Original Article

Thyroid volume by ultrasound in asymptomatic gravid and non-gravid controls in a negroid population in Nigeria

Okafor Chioma Henrietta, Ugwu Anthony C.[1], Adejoh Thomas

Department of Radiology, Nnamdi Azikiwe University Teaching Hospital, [1]Department of Radiography and Radiological Sciences, College of Health Sciences, Nnamdi Azikiwe University, Nnewi, Nigeria

Abstract

Background: The thyroid gland is among the most commonly imaged glands using ultrasound due to the limitation of clinical examination. During pregnancy, thyroid volume responds physiological to the increased demands for iodine and energy. An enlargement of the thyroid gland during gestation is, therefore, not abnormal. However, this may be confused for goiter, which the World Health Organization (WHO) and the International Council for the Control of Iodine Deficiency Disorders have recommended to be investigated through ultrasound. **Objective:** To establish a local reference volume of the thyroid gland in asymptomatic pregnant women that could be used to define goiter in the context of iodine deficiency disease monitoring. **People and Methods:** A total of 430 volunteers made up of 399 pregnant women and 31 nonpregnant female control were recruited prospectively and purposively. After obstetrics scan with a 3.5 MHz curvilinear transducer, the subject's thyroid gland was subsequently scanned with a 7.5 MHz linear transducer. The cranio-caudal, antero-posterior, and transverse diameter of each lobe represented the length, height, and width, respectively. These were subsequently multiplied with a WHO-recommended correction factor (0.479) to derive the volume. A summation of the volumes of both lobes gave the total thyroid volume for each subject. **Results:** The mean thyroid volumes (±standard deviations) in pregnant women and nonpregnant controls were 8.26 ± 4.17 cm^3 and 2.54 ± 0.46 cm^3, respectively. The mean for the first to third trimesters were 5.17 ± 1.83 cm^3, 7.81 ± 2.44 cm^3, and 11.81 ± 4.53 cm^3, respectively. A one-way analysis of variance showed significant differences in the mean thyroid volumes within the three trimesters (P = 0.000). **Conclusion:** The wide variation in thyroid volume between pregnant women and nonpregnant controls points to the possibility of deficient dietary iodine intake during gestation in our locality. Special attention on daily minimum iodine intake for gravid women as recommended in other countries is advised.

Key words: Pregnant women, thyroid, ultrasound, volume

Address for correspondence:
Dr. Okafor Chioma Henrietta,
Department of Radiology, Nnamdi Azikiwe University Teaching Hospital, Nnewi, Nigeria.
E-mail: beholi80@yahoo.com

Access this article online	
Quick Response Code:	Website: www.jecajournal.com
	DOI: 10.4103/1596-2393.177025

INTRODUCTION

Differences in pregnancy-associated alterations in thyroid volume have been attributed to geographical variations

How to cite this article:
Okafor, C. H., Ugwu, A. C. & Adejoh, T. (2015). Thyroid volume by ultrasound in asymptomatic gravid and non-gravid controls in a negroid population in Nigeria. Journal of Experimental and Clinical Anatomy, 14(2), 116-119.

in dietary iodine intake and increased renal loss of iodine has been suggested as the cause of thyroid enlargement, the so-called pregnancy goiter (Smyth *et al*., 1997). The diagnosis of increased thyroid volume in field studies has been based on inspection and palpation using the World Health Organization (WHO) criteria of thyroid lobes that are larger than the terminal phalanges of the thumb. However, this criterion has been questioned because it has been shown that inspection and palpation suffer from marked inter-observer variability, an overestimation of goiter prevalence, (Mehraj *et al*., 2004) and a low sensitivity and specificity (Servet and Ismet, 2010).

These limitations have made alternative assessment procedures such as ultrasound, radionuclide studies, computed tomography (CT), and magnetic resonance imaging (MRI) very desirable. However, while CT and MRI provide structural information of the thyroid gland just like ultrasound, they are relatively more expensive. Radionuclide studies, on the other hand, provide functional rather than structural information (Tahir *et al*., 2002) Ultrasound is noninvasive, widely available, less expensive, and does not use any ionizing radiation. Furthermore, real-time ultrasound imaging helps to guide diagnostic and therapeutic interventional procedures in cases of thyroid disease (Chaudhary and Bano, 2012).

Although, ultrasound is operator dependent, suffers from inter-observer variability (Mehraj *et al*., 2004), and cannot determine thyroid function, for which a blood test or radioactive isotope uptake test is generally required, it is the most sensitive imaging modality available for examination of the thyroid gland and associated abnormalities (Chaudhary and Bano, 2013).

The superficial location of the thyroid gland also makes it even more suitable for investigation with ultrasound as the high-resolution property of the scanner gives the opportunity for evaluating the morphology and dimensions of the gland adequately (Servet and Ismet, 2010).

Although it has been observed that thyroid volume is variable in different regions the WHO has gone ahead to recommend universal normative values, the suitability of the concept has been questioned, with important issues being inter-observer variability (Mehraj *et al*., 2004). Nevertheless, the WHO values provide an appropriate standard for comparison of regionally-quantified volumes (Marwaha *et al*., 2008). However, a standard normative value of thyroid volumes in pregnancy that can form the basis for predicting goiter is not available in our locality. The study aims to investigate likely values of thyroid volumes during pregnancy.

PEOPLE AND METHODS

The study was a clinic-based prospective and cross-sectional study involving 399 pregnant volunteers and 31 nonpregnant control aged 20–40 years. The formula was used to determine a sample size of 430 volunteers who were recruited through convenience sampling. The research was carried out in May and June 2015 at the Ultrasound Units of Nnamdi Azikiwe University Teaching Hospital, Nnewi (NAUTH) and Saint Charles Borromeo Hospital, Onitsha (Borromeo).

A 2008 Japan-made, Siemens Aloka-Prosound (SSD-3500SX) ultrasound machine and a Siemens Sonoline both with 7.5 MHz linear transducers were available at NAUTH and Borromeo Hospitals, respectively. Both institutions also had lower frequency transducers for obstetrical scans. The two institutions are foremost hospitals in Anambra State with well-calibrated ultrasound machines, high throughput of obstetrics patients, and adequate space to accommodate the research. Ethical approval (NAUTH/CS/66/Vol. 6/02 of May 2015) was obtained from the Human Research Ethics Committee of NAUTH. Subjects also gave and signed informed consents and the confidentiality of elicited information as well as patient anonymity were strictly maintained.

The pregnant volunteers who were obstetrics patients were scanned with their heads on pillows for comfort. Third trimester patients were occasionally turned onto lateral decubitus position to minimize supine hypotension syndrome. The gestational age (GA) of the embryo was obtained with the crown-rump length metric while biparietal diameter and femur length were used to obtain the GA for the second and third trimesters respectively. A trimester consisting of 13 weeks was adopted.

For the thyroid scan, patients with a history of thyroidectomy and those whose glands were displaced from its central locations as observed during scan were excluded (Moore and Dalley, 1999). From the *ab initio* obstetrics scan position, the pillow was re-adjusted to bring it behind the shoulders to create maximum surface area of the thyroid gland through hyperextension of the neck. From frozen longitudinal images, a cranio-caudal and antero-posterior diameter which represented length (L) and depth (D) were obtained while width (W) was quantified from a frozen transverse image [Figures 1 and 2]. The volume for each lobe was derived by multiplying a WHO-recommended correction factor (0.479) by the L × W × D (Shabana *et al*., 2006). The left and right thyroid lobe volumes for each patient were then summed up to obtain the total thyroid volume.

The data were analyzed with the aid of the Statistical Package for the Social Sciences, version 17.0

(SPSS Inc., Chicago, Illinois, USA). The results are expressed as a mean ± standard deviation. While independent sample *t*-test was used to test for significance of differences in mean thyroid volume between pregnant volunteers and controls, an analysis of variance was used for the same purpose in the three semesters. The criteria for statistical significance adopted was $P < 0.05$.

RESULTS

A total of 399 gravid volunteers and 31 nongravid control aged 20–40 years participated in the study. The mean age and body mass index (BMI) was 30.04 ± 5.5 years and 26.21 ± 3.19 kg/m² respectively. The mean thyroid volumes derived were 5.16 ± 1.83 cm³; 7.81 ± 2.45 cm³; and 11.80 ± 4.43 cm³ for first, second, and third trimesters, respectively. The results are summarized in Tables 1 and 2.

Pearson's bivariate correlation analyses indicated a moderate relationship between thyroid volume and weight (r = 0.53; P = 0.000), a poor relationship with BMI (r = 0.34; P = 0.000) and height (r = 0.31; P = 0.000) and no relationship with age whatsoever (r = 0.02; P = 0.711). Aside age, however, all the relationships were statistically significant [Table 3].

DISCUSSIONS

Ultrasound-measured increases in thyroid volume during pregnancy have been reported from areas where daily dietary iodine intake was low. In contrast, areas replete in iodine showed either no difference or only a slight increase in goiter prevalence on ultrasound-measured thyroid volume between pregnant and nonpregnant women (Smyth *et al*., 1997). This observation was the motivation for this work. In our country, only iodized salt is permitted for sale. However, whether our locality is iodine-deficient or replete was not verified.

Table 1: Anthropometric characteristics of volunteers (*n*=430)

Variable	Age (years)	Height (m)	Weight (kg)	BMI (kg/m²)
Range	20-40	135-176	52-106	20.02-40.89
Mean	30.04±5.50	162.7±6.92	68.79±9.12	26.21±3.19

BMI - Body mass index

Our work established a mean thyroid volume of 8.26 ± 4.17 cm³ and 2.54 ± 0.46 cm³ for pregnant and nonpregnant control, respectively. The thyroid volume increased progressively from 5.16 ± 1.83 cm³, through 7.81 ± 2.45 cm³–11.80 ± 4.43 cm³ in first, second, and third trimesters, respectively [Table 2]. A previous work studied pregnant women and controls in an area of moderate iodine intake and derived a mean thyroid volume of 13.9 ± 0.8 mL and 16.0 ± 0.7 mL for first and third trimesters, respectively (Smyth *et al*., 1997).

Although the increment found in their work as well as in another work (Fister *et al*., 2009), confirm our finding, there was a higher volume from the earlier work as shown by the mean value from their control (11.3 ± 0.5 mL) being comparable to our third trimester value (11.80 ± 4.43 cm³). It is reported in the literature that a moderate increment in thyroid volume during pregnancy is normal in iodine-sufficient areas (Sebotsa *et al*., 2003). We observe this moderate tendency in our subjects and infer that our area may be iodine sufficient.

The range of thyroid volume in nonpregnant control from our work was 1.80 to 3.69 cm³. However, previous works in other regions reported a normal limit of 10–15 cm³ (Vila *et al*., 2008), and 8–16 cm³ (Smyth *et al*., 1997) The low value in our work may be pointer to the fact that there is iodine sufficiency in our region.

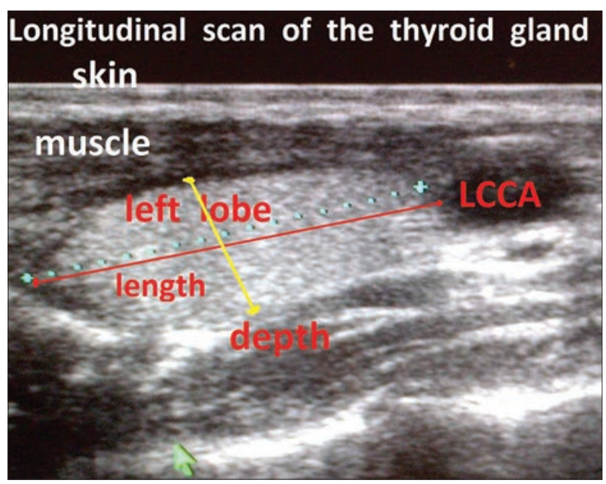

Figure 1: Measurement reference points for length and depth

Table 2: Thyroid volumes in trimesters

Groups	Number of subjects	Range (cm³)	Mean (cm³)	Mean test metric	P
Control	31	1.80-3.69	2.54±0.46	*t*-test	0.000 (significant)
1st trimester (0-13 weeks)	133	2.79-17.30	5.16±1.83	ANOVA	0.001 (significant)
2nd trimester (14-26 weeks)	133	3.42-14.56	7.81±2.45		
3nd trimester (27-39 weeks)	133	3.98-23.23	11.80±4.43		
Mean	399 (gravid)		8.26±4.17		

ANOVA - Analysis of variance

Table 3: Correlation of thyroid volume with anthropometric variables

Anthropometric variable	Bivariate correlation (*n*=399)	
	Coefficent (*r*)	*P*
Age	0.02	0.711
Height	0.31	0.000
Weight	0.53	0.000
BMI	0.34	0.000

BMI - Body mass index

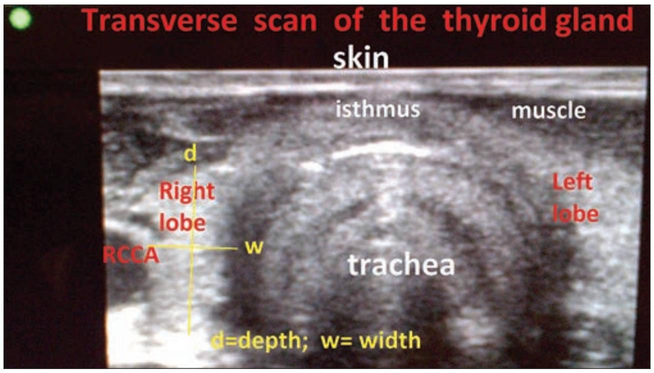

Figure 2: Measurement reference points for width

As was as also reported in the literature, thyroid volume is influenced by anthropometric variables (García-Solís *et al*., 2013). Our control subjects were mostly very young undergraduate students with negatively-skewed ages and weights.

This study also found significant correlation between thyroid volume and weight ($r = 0.53$; $P < 0.05$) in pregnant subjects [Table 3]. This finding is corroborated by closely-similar works (Servet and Ismet, 2010; García-Solís *et al*., 2013), where it was reported that in addition to weight, thyroid volume also correlated significantly with age, height, weight, body surface area and BMI. We found no correlation whatsoever with age ($r = 0.02$) but noticed some poor correlation with BMI ($r = 0.34$) and height ($r = 0.31$). Perhaps if we had analyzed nonpregnant controls separately from pregnant women, we might have arrived at the same conclusion as other researchers.

CONCLUSION

Normal thyroid volumes in three trimesters of pregnancy which will serve as a reference point in screening for goiter has been established.

Limitation

There was difficulty in recruiting older ladies and slightly-obesed ladies as control. Most of our control subjects were young and of normal weight.

Recommendations

A longitudinal study in same subjects before, during and after pregnancy will be quite profound.

Financial Support and Sponsorship

Nil.

Conflicts of Interest

There are no conflicts of interest.

REFERENCES

1. Chaudhary V., Bano S. (2012). Imaging of the thyroid: Recent advances. Indian J Endocrinol Metab 16 (3):371-6.
2. Chaudhary V., Bano S. (2013). Thyroid ultrasound. Indian J Endocrinol Metab 17 (2):219-27.
3. Fister P., Gaberscek S., Zaletel K., Krhin B., Gersak K., Hojker S. (2009). Thyroid volume changes during pregnancy and after delivery in an iodine-sufficient Republic of Slovenia. J Eur Obstet Gynecol Reprod Biol 145 (1):45-8.
4. García-Solís P., Solís S.J., García-Gaytán A.C., Reyes-Mendoza V.A., Robles-Osorio L., Villarreal-Ríos E, *et al*. (2013). Iodine nutrition in elementary state schools of Queretaro, Mexico: Correlations between urinary iodine concentration with global nutrition status and social gap index. Arq Bras Endocrinol Metabol 57 (6):473-82.
5. Marwaha R.K., Tandon N., Ashraf G.M., Ganguly S.K., Batra A., Aggarwal R., *et al*. (2008). Ultrasound evaluation of thyroid size: A large nationwide study of school children in India. Natl Med J India 21 (2):69-74.
6. Mehraj S., Suhail A.R., Tariq S., Al-Shoumer K.A. (2004). Technical observations on the assessment of thyroid volume by palpation and ultrasonography. J Ultrasound Med 23 (2):261-6.
7. Moore K.C., Dalley A.F. (1999). Imaging tests and clinical relations of thyroid gland. Clinically Oriented Anatomy. 4th ed. Lippincott Williams and Wilkins, Philadelphia, p. 1033-5.
8. Sebotsa M.L., Dannhausr A., Joost P.L., Joubert G. (2003). Prevalence of goiter and urinary iodine status of primary-school children in Lesotho. Bull World Health Organ 81 (1):28-34.
9. Servet Ş., Ismet T. (2010). Determination of thyroid volume and its relation with isthmus thickness. Eur J Gen Med 7 (2):125-9.
10. Shabana W., Peeters. E., Michel D.M. (2006). Measuring thyroid gland volume: Should we change the correction factor? Am J Radiol 186 (1):234-6.
11. Smyth P.P., Hetherton A.M., Smith D.F., Radcliff M., O'Herlihy C. (1997). Maternal iodine status and thyroid volume during pregnancy: Correlation with neonatal iodine intake. J Clin Endocrinol Metab 82 (9):2840-3.
12. Tahir A., Ahidjo A., Yusuph H. (2002). Ultrasonic Assessment of thyroid size in Maiduguri, Nigeria. West Afr J Ultrasound 3:26-31.
13. Vila L., Legaz G., Barrionuevo C., Espinel M.L., Casamitjana R., Muñoz J, *et al*. (2008). Iodine status and thyroid volume changes during pregnancy: Results of a survey in Aran Valley (Catalan Pyrenees). J Endocrinol 31 (10):851-5.