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Ultrasonographic Estimation of Thyroid Gland Volume among Bangladeshi Population

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Abstract

Background: Ultrasonography is the most commonly usedmethod to determine thyroid gland volume because of its superficial anatomical placement. Aim of this study was to evaluate the volume of normal thyroid gland and its correlation with Body Mass Index (BMI) among Bangladeshi population from Chattogram district.

Materials and methods: This cross-sectional study was carried out in the Department of Anatomy, Chittagong Medical College, from July 2022 to June 2023 among 200 (100 male, 100 female) Bangladeshi population of Chattogram district. Expert sonologists performed thyroid ultrasound and calculated thyroid gland volume of each lobe. The statistical analysis was done using SPSS version 26 and p-value was considered significant if it was <0.05 at 95% level of significance.

Results: The mean total thyroid gland volume was 3.74±1.713 ml. The left lobe volume (1.93±0.999 ml) was larger than the right lobe volume (1.81±0.867 ml) but was not statistically significant (p>0.05). Spearman's correlation test revealed that total thyroid gland volume was negatively correlated with BMI (p=0.440).

Conclusion: Result of the present study provides some baseline data about normal thyroid gland volume of Bangladeshi population of Chattogram district which will help to establish the reference valuesfor the physicians and surgeons to deal with various thyroid pathologies.

Key words: Reference value; Thyroid gland volume; Ultrasonography.

Introduction

The largest and most significant endocrine gland in the human body is the thyroid gland. It is incredibly vascular and situated anteriorly in the lower neck, amid the first and fifth cervical vertebrae. It is made up of two lobes that are symmetrical and connected by a median isthmus that is located in the space between the tracheal rings two, three and four.[1]

In healthy individuals, the glands vary generally in size and shape. Age, sex, weight, height, Body Mass Index (BMI) Body Surface Area (BSA) waist-to-hip ratio, lean body mass, reproductive status and other characteristics are significant in determining the size of the thyroid gland. A few socioeconomic variables include smoking, alcohol use and the use of excess goitrogens and dietary iodine.[2]

The thyroid's morphometry, with particular focus on its volume, is the most crucial factor that needs to be assessed.It is valuable in the diagnosis and follow-up of a number of thyroid conditions.[3] Thyroid size and volume can be estimated using a variety of techniques, including post mortem dissection in cadavers, Magnetic Resonance Imaging (MRI) Computed Tomography (CT) radionucleotide study, ultrasoundand palpation in live subjects. Thyroid gland ultrasonography has largely superseded other imaging modalities due to its non-invasive, non-ionizing, quick, affordable, readily available and extremely informative nature.[4,5] Sonography makes it possible to precisely measure the thyroid gland's size, volume and parenchymal echo structure. It also makes it possible to identify a variety of diffuse and focal abnormalities in the gland and its surrounding structures.[6]

The size of the thyroid gland varies with these parameters, according to studies done for the ultrasonographic estimation of Thyroid Gland Volume (TGV) and its relationship with a variety of anthropometric and demographic parameters.[7] Therefore, it can be assumed that as population demographics change the normogram will vary across different geographic regions.[8] Keeping in mind the above mentioned background and

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knowledge the present study was intended to create normative reference data of thyroid gland volume using ultrasonography among adult population of Bangladesh and analysed the data to find out any statistically significant difference of these parametersamong the study population.

Materials and methods

This cross sectional observational study with some analytical component, conducted between July 2022 to June 2023 at the Department of Anatomy of Chittagong Medical College, Chattogram, included 200 (100 male, 100 female) normal adult Bangladeshi population of Chattogram district. Approval was issued from ethical review committee of Chittagong Medical College. Data were collected from the patients attending the Department of Radiology and Imaging of Chittagong Medical College Hospital (CMCH) and Institute of Nuclear Medicine and Allied Sciences (INMAS) and Parkview Hospital Limited, Chattogram according to enrollment criteria. Participants were enrolled based on having normal thyroid ultrasonography as reported by expert sinologists and being Bangladeshi by birth. The thyroid status of the subjects was confirmed by hormonal assay. Estimation of serum Thyroid Stimulating Hormone (TSH) was done by Immunoradiometric Assay (IRMA) to select normal thyroid subject for this study. Subjects with symptoms of tremors, elevated heart rate, hoarseness of voice, intolerance to heat or cold, rapid weight loss despite an increase in appetite, positive family history of thyroid cancer, undergoing neck surgery or radiotherapy, received treatment for thyroid conditions or who have palpable or visible masses in the neck were excluded from the study. Without footwear, weight was measured in kilograms using digital weighting scale, which was placed on a firm,level surface. A measuring tape was used to record the height in centimeters against a flat vertical surface. BMI was calculated by dividing weight of a person in kilograms (kg) with his or her height in meter squared.[9] Ultrasound examination was performed using PHILIPS EPIQ ELITE multipurpose ultrasound machine, 22-2 MHz frequency, CL 18-4 probes, 24 HD max display, 2D optimization signal processing unit. Subjects were examined in supine position and observations were reported by expert sonologists. The measurements were done with the measuring scale in image analyzing software. Formula used to compute the volume of each lobe[10]:

Volume (cm^3) = Width (cm) × Length (cm) × Depth (cm) × 0.523.

The sum of the volumes of the two lobes is used to estimate the thyroid volume, excluding the isthmus's volume. The total and each lobe volume were represented by mean. To determine whether the variables were normal, the Shapiro-Wilk test was employed ($p>0.05$). Wilcoxon signed rank test analyzed the comparisons between volume of right and left thyroid lobe and Spearman's correlation coefficient was used to correlate thyroid gland volume to body mass index.

Results

The study comprised 100 male and 100 female subjects. Respondents' age ranged from 18-59 years while the mean ± SD age was 31.81±10.28 years. The respondents' mean weight was 60.69±10.52 kg and mean height was 158.31±9.33 cm. The BMI of the respondents ranged from 14.6-34.8 kg/m^2 with the majority of respondents (53%) within normal range; mean BMI was 24.24±3.89 kg/m^2.

The mean volume of left lobe of thyroid gland was higher than that of right lobe but according to Wilcoxon signed rank test the difference was not statistically significant (p=0.056) (Table I).

Table I Total thyroid gland and its lobe volumeof the respondents (n=200)

Lobe	Range	Mean ± SD	Median	p value
Right lobe volume	0.41-5.50	1.81±0.867	1.630	
			(1.173, 2.228)	p=0.056
Left lobe volume	0.49-7.00	1.93±0.999	1.685	
			(1.258, 2.318)	
Total gland volume	1.25-12.50	3.74±1.713	-	-

(p> 0.05= not significant).

Scatter diagram with regression line revealed negative correlation of thyroid gland volume with Body Mass Index (BMI). The relationship was evaluated as not significant [r (198) = -0.055, r^2=0.003, p=0.440] through Spearman's correlation.

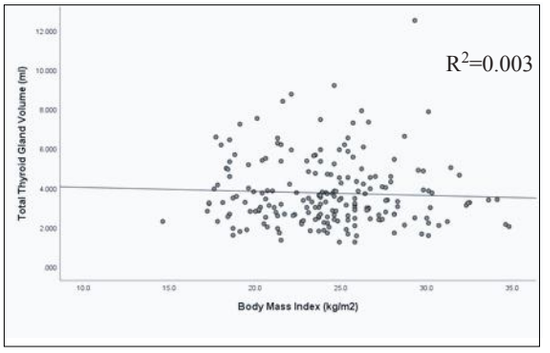

Figure 1 Correlation of thyroid gland volume with body mass index (BMI)

Discussion

According to present study, the mean volume of right lobe was 1.81±0.867 ml and the left lobe was 1.93±0.999 ml. The difference among the lobe volume was statistically not significant (p=0.056) (Table I). In contrast, Kayastha P et al. in their study included 485 participants among them 221 were male and 264 female ranged between 1-83 years. The study revealed that the mean right lobe volume was 3.79±0.06 ml and was observed greater than mean left lobe volume which was 2.83±0.05 ml and this variation was statistically significant ($p<0.0001$)[2]. Another study conducted by Salaam et al. (2020) in Nigeria on 400 healthy adults found that the mean right lobe volume was 3.2±1.47 cm^3 and was significantly greater (p=0.000) than that of left lobe (Mean left lobe volume was 2.77±1.35 cm^3).[11] A similar study conducted by Aggarwal et al. among 100 participants and revealed that mean right and left lobe volumes were 3.89±1.28 ml and 3.59±1.09 ml respectively and the right lobe being larger than the left lobe was also statistically significant (p=0.001).[8] A study done by Msuega et al. on 500 populations found that the mean right lobe volume on the right side was 3.56±1.14 cm^3 and on the left side was 3.35±1.10 cm^3. In their study, the right lobe was significantly larger than the left lobe (p=0.000).[12] Among 102 Pakistani participants between 20-44 years Memon and Rasheed found mean volume of right lobe was 5.27±3.82 cm^3 and left lobe was 3.82±1.41 cm^3. The finding revealed significantly higher ($p<0.005$) right lobe volume than left lobe.[13] Ananalogous study conducted by Bhattacharjee P K et al. in Bangladesh on 160 populations and revealed that mean right and left lobe volume were 3.67±0.64 ml and 3.58±0.61 ml respectively in which right lobe volume was larger than the left lobe.[14] Researchers in Turkey found that the mean right lobe volume and left lobe volumewas 7.22±3.65 ml and 5.78±2.91 ml respectively. Right lobe volume was found greater than that of left lobe.[15] All these results have shown dissimilarities with the present study. This unlikeness may be due to racial, geographical, sample size and participants' age range variation. The left lobe of thyroid gland is larger in right-handed individuals than in left-handed ones.[16] But handedness was not observed in our study.

In this study, mean total thyroid gland volume was 3.74±1.713 ml (Range: 1.25ml-12.5ml) (Table I). In contrast, Salaam A J et al. found the calculated mean thyroid volume to be 6.03±2.49 cm^3 (Range: 1.38cm^3-11.34 cm^3)[11]. In one more study conducted by Kayastha P et al. revealed that mean total thyroid gland volume was 6.62±2.50 ml (Ranged 1.59 ml-24.95 ml)[2]. Aggarwal N et al. described that the mean total thyroid volume was 7.48±2.22 ml.[8] Mean total thyroid volume for both lobes was 6.91±2.41 cm^3 in a further study by Msuega C D et al.[12] A study done by Bhattacharjee P K et al. in Bangladesh revealed that the mean total thyroid gland volume was 7.25±1.18 ml (Range 5.00 ml-10.17 ml).[14] Moghadam R N in Iran conducted a study on 314 participants and found that the mean thyroid volume was 8.34±2.37 ml (Ranged 2.67-13.4 ml).[17] Mean total thyroid gland volume was 8.55±1.82 cm^3 in one more study on 143 subjects.[18] All these study result differ from the current study's conclusion. Genetic, dietary, racial, geographical and environmental factors may contribute to variations in thyroid gland volume. Variation in sample size or imaging technique or measurement protocols could be the cause of this discrepancy.

Spearman's correlation test between total thyroid gland volume with BMI revealed negative correlation between them and it was not statistically significant [$r(198) = -0.055$, $r^2=0.003$, p=0.440] (Figure 1). Total thyroid volume evaluated by 2D ultrasonography among 102 Pakistani during a cross sectional study revealed no statistical correlation between thyroid gland volume and BMI ($p<0.005$). The finding of this study is similar to the findings of present study.[13]

Another study in Karachi, Pakistan showed positive but statistically insignificant correlation between total thyroid gland volume and BMI (r=0.73, p=0.29).[19] Extremely statistically significant correlation (p<0.0001) was found among Saudi males where thyroid volume was decreased significantly as participants' BMI increase.[20]

Seker S and Tas I in Turkey conducted a study included 251 volunteers age range between 15 and 78. Thyroid gland volume measurements were done by 2D ultrasonography. A significant correlation was found when BMI was correlated with thyroid volumes (r=0.185, p<0.003).[15] The finding of this study is not similar to the findings of present study. This dissimilarity may be due to racial factor.

Limitations

The study was carried outin a designated area within short time frame including relatively small sample. So the current study may not accurately representthe Bangladeshi population.

Conclusion

This study anticipated the reference value of total thyroid volume for Bangladeshi population of Chattogram district which are significantly lower than the reference ranges obtained from various other countries and is negatively correlated with the BMI. This study also revealed left lobe volume of thyroid gland was larger than the right lobe volume. Results of the present study provide some baseline data about normal thyroid gland volume and also both lobe volume of Bangladeshi population which might be helpful for the radiologists, physicians and surgeons in clinical diagnosis, grading and managing thyroid pathologies.

Recommendation

Multicenter grounded study with larger sample size all over Bangladesh can be performed which make the study completely representative among Bangladeshi population.

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Contribution of author

RSL-Conception, design, acquisition of data, interpretation of data, manuscript writing & final approval.
MA-Conception, design,drafting & final approval.
UH-Design, data collection, manuscript writing & final approval.
TZ-Design, data collection, data analysis, critical revision & final approval.
UC-Conception, data interpretation, critical revision & final approval.
RR-Design, data analysis, critical revision & final approval.

Disclosure

All the authors declared no conflict of interests.

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