

Is Preoperative Ultrasonographic Thyroid Gland Volume a Good Predictor of Postoperative Complications in Thyroidectomy?: A Prospective Cohort Study

S VAISAKH¹, PS RAJESH²

ABSTRACT

Introduction: Thyroidectomy is a commonly performed surgical procedure, especially in areas with a high prevalence of thyroid disorders. Accurate estimation of thyroid volume is crucial for evaluating and managing these conditions, as thyroidectomy in patients with enlarged thyroids can lead to specific concerns regarding optimal preoperative, intraoperative, and postoperative care.

Aim: To assess the relationship between thyroid volume and thyroidectomy complications, specifically Vocal Cord Paralysis (VCP) and hypocalcaemia, using preoperative ultrasound and ellipsoid volumetric analysis.

Materials and Methods: A prospective cohort study in the General Surgery ward at a Government Medical College, Kottayam, Kerala, India. A total of 70 patients (64 females and six males) with benign thyroid swelling underwent total Thyroidectomy between June 2020 and December 2020. Follow-up was conducted for one year until December 2021. Thyroid gland volume was assessed using ultrasound and calculated using the ellipsoid formula. Based on volume, patients were classified into two groups: 1) <50 mL (mild enlargement), and 2) >50 mL (moderate to severe enlargement). Preoperative

examination of vocal cords was performed by the Department of Otorhinolaryngology. Serum calcium levels were measured 48 hours postoperatively, or earlier if symptomatic. Hypocalcaemia was defined as corrected calcium <8.4 mg/dL. The association between thyroid gland volume and complications was analysed to determine if volume could be an effective factor in patient morbidity. Data were entered into Microsoft Excel and analysed using Statistical Package for the Social Sciences (SPSS) version 16.0. Chi-square test was used for qualitative analysis, with a significance level set at $p < 0.05$.

Results: The mean thyroid volume for patients with volumes <50 mL and >50 mL was 26.9 mL and 103.2 mL, respectively. Temporary hypocalcaemia (resolving within six months) was significantly higher in patients with volumes <50 mL ($p = 0.044$). Temporary VCP was significantly more frequent in patients with larger volumes ($p = 0.027$). No intraoperative complications were observed in the present study.

Conclusion: Thyroid gland volume appears to be an important factor influencing thyroidectomy complications. Smaller thyroid volumes are associated with an increased risk of postoperative hypocalcaemia, while larger volumes are associated with a higher risk of VCP.

Keywords: Hypocalcaemia, Paralysis, Thyroid, Ultrasound

INTRODUCTION

Neoplastic, inflammatory, and endocrine thyroid disorders are common, with about 12% of adults having a palpable goiter [1]. Thyroid nodules are seen in upto 50% of the general population, with females being 5 to 10 times more likely to have thyroid disease than males [1]. Several factors affect the size of the thyroid gland, including sex, age, height, weight, body mass index, and body surface area. Inadequate iodine in the diet and smoking can also impact thyroid volume [2]. Iodine deficiency is the primary cause of endemic goiter, but in iodine-replete countries, autoimmune diseases like Hashimoto's and Graves' disease are the leading causes [3]. Other causes include defects in thyroid hormone production and certain medications like aminosalicylic acid, lithium, and excessive iodine intake. Preoperative assessment of thyroid disorders is typically based on personal experience rather than objective parameters. Knowing the estimated thyroid volume through reliable methods can provide surgeons with reassurance and help in preparing for potential complications. Ultrasonographic volumetry is considered the most convenient, reliable, and accurate method to determine thyroid volume and assess its echostructure [4]. Normal thyroid gland volume ranges from 10-15 mL for adult females and 12-18 mL for adult males [4].

Thyroid surgery has evolved with improved aseptic techniques and anesthesia. However, it still carries risks of complications such as

hypocalcaemia and injury to the recurrent laryngeal nerve, which can result in VCP [5,6]. Hypocalcaemia can have long-term effects on bone metabolism and cardiac function, while recurrent laryngeal nerve injury can lead to persistent vocal and laryngeal dysfunction. Surgeon experience is associated with lower complication rates and shorter hospital stays following thyroidectomy [7]. Even experienced surgeons can inadvertently injure the nerve due to anatomical variations and challenges in nerve identification under certain conditions [8]. The present study focused on the relationship between thyroid volume and thyroidectomy complications, particularly VCP and hypocalcaemia, using preoperative ultrasound and ellipsoid volumetric analysis.

MATERIALS AND METHODS

A single-centre prospective cohort study was conducted in the General Surgery Department at a Government Medical College, Kottayam, Kerala, India, from June 2020 to December 2020, with one year of follow-up until December 2021. The study received approval from the Institutional Review Board (Ref no. 20/2020, dated 16/06/2020).

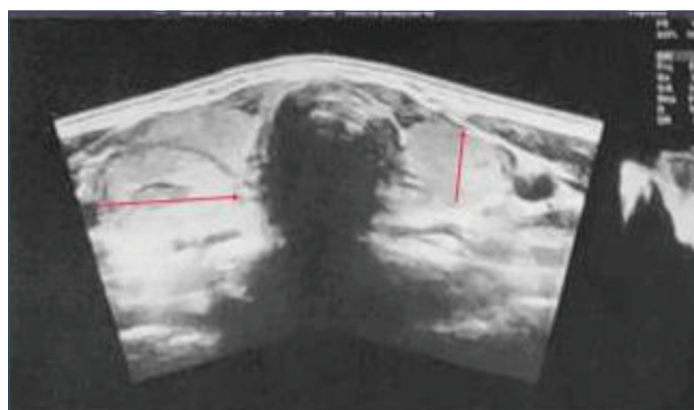
Inclusion criteria: A total of 70 patients who underwent total thyroidectomy for benign goiter, without a preoperative diagnosis of malignancy or mediastinal goiter were included in the study.

Exclusion criteria: Recurrent goiters were excluded from the study.

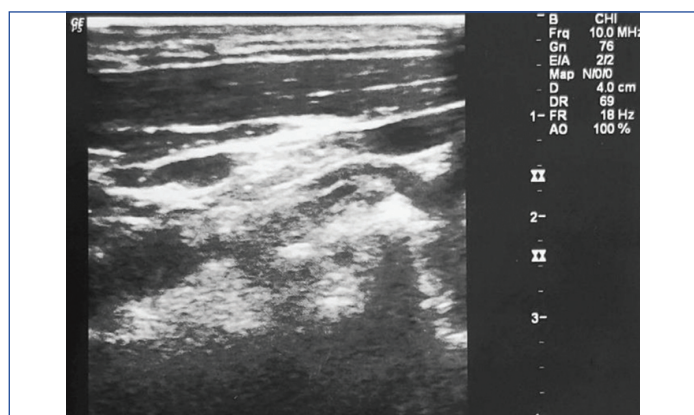
Sample size calculation: The sample size was calculated using the formula $(Z_A + Z_B) \times PQ \times 2 / (P_1 - P_2)^2$, where $Z_A = 1.96$, $Z_B = 0.84$, $P = P_1 + P_2$, $Q = 100 - P$, $P_1 = 29.9$, and $P_2 = 8.6$. These values were taken from a previous study conducted on Turkish patients who underwent total thyroidectomy for benign thyroid swelling [9]. The calculated sample size resulted in $N_1 = 46$ (<50 mL) and $N_2 = 46$ (>50 mL), with a total sample size of 92. However, due to the COVID-19 pandemic, the present study was unable to reach the estimated sample size.

Study Procedure

Thyroid ultrasound examinations were performed in the Radiology Department using the ellipsoid formula (volume = width X height X depth X 0.479) to calculate thyroid volume [10]. Different ultrasound views were used to measure the thyroid gland, as illustrated in [Table/Fig-1,2].



[Table/Fig-1]: Thyroid ultrasound longitudinal view.



[Table/Fig-2]: Thyroid ultrasound showing transverse view.

Based on thyroid volume, patients were classified into two groups: 1) <50 mL, and 2) >50 mL. Preoperatively, vocal cords of all patients were examined by the Department of Otorhinolaryngology. Serum calcium levels were measured 48 hours after the operation or earlier if symptomatic. Hypocalcaemia was defined as corrected calcium <8.4 mg/dL. Corrected calcium was calculated as: Serum calcium + $0.8 \times (4.0 - \text{serum albumin in g/dL})$ [11]. Hypocalcaemia could be clinically elicited by percussing over the branches of the facial nerve, resulting in facial muscle twitching (Chovstek's sign). Vocal cord paralysis (VCP) lasting less than one year was considered temporary, while VCP lasting more than one year was considered permanent. Hypocalcaemia lasting less than one year was considered temporary, while hypocalcaemia lasting more than one year was considered permanent.

STATISTICAL ANALYSIS

The data were entered into a Microsoft Excel sheet and analysed using SPSS version 16.0. Descriptive statistics, such as means for continuous variables and percentages for categorical variables,

were used to describe the data. The Chi-square test was employed to compare the two groups for categorical variables and determine the statistical significance level at $p < 0.05$.

RESULTS

Among the 70 patients, 64 were females and six were males. The mean age of the study population was 48.01 ± 10.73 years. Among them, 48 were diagnosed with Multinodular Goiter (MNG), four with solitary nodule thyroid, nine with toxic controlled MNG, and nine with MNG with retrosternal extension. Out of the nine cases with MNG and retrosternal extension, seven had a thyroid volume of more than 50 mL. Of the 70 patients, 47 had a thyroid volume <50 mL, while the remaining had a volume above 50 mL. The mean age of patients who underwent total thyroidectomy with a volume <50 mL and >50 mL was 45.32 ± 10.12 years and 53.5 ± 10.25 years, respectively. The mean thyroid gland volume for the study population with a volume <50 mL and >50 mL was 26.99 ± 11.17 mL and 103.2 ± 77.92 mL, respectively. No intraoperative complications were observed.

Postoperatively, hoarseness of voice was present in seven out of 70 cases, with 71.4% of them having a thyroid volume of more than 50 mL [Table/Fig-3]. Among these seven cases, five had hoarseness of voice for upto one month, and the majority returned to normal within six months, except for one case that took one year to recover. None of the patients required tracheostomy.

Hoarseness of voice		Thyroid gland volume (mL) <50 >50		Total	χ^2	p-value
		Count	%			
No	Count	45	18	63	4.88	0.027
	%	71.4	28.6	100		
Yes	Count	2	5	7		
	%	28.6	71.4	100		
Total	Count	47	23	70		
	%	67.1	32.9	100		

[Table/Fig-3]: Postoperative hoarseness of voice and thyroid gland volume.

In the present study, 30 out of 70 cases had hypocalcaemia (postoperative corrected calcium less than 8.4 mg/dL), with 80% of them having a thyroid gland volume less than 50 mL [Table/Fig-4]. Among the 30 hypocalcemic patients, only 18 showed signs of hypocalcaemia (Chovstek's sign). Out of the 30 patients, 14 recovered within one month, 15 recovered within six months, and only one patient had permanent hypocalcaemia even after one year.

Corrected calcium (mg/dL)		Thyroid gland volume (mL) <50 >50		Total	χ^2	p-value
		Count	%			
<8.4	Count	24	6	30	4.07	0.044* (<0.05)
	%	80	20	100		
≥8.4	Count	23	17	40		
	%	57.5	42.5	100		
Total	Count	47	23	70		
	%	67.1	32.9	100		

[Table/Fig-4]: Postoperative hypocalcaemia and thyroid gland volume.

DISCUSSION

The present study included 70 patients diagnosed with benign thyroid disease via ultrasound neck (using thyroid imaging reporting and data system) and fine needle aspiration cytology (using Bethesda reporting), who underwent total thyroidectomy during the study period. According to Pandey AK et al., a study conducted between 2011-2013 among 80 patients in Uttarakhand, hypocalcaemia and VCP are major complications associated with thyroid surgery [12]. Additionally, Berri T and Houari R, found that larger thyroid glands are more prone to complications [13].

In a study by Karabeyoglu M et al., in 2009, which included 500 Turkish individuals who underwent total thyroidectomy for benign

goiters, the rate of both temporary and permanent VCP increased with higher thyroid volumes. The incidence was 7.3% for volumes <50 mL and increased to 29.9% for volumes >50 mL [9]. In the present study, seven out of 70 cases experienced postoperative hoarseness of voice (attributed to VCP), with 5 of them (71.4%) having a volume greater than 50 mL. Temporary hoarseness may result from neuropraxia of the recurrent laryngeal nerve during cautery dissection or hemostasis, as larger glands or thyroiditis-associated disease tend to bleed more due to increased vascularity. Although postoperative hoarseness of voice can have multiple causes, larger thyroid volumes pose a risk due to increased vascularity and potential nerve injury during hemostasis. Therefore, the authors emphasised the importance of careful dissection, particularly in cases with volumes exceeding 50 mL, and the surgeon's experience. Bhattacharya N and Fried MP, in their study published in 2002, examined a population of 517 individuals in the USA who underwent total thyroidectomy from 1995-1999. They concluded that risk factors for hypocalcaemia are highly variable [14]. Similarly, Karabeyoglu M et al. found that hypocalcemic patients had lower average thyroid volumes compared to non-hypocalcemic patients [9]. Their study also showed a significant increase in the rate of hypocalcaemia as the thyroid volume approached the normal volume of 18 mL.

In the present present study, 30 out of 70 cases experienced hypocalcaemia (postoperative corrected calcium <8.4 mg/dL), with 80% of them having a thyroid gland volume less than 50 mL. Among the hypocalcemic patients, only 18 exhibited signs of hypocalcaemia (Chvostek's sign), while no patients displayed Trousseau's sign, convulsions, or stridor. It is important to note that patients with biochemical evidence of hypocalcaemia may not always show clinical signs. Treatment for hypocalcemic patients involved intravenous calcium gluconate administration if signs of hypocalcaemia were present, otherwise, oral calcium and vitamin D supplementation were given. Hypocalcaemia after thyroidectomy is associated with smaller thyroid gland volumes, particularly in cases of thyroiditis. Thyroiditis can cause inflammation that leads to adhesion between the surgical capsule of the gland and parathyroid tissues, making it challenging to protect the parathyroids during dissection. Dissecting hard and small thyroids is also more difficult and may result in bleeding, disrupting exposure during dissection. This can potentially lead to parathyroid ischemia or unintentional parathyroidectomy, resulting in hypocalcaemia. Surgeons should be aware of the risk of parathyroid injury in cases where the thyroid gland volume is less than 50 mL and inform patients in advance about this risk and available treatment options.

In the present study, none of the patients developed postoperative hematoma/seroma, as our surgeons utilise energy devices for dissection and hemostasis in addition to conventional ligation/clipping techniques. Furthermore, we employ suction drains to

prevent blood collection or seroma formation postoperatively. The study also observed no cases of postoperative breathlessness or dysphagia.

Limitation(s)

The present study had a relatively smaller sample size compared to previous studies, which can be attributed to the study being conducted during the COVID-19 pandemic.

CONCLUSION(S)

The volume of the thyroid gland appears to be an important factor that affects complications during thyroidectomy. In smaller-volume thyroid glands, the risk of postoperative hypocalcaemia increases, while in larger-volume glands, the risk of VCP increases. Estimating the thyroid gland volume based on ultrasound data in the preoperative period would be a useful approach for better preparation against these complications.

REFERENCES

- [1] The Endocrine Society: Endocrine Facts and Figures: Thyroid: 2015.
- [2] Weirsinga WM. Smoking and thyroid. *Clin Endocrinol (OXF)*. 2013;79(2):145-51.
- [3] Vanderpump MPJ. The epidemiology of thyroid disease. *Br Med Bull*. 2011;99:39-51.
- [4] Dighe M, Barr R, Bojunga J, Cui Xw, Dong Y, Vinayak S, et al. Thyroid ultrasound: state of the art. Part 1 - thyroid ultrasound reporting and diffuse thyroid disease. *Med Ultrason*. 2017;19(1):79-93.
- [5] Kerimoglu R, Gozalan U, Kama N. Complications of thyroid surgery: Analysis of 1159 cases. *IJMMS*. 2013;1:35-38.
- [6] Christou N, Mathonnet M. Complications after total thyroidectomy. *Journal of Visceral Surgery*. 2013;150(4):246-49.
- [7] Loyo M, Tufano RP, Gourin CG. National trends in thyroid surgery and the effect of volume on short term outcomes. *The Laryngoscope*. 2013;123(8):2056-63.
- [8] Chiang FY, Lee KW, Chen HC, Chen HY, Lu IC, Kuo WR, et al. Standardization of intraoperative neuromonitoring of recurrent laryngeal nerve in thyroid operation. *World J Surg*. 2010;34(2):223-29.
- [9] Karabeyoglu M, Unal B, Dirican A, Kocer B, Gur AS, Bozkurt B, et al. The relation between preoperative ultrasonographic thyroid volume analysis and thyroidectomy complications. *Endocr Regul*. 2009;43(2):83-87. PMID: 19856713.
- [10] Johnson A, Edwards C, Reddan T. A review of sonographic thyroid volume and iodine sufficiency in children: An Australian perspective. *Australas J Ultrasound Med*. 2020;23(1):33-38. Doi: 10.1002/ajum.12189. PMID: 34760580; PMCID: PMC8411731.
- [11] Parent X, Spielmann C, Hanser AM. Calcémie "corrigée": sous-estimation du statut calcique des patients sans hypoalbuminémie et des patients hypercalcémiques "Corrected" calcium: Calcium status underestimation in non-hypoalbuminemic patients and in hypercalcaemic patients. *Ann Biol Clin (Paris)*. 2009;67(4):411-18.
- [12] Pandey AK, Maithani T, Agrahari A, Varma A, Bansal C, Bharadwaj A, et al. Postoperative complications of thyroid surgery: a corroborative study with an overview of evolution of thyroid surgery. *International Journal of Head and Neck Surgery*. 2015;6(4):149-54.
- [13] Berri T, Houari R. Complications of thyroidectomy for large goiter. *Pan Afr Med J*. 2013;16:138. Doi: 10.11604/pamj.2013.16.138.3277. PMID: 24847400; PMCID: PMC4024433.
- [14] Bhattacharya N, Fried MP. Assessment of the morbidity and complications of total thyroidectomy. *Arch Otolaryngol Head Neck Surg*. 2002;128:389-92.

PARTICULARS OF CONTRIBUTORS:

1. Senior Resident, Department of General Surgery, Government Medical College, Kottayam, Kerala, India.
2. Additional Professor, Department of General Surgery, Government Medical College, Kottayam, Kerala, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

S Vaisakh,
Sankaramangalam Near Arya Central School PMRA, A 45 West Pattom-695004,
Thiruvananthapuram, Kerala, India.
E-mail: vaisakhsatheesh93@gmail.com

AUTHOR DECLARATION:

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. No

PLAGIARISM CHECKING METHODS: [\(Lain Hei et al.\)](#)

- Plagiarism X-checker: Apr 01, 2023
- Manual Googling: Jun 26, 2023
- iThenticate Software: Jun 29, 2023 (10%)

ETYMOLOGY: Author Origin

EMENDATIONS: 6

Date of Submission: **Mar 28, 20223**

Date of Peer Review: **May 25, 2023**

Date of Acceptance: **Jun 30, 2023**

Date of Publishing: **Sep 01, 2023**