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Maxillary sinus volumes of patients with unilateral cleft lip and palate

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ABSTRACT

Background and objective: Studies about maxillary sinuses of cleft lip–palate patients have increased since sinusitis is commonly observed in these patients. It is evident that maxillary sinus will be morphologically affected in these patients. And anatomic differences may be a cause or at least a contributor of sinusitis. The aim of this study was to compare maxillary sinus volumes of the non-syndromic patients with unilateral cleft lip–palate and control group by using Cone-Beam computed tomography.

Methods: Tomography scans of 44 unilateral cleft lip–palate patients (18 right and 26 left) with age and gender matched 45 control patients were evaluated for the study. The images used in the study were part of the diagnostic records collected due to dental treatment needs. All tomographs were obtained in supine position by using Cone-Beam computed tomography (NewTom 5G, QR, Verona, Italy). The patient-specific Hounsfield values were set to include the largest amount of voxels in the sinuses volume calculation individually. All data were measured in mm^3.

Results: There was no statistically difference between the gender and age distributions of the groups. No statistically significant difference was found on the cleft and non-cleft side, the right and left side of the unilateral cleft lip–palate patients and the control group ($P > 0.05$). For the inter group comparison, mean maxillary sinus volumes volume of unilateral cleft lip–palate patients (9894.55 ± 4171.44 mm^3) was statistically smaller than the control group ($11{,}977.90 \pm 4484.93$ mm^3) ($P < 0.05$).

Conclusion: Maxillary sinus volumes were effected negatively in unilateral cleft lip–palate patients when compared with the healthy control group. No difference was found on the cleft, non-cleft side and the right-left side of the unilateral cleft lip–palate patients.

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1. Introduction

Cleft lip and palate (CLP), one of the most significant congenital developmental disorder, is formed at the beginning of the fetal period due to adhesion deficiency during formation of primary palate. Maxillary sinus (MS) consists of the mesodermal structures of first branchial arch, and its development starts at the 3rd week of gestation and continues up to pubertal praecox. Individuals suffering from CLP have numerous problems with regards to nutrition, speaking, hearing, chronic upper airway infections, dentition, face morphology and psychological aspects. It is evident that MS, one of the most important structures of midface, will be morphologically affected in patients with CLP [1]. To evaluate the MS volumes (MSV) of the patients with CLP may be helpful to determine possible differences from normal. These differences may lead to impairments, like sinus diseases.

The causes of maxillary sinusitis, frequently observed in patients with CLP, are not completely understood, and this fact increases the focus on studies relating to MS size and volume in these patients to understand of its role in the developmental process of the sinusitis. Impairments of MS will cause drainage pathology due to malposition of ostium and it will make a predisposition to sinusitis [2]. Numerous studies were performed to evaluate MS size; and it was demonstrated that there was no

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difference in normal population compared to patients with CLP, and there was no difference in cleft side compared to non-cleft side in unilateral cleft lip and palate (UCLP) patients [2–5]. However, these studies were performed mostly with conventional radiography and computed tomography (CT) and 2D evaluation was performed.

In addition to clinic anthropometric examination, cephalometric analysis, conventional graphy methods, in recent years, Cone-Beam CT (CBCT) use has increased for the evaluation of patients with CLP in order to understand the anatomic abnormality in the complex structure of maxilla better [6]. For patients with CLP, CBCT has an important advantage in comparison with other radiological methods as it provides 3D evaluation. There is limited number of studies using 3D evaluation of MSV of patients with CLP in the literature [7–9]. In this study we aimed to compare MSV of the UCLP patients and the healthy control patients by using CBCT. Also the volume differences between the cleft and non-cleft sides and right-left side MS were also evaluated.

2. Materials and methods

CBCT scans of 44 patients (27 males and 17 females; mean age: 13.8 ± 3.9 years) with non-syndromic UCLP (18 right and 26 left) and 45 control patients (25 males and 20 females; mean age: 14.2 ± 1.55 years) were selected from the archives of the Oral and Maxillofacial Radiology Department, Erciyes University, Faculty of Dentistry (Table 1). All of the UCLP patients had the same protocol for surgical treatments. In this study, sample size calculation was based on Pandis' formula, a significance level of 0.05 and a power of 85% to display a difference of 22.2 mm^3 (±1.8 mm^3) for the MSV between UCLP and control groups [10]. Minimum forty-two patients were required in each group according to the power analysis using the findings of Celikoglu et al. [11].

This was a retrospective study and the images used in the present study were part of the diagnostic records collected due to dental treatment needs. Factors that will affect the MSV for both study and control patients like presence of mucosal thickening, retention cysts, mucosal, sinusitis or any type of other sinus pathologies, as well as previous maxillofacial neoplasia, trauma or surgery and any diagnosed craniofacial syndrome were excluded from the study. Systemic disorders such as Wegener's granulomatosis, thalassemia, Paget's disease and fibrous dysplasia have also been excluded. No patients were contacted and no CBCTs were taken for the objectiveness of the present study. The patients had signed an informed consent form allowing the use of their data for any scientific purposes. The study was approved by the local ethics committee of the same university.

ALARA principle (as low as reasonably achievable) and the current European SEDENTEX CT guidelines were considered on the taking of CBCTs. Control patients were matched by age and gender to the UCLP patients in the study. All tomographs were obtained in supine position by using CBCT (NewTom 5G, QR, Verona, Italy). Scanning time was 18 s, collimation height was 13 cm, exposure time was 3.6 s, and the voxel size was 0.3 mm^3. Sinuses segmentation was carried out using SimPlant Pro software (version 13.0; Materialise, Leuven, Belgium) (Fig. 1).

The patient-specific Hounsfield values (min: −1024; max: −300) were set to include the largest amount of voxels in the sinuses volume calculation individually. Editing masks and segmentations of the sinuses were performed by manually. The connections between the nasal cavities and other sinuses were erased on the axial, coronal and sagittal planes. After editing masks, the volume of the maxillary sinuses were performed by the software. All data were measured in mm^3 and measurements were made by the same author (F.I.U.) to prevent inter observer variability.

2.1. Statistical analysis

To determine the random error, 15 images were selected randomly and then sinuses volume measurements were repeated 3 weeks after the first examination by the same orthodontist with no knowledge of the first measurements. The coefficients of reliability according to the Houston method for volumetric measurements confirm reliability [12]. Intra class correlation coefficients (ICC) were performed to assess the reliability of the measurements, and the difference between the two examinations was tested by means of a paired *t*-test.

All statistical analyses were performed using the statistical package for social sciences, 13.0 (SPSS for Windows; SPSS Inc., Chicago, IL, USA). Normality of the data was tested using Kolmogorov–Smirnov test. All UCLP data was normally distributed with homogeneous variance. Therefore, we used parametric tests to evaluate the volumetric data. Independent sample *t*-test was used to compare the gender differences in the cleft and non-cleft sides of UCLP patients, in the right and left sides of control patients. We performed paired sample *t*-tests to evaluate side differences between the cleft and non-cleft sides of UCLP and between the right and left sides of the control patients. The right and left sides of the control group and cleft and non-cleft sides of UCLP were pooled to determine the sinus volumes of UCLP and control groups. Then, independent sample *t*-test was used to evaluate the differences in sinus volumes between UCLP and control patients. *P*-values less than 0.05 were considered as significant.

3. Results

The ICC values were 0.992, confirming the reliability of the measurements ($P > 0.05$). No statistically significant gender differences were found in either cleft or non-cleft sides in all parameters ($P > 0.05$) (Table 2).

Descriptive statistics, comparisons of the sinuses between the cleft and non-cleft sides of UCLP patients and both sides of the control group are presented in Table 3. No statistically significant difference was found on the cleft and non-cleft side of the UCLP patients and the right and left side of the control group ($P > 0.05$).

Table 1
Chronological ages of the groups.

	Age (years)			
	UCLP		Control group	
	Mean	S.D.	Mean	S.D.
Female	12.4	3.81	13.9	1.64
Male	14.8	3.87	14.9	1.48
Total	13.8	3.9	14.2	1.55

S.D.: standard deviation.

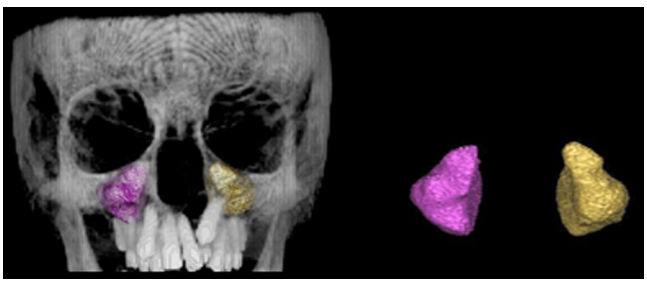

Fig. 1. 3D reconstruction of the maxillary sinuses.

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