



THE RELATIONSHIP OF THYROID GLAND VOLUME (TGV) WITH THYROID STIMULATING HORMONE (TSH) AND THE QUANTITATIVE MEASUREMENT OF THE VARIATIONS IN TGV IN RELATION TO PER UNIT INCREASE IN SERUM TSH

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ABSTRACT

Introduction: Thyroid gland (TG) secretes thyroid hormones that are essential for physical growth, mental development and metabolic homeostasis. Thyroid Stimulating Hormone (TSH) plays an important role in controlling thyroid gland volume (TGV) due to its mutagenic effects on thyroid follicular cells. Objectives of this study are to determine the relationship between thyroid gland volume (TGV) and serum TSH and also to measure the amount of variation that take place in TGV due to per unit increase in serum TSH levels in Karachi population.

Methodology: It was a cross sectional study in which serum TSH level of 128 subjects was evaluated. TGV was determined through ultrasonography. Linear Correlation and regression analysis between TGV and serum TSH level was then analyzed on SPSS version 21. P=Value <0.05 was considered significant. **Results:** Mean value of serum TSH of 128 subjects was $1.777 \mu\text{I/ml} \pm 1.108 \mu\text{IU/ml}$. Significantly negative correlation was observed between serum TSH and total TGV (P Value =0.03) and right lobe volume (P-Value =0.029). Through regression analysis it was determined that 3.7% of total variation in total TGV and also in right lobe volume are due to serum TSH. However the effect of serum TSH on left lobe volume of thyroid was found to be insignificant (P-Value =0.067). **Conclusion:** Correlation between Serum TSH and TGV demonstrated negative but significant effects on total TGV and right lobe volume. Regression analysis demonstrated with per unit increase in serum TSH, total TGV and right lobe volume decrease significantly. More detailed studies may accurately determine the volume of thyroid gland for the known level of serum TSH.

KEYWORDS: Thyroid Gland, Thyrotropin, Diagnostic imaging.

INTRODUCTION

Thyroid gland (TG) is one of the most researched organs as its normal development and function is vital for the almost all systems of human body. It regulates important body functions via the release of thyroid hormone.^[1] TG weighs about 25gms, is one of the main endocrine gland lying in cervical region. Grossly consists of two lobes connected to each other by isthmus. Each lobe of TG measures about 5 cm in length, 3cm in width and 2cm in thickness.^[2] TG needs optimum intake of iodine to maintain its standard metabolic state. Thyroid hormones are essential for physical growth, mental development and metabolic homeostasis.^[1]

Quantitative analysis of Thyroid Gland Volume (TGV) serves as an important factor which helps in analysis of various thyroid diseases. Age, gender, height, weight, body mass index, body surface area and lean body mass are the factors which influence TGV.^[3-9] Genetic variations in growth and development of populations also affect TGV.^[7] Previously, most extensive studies done are on the effect induced by iodine intake^[10, 11] and thyroid stimulating hormone (TSH) on TGV.^{[12,13][14-15]} TGV also gives us the evidence whether the gland is functioning properly. Thyroid hormones secretions are regulated by hypothalamus via the secretion of thyroid releasing hormone (TRH). TRH then signals pituitary gland to release TSH. When TSH binds to its receptors on the follicular cells of TG, it then stimulates the growth

of those follicular cells. Follicular cells in turn increase the synthesis and secretion of thyroid hormones.^[1, 14, 15]

It is also well documented that TSH and TSH receptor pathway is important in both, organization of the follicular cells of the thyroid and controlling TG size (1, 14, 15). Objectives of this study are to determine the relationship between TGV and serum TSH and also to measure the amount of variation that take place in TGV due to per unit increase in serum TSH levels.

METHODOLOGY

This study was permitted by the Ethical Review Board of the Ziauddin University and Hospital. The study was carried out at the Radiology Department of Ziauddin University Hospital Karachi. This is a cross-sectional study in which volunteers were gathered through the convenient sampling. A total of 145 healthy subjects of aged between 21 years and onwards were recruited initially. All the participants agreed and gave the consent in writing for participating in the study.

Subjects with personal or family history of thyroid disease were excluded from the study. Additionally, pregnant woman and those who had delivered within the last 12 months were also excluded as these conditions may affect TGV. Palpation of TG and signs and symptoms of thyroid disease were noted in order to exclude the volunteers with ignored thyroid disease.

Subjects were asked to fill a proforma based on demographic profile including age, gender, and socioeconomic status. Anthropometric parameters (height and weight) of each subject were also measured through the standard techniques. Physical examination of TG was performed and 17 volunteers were excluded due to palpable thyroid gland or thyroid nodule on physical examination. Serum TSH samples were then taken.

Ultrasonography of 128 subjects was done. Ultrasound machine Toshiba model SSA-590A with a 7.5-11 MHz transducer was used. Each volunteer was examined in supine position, with the neck hyperextend. Medirolateral and antero-posterior and craniocaudal dimensions of TG was noted. Total TGV was calculated by combining the volume of both the lobes that was obtained by using formula for prolate ellipsoid in 128 subjects. Volume of each lobe of thyroid was calculated by a formula that was recommended by WHO that is: Antero-posterior X Cranio-caudal X Medio-lateral X 0.479 (correction factor). Total TGV was determined by adding up the volume of both lobes. Isthmus dimensions were not included in the formula recommended by WHO.^[16]

Statistical Analysis

Data was analyzed using SPSS version 21. Kolmogorov-Smirnov test was applied to check the normality. The data failed to follow the normality assumption therefore Log transformation was applied to

normalize the data. Pearson's correlation was applied to determine the correlation between TGVs and serum TSH level. Regression analysis was applied to determine the amount of variation in TGV due to per unit increase in serum TSH. P-value < 0.05 was considered as significant.

RESULTS

Mean value of serum TSH of 128 subjects was 1.777 $\mu\text{I}/\text{ml} \pm 1.108 \mu\text{IU}/\text{ml}$. Minimum and maximum range of serum TSH was 0.31 $\mu\text{I}/\text{ml}$ and 7.58 $\mu\text{I}/\text{ml}$ respectively. Significantly negative correlation is observed between serum TSH and total TGV and right lobe volume. Correlation between TGV with serum TSH level is shown in table 2.

Table 1: Correlation analysis between serum TSH and thyroid gland volume

N=128	Right lobe volume	Left lobe volume	Total Thyroid gland volume
Correlation Coefficient	-0.193	-0.162	-0.192
Sig(2-tailed)	0.029*	0.067	0.030*

*. Correlation is significant at the 0.05 level (2-tailed).

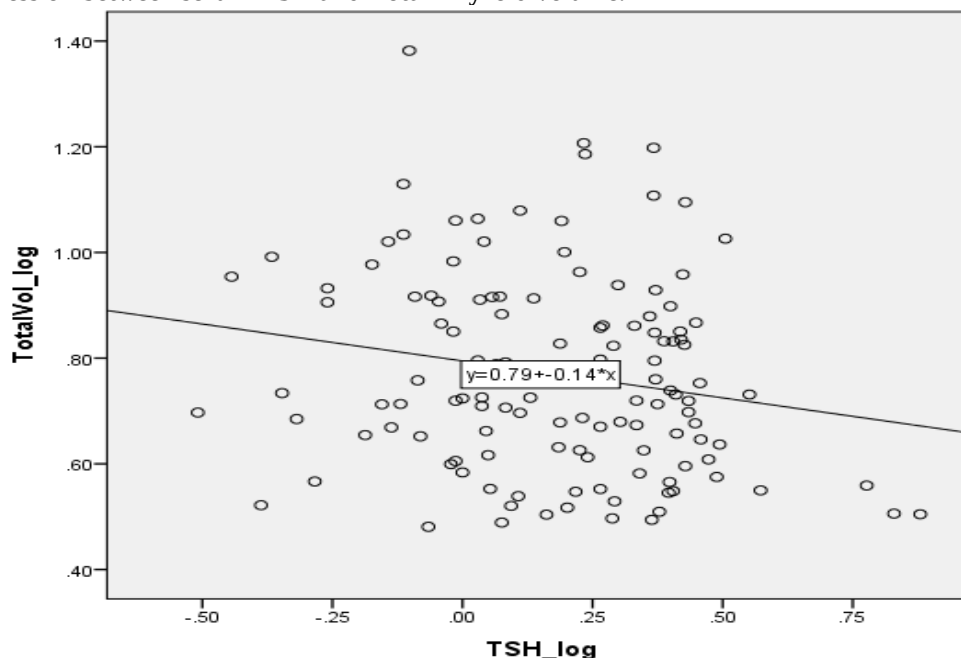
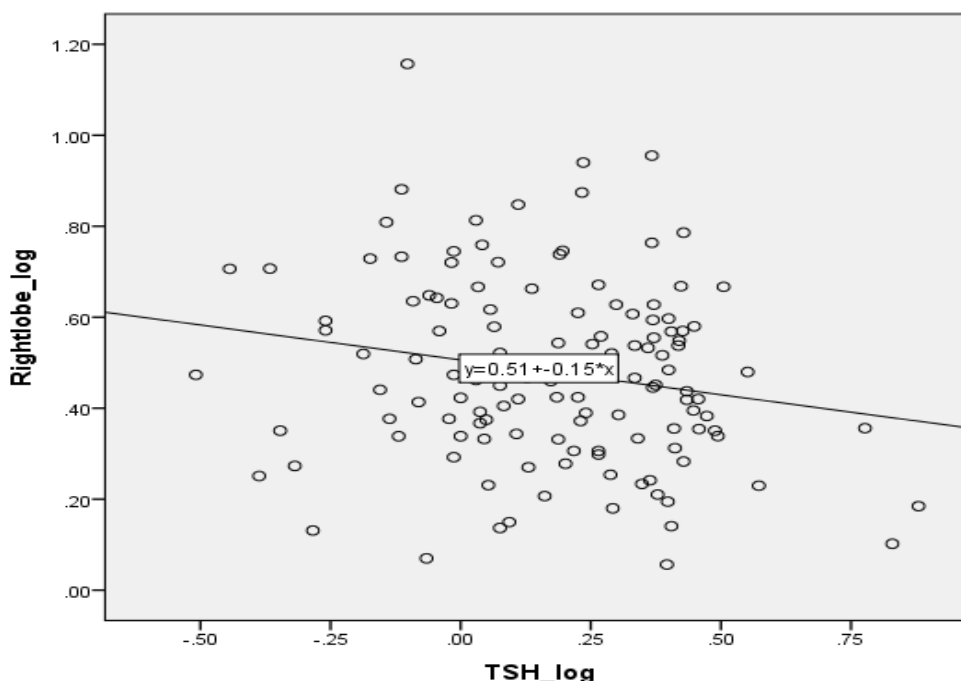
Amount of variation in Total TGV, Right lobe volume and left lobe volume due to per unit increase in serum TSH is shown in table 2.

Table 2: Variation in TGV due to per $\mu\text{IU}/\text{ml}$ increase in serum TSH.

Thyroid volumes and dimensions N=128	β_1	β	R - square	P- Value
Left lobe volume	-0.122	0.471	0.026	0.067
Right lobe volume	-0.153	0.506	0.037	0.029*
Total thyroid volume	-0.140	0.797	0.037	0.030*

Table 2: β_1 =regression intercept, β = Constant P-Value < 0.05 is significant.

*. Correlation is significant at the 0.05 level (2-tailed).

Graph 1: Regression between serum TSH and Total Thyroid volume.**Graph 1: Regression analysis determining the inverse linear relationship between serum TSH and Total Thyroid volume.****Graph 2: Regression between serum TSH and Right Thyroid Lobe Volume****Graph 2: Regression analysis determining the inverse linear relationship between serum TSH and Right Thyroid Lobe volume.**

DISCUSSION

Overestimation of goiter in a population is common and clinical measurement of TGV is usually inclined to inaccuracy. Therefore detailed study of TGV and its determinant is vital.^[17] Among the numerous factors that

are involved in regulation of TGV, most comprehensively studied is the effect of serum TSH on thyroid gland volume. Data obtained from previous studies demonstrated that TSH has a mitogenic effect on thyroid follicular cell.^[13] These follicular cells in turn

increase the synthesis and secretion of thyroid hormones in almost every possible approach.^[14, 15] Therefore objectives of this study were to determine the relationship between thyroid gland volume and serum TSH and also to determine the amount of variation in thyroid gland volume due to per $\mu\text{IU/ml}$ increase in serum TSH levels in Karachi populations.

In this study negative and weak correlation has been observed between TGV and serum TSH among the healthy adults. This finding is very much similar to the study done by Gomez et al where he also demonstrated negative correlation between serum TSH and TGV in Spanish subjects ($r=-0.26$, $P\text{-value}=0.001$).^[18] Barrere et al also demonstrated inverse relationship between serum TSH and TGV among French subjects in both the genders.^[19] while results from Hegedüs et al. (1983), Berghout et al. (1987) and Adibi et al (2008) does not support this finding and concluded that there is a lack of significant correlation between serum TSH level and TGV.^[8, 11, 20]

The study also demonstrated through the regression analysis that if the effect of serum TSH is completely eliminated then the average volume of TG would be 0.797ml. And the average right lobe volume would be 0.506ml. With per unit ($\mu\text{IU/ml}$) increase in serum TSH level total TGV and right lobe volume decreases by 0.140 ml ($P\text{-value}= 0.03$) and 0.153ml ($P\text{-value}=0.029$) respectively. Through regression analysis we can also determine that 3.7% of total variation in total TGV and also in right lobe volume are probably due to serum TSH. However the effect of serum TSH on left lobe volume of thyroid was found to be insignificant ($P\text{-Value}=0.067$).

The study was limited to the use of 2 dimensional ultrasound machines. However 3 dimensional ultrasound machines with larger sample size would have given better and more appropriate results.

CONCLUSION

Wide varieties of environmental factors including serum TSH level are known to stimulate thyroid growth. Correlation between Serum TSH and TGV demonstrated negative but significant effects on total TGV and right lobe volume. Regression analysis demonstrated with per unit increase in serum TSH total TGV and right lobe volume decrease significantly. More detailed studies may accurately determine the volume of thyroid gland for the known level of serum TSH.

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