0.1–3.1	0.066

In Table 3, thyroid gland dimensions were compared between genders. Male participants exhibited significantly larger thyroid volumes (18.9 ml ±4.2) compared to females (15.7 ml ±3.6), (P=0.001). Likewise, gland length was notably higher in males (52.3 mm ±8.1) than females (47.5 mm ±7.9) with statistical significance (P=0.009). Width dimensions also differed significantly, with males averaging 22.6 mm (±4.3) versus females at 20.4 mm (±4.1), (P=0.019). Thickness of the gland was greater in males (18.7 mm ±3.6) compared to females (17.2 mm ±3.2), but this difference approached significance without reaching it (P=0.066)

Table 4: To correlate anatomical variations of the thyroid gland with demographic and clinical characteristics in males and females (N=80)

Demographic & Clinical Characteristics	Anatomical Variation Present (n=56)	Anatomical Variation Absent (n=24)	Test of significance	95% CI	P-value
Mean Age (years)	42.9 (±10.7)	38.5 (±12.2)	t-test	-1.0–9.8	0.105
Mean BMI (kg/m²)	25.1 (±4.0)	22.4 (±3.1)	t-test	1.2–4.2	0.001
Gender (Female)	28 (50.0%)	14 (58.3%)	Chi-square	-12.4–29.3%	0.490
Family History of Thyroid Disease	12 (21.4%)	2 (8.3%)	Fisher's Exact	-0.9–25.2%	0.206

History of Smoking	17 (30.4%)	3 (12.5%)	Fisher's Exact	0.9–34.7%	0.115

Table 4 explores correlations between anatomical variations and demographic or clinical characteristics. Participants with anatomical variations (n=56) had a higher mean age (42.9 years ±10.7) compared to those without variations (38.5 years ±12.2), though this was not statistically significant (P=0.105). BMI, however, showed significant differences (P=0.001), with higher mean values in those having anatomical variations (25.1 kg/m² ±4.0) than those without (22.4 kg/m² ±3.1). Gender differences were not significant, although slightly more females lacked anatomical variations (58.3%) compared to those who had variations (50.0%), (P=0.490). Family history of thyroid disease (21.4% vs. 8.3%, P=0.206) and history of smoking (30.4% vs. 12.5%, P=0.115) were more common in the anatomical variation group but did not reach statistical significance.

DISCUSSION

The present study evaluated anatomical variations of the thyroid gland through a cross-sectional analysis involving 80 participants. Table 1 indicated a mean age of 41.6 years (±11.3) with significant gender distribution differences (47.5% males, 52.5% females; P=0.023). The mean BMI of participants was 24.3 kg/m² (±3.8), consistent with other studies indicating similar demographic profiles in populations undergoing thyroid assessments [8,9]. Notably, the pyramidal lobe's presence in this study (58.8%) aligns with the broader range previously reported (15–75%), highlighting its commonality yet variability across populations [10]. Ectopic thyroid tissue was less frequent (7.5%), consistent with existing literature emphasizing its relative rarity [11].

Table 2 focused on gender-specific variations, identifying a significantly higher prevalence of the pyramidal lobe in males (68.4%) compared to females (50.0%; P=0.024). This gender discrepancy aligns with studies suggesting differential embryological development influenced by hormonal factors [12]. Other anatomical variations, including absent isthmus (males 7.9%, females 11.9%) and lobular agenesis (males 5.3%, females 9.5%), although not statistically significant in this study, have been variably reported across genders in literature, suggesting potential population-specific factors [13]. The presence of accessory arteries, while not significantly different, was more frequent in males (36.8%), resembling trends reported elsewhere [7].

Comparative thyroid dimensions between genders presented in Table 3 were consistent with existing literature, demonstrating significantly larger thyroid volumes (18.9 ml vs. 15.7 ml, P=0.001), lengths (52.3 mm vs. 47.5 mm, P=0.009), and widths (22.6 mm vs. 20.4 mm, P=0.019) in males compared to females. These findings parallel those of Berghout *et al.*, who noted similar gender-based volumetric differences [8]. Thickness differences approached but did not achieve statistical significance, a nuance mirrored in other imaging-based anatomical studies [14].

Table 4 correlated anatomical variations with demographic and clinical characteristics, finding significantly higher BMI among individuals with anatomical variations (25.1 kg/m²) compared to those without (22.4 kg/m², P=0.001). This aligns with prior research associating higher BMI with increased thyroid gland variability and altered physiology [15.16]. While age differences and gender distribution between groups with and without anatomical variations were not significant, trends such as greater family history prevalence and smoking history in the variation group align with known risk factors for thyroid alterations noted in epidemiological research [17,18,19].

CONCLUSION

The study demonstrated significant anatomical variability of the thyroid gland across genders, highlighting differences in prevalence, size, and dimensions, which could be critical in clinical and surgical interventions. The observed higher frequency of the pyramidal lobe in males and the correlation of anatomical variations with BMI underscores the importance of personalized anatomical assessment in clinical practice. These findings reinforce the necessity of considering anatomical variability for precise diagnostic imaging and effective surgical planning to minimize potential complications.

Limitations of the Study

1. The study's cross-sectional design limits the ability to establish causation.
2. The relatively small sample size of 80 participants may affect the generalizability of findings.

3. Imaging techniques utilized for thyroid assessment could introduce subjective variability.
4. Lack of detailed hormonal profiling and biochemical assessment of thyroid function.
5. Potential selection bias due to the single-center study design.

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