ORIGINAL ARTICLE

Correlation of Thyroid Gland Volume with Age and Gender in a Subset of Karachi Population

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ABSTRACT

Background: Thyroid gland volume (TGV) is highly variable as it is greatly influenced by age, gender, anthropometric measurements and geographical location. It has become essential for every population to determine reference range of their normal thyroid gland volume (TGV) in healthy individuals. This in turn will help the population in grading of goiter and will guide in large scale iodine monitoring programs.

Objective: To determine TGV in a subset of Karachi population and to determine its association with age and gender.

Methods: A cross-sectional study employing 421 volunteers aged 21 years and above went through the ultrasound (US) examination of their thyroid gland (TG) after being confirmed euthyroid by their serum thyroid stimulating hormones (TSH) evaluation.

Results: TGV in the study was found to be 6.26 ± 2.89 ml. Males had significantly higher TGV 6.78 ± 2.88 ml as compared to females 5.7 ± 2.79 ml (P=0.00). Volume of right lobe was significantly greater than that of left lobe (P=0.00) in both the genders. TGV increased significantly with age till 60 years (P<0.05) and after the age of 60 years it decreased (P=0.035)..

Conclusion: Mean volume of thyroid gland in this studied population is not only smaller than that of the Western countries but is also much smaller than the neighboring country Iran. The study has also proved

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that there was a significant decrease in mean thyroid gland volume after the age of 60 years. Prolonged and severe iodine deficient status of Pakistan till recent past could be an answer for small thyroid gland volume in the studied population. Similar studies in future will give more accurate facts and figures regarding mean thyroid gland volume in this population if Pakistan retains itself as an iodine sufficient State.

KEY WORDS: *Thyroid Gland, Ultrasonography, Reference value, Goiter, Thyroid Hormones, Iodine.*

Cite as: Kamran M, Hussan N, Ali M, Ahmad F, Raza F, Zehra N, Bughio S. Correlation of Thyroid Gland Volume with Age and Gender in a Subset of Karachi Population. Pak J Med Dent 2014; 3(2):26-32.

INTRODUCTION

The presence of around 12 or more follicles in Anatomical as well as physiological importance of thyroid gland (TG) is certain. TG is encapsulated and occupies the anterior triangle of neck at the level of C5 to T1 vertebrae. It consists of right lobe (RL) and left lobe (LL) that lie anterolateral to larynx and trachea. Each lobe is pear shaped with the apex directed up wards. Isthmus joins the two lobes and extends across the 2nd to 4th tracheal rings.[1] TG produces thyroid hormones and calcitonin which maintain favorable level of metabolism in the tissues and regulates the level of calcium in blood respectively.[2]

It has been universally established that thyroid gland volume (TGV) varies from country to country. Many studies have suggested that the TGV varies with age, gender, height, weight, body mass index (BMI),body surface area (BSA) and lean body mass (LBM). [3,4,5,6,7,8] Nafisi et al from Iran in 2011 concluded that this dissimilarity is probably due to hereditary variations in growth and development, geographical location or iodine consumption on daily basis.[9] Rasmussan et al in 2002 concluded that TGV differs considerably with the intake of iodine.[10]

It is a consistent finding of nearly all the studies that TGV in healthy individuals is greater in males than in females.[3,4,5,6,7&11] Asymmetry of TG is also very frequent and the volume of RL is greater than that of the LL in both the genders.[4,5,6,7] It was proposed by Seker et al while studying on Turkish subjects in 2010 that TGV increases till the age of 65 years and after that it decreases with the increase in age. This theory, however, could not be proved by him because of the small number of volunteers in this age group.[5]

Various techniques have been established that can determine the TGV like ultrasound (US), magnetic resonance imaging (MRI) and computed tomography (CT). Measurement of TGV by ultrasound (US) is a correct and precise method. It is a non-invasive, rapid, inexpensive, easily available, safe and comfortable technique.[12] It can determine the echogenicity of tissue, show the vascularity and velocity of blood flow in the gland, identify and classify thyroid incidentalomas and determine the malignancy in the gland.[13,14] World health organization (WHO) and the International Council for the Control of Iodine Deficiency Disorders (ICCIDD) now consider US of thyroid as the technique of choice for the assessment of goiter.[15] Brunn et al in 1981 proposed that determination of TGV by US is based on an ellipsoid model. The height, the width, and the depth of each lobe are measured and multiplied. The acquired result is then multiplied by a correction factor of 0.479.[16]

Determination of normal TGV according to the population's own age, gender, height and weight has now become essential especially in grading of goiter. Determination of TGV is also important for the calculation of the dose of radioiodine I^{131} needed for treating thyrotoxicosis, for the assessment of response to suppression treatment and also to assess the patients undergoing the long term treatment with drugs which causes goiter or can alter thyroid function tests like lithium, carbamazepine, phenytoin, amiodarone and oral contraceptives.[17] Range of TGV for a particular population is required for large scale iodine monitoring programs.[18]

The objectives of this study were to determine TGV in a subset of Karachi population and also to determine the effects of age and gender on TGV.

METHODOLOGY

This was a cross-sectional study carried out from October 2012 to September 2013. 421 volunteers participated in the study and went through US examination at Radiology Department of Ziauddin Hospital Clifton. Sample size was calculated by the formula: n= Z^2 X P (1-P) /D^2, (where n= no of individuals, Z = 1.96, P= 50% at 95% confidence interval and D= 0.05).

Written informed consent was taken and proforma was filled. All those individuals with history of thyroid disease, thyroid surgery, thyroid nodule or with any other thyroid abnormality either on examination or on US were excluded from the study. Individuals on drugs that cause goiter, females with pregnancy, mothers who have delivered during last 12 months and lactating mothers were also excluded from the study.

Participants were investigated for serum TSH level in order to select euthyroid individuals for US examination. Serum TSH of the subjects was determined by chemiluminescence method. Reference range of TSH was 0.23 – 4.0 µIU/ml as used by the laboratory of Ziauddin University Hospital.

US machine Toshiba SSA-590A with 7.5 MHz linear probe was used to determine TGV of our sample population. Participant was examined in supine position with his/ her neck hyperextended and pillow under his/her shoulders. Anteroposterior, craniocaudal and mediolateral diameter of each lobe of thyroid was calculated. Volume of each lobe of thyroid was then calculated by WHO recommended formula: Anteroposterior X Craniocaudal X Mediolateral X 0.479.[19] Total TGV was taken by summing up the volume of both lobes. Transverse dimension and anteroposterior dimension of isthmus were also noted. Participants were divided into 5 age groups with a 10 year difference starting at 21.

The study conducted was in accordance with the Ethical Review Committee of Ziauddin University Karachi. Data was entered on Microsoft Excel and SPSS version 17 was used for statistical analysis. Means and standard deviations were derived for numerical variables and ANOVA was applied to determine the significance among age groups. Paired t-test was used to compare the difference between the volumes of two lobes. Independent T-test was applied to calculate significance between genders and for age group 60 years and above. P- Value of < 0.05 was considered to be significant.

RESULTS

Mean age of participants in the study was 42.08 ± 15.29 years. The minimum and maximum age in the study was 21 to 82 years. 52.5% participants (221 out of 421) were males and 47.5% participants (200 out of 421) were females with their mean age 43.16 ± 15.99 and 40.88 ±14.42 years respectively (P=0.127).
Mean TGV of 421 individuals was 6.26 ± 2.89 ml. The minimum and maximum TGV was 1.98 ml to 15.77 ml. Mean volume of RL was 3.27 ± 1.75 ml. It was significantly greater than that of LL 2.99 ± 1.4 ml (p-value 0.00). Mean thickness (AP dimension) of isthmus was 0.37 ± 1.64 cm and transverse dimension of isthmus was 1.56 ± 0.44 cm.

Table 1: Comparison of Mean Thyroid Gland Volume in Males and Females

	Total Participants n=421		**Males n=221**		**Females n=200**		**P-Value**
	Mean	**St.dev**	**Mean**	**St.dev**	**Mean**	**St.dev**	
Total vol (ml)	6.26	±2.89	6.78	±2.88	5.7	±2.79	0.00
Right Lobe vol (ml)	3.27	±1.75	3.54	±1.77	2.98	±1.68	0.001
Left Lobe vol (ml)	2.99	±1.4	3.24	±1.4	2.7	±1.36	0.00

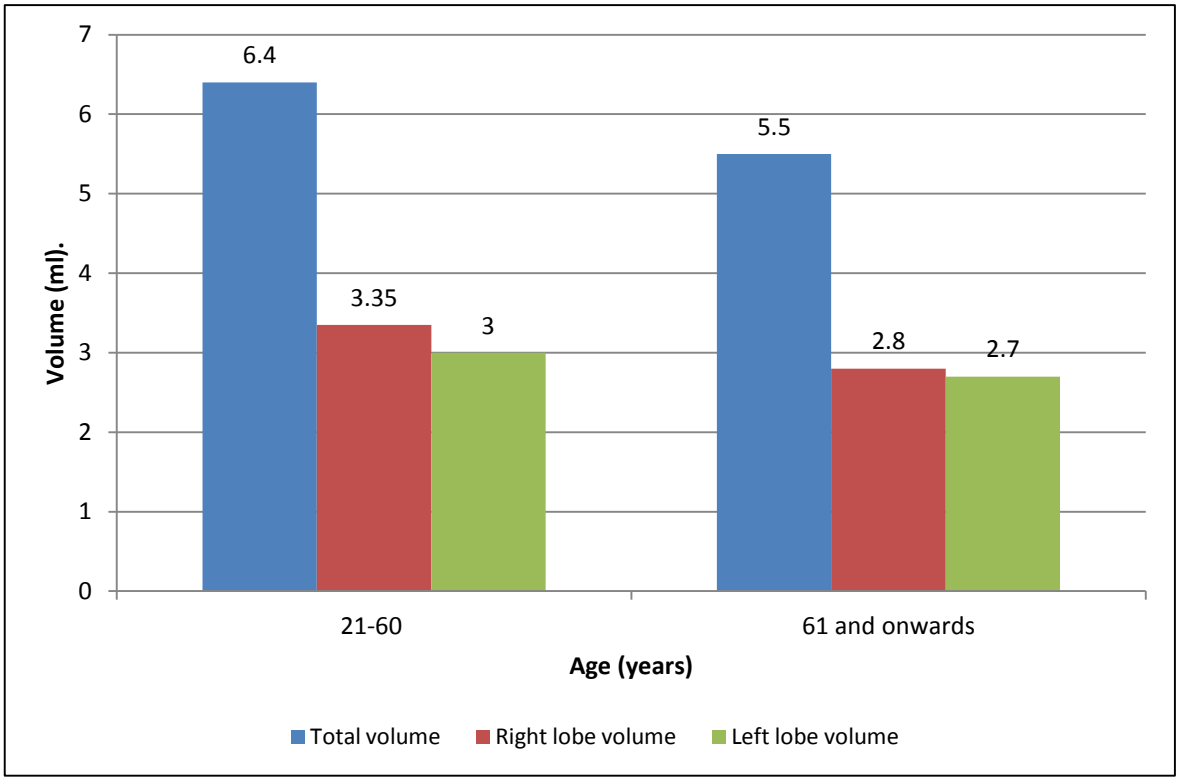
P-value of <0.05 is significant

Table 2: Thyroid Volume in Different Age Groups

Age Groups (yrs)	1 (21-30)	2 (31-40)	3 (41-50)	4 (51-60)	5 (61-onward)	P value
Total (N)	N:98	N:121	N:65	N:78	N:59	
Total Volume (ml)	5.6 ± 2.8	6.3 ± 2.76	6.69 ± 2.45	7.3 ± 3.45	5.5 ± 2.5	0.001
Right Lobe Volume (ml)	2.96 ± 1.43	3.27 ± 1.65	3.48 ± 1.71	3.86 ± 2.24	2.79 ± 1.53	0.002
Left Lobe volume (ml)	2.64±1.51	3 ± 1.29	3.2+/-1.28	3.4 ± 1.6	2.73±1.12	0.002

P-value <0.05 is significant.

Figure 1: Comparison of TGV with Age Group 21-60 years and 61 years and Onwards.



DISCUSSION

It is important to determine TGV according to the geographical locations. Most countries are now determining their own reference values for normal TGV according to their age, sex, height, weight and iodine intake. Mean TGV of healthy adults was noted to be as 6.44 ± 2.44ml in Sudan,[6] 6.629 ± 2.5ml in Nepal, [20]7.7 ± 3.3 ml in China,[3] 8.34 ± 2.37ml in Iran,[9] 8.55 ± 1.82ml in Nigeria,[4] 10.68 ± 2.83ml in Croatia,[21] 10.7 ± 4.6 ml in Netherland, [22] 11.9-12.6 ml in Denmark [10] and 13 ± 6.27ml in Turkey.[5] Mean TGV in this studied population was much smaller than that of the rest of the countries. It is a known fact that Pakistan has been an area of severe iodine deficiency for many years[23] and only recently International Council for Control of Iodine Deficiency Disorders 2013 (ICCIDD) has declared Pakistan as an iodine sufficient state.[24]

It is strongly suggested, that severe and prolonged iodine deficient status of Pakistan in recent past is probably responsible for small TGV in this population.

The study has also reported that mean TGV was significantly greater in males when compared to the females (P=0.00). Hasio YL et al from China in 1994,[3] Berghout et al from Amsterdam in 2008,[22] Yousef M et al from Sudan in 2011[6] and Seker et al from Turkey in 2010[5] has also reported significantly greater TGV in males than females. Many explainations have been given for the difference in TGV between the two genders. Nafisi et al and Hegedus et al suggested that the difference in body weight between male and female was the reason for this difference in TGV.[9,11] Abidi et al and Berghout et al proposed that the difference in lean body mass between the two genders could be an answer for an increased TGV in males.[7,22] The researchers suggested that larger size of anatomical structures in males can also be answer for increased TGV in males. However, these results were contrary to the study done in other Asian countries. Faraj F.H et al from Iran in 2007 and Kayastha P et al from Nepal in 2010 reported that difference in mean TGV in males and females was insignificant (P=0.076) (P>0.05).[25,20] However Kayastha P et al from Nepal in her study did prove significant correlation between TGV and anthropometric measurements.[20]

The study has also showed that the mean isthmus thickness (AP dimension) in males was significantly greater than that of females (P=0.00).Mean of transverse dimension of the isthmus was also significantly greater in males when compare to the female (P=0.00). Seker et al from Turkey in 2010 has supported this study and reported that mean isthmus thickness (AP dimension) in males (0.342 ± 0.114 cm) was also significantly greater than that of the females (0.310 ± 0.105cm) (p-value 0.021).[5] The researchers again suggest that difference in anthropometric measurements and anatomically larger organ size in males can the reasons for this difference.

The study showed that RL volume of thyroid was significantly greater than that of the LL in both the genders (P=0.001). Tahir et al in 2001, Seker S. et al in 2010, Yousef M. et al in 2008 and Ying M 2009 reported that the mean volume of RL of thyroid was also significantly greater than that of the LL of thyroid in both genders.[4,5,6,8,]. Asymmetry between the two lobes of thyroid gland is probably due to the presence of adjacent structures. Esophagus is normally deviated towards the left side of the midline. It is suggested that the deviation of esophagus gives more space to the right lobe of thyroid to grow resulting in the larger volume of the right lobe.[1,8]

The study has demonstrated that TGV increases with age. Mean TGV found in this study were 5.6 ml, 6.3 ml, 6.7 ml, 7.3 ml and 5.5 ml in age groups 1,2,3,4 and 5 respectively. The difference in TGV among the age groups was significant (P<0.05). Largest mean TGV reported in this study was in age group 4 (51 -60 years) (7.4± 3.8 ml). Reason for highest TGV in 51-60 years age group is not known but the study results are in accordance with those of Seker et al. He reported that TGV increased with increase in age till the age of 65 years. Mean TGV found in different age groups by Seker were 10ml, 13 ml, 14 ml, 16 ml, 17 ml and 12ml in age groups 15-24, 25-34, 35-44, 45-54, 55-64 and 65 years and above respectively.[5] However, In a study by Kayastha et al on Nepalese in 2010 largest TGV was found in age group 70 to 79 years (8.5 ± 4.9 ml).[20] Berghout et al in 1987 and Nafisi et al in 2010 failed to prove significant correlation between the age and TGV.[22,9]

Seker et al in 2010 hypothesized that TGV increases till 65 years of age and after 65 years the TGV decreases with the advancement in age.[5] This could not be proved as Seker was able to recruit only 9 individuals in this age group. The researchers in this study have tried to confirm this hypothesis and found a considerable decrease in TGV after the age of 60 years (P=0.044) and also after the age of 65 years (P=0.029). Ahmed Z et al in 2009 demonstrated decrease in serum TSH level after the age of 60 years which may probably be the reason for this decrease in TGV.[26] Secondly, atrophy of the organs due to aging can also be the reason for decreased TGV in elderly. [27] This finding is contrary to the study by Kayastha P et al where she reported an increase in TGV till the age of 80 years.[20]

This study was done on 2-dimensional ultrasound; 3-dimensional ultrasound would have given more accurate estimation of TGV.

CONCLUSION

Mean volume of thyroid gland in this studied population is not only smaller than that of the Western countries but is also much smaller than as reported in the neighboring country Iran. The study has also proved that there was a significant decrease in mean thyroid gland volume after the age of 60 years. Prolonged and severe iodine deficient status of Pakistan till recent past could be an answer for small thyroid gland volume in the studied population. Similar studies in future will give more accurate facts and figures regarding mean thyroid gland volume in this population if Pakistan retains itself as an iodine sufficient State.

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