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Thyroid Volume and Doppler Indices of the Inferior Thyroid Artery in Clinically Euthyroid Adults in Kashmir

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Abstract. The objective of the research was to evaluate thyroid volume and spectral indices (the resistivity index, the pulsatility index and the peak systolic velocity) in normal euthyroid adults in Kashmir.

Materials and methods. There was carried out a prospective observational study at a tertiary care hospital; 182 normal euthyroid adults (102 males and 80 females) were included in the study. Thyroid gland volume was calculated from grey-scale ultrasound images followed by spectral Doppler evaluation of the bilateral inferior thyroid arteries; the resistivity index, the pulsatility index and the peak systolic velocity were calculated for the bilateral inferior thyroid arteries with calculation of the mean values.

Results. The mean thyroid volume was 7.8 ± 1.9 ml with no significant difference in males and females. The mean peak systolic velocity obtained was 15.65 ± 6.5 cm/s. The mean pulsatility index and resistivity index were 0.95 ± 0.29 and 0.58 ± 0.13 , respectively. There was no significant difference in the values obtained among both genders, and no significant difference was seen in values of the right and left inferior thyroid arteries.

Conclusions. The study showed no significant difference in the indices of thyroid volume and the inferior thyroid arteries measured by Doppler ultrasonography in euthyroid adult males and females. As thyroid vascularity is altered in many thyroid pathologies, the study will serve as the baseline for the evaluation of thyroid volume and Doppler parameters in patients with altered thyroid function.

Keywords: *peak systolic velocity; pulsatility index; resistivity index; inferior thyroid artery; thyroid function.*

Problem statement and analysis of the recent research

Ultrasound of thyroid gland is nowadays the most common investigation as thyroid pathologies are associated with alterations in thyroid volume, echogenicity and blood flow patterns of the thyroid gland. A number of studies have found the alterations in glandular vascularity in various thyroid disorders [1, 2]. High systolic velocities have been found in thyroid arteries with Doppler studies; the peak systolic velocity (PSV) of the superior or inferior thyroid arteries has been found to be useful in differentiating various causes of hyperthyroidism [3-7]. Doppler ultrasound of the thyroid gland is cheap and easily available test with no radiation exposure and is less time consuming. Limited studies have been conducted to establish normal parameters of the thyroid gland, the superior thyroid artery (STA) and the inferior thyroid artery (ITA) [8, 9] and no study exists in Kashmiri context. This study intended to find normal ranges of thyroid volume in Kashmiri population as well as Doppler indices of the inferior thyroid arteries (ITAs) to serve as baseline study for studies involving thyroid pathologies.

Materials and methods

A prospective observational study involving euthyroid individuals was carried out in a tertiary care hospital from January 2018 to July 2018. Institutional Ethics Committee clearance was obtained. Informed consent was taken from all individuals prior to performing the study. All of them underwent thyroid hormone analysis for routine evaluation earlier. All the subjects underwent detailed clinical evaluation including history taking, resting pulse rate, neck examination, etc., prior to ultrasonography. All the subjects were clinically euthyroid, with normal

thyroid function tests and no clinical manifestations of thyroid related conditions. Subjects with ages less than 15 years old and more than 60 years old were excluded from the study. Doppler ultrasonography of the subjects was performed after making them to take adequate rest. The subjects were made to lie in supine position with neck extended upon increasing pillow height. The study was conducted using the GE LOGIQ P5 ultrasound system and a linear array probe with frequency range of 6-12 MHz was used. Grey-scale ultrasound was performed first to assess normal thyroid echopattern, as well as to measure normal thyroid volume. Thyroid volume was calculated as the sum of the volumes of both thyroid lobes; the volume of the isthmus was excluded. The volume was calculated as anteroposterior (AP) dimension x transverse dimension x longitudinal dimension x 0.50 as is measured for any ellipse. Any subjects with abnormal thyroid parenchymal echogenicity or an incidentally found thyroid nodule were excluded from the study as well. Then, the inferior thyroid artery was found just posterior to the inferior pole of the thyroid gland and spectral Doppler pattern was taken and the values such as the PSV, the resistivity index (RI), the pulsatility index (PI) were calculated for the bilateral inferior thyroid arteries. The parameters used for Doppler assessment were pulse repetition frequency (PRF) of 2.7 kHz, the frequency of 7.2 MHz, the wall filter of 76 Hz with Doppler angle <60 degrees. The observations were tabulated using Microsoft Excel 2010 worksheet. The mean values of all parameters were calculated. The Mann-Whitney U test was used to compare the values between both genders and the values of the parameters in the bilateral thyroid arteries.

Results

A total of 182 subjects were included in the study; there were 102 males (56.1%) and 80 females (43.9%). The age range of subjects was 19 to 58 years (the average age was 34.6 years). All subjects were clinically euthyroid with normal thyroid function tests which they underwent six months prior to study. At first, grey-scale ultrasound of the thyroid gland was performed, and thyroid volume was calculated as the sum of the volumes of both thyroid lobes. The mean volume of the thyroid gland was 7.8 ± 1.9 ml. The mean volume of the right lobe was 4.1 ± 1.6 ml, the mean volume of the left lobe was 3.8 ± 1.6 ml; the difference in the volumes was statistically insignificant ($p=1$). The difference in thyroid volume between males (mean volume - 8.1 ± 1.9 ml) and females (mean volume - 7.5 ± 1.8 ml) was statistically insignificant as well.

Then, Doppler evaluation of the bilateral inferior thyroid arteries was performed in all subjects, and a total of 364 inferior thyroid arteries were evaluated. Each examination lasted approximately 10 minutes. All the ITAs sampled showed an initial steep systolic upstroke and a more gradual initial diastolic downstroke, followed by a plateau in diastolic phase on spectral tracing. The flow indices were calculated manually. The mean PSV of 15.65 ± 6.5 cm/s was observed in the inferior thyroid arteries. The mean PSV of the right ITA was 16.25 ± 6.3 cm/s, the mean PSV of the left ITA was 15.05 ± 5.5 cm/s. The difference in the values of the mean PSV in the bilateral ITAs was not statistically significant. The mean PSV of the ITA in males was 15.3 ± 5.2 cm/s, the mean PSV in females was 15.9 ± 6.1 cm/s; the

Table 1. Mean values of thyroid volume and Doppler indices in euthyroid individuals

Parameter	Mean values of all subjects	Mean value in females	Mean value in males
Thyroid volume	7.8±1.9 ml	7.5±1.8 ml	8.1±1.8 ml
PSV	15.65±6.5 cm/s	16.1±6.1 cm/s	15.3±5.2 cm/s
RI	0.58±0.13	0.55±0.15	0.61±0.11
PI	0.95±0.29	0.91±0.30	0.98±0.28

Note: $p > 0.05$ for all parameters

difference in the mean values was statistically insignificant.

The mean RI and PI values were found to be 0.58 ± 0.13 and 0.95 ± 0.29 , respectively. There was no statistically significant difference in the mean RI and PI values between males (RI= 0.61 ± 0.11 , PI= 0.98 ± 0.28) and females (RI= 0.55 ± 0.15 , PI= 0.91 ± 0.30) (Table 1).

Discussion

Thyroid disorders are of important concern due to their effect on thyroid function causing either hyperthyroidism or hypothyroidism. Both hypothyroidism and hyperthyroidism have serious implications for the patients' overall wellbeing. Early diagnoses of thyroid pathologies may help in treating the patient at early stages of the disease thereby curtailing the long-term effects of hypo/hyperthyroidism.

Although blood tests are quite specific for diagnoses of various thyroid disorders, the differentiation of the underlying etiology is not always possible which results in significant therapeutic implications. Radionuclide studies play an important role; however, they have certain limitations, namely non-availability, time consuming, radiation exposure; in addition, they are contraindicated for use during pregnancy and lactation. Therefore, recently, emphasis has been laid upon ultrasound features of various thyroid pathologies and the assessment of the alterations in blood supply of the thyroid gland that has been found to be useful in differentiating various thyroid pathologies (Grave's disease versus other autoimmune thyroiditis). However, there is a lack of studies involving normal values in euthyroid individuals to serve as baseline for studies in thyroid pathologies. Our study was carried out for the same purpose.

Several studies have found some variations in thyroid volume in patients with thyroiditis [9]. In our study, the mean thyroid volume was 7.8 ± 1.9 ml. We found no significant difference in thyroid volume between males and females. Berghout et al. found the mean thyroid volume of 10.7 ± 4.6 ml in 50 healthy adults in Amsterdam that slightly exceeded our mean value. Moreover, they found that thyroid volume is related to body weight and is not related to age which may explain the findings [10].

Several studies have documented altered vascularity of the thyroid gland in diffuse thyroid diseases. Jebreel et al. [1] found that the expression of the vascular endothelial growth factor gene varied in different types of thyroid pathologies. Bogazzi et al. [4] discovered increased thyroid parenchymal vascularity in many forms of thyrotoxicosis, as well as Graves' disease. Zhao et al. and Uchida et al. demonstrated the superior thyroid arterial PSV of above 40–50 cm/s as a diagnostic feature of Graves' disease; according to them, the PSV of the STA ensures a reliable differentiation of various etiologies of thyrotoxicosis [5, 11]. These researches have studied cut off PSV values for Graves' disease; however, only few studies have been carried out to establish normal values of Doppler indices of the STA and the ITA.

In our study, we found the mean PSV of 15.65 ± 6.5 cm/s. The mean PSV of the right ITA was 16.25 ± 6.3 cm/s, mean PSV of the left ITA was 15.05 ± 5.5 cm/s. The mean PSV of the ITA in males was 15.3 ± 5.2 cm/s, the mean PSV in females was 16.1 ± 6.1 cm/s. We found no significant difference between the mean PSV of the right and left ITAs and between the means of males and females. Banaka I et al. [12] found the PSV of 19.2 cm/s in normal euthyroid individuals with the RI of 0.58 that is similar to the values obtained in our study. In addition, they found the PSV of 60 cm/s to be highly specific for differentiating Hashimoto's disease from Grave's disease. Tulio A Macedo et al. [7] found the mean PSV of 19.20 cm/s in females and 20.35 cm/s in males with the RI values of 0.61 and 0.61, respectively that is similar to the values obtained in our study.

Conclusions

In this study, we found the mean values of thyroid volume and Doppler indices of the ITA which can be used as reference values for the studies involving the same parameters in patients with thyroid pathologies. Further studies should focus on assessing the role of altered Doppler indices in the evaluation of thyroid pathologies and their role in early diagnosis of thyroid disorders.

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