Cerrahpaşa Med J 2023; 47(3): 302-305 ORIGINAL ARTICLE

A Tissue Ignored In Cervical Ultrasound: Relationship of Palatine Tonsil Size with Age, Sex, Body Mass Index, and Body Surface Area in the Pediatric Population

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Cite this article as: Bozbeyoğlu SG, Dogan MB. A tissue ignored in cervical ultrasound: Relationship of palatine tonsil size with age, sex, body mass index, and body surface area in the pediatric population. *Cerrahpaşa Med J.* 2023;47(3):302-305.

Abstract

Objective: Evaluation of the palatine tonsils is an important issue both in cases of acute infection and in diseases such as obstructive sleep apnea. This study aimed to determine whether there is a relationship between the palatine tonsil volume and gender, age, body mass index, and body surface area in children by ultrasonography.

Methods: Two hundred patients aged 3-15 years were included. The study population was divided into 4 groups, three years apart. Tonsil volume was calculated in mm using the formula "0.52 × length × width × height". Pearson and Spearman rho tests were used for correlation.

Results: Of the study group, 99 (49.5%) were girls. The mean age of the cases was 8.5 ± 3.4. When the patients' ages and right and left palatine volumes were evaluated, a significant but very weak correlation was observed ($r = 0.167$, $P = .018$; $r = 0.161$, $P = .023$, right and left, respectively). When the palatine volumes of the patients were evaluated according to their body mass index (BMI) and body surface area (BSA), the results were similar (BMI: $r = 0.253$, $P < .01$; $r = 0.282$, $P < .01$; BSA: $r = 0.207$, $P = .003$; $r = 0.242$, $P = .001$). In the post hoc evaluation, statistical significance was observed in the 3-6 age group and the 9-12 age group ($P = .028$).

Conclusion: In this study, it has been observed that tonsil size increases with variables such as age, BMI, and BSA. Determining the normal value of tonsil volume in healthy children will be useful in the diagnosis of diseases with tonsil enlargement.

Keywords: Palatine tonsil, ultrasonography, volume

Introduction

Palatine tonsils serve as an immunocompetent tissue located in the palatopharyngeal space in the oropharynx. Evaluation of the palatine tonsils is an important issue in acute infection cases and diseases such as obstructive sleep apnea, and it is quite common, especially in children.[1] Due to obstructive sleep apnea, excessive daytime sleepiness, hyperactivity, attention deficit disorder, and physical weakness may develop.[2] For this reason, tonsil diseases in children are important as they can affect the daytime quality of their lives. Magnetic resonance imaging (MRI) and computed tomography (CT) have been widely used to assess palatine tonsils and associated pathologies. However, these methods require high costs, and contrast agents and sometimes sedation is needed. In addition, CT examinations include radiation.[3,4]

Ultrasound is a safe and easily accessible test for the demonstration of tonsillar pathologies and presurgical evaluation.[5] Therefore, it is necessary to know the normal sonographic dimensions of the palatine tonsils. This study aims to measure the palatine tonsil size by ultrasound in healthy children and to determine whether it is associated with sex, age, body mass index, and body surface area. This study was tested in a prospective clinical trial.

Received: February 20, 2023 **Accepted:** July 13, 2023
Publication Date: December 12, 2023
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DOI: 10.5152/cjm.2023.23017

Methods

The local institutional review board approved the current prospective study. Informed consent was acquired from the parents. The study data were collected in 2 months between October 2022 and December 2022. Ethics committee approval was obtained for the study (2022/0606). The measurement of palatine tonsil size was made with a 5-12 MHz linear array transducer (Aplio 500; Toshiba, Otawara, Japan) by a radiologist with more than 10 years of pediatric radiology experience. During the examination, patients with a clinical diagnosis of acute tonsillitis, peritonsillar abscess, and cervical lymphadenopathy were excluded from the analysis. In addition, patients with malignancy who had previously received RT and KT treatments, those who received immunosuppression therapy, and those who had tonsillectomy were excluded from the study.

The study included two hundred healthy children aged 3-15 years. Like the adenoid, palatine tonsil size increases significantly until 3 years of age and does not increase significantly between 3 and 12 years of age. Therefore, our study did not include patients under 3 years of age. The patients were divided into 4 groups, with 50 patients from each group, 3 years apart: (i) 3-6 years; (ii) 6-9 years; (iii) 9-12 years; and (iv) 12-15 years. Measurements were made in the supine position, with the neck slightly extended and laterally rotated. By placing the transducer under the mandible, first the submandibular, we found the gland, then we found the palatine tonsil gland immediately deep, and we did this twice for the right and left tonsils. The hypoechoic tonsils were visualized in the transverse and longitudinal planes

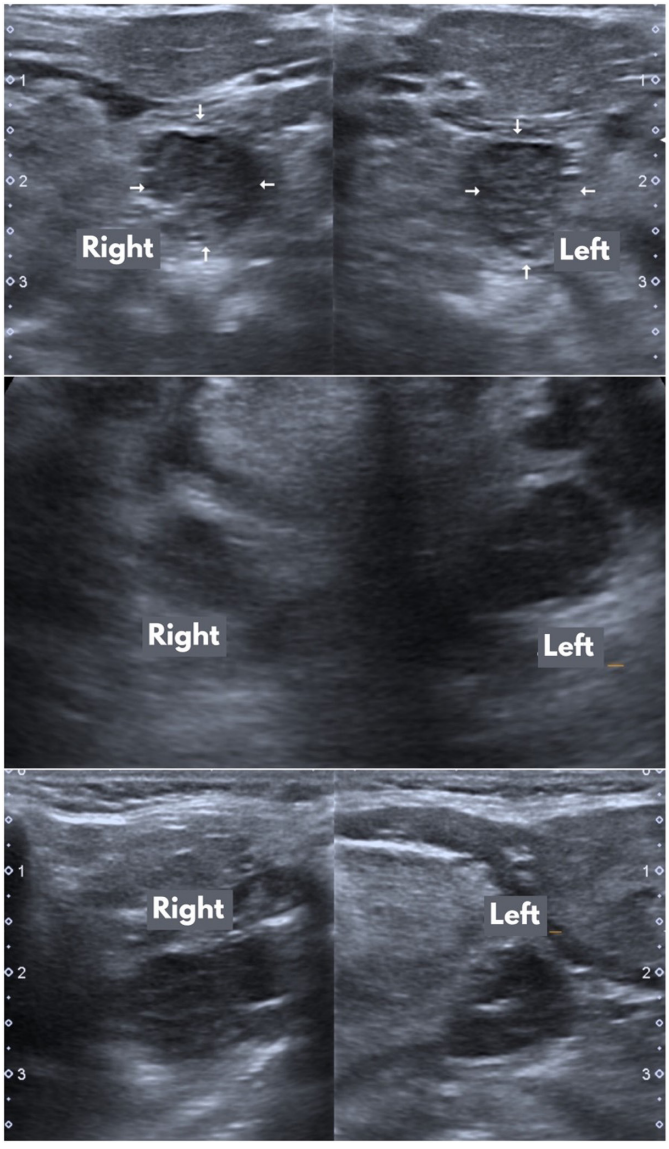

Figure 1. Sonographic image of palatine tonsils of 3 different patients.

(Figure 1). Tonsil volume was calculated in mm using the formula "0.52 × length × width × height" (Figure 2). The formula for body mass index (BMI) (kg/m^2) is weight in kilograms divided by height in meters squared. Body surface area (BSA) calculation with the formula: BSA (m^2) = ([Height (cm) × Weight (kg)]/3600)½. Body mass index and BSA were calculated using these formulas. The study attempted to find a correlation between BMI, BSA, and tonsil volume.

Statistical Analysis

Statistical evaluation was performed using Statistical Package for Social Science Statistics software, version 22.0 (IBM SPSS Corp.; Armonk, NY, USA). In this study, data were given as mean ± SD for continuous variables, numbers, and percentages for categorical data. Continuous variables with a normal distribution were evaluated with paired sample's *t*-test, while those with an abnormal distribution were evaluated with one-way analysis of variance. The chi-square test was used to evaluate categorical variables. Pearson correlation analysis was used to evaluate the correlation of continuous variables, while Spearman rho correlation was used for the correlation of categorical and continuous variables. The statistical significance level was determined to be .05.

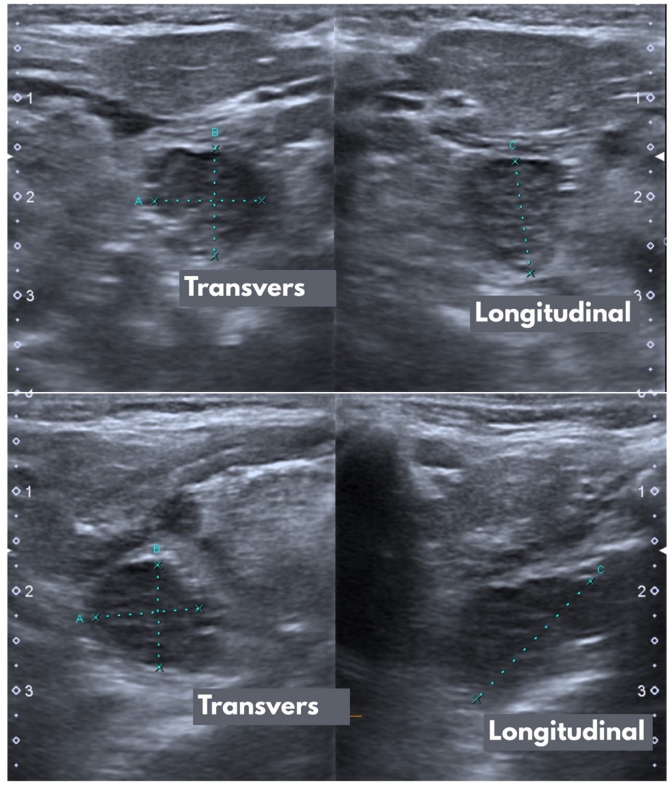

Figure 2. Sonographic measurement of palatine tonsil dimensions of 2 different patients.

Results

A total of 200 patients aged 3-15 years were included in the study. Of the patients, 101 (50.5%) were male and 99 (49.5%) were female. The mean age of the patients was 8.5 ± 3.4 years. Sex was not statistically different between the groups. A normal palatine tonsil appears more hypoechoic than the submandibular gland, and soft tissue is composed of alternating linear hyperechoic and hypoechoic lines. When the patients' ages and right and left palatine volumes were evaluated, a significant but very weak correlation was found (r = 0.167, P = .018; r = 0.161, P = .023, right and left, respectively). When the palatine volumes of the patients were evaluated according to their BMI, the result was similar (r = 0.253, P < .01; r = 0.282, P < .01). When the evaluation is made according to BSA, a statistically significant but very weak correlation was observed between volume and BSA (r = 0.207, P = .003; r = 0.242, P = .001). Tests were also carried out for groups formed 3 years apart (Table 1). The post hoc evaluation found it statistically significant in the 3-6 age group and the 9-12 age group (P = .028).

Discussion

In this study, it has been seen that palatine tonsil size increases with variables such as age, BMI, and BSA. Determining the normal value of tonsil size in healthy children in the Turkish population will be useful in the diagnosis of diseases with tonsil enlargement. Therefore, the evaluation of tonsil size in children is an important issue, especially in cases such as tonsillitis and obstructive sleep apnea.[6]

Using lateral neck radiographs, the degree of obstructive sleep apnea can be assessed; however, only from the right of the

Table 1. Demographic Characteristics of the Study Population, and Tonsil Volume in Different Gender and Age Groups

	3-6 Years n = 61	6-9 Years n = 59	9-12 Years n = 43	12-15 Years n = 37	*P*
Boy	38 (62.3%)	27 (45.8%)	21 (48.8%)	15 (40.5%)	.142
Girl	23 (37.7%)	32 (54.2%)	22 (51.2%)	22 (59.5%)	
Right palatine volume (mm^3)	2192 ± 1163	2692 ± 1747	2824 ± 1806	2777 ± 1806	.127
Left palatine volume (mm^3)	2128 ± 1010	2721 ± 1719	3060 ± 1644	2391 ± 1333	.010
Body mass index (kg/m^2)	16 ± 2.9	17 ± 3.0	20.8 ± 4.6	21.1 ± 3.88	<.01
Body surface area (m^2)	0.75 ± 0.13	1.00 ± 0.21	1.31 ± 0.28	1.49 ± 0.25	<.01
Average palatine volume	2160 ± 980	2702 ± 1567	2942 ± 1423	2584 ± 1504	.03

2-dimensional view of the tonsils, which does not show the transverse size of the organ.[7,8]

Studies have different findings about whether palatine tonsil dimensions change with age. Susan et al reported that normal tonsils began to increase in the fifth or sixth year of life and that they reached their maximum size at puberty. The average vertical and transverse diameters of tonsils at puberty were measured as 20-25 mm and 10-15 mm, respectively.[9]

Songu et al reported an increase in tonsil size in children up to 5 years of age and there was a plateau until age 11.[10] Arens et al observed that tonsil size increased linearly during the first ten years of life and reached its maximum size between 7 and 10 years of age.[11]

According to Jaw et al,[12] adenoid sizes between 2 and 7 years it was drawing a plateau.

Similarly, in the studies of Honk, Hosokawa, and Öztürk, they said that palatine tonsil volume did not differ according to gender and right/left dimensions.[1,5,6] Therefore, any difference in tonsil size between the 2 sides can be used as a warning for pathologies.

Similar to our results, Wang et al reported that between tonsil size and age in the pediatric population, objective tonsil size was larger in obese children compared to the control group.[13]

As expected, both BMI and BSA showed an increase in size with age, which is a common finding. While Hong et al did not detect a correlation with BMI, Ozturk did.[1,5] But Hong et al reported a correlation between the tonsil size, and height ($r = 0.51$), and weight (0.37) of 161 children. In our study, the palatine tonsil volume increased with the increase in BMI. The relationship between BSA and palatine tonsils was also examined for the first time.

Asimakopoulos et al stated that a preoperative evaluation of tonsil anatomy and a risk classification system can be made by using ultrasound in obstructive sleep apnea.

The diagnosis of severe obstructive sleep apnea syndrome, response to surgery, and risk estimation of perioperative complications can be made with ultrasound.[14]

Ultrasound has also been reported to be useful in the evaluation of tonsillitis, peritonsillar abscesses, malignant diseases, and neck masses.[15,16] Tonsillitis appears as an enlarged gland with a striated appearance and preserved hypoechoic echo tissue whereas peritonsillar abscesses appear as enlarged glands containing cystic changes.[17] Especially if tonsillar cellulitis and abscess are complicated and can cause mediastinitis, acute airway obstruction, and sepsis.[18] For tonsillitis and evaluation of a suspected abscess, CT or MRI is usually indicated to evaluate for complications such as infection or extension of an infection beyond the tonsils.[19,20] For children, CT is disadvantageous because it contains radiation, and MR is the preferred imaging modality due to its enhanced soft tissue detail. However, an MRI is difficult to access and expensive, and sedation is needed because the scan takes a long time. Ultrasound, which is easily accessible, simple, useful, and noninvasive, can be an alternative to CT or MRI. This study aims to determine normal volume values for tonsils in a pediatric population and to find reference measurements in the pathology of tonsils.

The limitation of this study is that the ultrasound was performed by a single experienced radiologist, and interobserver and/or interobserver reliability were not taken into account.

This study aims to define palatine tonsil size in healthy children. To distinguish children with tonsil pathology from healthy children, it is necessary to know the normal sizes and cutoff values.

In conclusion, the ultrasound is an easily applicable and noninvasive pediatric palatine tonsil evaluation technique. Tonsil size measurements can be used to diagnose tonsil infections, lesions, and diseases related to tonsil size.

Ethics Committee Approval: Ethical committee approval was received from the Ethics Committee of Istanbul Medeniyet University (Approval no: 2022/0606, Date: 19/10/2022).

Informed Consent: Verbal informed consent was obtained from the patients who agreed to take part in the study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – S.G.B., M.B.D.; Design – S.G.B.; Supervision – S.G.B.; Resources – S.G.B., M.B.D.; Materials – S.G.B., M.B.D.; Data Collection and/or Processing – S.G.B., M.B.D.; Analysis and/or Interpretation – S.G.B., M.B.D.; Literature Search – S.G.B., M.B.D.; Writing Manuscript – S.G.B., M.B.D.; Critical Review – S.G.B., M.B.D.

Declaration of Interests: The authors have no conflict of interest to declare.

Funding: The authors declared that this study has received no financial support.

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