

Comparison Of Proximal Airway Status In Benign Multi-Nodular Goitres Before And After Total Thyroidectomy Using The Profile Of Pulmonary Function Test (PFT) -Spirometry

Dr.M. Poorna Chandhar¹, Dr.R. Yuvaraj Karthick², Dr. Riju R menon³, Dr. Ankitkumar Sharma⁴, Dr.C. Gopalakrishnan Nair⁵

¹Senior Resident in Department of CVTS, Vardhaman Mahavir Medical College & Safdarjung Hospital, New Delhi.

E-mail: m.poornachandhar@yahoo.com

²Assistant Professor of Surgery, Department of General Surgery, KMCH Institute of Medical Sciences and Research, Coimbatore, Tamil Nadu. E-mail: dr.yuvaraj.karthick@gmail.com

³Professor of Surgery, Department of General Surgery, Amrita School of Medicine, Kochi, Kerala.

E-mail: rijurmenon@gmail.com

⁴Assistant professor of Surgery, Department of General Surgery, KMCH Institute of Medical Sciences and Research, Coimbatore, Tamil Nadu. E-mail: dr.ankitkumarsharma@gmail.com

⁵Professor of General Surgery, Amrita School of Medicine, Kochi, Kerala. E-mail: gknsuseela@gmail.com

DOI: 10.47750/pnr.2023.14.03.275

Abstract

Background and Purpose: Pressure symptoms are usually uncommon in multinodular goitre (MNG). Imaging modalities fail to define the functional air flow dynamics of the upper airway. The airway-related changes due to MNG can be understood using a Pulmonary function test (PFT). To address this lacuna, this study was conducted to compare the pulmonary function profile of patients undergoing total thyroidectomy with benign MNGs using a pre-operative and post-operative pulmonary function test using Spirometry and assessing if surgery had an impact on airway status with varying volumes of thyroid gland measured with ultrasound

Methods: The study was conducted in a tertiary care centre in South India between 2019-2020. Twenty-five patients with MNG undergoing total thyroidectomy were included in the study population. PFT (Spirometry – Lung volume & Flow volume loop) was performed pre-operatively and was compared with post-operative PFT after 6 weeks of surgery. The desired variables – Forced Vital Capacity (FVC), Forced expiratory volume in 1 second (FEV1), FEV1 ratio & Peak expiratory flow rate (PEFR) were analysed & interpreted to ascertain changes in respective values attributable to surgery.

Results: Mean (MEDIAN)thyroid gland volume(cc) of 25 participants in our study was 50.28 ± 50.03 . Statistically significant improvement was observed in the FVC (Preoperative mean 2.16 ± 0.59 to post-operative mean 2.43 ± 0.78), FEV1 (1.79 ± 0.53 to 2.07 ± 0.69), PEFR (356.8 ± 101.4 to 388 ± 99.4). However, the change in FEV1/FVC ratio (0.83 ± 0.05 to 0.84 ± 0.05) did not approach statistical significance. The study showed that in patients without restrictive lung disease, there is a statistically significant improvement in airflow dynamics following total thyroidectomy, irrespective of the volume of the gland.

Conclusion: Alleviating upper airway obstruction is an important facet of surgical intervention for thyroid disease. Early surgery to prevent progressive worsening of the degree of obstruction should be considered, irrespective of the volume of the thyroid gland for patients with intrathoracic goitre and in cervical MNG with pre-existing airway compromise.

INTRODUCTION

Background

The thyroid is an endocrine gland located in the neck anterior to the trachea with both lobes on both wrapping it laterally and the isthmus anteriorly. Any enlargement of the gland can cause a compression effect over the trachea and therefore reduces the diameter of the trachea. This may result in a reduction in the effective passage of air. Despite being the most common cause of thyroid enlargement, multinodular goitre (MNG) uncommonly causes compression symptoms. (1) Compression symptoms include dyspnoea and dysphagia. Thoracic outlet obstruction and symptoms similar to compression of the superior vena-cava

occur when there is a retrosternal extension. A patient presenting with pressure effects usually has grade 2 goitres or an intrathoracic extension which has a prevalence of 15 – 20%. (2), (3).

Evidence of upper airway obstruction (UAO) becomes evident only when more than 50% of the trachea is narrowed at which point it can be objectively seen in a Pulmonary function test (PFT). (4) The patient becomes symptomatic after UAO of more than 75%. Clinical evaluation is a poor tool for assessing UAO. Imaging modalities like Ultrasound or Computerised Tomography tend to evaluate the anatomical extent of the obstruction. (5) However, imaging modalities cannot assess the airflow dynamics and hence cannot provide a picture of the physiological changes secondary to the presence of a goitre. Pulmonary function tests (PFT) provide an assessment tool to help understand the changes occurring in airflow dynamics. (6)

Airflow dynamics are based on Poiseuille's law which states, "velocity of a steady flow of fluid through the narrow tube is directly proportional to pressure & fourth power of the radius of the tube". (7) In simpler terms, radius & resistance are inversely proportional. Even with a minimal increase in the radius of the trachea, there has to be a significant increase in the velocity or decrease in the resistance. Previous studies have assessed this correlation of this in patients with MNG but are limited by sample size and lack of regional variance.

Aim and Objectives

- The primary objective of the study was to assess the difference in pulmonary function tests before total thyroidectomy and at least 6 weeks post total thyroidectomy.
- The secondary objective was to assess the effect of total thyroidectomy in proximal airway compromise in varying volumes of benign goitres.

METHODS

Selection, Description and Evaluation Process of Participants

We conducted a prospective observational study at a tertiary care centre in south India. on a cohort of consenting patients with MNG who were planned for total thyroidectomy admitted under the General Surgery department. The study commenced after approval from the Institutional Review Board & Ethical committee. (IRB -AIMS-2019-029).

The total duration of the study was 2 years (SPECIFY MONTH 2019-2020). All patients had undergone thyroid function studies (Free T4 and TSH) and USG neck (for evaluation of the volume of the enlarged gland and to note for narrowing of the trachea). USG-guided aspiration cytology was done and cytology was confirmed to be benign. X-ray of the neck anterior and lateral soft tissue view was done to assess the trachea. X-ray of the chest PA view was done to assess lung parenchyma. CT scan of the neck and upper thorax was done for patients with retrosternal extension to assess the extent of the goitre. Indirect laryngoscopy was done to ascertain the normalcy of vocal cords. All patients subsequently underwent complete Respiratory evaluation which included clinical examination and PFT.

After anaesthesia clearance, patients underwent total thyroidectomy. Post-operative vocal cord assessment was done at the time of extubating the patient. Patients were observed for a period of 48 hours. Periodic monitoring for clinical and biochemical hypocalcaemia was done and any evidence of the same was corrected with an appropriate dose of oral or intravenous calcium supplementation. Patients were subsequently discharged and the review is done after 14 days for suture removal and assessment of histopathology of the tissue. Patients with benign histopathology were started on the appropriate dosage of Thyroid supplementation and reviewed after 6 weeks (from the date of surgery). In the second review at 6 weeks postop patients' Respiratory assessment was repeated with clinical examination and PFT.

Exclusion Criteria

Patients with FNA cytology - Bethesda Category V & VI; USG - TIRADS 4 & 5, recurrent goitres, history of obstructive/restrictive lung pathologies like - Chronic obstructive pulmonary disease (COPD), Bronchial Asthma, Bronchiectasis, Pleural effusion, interstitial lung disease (ILD), and established vocal cord palsies were excluded from the study population.

Methods

The volume of the thyroid was calculated using the measurements of ultrasound reports of the patients using the ellipsoidal formula for thyroid sonography (8).

Apart from the usual clinical, radiological & biochemical assessments, a pulmonary function test was done before surgery and was repeated 6 weeks post-surgery. Post-operative PFT was compared with respective pre-op PFT for differences in desired variables like Functional Vital Capacity (FVC), Forced Expiratory Volume at 1st second (FEV1), the ratio of FEV1 & FVC and Peak expiratory flow rate (PEFR). The PFTs were interpreted by the same Pulmonologist & the spirometry was done by the

same technician following American Thoracic Society (ATS) guidelines using Vitalograph Spirometer - Fleisch pneumotachograph, during the study period.

Statistical analysis was performed using IBM SPSS version 20.0 software. Categorical variables were expressed using frequency and percentage. Continuous numerical variables were represented using mean/MEDIAN & standard deviation. To assess the statistical significance of the difference in Spirometry, and flow volume loops before & after total thyroidectomy, paired 't-test was used. Wilcoxon signed-rank test was used for skewed data. A p-value of <0.05 was considered to be statistically significant.

RESULTS

Twenty-five patients met the inclusion criteria and were included in the study. On review of postoperative histology, six patients had micropapillary carcinoma and one patient had follicular carcinoma less than 1 cm, eighteen patients had benign histopathology. The mean age group of the patient was 51.76, ranging between 33 to 74 years. Twenty-one patients were females and four were males. The mean volume of the thyroid gland in the subjects was 50.28+/- 50.03.

The preoperative mean FVC was 2.16 +/- 0.59 and the postoperative FVC was 2.43 +/-0.78 (Table 1). FVC showed a statistically significant improvement when compared between the preoperative and the postoperative group (p-value < 0.001). There was also a statistically significant improvement in FEV1 in the postoperative period (p value<0.001), with preoperative FEV1 1.79 ± 0.53 and postoperative 2.07 +/- 0.69 (Table 2). Peak expiratory flow rate also improved in the postoperative period (p-value = 0.005) (Table 3). FEV1/FVC (Table 4) comparison showed no statistically significant difference (p-value = 0.328).

DISCUSSION

Thyroid disorders are common in surgical practice and their incidence is more in females compared to males (1). The preoperative evaluation for thyroid pathology concentrates on indirect laryngoscopy for vocal cord assessment more as a legal requirement. Though thyroid swelling can compress the airway, pressure effects on the upper airway and the oesophagus is not actively evaluated preoperatively. The evaluation of the upper airway is largely based on anatomical obstruction. Traditional evaluation of UAO due to thyroid enlargement has been performed using imaging modalities (5). The physiological effects of airway obstruction are not routinely addressed. We tried to assess the physiological airflow dynamic changes of the upper airway secondary to thyroid pathology preoperatively and the effect of thyroidectomy using various parameters obtained from PFT.

Abnormal FEV1/FVC is a ratio which suggests whether there is pre-existing lower airway disease. (6) In our study, all patients had normal FEV1/FVC, which suggested that any improvement in restriction pattern seen in the airway or an improved airflow dynamics post-procedure could be attributed to an increase in tracheal radius and thereby reduced resistance.

Further, there was a significant improvement in airflow dynamics with improvements in FVC, FEV1 and PEFr in the post-operative PFT, which can be attributed to total thyroidectomy.

Improvement in the variables of spirometry & flow volume loop curve was noted even in asymptomatic thyroid gland volume post-total thyroidectomy indicates the presence of UAO detected by PFT in patients with apparently asymptomatic MNG (2). Previous studies assessed only flow volume loop curves rather than incorporating significance with comparative FVC, FEV1 & PEFr.

Our study observed that the prevalence of abnormal upper airway dynamics in patients with goitres may be higher than previously reported, similar to the study conducted by Geraghty et al (9). A notable observation there was a lack of correlation between the change in the postoperative flow volume loop and spirometry values, and the volume of the thyroid gland measured sonologically.

Miller et al (10) observed that ultrasound and simple radiography of the thorax are useful for predicting the retrosternal extension of the goitre but not for detecting airway obstruction. However, it must be emphasized that the airway will be affected in nearly all symptomatic patient. A patient being asymptomatic does not rule out such involvement (8).

A comparison of the spirometry variables of patients having MNG with retrosternal extension (RSE) against those without RSE, showed no significant statistically significant difference. This suggests that there is an improvement in the airflow dynamics irrespective of the volume of the gland.

Routine tools used clinically i.e., X-ray neck or USG neck show evidence of anatomical evidence of UAO which could be a late presentation. Our study employs physiological changes evident in the PFT to demonstrate the difference in airflow dynamics. It is also evident from the results that a relatively smaller gland size also tends to alter the airflow dynamics thus providing an early indication of airflow compromise in comparison with an image-guided assessment of the airway.

Based on our study, clinicians should be inclined towards total thyroidectomy when indicated in MNG as a significant improvement has been observed in obstructive changes post operatively.

LIMITATIONS

Despite attaining statistical p-value the study had included a sample size of 25 patients which is lesser than the previous studies (5, 7). The gross disparity among the gender makes it difficult to attain a gender-based comparison. Though spirometry is the gold standard for determining the severity of airflow dynamics, its key limitation is effort dependence and postural variation.

CONCLUSION

There is a significant improvement in the flow loop curve, FVC, FEV1 and PEFR, suggesting a significant reduction of UAO and improvement of the airflow parameters after thyroidectomy, Irrespective of the volume of the goitre.

The study emphasises the importance of spirometry as a tool to assess the physiology of the airway before total thyroidectomy rather than imaging modalities alone.

Table 1: Comparison of mean FVC (L) in pre & post thyroidectomy

FVC (L)	n	Mean ± SD	p value
Pre thyroidectomy	25	2.16 ± 0.59	<0.001
Post thyroidectomy	25	2.43 ± 0.78	

Table 2: Comparison of mean FEV1 (L) in pre & post thyroidectomy

FEV1 (L)	n	Mean ± SD	p value
Pre thyroidectomy	25	1.79 ± 0.53	<0.001
Post thyroidectomy	25	2.07 ± 0.69	

Table 3: Comparison of mean PEFR (L/min) in pre & post thyroidectomy

PEFR (L/min)	n	Mean ± SD	p value
Pre thyroidectomy	25	356.8 ± 101.4	0.005
Post thyroidectomy	25	388 ± 99.4	

Table 4: Comparison of mean FEV1 / FVC in pre & post thyroidectomy

FEV1/FVC	n	Mean ± SD	p value
Pre thyroidectomy	25	0.83 ± 0.05	0.328
Post thyroidectomy	25	0.84 ± 0.05	

REFERENCES

1. Stang, M.T., Armstrong, M.J., Ogilvie, J.B., Yip, L., McCoy, K.L., Faber, C.N., Carty, S.E. Positional dyspnea and tracheal compression as indications for goiter resection. *Archives of Surgery*. 2012 Jul 1;147(7):621-6.
2. Asokan, M., Cholakkal, S., Susheela, B.B., Abdurahiman, H. Multinodular goitre: a clinicopathological study from Kerala. *Int Surg J*. 2020 Sep 23;7(10):3333-9.
3. Wen-Chien Huang, Chou-Hai Huang, Han-Shui Hsu, et al. Intrathoracic Goiter in Elderly Patients, *International Journal of Gerontology*, Volume 7, Issue 1, 2013, Pages 8-12.
4. Bright, P., Miller, M.R., Franklyn, J.A., Sheppard, M.C. The use of a neural network to detect upper airway obstruction caused by goiter. *Am J Respir Crit Care Med*. 1998; 157:1885-91.
5. Prasad, A., Yu, E., Wong, D.T., Karkhanis, R., Gullane, P., Chan, V.W. Comparison of sonography and computed tomography as imaging tools for assessment of airway structures. *J Ultrasound Med*. 2011 Jul;30(7):965-72. doi: 10.7863/jum.2011.30.7.965. PMID: 21705729.
6. Ranu, H., Wilde, M., Madden, B. Pulmonary function tests. *Ulster Med J*. 2011 May;80(2):84-90. PMID: 22347750; PMCID: PMC3229853.
7. "Poiseuille's law." Merriam-Webster.com Medical Dictionary, Merriam-Webster, <https://www.merriam-webster.com/medical/Poiseuille%27s%20law>. Accessed 2 Feb. 2023.
8. Erçikti, E., Acer, N., Apaydin, N., Güven, I. & Zararsiz, G. Which method is gold standard for determination of thyroid volume? *Int. J. Morphol.*, 35(2):452-458, 2017.
9. Geraghty, J.G., Coveney, E.C., Kiernan, M., O'Higgins NJ 1992 Flow volume loops in patients with goiters. *Ann Surg* 215:83-86
10. Miller, D.L., Smith, N.B., Bailey, M.R., Czarnota, G.J., Hynynen, K., Makin, I.R.; Bioeffects Committee of the American Institute of Ultrasound in Medicine. Overview of therapeutic ultrasound applications and safety considerations. *J Ultrasound Med*. 2012 Apr;31(4):623-34. doi: 10.7863/jum.2012.31.4.623. PMID: 22441920; PMCID: PMC3810427.
11. Sorensen, J.R., Lauridsen, J.F., Dossing, H., et al. Thyroidectomy improves tracheal anatomy and airflow in patients with nodular goiter: a prospective cohort study. *Eur Thyroid J*. 2017; 6:307-314. doi: 10.1159/000480348.