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TIKUR ANBESSA

ADDIS - ABABA UNIVERSITY, COLLEGE OF HEALTH SCIENCE

SCHOOL OF MEDICINE, DEPARTMENT OF RADIOLOGY

ADDIS ABABA, ETHIOPIA

A Research on

**Sonographic estimation of normal palatine tonsil size in under
18-year-old patients who visit TASH: ADDIS-ABABA, ETHIOPIA**

Addis Ababa, Ethiopia

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Sonographic estimation of normal palatine tonsillar size in under 18-year-old patients who visit TASH: ADDIS-ABABA, ETHIOPIA

A Thesis Submitted to Addis Ababa University, College of Health Sciences, School of Medicine, Department of Radiology, In Partial Fulfillment of the Requirements for Postgraduate Specialty Certificate in Radiology 2023

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Declaration

I, Dr. Raja Tamiru Muleta with the registration number of GSR/2052/13; do hereby declare that this thesis entitled 'Sonographic estimation of normal palatine tonsillar size in under 18-year-old patients who visit TASH: Addis-Ababa, Ethiopia' is my original work and that it has not been submitted partially; or in full, by any other person for an award of degree in any other university/institution.

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Approval

*The undersigned certify that they have read and hereby recommended to Addis Ababa University to accept the thesis submitted by **Dr. Raja Tamiru Muleta** entitled '**Sonographic estimation of normal palatine tonsillar size in under 18-year-old patients who visit TASH: Addis-Ababa, Ethiopia**' for partial fulfillment of the requirements for the award of certificate in Clinical Radiology.*

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ABSTRACT

Background

Currently, there is no standard normal tonsillar measurement using ultrasound which can be used for comparison with an abnormal palatine tonsil in clinical practice.

Objectives

In this study we aim to estimate normal palatine tonsil size using ultrasound in children who have no tonsillar related disease in TASH, Addis Ababa, Ethiopia.

Methods

A prospective cross-sectional study was conducted at TASH. The study was conducted on patients under age of 18 years who visit the hospital for complaints unrelated to tonsillar diseases from May 26 - September 30, 2023. A structured research tool was used to collect all the necessary data from participants selected by convenience sampling. Data was entered and analyzed using SPSS version 27 software.

Results

A total of 265 patients were enrolled in the study in the age range of 0 – 18 years. The mean palatine tonsillar volume \pm SD for the right palatine tonsil was $0.97\text{cm}^3 \pm 0.55$ and it was $0.97\text{cm}^3 \pm 0.56$ for the left tonsil. We did not identify any significant correlation between PT values and sex as well as the side of palatine tonsil measured. We detected a significant positive correlation between PT values and height, weight and BMI. Height having strongest correlation and BMI the least.

Conclusion

These normal tonsillar sizes on transcervical ultrasound can be used to diagnose tonsillar pathologies. Palatine tonsil size correlates with age, height, weight, and BMI; however, no correlation is present for sex and side.

Key words: palatine tonsil, transcutaneous ultrasound, tonsillitis.

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ABBREVIATIONS

AAU-Addis Ababa University

BMI- Body Mass Index

CT- Computed Tomography

MRI- Magnetic Resonance Imaging

PT- Palatine Tonsil

TASH- Tikur Anbessa Specialized Hospital.

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1. INTRODUCTION

The palatine tonsils are located between the palatoglossal arch and the palatopharyngeal arch of the soft palate, in the oropharynx. As located at the entrance to the upper respiratory and gastrointestinal tracts, the palatine tonsils serve as a main immunocompetent tissue in the body [1, 2]. The palatine tonsil is an ovoid, solid lymphoid gland located in the lateral wall of the oropharynx, between the anterior and posterior pillars. The tonsillar surface is irregular with numerous ingrowths of the surface epithelium known as tonsillar crypts. It is hypoechoic to the adjacent submandibular gland. The tonsillar parenchyma has a striated appearance with alternating linear hyperechoic and hypoechoic bands. The striated appearance is due to the tonsillar crypts [3].

There are different methods of assessing tonsillar size and volume. Among these, physical examination and inspection, have been traditionally used, although, the sensitivity and specificity are very low, and there is significant inter-observer variation [4]. Magnetic resonance imaging (MRI) and computerized tomography (CT) have been widely used to assess palatine tonsils and associated pathologies. However, these imaging modalities have some limitations, such as high costs, need for sedation, and exposure to ionizing radiation [5, 6]. Recently, ultrasound (US) has been increasingly used to diagnose peritonsillar infections and evaluate the morphological and volumetric changes of tonsil [7]. With no risk of radiation and no need for sedation, ultrasound is a safe diagnostic tool for tonsil diseases [8].

There are two methods of ultrasound evaluation of palatine tonsils which are transcutaneous and intraoral US and they showed high diagnostic accuracy, without a significant difference between them [9]. Tonsil diseases, such as tonsillitis, peritonsillar abscess, and obstructive sleep apnea, are commonly encountered in pediatric clinical practice [8]. Defining normal dimensions and volumes of tonsils by US is crucial for a prompt and precise diagnosis of peritonsillar infections [7, 10]. Previous US studies about tonsils mainly consist of

case reports and/or technical reports. There were a limited number of studies concentrating on normal values of tonsils [7].

However, to the best of my knowledge, there is no research conducted in our country, particularly, in our institution on ultrasound determination of normal palatine tonsil size in the under 18-year-old population. So, the purpose of this study is to estimate the normal palatine tonsil size and volume in under 18-year-old patients who visit TASH for non-tonsil related complaints and contribute towards the relatively new practice, especially in our institution, of using ultrasound for tonsillar pathologies by estimating the normal palatine tonsil measurements in under 18-year-olds.

2. LITERATURE REVIEW

Ultrasound (U/S) has been increasingly used for the diagnosis of tonsillar pathologies especially in pediatric population. Previous studies stated that U/S is successful in the evaluation of tonsils and ultrasound volume correlates well with actual tonsil volumes [11].

The normal values of PT size have been recently evaluated, and there are a limited number of studies about normal tonsil measurements/volume [7].

In a study done by Aydin S. et al. age range of the whole population was 0–16 years and tonsil volume was $1.5 \pm 0.9 \text{ cm}^3$ for right and left sides. They did not detect any significant correlation between PT values and sex. They detected a significant positive correlation between PT values and height, weight and BMI [7]. Similarly, a study done by Hosokawa and et al. on 421 Japanese children without tonsil associated symptoms showed the mean palatine tonsillar size of $1.5 \pm 1.0 \text{ cm}^3$ and $1.49 \pm 1.0 \text{ cm}^3$ for right and left side respectively; this study also showed correlation of tonsillar size to age, weight and height with strongest correlation with height but did not showed correlation with BMI. On the other hand, Sonay Aydin and Cigdem Uner in their study detected a significant positive correlation between PT values and height, weight and BMI which found out BMI to be most strongly correlated with PT size [7].

A study done by Hosokawa and et al. additionally, showed the tonsil size increases significantly each year in children less than 3 years and then doesn't increase significantly between years 3 and 12 [8]. This finding is in accordance to study by Sonay Aydin and Cigdem Uner which stated tonsil sizes increased with age for children younger than 4 years of age [7].

A study done on Sudanese children by Wahab Abdel et al showed linear correlation of tonsillar size with age. This study also identified that weight and tonsillar size have linear relationship. This result is in conformation to study of

Wang et al. which found that obese child with sleep disordered breathing had larger palatine tonsil than normal weight children with sleep disordered breathing. The study by Wahab Abdel and et al. showed that the normal height diameters differ from the right to left tonsils [12]. This finding is in contradiction to studies done by Aydin S. et al. and Hsokawa and et al. which suggests similar size of right and left PT [7]. Wahab Abdel and et al. suggested normal height diameter of the tonsil don't increase with constant manner according to the age. These findings suggest that the height diameter may not have a reliable contribution to predict the tonsil size [12]. This study also showed PT reach maximum size between 7 to 10 years [12] other prior studies suggested maximal tonsillar size is achieved at puberty.

3. OBJECTIVE

3.1 General objective

To estimate the normal palatine tonsil size in under 18-year-old patients: TASH, ADDIS- ABABA, ETHIOPIA

3.2 Specific objectives

To measure and estimate the normal palatine tonsil size and volume in under 18-year-old patients who visit TASH.

To compare the local palatine tonsil size with the current tonsillar measurement values stated in the literature.

To assess how the palatine tonsil size is related to age, sex, weight, height, BMI and side of the PT.

4. METHODS AND MATERIALS

4.1 Study area and period

The study was conducted at Tikur Anbessa Specialized Hospital (TASH) from May 26 – September 30, 2023 GC. TASH is a large referral teaching Hospital, under the administration of Addis Ababa University, located in Addis Ababa, Ethiopia.

4.2. Study design

A prospective cross-sectional study design was employed to determine the sonographic normal palatine tonsil size and volume in under 18-year-old patients who visited the hospital (TASH).

4.3. Source and study population

All under 18-year-old patients who visited pediatric ultrasound room and adult ultrasound room from May 26 - September 30, 2023 GC. served as the source population and the study population are those who fulfilled the inclusion criteria.

4.4. Eligibility criteria

Inclusion criteria

All patients who are under the age of 18 years who visited the hospital for complaints not related to tonsillar disease were included in the study.

Exclusion criteria

Patients who have tonsillar disease, tonsillectomy, neck infection, those with malignant disease (like leukemia, neuroblastoma, lymphoma), clinical suspicion of air way, those in a critical condition, or difficult for scanning were excluded from the study. Similarly, parents or patients who refused to give consent were excluded.

4.5. Sampling procedure and sample size

All eligible children who visit TASH in the study period were included until the sample size is reached; using a non-random consecutive sampling approach.

4.6. Study variables

Independent variables

- Age, Sex, Weight, Height, BMI, Side of the tonsil

Dependent variable

- Palatine tonsil size

4.7 Data collection and measurements

4.7.1 Data collection instruments

Data was be collected on the date of visit to pediatric and adult ultrasound rooms using standard weight and height measurement instruments. The palatine tonsil size and volume were determined with Mindray DC 60 ultrasound linear high-frequency probe.

4.7.2 Data collection technique and data collectors

The data was collected by the researcher and colleagues. Data collectors were communicated and trained before data collection.

During an examination, patients were put on supine with the neck slightly extended and the examiner on the side of the patient. For infants, the mother or caretaker hold on their lap with their neck extended. After adequate gel application, a high-frequency transducer used for trans cutaneous submandibular approach palatine tonsil evaluation. The palatine tonsils were evaluated in both long and short axis views then measurements were taken in three dimensions and volume was obtained using $abc \times 0.52$ formula of ellipsoid volume calculation. (Figure 1 a and b)

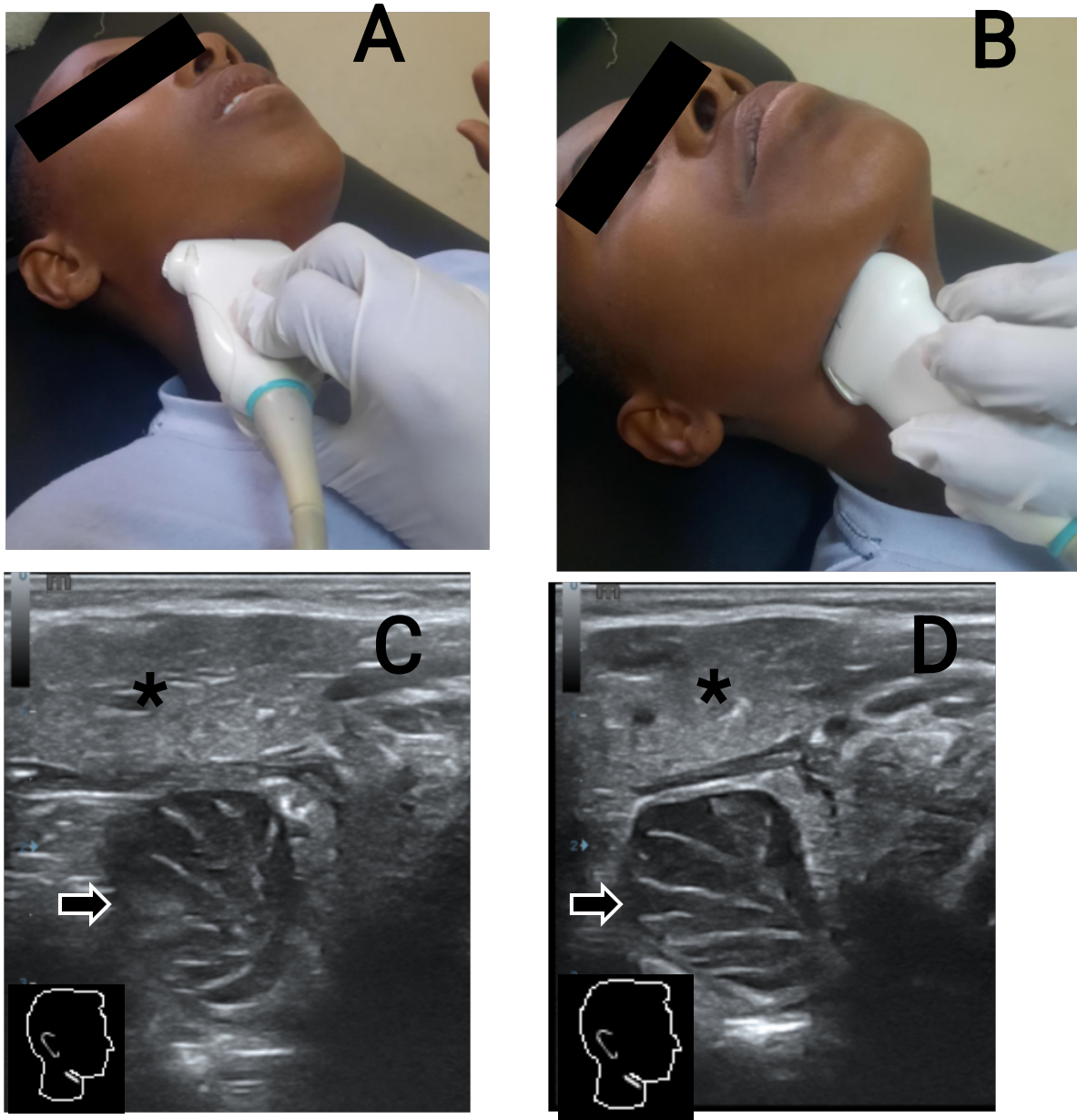


Figure 1: Tonsil US performed via submandibular approach on a 10-year-old volunteer. The correct placement of the linear transducer in the transverse plane with the probe marker facing the patient's right ear(A). The transducer held in the longitudinal plane underneath the mandible(B). Gray-scale image on transverse (C) and longitudinal planes(D) show the right palatine tonsil (arrow) as an ovoid hypoechoic structure located deep to submandibular gland(asterisk).

4.8 Data processing

4.8.1 Data handling

The collected data was entered, cleaned, stored, and checked for completeness and internal consistency.

4.8.2 Data processing and analysis

Data was coded and entered into a computer by using SPSS version 27 for analysis. Mean with standard deviation was computed. The result of the study was presented by tables and charts.

4.9 Data Quality Control and Measurement

Patient data and measurements was checked for completeness by data collectors and supervisors daily. Furthermore, re-checking was done before data entry.

4.10. Ethical Clearance

Data collection was done after formal letter was forwarded and permission obtained from the department of ethics/research committee of AAU. All information obtained was handled confidentially by keeping anonymity of the study subjects using code numbers on questionnaires during the data collection process.

The available parent or caretaker of the study participants were asked for their consent before asking for any information or data collection, and verbal informed consent was taken. No person was obligated to be included in the study without well-informed consent.

5. RESULTS

A total of 265 patients under 18-year-old were included in the study who visited TASH for tonsil unrelated complaints. Of them, 130 (49%) were male, and 135(51%) were female. The population median age was 6 years with age range of 0-18 years.

The normal palatine tonsil appearance on ultrasound was hypoechoic soft tissue with internal linear hyperechoic lines. The palatine tonsils appear hypoechoic as compared to the adjacent submandibular gland.

The mean size of the right palatine tonsil for the whole population was $0.97\text{cm}^3 \pm 0.55$ and it was $0.97\text{cm}^3 \pm 0.56$ for the left tonsil. The PT measurement normal values (mean \pm standard deviation) based on age groups are presented on Tables 1 and 2.

Table 1. Normal values for right palatine tonsil.

Age (years)	Patient number	PT diameters (cm)			PT volume (cm^3)
		AP	Transverse	Longitudinal	
<1	47	0.60 ± 0.14	0.67 ± 0.16	0.79 ± 0.15	0.21 ± 0.14
1-4	60	1.01 ± 0.19	1.12 ± 0.19	1.36 ± 0.30	0.86 ± 0.42
5-9	78	1.10 ± 0.16	1.20 ± 0.17	1.43 ± 0.25	1.02 ± 0.34
10-14	50	1.16 ± 0.15	1.32 ± 0.21	1.61 ± 0.24	1.34 ± 0.40
≥ 15	30	1.28 ± 0.09	1.41 ± 0.14	1.69 ± 0.29	1.64 ± 0.38

Table 2. Normal values for left palatine tonsil.

Age (years)	Patient number	Mean PT diameters (cm)			Mean PT volume (cm ³)
		AP	Transverse	Longitudinal	
<1	47	0.60 ± 0.13	0.67 ± 0.14	0.81 ± 0.17	0.19 ± 0.13
1-4	60	1.04 ± 0.18	1.13 ± 0.20	1.32 ± 0.26	0.87 ± 0.40
5-9	78	1.09 ± 0.18	1.20 ± 0.20	1.42 ± 0.22	1.01 ± 0.35
10-14	50	1.25 ± 0.28	1.31 ± 0.18	1.57 ± 0.23	1.33 ± 0.38
≥15	30	1.28 ± 0.11	1.50 ± 0.13	1.68 ± 0.29	1.73 ± 0.39

The measurement of PT diameters and PT volume were similar for boys and girls as suggested by in an independent samples t-test ($p=0.61$). Similarly, paired samples T-test showed the measurements have insignificant difference for right and left side PT ($p=0.71$). Based on correlation analysis significant correlation detected between PT values and age, weight, height, and BMI. Height has strongest correlation while BMI has the least correlation with PT values (Table 3).

Table 3. Correlations between palatine tonsil values and anthropometric parameters.

	Age	Weight	Height	BMI

Right Tonsil volume	<i>r</i>	0.74	0.75	0.78	0.30
	<i>p</i>	<0.001	<0.001	<0.001	<0.001
Left Tonsil volume	<i>r</i>	0.76	0.76	0.80	0.30
	<i>p</i>	<0.001	<0.001	<0.001	<0.001

A scatter plot of the right/left tonsil size in relation to age, weight, height and BMI can be seen in Figure 2.

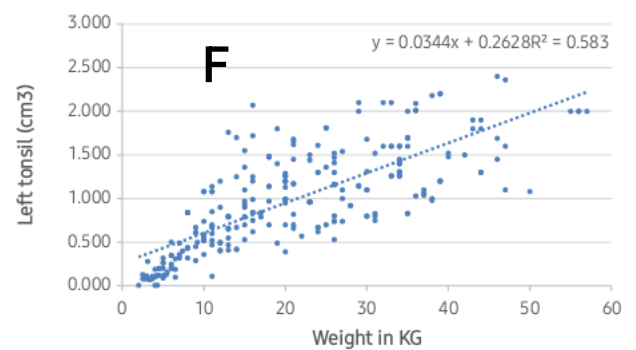
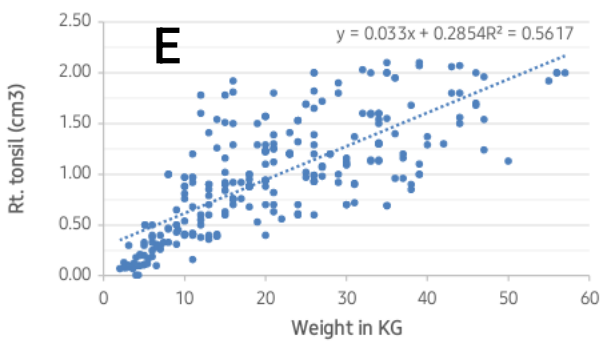
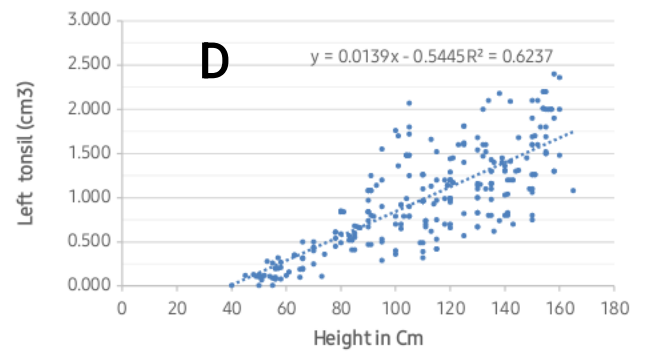
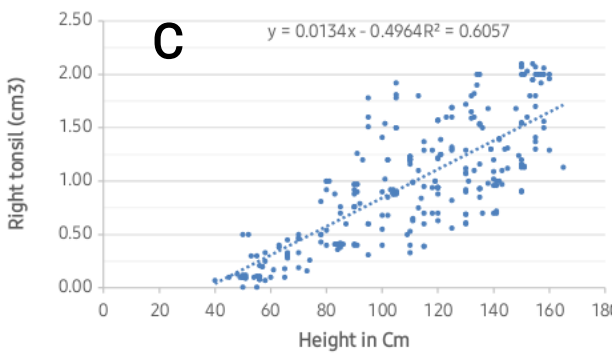
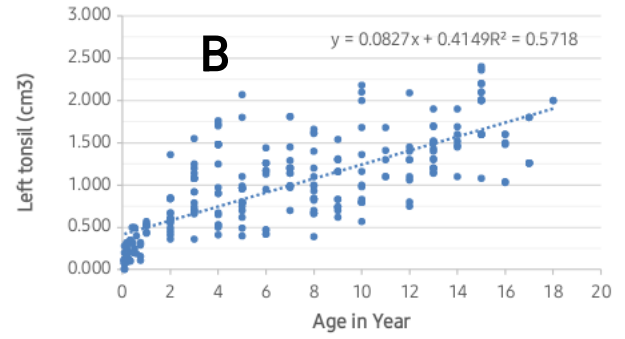
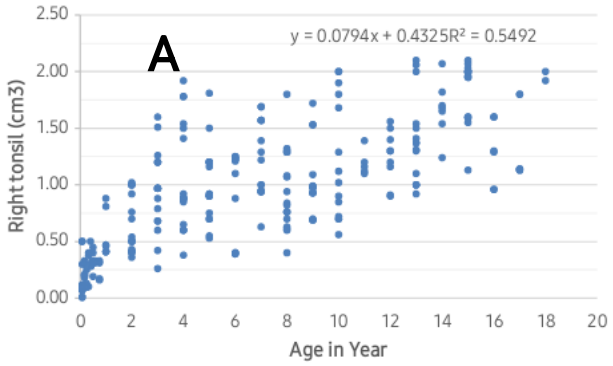


Figure 2. Scatter plot of anthropometric measurements relative to the size of right/left tonsil based on single linear regression analysis. A and B show scatter plots of age and size of the right/left tonsil. C and D show a scatter plot of height and size of the right/left tonsil, and E and F show that of the weight and size of

the right/left tonsil.

6. DISCUSSION

Ultrasonography has been used for evaluation of tonsillar infections. It is simple noninvasive technique that can precisely differentiate peritonsillar abscesses from peritonsillar cellulitis. Moreover, it also avoids blind needle aspiration of peritonsillar abscess and its associated potential complications [3, 13, 14]. A study done by Miziara et al showed 92.3% sensitivity and 62.5% specificity of intraoral US in diagnosis of peritonsillar abscess [15]. On the other hand, Filho and et al. reported comparable accuracy of transcutaneous and intraoral US [16].

CT and MRI can be used for evaluation of tonsillar pathologies. CT is indicated for evaluation of tonsillitis and abscess or extra-tonsillar infection spread assessment. The main drawback of using CT is its associated ionized radiation that highly affects radiosensitive organs in the scanning field such as the thyroid gland [17]. MRI provides a better soft tissue resolution and it does not contain ionizing radiation. However, the requirement for sedation, cost and relative unavailability are downsides of MRI. Use of ultrasound decreases the exposure to ionizing radiation, is less expensive, and easily available as compared to CT or MRI. Defining normal dimensions and volumes of tonsils by US is crucial for a prompt and precise diagnosis of peritonsillar infections [7, 10]. However, little information is available regarding the normal values of PT size and volume.

This study defines normal PT measurements and volume in the ages between 0 and 18years using ultrasonography. This study provides estimated PT measurements that can be used for diagnosis of tonsillar infections and other pathologies associated with PT size alteration. According to our results mean PT volume is $0.97\text{cm}^3 \pm 0.55$ for the right and $0.97\text{cm}^3 \pm 0.56$ for the left tonsil. A study on exactly same age groups by Hong et al. showed comparable mean PT volume of $0.85 \pm 0.75\text{cm}^3$ for the right and $0.75 \pm 0.56\text{cm}^3$ [9]. These results are smaller as compared to Sonay Aydin's and Hsokawa et al.'s studies [7, 8]. These variations could be because of difference in population and age distribution.

We found that for children under the age of 5 tonsil sizes increase with age. Our

findings agreed with the study by Sonay Aydin as well as Jaw et al which found that tonsillar diameters had plateau in the age range of 2 to 7 years [7, 18].

According to our results, a significant positive correlation was found between PT size and height, weight and BMI. These findings were also evidenced by other prior studies by Hosowaka et al., Sonay Aydin et al and Zohida Abdel et al [7, 8, 12]. In our study, height has strongest positive correlation with PT size while BMI had the weakest correlation. This finding is consistent with the findings of Hosokawa et al [8]. However, Hong et al. reported opposing result in which they found no correlation for height and weight. This difference in result can be due to smaller number of participants as compared to ours (161 vs. 265 respectively).

In line with previous researches we are unable to identify any differences in PT size between sexes or between right and left sizes [8, 9, 19]. Therefore, any variation in tonsil diameters between two sides may serve as pathology warning signal. Furthermore, during tonsillar ultrasound, it is unnecessary to take into account sex of patients for difference in PT size.

7. CONCLUSION

Tonsillar US is a well-tolerated, noninvasive procedure that can be used in pediatric populations. Its use not only avoids radiation exposure but also help radiologists identify tonsillar pathologies accurately. Tonsillar lesions can be diagnosed using these normal values. In this study we provided estimated measurement values for normal right and left palatine tonsils of patients in the age range of 0 to 18 years. Over the first five years, we saw a considerable increase in tonsil size. Lastly, there was a relationship between tonsil size and anthropometric indices such as age, weight, and height and BMI with height exhibiting the most robust association.

8. LIMITATIONS OF THE STUDY

There are few noteworthy drawbacks to this study. The use of a single study area and the relatively new practice of using ultrasound for tonsillar assessment in our institution are the limitations of the study. This research seeks to define normal tonsil size in patients with no tonsillar pathologies. Studying alongside both normal and with tonsillar diseases can facilitate to define a threshold value to distinguish between normal as well as pathologic tonsil sizes. Given that tonsil size and anthropometric parameters are correlated, normal values may alter with various societies, and/or nations. Most of the patients were assessed by a single investigator, and as a result, we are unable to provide measurements with any inter-observer reliability data.

9. RECOMMENDATION

Use of multiple study areas in future studies helps to bring more representative measurement values to define normal palatine measurements. This study aims to estimate tonsil size in healthy children. Studying with both healthy children and the ones with tonsillar pathologies can enable researchers to define cutoff values to differentiate normal and abnormal tonsil sizes. Employing multiple investigators in-order to take into account inter-observer variabilities of measurements is also recommended.

DATA COLLECTION TOOL

Sonographic estimation of normal palatine tonsil size in under 18-year-old patients who visit TASH: ADDIS-ABABA, ETHIOPIA

I. Socio-demographic information of the patient

1. ID _____
2. Date of exam_____
3. Age: _____
4. Sex: A. Male B. Female
5. Height in cm _____
6. Weight in kg _____

II. Sonographic examination of the palatine tonsil and measurements

1. Does both palatine tonsils have striated appearance?
A. YES B. NO
2. Is there fluid collection surrounding the tonsil?
A. YES B. NO
3. Measurements: in cm

Right palatine tonsil:

AP dimension:_____

Transverse dimension:_____

Longitudinal dimension:_____

Right palatine tonsil volume _____

Left palatine tonsil:

AP dimension:_____

Transverse dimension:_____

Longitudinal dimension:_____

Left palatine tonsil volume: _____

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