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Sonographic measurement of palatine tonsil volume in children and comparison with actual volume

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Abstract

Aim of this study is to compare the palatine tonsil (PT) volume measured with transcervical ultrasonography (TCU) in children with the actual volume to research the correlation with tonsillectomy indications. This prospective study included a total of 67 children, 37 boys and 30 girls, aged from 3-17 years who underwent bilateral tonsillectomy. Cases were divided into two groups based on tonsillectomy indications as chronic tonsillitis (Group 1) and obstructive sleep apnea syndrome (OSAS) (Group 2). The sonographic volume was measured with a 4.8-11.0 MHz linear transducer before tonsillectomy, while the actual volume was measured with the water displacement method. The correlation between both volume values was researched. Partial Correlation test was used to analyze correlations between variables after analysis of SPSS 22.0 program and age and gender factors. The mean ages in Groups 1 and 2 were 115.83±53.2 and 120.6±54.7 months, respectively. The actual and sonographic tonsil volumes in Group 1 were 2.03±0.82 ml and 2.22±0.85 ml (p=0.093), in Group 2 were 5.19±0.83 ml and 5.36±1.06 ml (p=0.074), respectively. In both groups the sonographic volume was correlated with the actual volume (r=0.788 and 0.829, respectively). The measured volumes with both methods were higher in Group 2 (p<0.001). TCU is a reliable, cheap, non-invasive and easily accessed method for evaluation of PT volume. It provides beneficial information about the PT size, anatomy and tonsillectomy indications in children.

Keywords: Palatine, tonsil, volume, children, ultrasonography

Introduction

The palatine tonsils (PT) and adenoid tissue form an important part of the defense system in children. Adenotonsillar hypertrophy is common in the childhood period. Adenotonsillectomy is among the most commonly performed operations in ear, nose and throat clinics. The most important factor in the frequency of the operation is that it has a broad spectrum of many indications. Appropriate surgical intervention in necessary cases provides a significant contribution to the quality of life of the patient.

Among adenotonsillectomy indications there are many diseases ranging from chronic upper respiratory tract infections to sleep apnea [1]. The most noteworthy indication is repeated infections and insufficient response to medical treatment. In recent times, respiratory difficulty and sleep disorders linked to narrowing of the upper respiratory tract due to hypertrophy of adenotonsillar tissue are among other important causes [2].

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Knowing the size of the tonsils and relationship to surrounding structures before surgery is very important in terms of the success of the procedure [3].

PT is easily identified in the oropharynx during physical examination. In some situation, the size and position of the tongue and tongue root may make sufficient assessment impossible. In routine examination, clinical classification and lateral x-rays are used to assess the size of the tonsils. Clinical classification is made according to the transverse extension of tonsils toward the central line. However, depth in the oral aspect and medial boundary extending toward the pharynx are not assessed [4,5]. In recent years, there are studies reporting that transcervical ultrasound (TCU) is an effective and beneficial method to measure PT volume in children [6,7].

The aim of this study is to compare the PT volume measured with TCU with the actual volume in children and assess the correlation with tonsillectomy indications.

Material and Methods

This prospective study assessed a total of 67 adolescent cases, 37 boys and 30 girls, from November 2015 to March 2017 after receiving local clinical research ethics committee approval. The

parents of all cases accepted into the study provided "informed consent" before TCU investigation.

Patients

The tonsillectomy indications of cases were chronic tonsillitis and obstructive sleep apnea syndrome (OSAS). Chronic tonsillitis diagnosis was placed due to three or more tonsillitis attacks within a year and resistance to medical treatment. OSAS diagnosis was placed due to clinical examination findings (tonsil size Friedman degree ≥3) and history (apnea attacks witnessed by parents, frequent sleep disorder, mouth breathing).

Exclusion criteria included rejecting participation in the study, fever during examination, acute tonsillitis, tumor related to the tonsils, trauma and surgical history. As all TCU images and tonsillectomy material were sufficient for assessment, no case was later excluded from the study.

Ultrasound Investigation

Investigations were performed by a pediatric radiology expert with 5 years experience of pediatric radiology with an AplioTM 500 (Toshiba Medical Systems Co. Ltd., Otawara, Japan) device.

Tonsil dimensions were measured with a 4.8-11.0 MHz transducer. The patient lay on their back and extended the neck in the opposite direction to the investigation side. After clearly defining the mandibular angle, the probe was placed below the lower chin angle and above the hyoid bone in the transverse and longitudinal planes. In this position, the tonsils were a well-defined hypoechoic structure lateral of the tongue root below the submandibular gland (Figure 1 a, b and 2 a, b). The tonsils were observed to have striated appearance due to linear hyperechoic and hypoechoic bands caused by the parenchyma crypts. The foci with intense echogenous motion commonly observed medial of the tonsil represent air in the pharynx. The volumes of both tonsils were measured separately. Due to their ellipsoid shape, the tonsil volume was calculated in mm3 (ml) using the formula "0.52 x length x width x height". Actual volume measurement

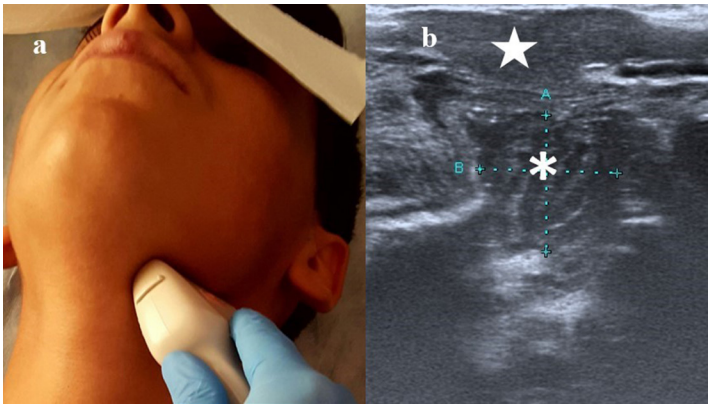

Figure 1 a, b. Measurement of tonsil size in transverse planes by means of transcutaneous approach. The probe is placed longitudinally to the mandibular angle (asteriks: left tonsil, star: submandibular gland)

Tonsillectomy operations were performed by an ear nose and throat expert (5 years experience). The actual volumes of both tonsils were separately measured with the water displacement method in a graduated injector (Figure 3 a, b).

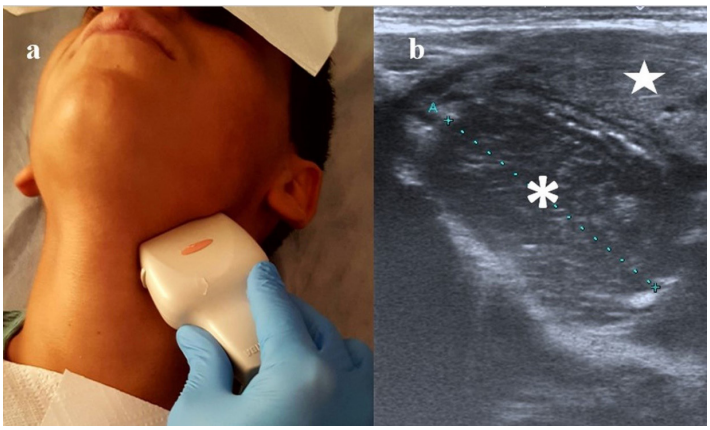

Figure 2 a, b. Measurement of tonsil size in longitudinal plane by means of transcutaneous approach. The probe is placed obliquely to the mandibular angle (asteriks: left tonsil, star: submandibular gland)

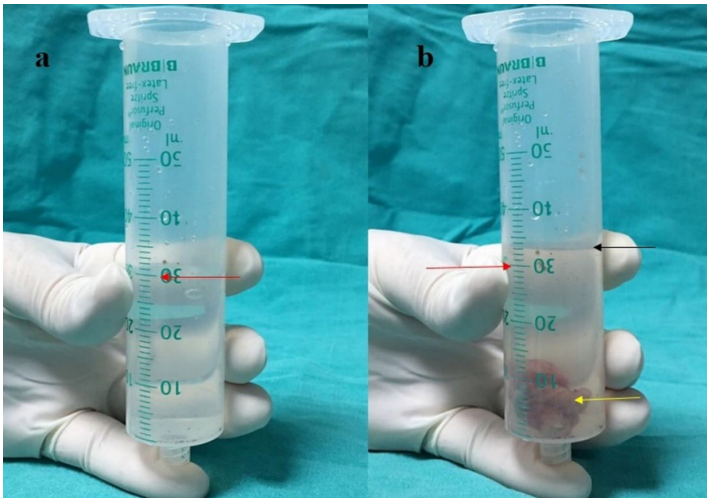

Figure 3 a, b. Actual volume measurement by displacement in water a) İnitial volume (initial water level: red arrow). b) Volume after tonsillectomy material is released (final water level: black arrow, tonsillectomy material: yellow arrow)

Statistical Analysis

For analysis of variables, the SPSS 22.0 (IBM Corporation, Armonk, New York, United States) program was used. Normal distribution of data was assessed with the Shapiro-Wilk test while variance homogeneity was assessed with the Levene test. Comparison of quantitative data from two independent groups used the independent samples t test Bootstrap results. Comparison to two repeated measurements of dependent quantitative variables used the paired samples t test with Bootstrap results. After checking the age and gender factors, the partial correlation test was used to investigate the correlation between variables. Comparison of categorical variables used the Pearson chi-square test with Monte Carlo simulation. Quantitative variables are given as mean ± SD (standard deviation) and categorical variables are shown as n (%) in tables. The variables were investigated at the 95% confidence level with p value lower than 0.05 accepted as significant.

Results

The mean ages in chronic tonsillitis (Group 1, n=32) and OSAS (Group 2, n=35) were 115.83±53.2 and 120.6±54.7 months, respectively. The actual and sonographic tonsil volumes in Group

1 were 2.03±0.82 ml and 2.22±0.85 ml (p=0.093) and in Group 2 were 5.19±0.83 ml and 5.36±1.06 ml (p=0.074), respectively. The demographic data and tonsil volumes are summarized in Table 1. In both groups the sonographic volume was correlated with the actual volume (r=0.788 and 0.829, respectively) (Table 2). The measured volumes with both methods were higher in Group 2 (p<0.001).

Table 1. Baseline descriptive data and tonsil volume of the study population

Variables	Chronic tonsillitis (Group 1) (n=32)	OSAS (Group 2) (n=35)	Total (n=67)	p value
Girls/ Boys	14/18	16/19	30/37	0.604
Age (months) mean ± SD	115.83±53.23	120.6±54.72	118.22±53.58	0.704
Sonographic volume	2.03±0.82	5.19±0.83	3.61±1.79	0.001
Actual volume	2.22±0.85	5.36±1.06	3.79±1.68	0.001
p value (for volume)	**0.093**	**0.074**	**0.736**	

SD: Standart Deviation

Table 2. Correlation of actual and sonographic volume

Indication group	r	p value
Chronic tonsillitis (Group 1)	0.788	**<0.001**
OSAS (Group 2)	0.829	**<0.001**
Total	0.947	**<0.001**

r: Correlation coefficient

Discussion

In this study important result were obtained when PT volumes measured with TCU were compared with actual volume in children and the correlation with tonsillectomy indications was assessed. TCU is an accurate, reliable, cheap, non-invasive and easily accessible method to objectively assess the tonsil volume in children and provided data complying with actual volumes.

In daily practice, diagnosis of tonsil diseases is based on history and physical examination. The patient is questioned on history of sleep disorders, snoring, chronic bad breath, hypersomnolence or hyperactivity, enuresis, dysphagia and low school success [8]. In children with tonsillar hypertrophy additionally examination findings like mouth breathing and disordered tooth development should be carefully explored. The oropharyngeal airway and nasal airway should be assessed together [9]. In recent years, obesity in the childhood period is increasing and together with this, the OSAS rate has increased. Polysomnography is the most valid method to diagnose OSAS at present [10].

Currently TCU has begun to be commonly used for assessment of PT. TCU objectively investigates the size, shape, perfusion and appearance of PT to evaluate the diagnosis and prevalence of tonsillar and peritonsillar infections [11,12]. TCU is an alternative and complementary imaging method to computed tomography and magnetic resonance imaging which have some limitations [13]. In recent times, Öztürk et al. in a study of 680 cases of healthy children, including all age groups, reported that tonsil volume varied from 1.8-2.2 ml as a result of TCU measurements with a positive increasing correlation to age and BMI, though there was no difference according to gender [6]. However, as that study was completed on healthy children, it was not possible to compare with actual volume.

A study of 277 pediatric cases by Wang et al. compared the subjective classification during preoperative oral examination with width, length, height and volume values after surgery. The best correlated parameter in the subjective classification was volume and actual tonsil volume was reported to vary from 2.17-4.7 ml [14]. A different study assessing the correlation between tonsil size and OSAS compared the preoperative subjective and actual volume after tonsillectomy and found that on both measurements tonsil sizes were higher in obese OSAS cases [15]. A study of 495 symptomatic pediatric patients in various age groups by Kang et al. assessed tonsil size subjectively. They stated that tonsillar hypertrophy and obesity were significant factors in the OSAS etiology in children [16]. Similarly in our study, sonographic and actual volume values were higher in OSAS cases. Additionally for the first time in our study, sonographic and actual volume measurements were performed for chronic tonsillitis and smaller volume values were identified compared to OSAS. However, as there was no control group, no comparison was made with normal values.

A study by Asimakopoulos et al. showed the mean volume measured with TCU for chronic tonsillitis and OSAS cases was 3.6 ml, while the actual volume after tonsillectomy was measured as 3.9 ml with both volume values in accordance. However, for both measurement methods PT volume was calculated with no distinction between chronic tonsillitis and OSAS but compliance of sonographic measurements was proven. Presurgical assessment of tonsil anatomy with US is stated to be beneficial to estimate response to tonsillectomy and perioperative complications [7]. In our study the PT volume with sonographic measurement was 2.03 ml for chronic tonsillitis, 5.19 ml for OSAS and 3.61 ml average, which were in accordance with actual volume values. Mean volume is similar to those in previous studies. In our study, differently, it was shown that volume varies according to tonsillectomy indication. It is not always easy to access polysomonography used in diagnosis of OSAS, but sonography of day patients in clinics may be easily assessed. Additionally, we believe sonography

may be very beneficial in identification of large tonsils appearing subjectively small during physical examination and for cases without clear symptoms of OSAS.

Children with advanced OSAS have high risk of postoperative respiratory problems [17]. The incidence of postoperative complications, especially in children younger than 3 years, is nearly four times higher [18]. Additionally, sonography may be used to predict which children may develop more postoperative complications after tonsillectomy in tonsillar hypertrophy and severe OSAS cases.

Among the limitations of our study are that TCU investigation was performed by a single person, variation in tonsil volume according to BMI was not calculated and the lack of histopathological diagnosis of tonsillectomy material.

In conclusion, TCU is a reliable, cheap, non-invasive and easily accessible method to assess PT volume in children. Additionally it provides beneficial information related to the size and anatomy of PT, tonsillectomy indication and postoperative risk assessment.

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