Necmettin Erbakan Üniversitesi Diş Hekimliği Dergisi
Necmettin Erbakan University Dental Journal (NEUDentJ)
DOI: 10.51122/neudentj.2023.58
Cilt:5 Sayı:2 Yıl:2023 Araştırma Makalesi / Research Article E-ISSN: 2687-5535

Assessment of the Volumetric Features of Nasolacrimal Canal on Patients with Unilateral Cleft Lip and Palate: A Cone-Beam Computed Tomography Study

Tek Taraflı Dudak ve Damak Yarıklı Hastalarda Nazolakrimal Kanalın Hacimsel Özelliklerinin Değerlendirilmesi: Konik Işınlı Bilgisayarlı Tomografi Çalışması

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ABSTRACT

Aim: This study aimed to evaluate the differences between angle, length and volume of the nasolacrimal canal in unilateral cleft lip and palate patients.

Material and Methods: A total of 29 unilateral cleft lip and palate patients (16 female and 13 male) and 58 nasolacrimal canals were examined. Images of all patients were evaluated by a dentomaxillofacial radiologist with 6 years of experience. Anteroposterior diameter, transverse diameter, length, angle and volume values of the nasolacrimal canal were measured and statistically compared. The normality of the distribution was evaluated with the Shapiro–Wilk test. If the distribution was normal, the paired-t test was used. If not, the Wilcoxon test was used. The significance level was accepted as $P < .05$.

Results: The mean nasolacrimal canal volume was 619.04±235.55 mm3 on noncleft side and 548.63±247.99 mm3 on cleft side and significant difference was found. The mean transverse diameter was 4.81±1.29 mm on noncleft side and 4.49±1.18 mm on cleft side and significant difference was found among them. There were no difference among the nasolacrimal canal length and anteroposterior diameter.

Conclusion: It can be thought that unilateral cleft lip and palate patients are more likely to have a nasolacrimal system problem on cleft side.

Keywords: Cone-Beam Computed Tomography, Nose Diseases, Maxilla

Received: 30.06.2023 **Accepted:** 09.08.2023 **Published:** 28.08.2023

ÖZ

Amaç: Bu çalışmada tek taraflı dudak ve damak yarıklı hastalarda nazolakrimal kanalın hacimleri, uzunlukları ve açıları arasındaki farkların değerlendirilmesi amaçlanmıştır.

Gereç ve Yöntemler: Toplam 29 tek taraflı dudak ve damak yarıklı hastanın (16 kadın, 13 erkek), 58 nazolakrimal kanalı incelendi. Tüm hastaların görüntüleri 6 yıllık deneyime sahip bir ağız, diş ve çene radyolojisi uzmanı tarafından değerlendirildi. Nazolakrimal kanalın transvers ve anteroposterior çapı, uzunluğu, açısı ve hacmi ölçüldü ve istatistiksel olarak karşılaştırıldı. Dağılımın normalliği Shapiro-Wilk testi ile değerlendirildi. Dağılım normal ise paired-t testi kullanıldı. Değilse, Wilcoxon testi kullanıldı. Anlamlılık düzeyi $P < .05$ olarak kabul edildi.

Bulgular: Yarık olmayan tarafta ortalama nazolakrimal kanal hacmi 619.04±235.55 mm3 iken, yarık olan tarafta 548.63±247.99 mm3 olup aralarında anlamlı bir fark bulundu. Yarık olmayan tarafta ortalama transvers çap 4,81±1,29 mm iken, yarık olan tarafta 4,49±1,18 mm olup aralarında anlamlı bir fark bulundu. Nazolakrimal kanalın uzunlukları ve anteroposterior çapları arasında fark bulunmamıştır.

Sonuç: Tek taraflı dudak ve damak yarığı olan hastalarda, yarık olan tarafta nazolakrimal sistem problemi yaşama ihtimalinin daha yüksek olduğu düşünülebilir.

Anahtar Kelimeler: Konik ışınlı bilgisayarlı tomografi, Burun hastalıkları, Maksilla

Geliş: 30.06.2023 **Kabul:** 09.08.2023 **Yayın:** 28.08.2023

Atıf/ Citation: Guler A.Y., Goksel S., Assessment of the Volumetric Features of Nasolacrimal Canal on Patients with Unilateral Cleft Lip and Palate: A Cone-Beam Computed Tomography Study. NEU Dent J. 2023;5:54-9.

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INTRODUCTION

Cleft lip and palate (CLP) is a common congenital anomaly. Facial clefts can occur in different combinations but most commonly present as cleft lip or cleft lip and palate. Patients with CLP may have speech disorders, dental problems, ear infections, hearing loss, and deformities in nasal structures.[1]

Patients with CLP may have deformities in nasal structures. In these patients, deviation of the septum, narrowing of the nasal cavity and obstructions in the nasal airway can be seen.[2]

The tear drains into the inferior meatus through the nasolacrimal duct. The nasolacrimal canal is in close contact with the lateral nasal wall, and the lacrimal system can be damaged due to Le Fort I osteotomies, midface fractures and nasal osteotomies. In addition, infection and pathology may obstruct the nasolacrimal system.[3,4]

The diameter of the nasolacrimal duct is vital for tear drainage. The diameter of the nasolacrimal duct may vary according to age and gender. In a narrow duct, tear flow can be slow and cause obstruction and cause a primary acquired nasolacrimal duct obstruction (PANDO).[5,6]

The lacrimal system is better studied with the widespread use of computerized tomography (CT) imaging. Nowadays, cone-beam computed tomography (CBCT) is widely used and preferred more than CT in the maxillofacial region due to its low cost, low radiation dose and high-resolution image acquisition. Few studies have examined the nasolacrimal system with CBCT so far.[7-9]

In these days many imaging software have been developed for the evaluation of CBCT images. These programs have been used in various subjects, such as periapical lesions, airway evaluation, and volume measurements, with high accuracy.[10,11]

A study using images of patients with nasolacrimal duct obstruction evaluated duct volume with 3D volumetric software and showed successful results.[12] Facial clefts can cause anomalies in the nasolacrimal system.[13]

Altun et al.[14] evaluated the nasolacrimal duct diameter in unilateral patients with CLP and found that the duct diameter was narrower on the affected side.

Today, with the development of 3D imaging software, it is possible to evaluate the nasolacrimal canal in cleft patients in 3D. To best to our knowledge no study in the literature evaluates the volume of the nasolacrimal canal in 3D in patients with CLP.

The aim of this study is evaluate the differences between volume, length and angle of the nasolacrimal canal in patients with unilateral CLP.

MATERIAL AND METHODS

This study was designed as a retrospective split-mouth study. Approval was obtained from the local ethics committee of our institution. (approval no: 94)

The CBCTs of the patients who applied to our clinic for prosthetic treatment were examined.

The control group is the unaffected side and the study group is the affected side with a cleft.

Inclusion criteria:

Patients with repaired unilateral CLP

Patients without syndrome

Patients over 18 years of age

Exclusion criteria:

History of trauma related to the nasal region, presence of pathology such as cyst/tumor

A total of 29 Caucasian patients (16 female and 13 male) were included in the study.

Radiological Examination

CBCT images (Castellini, X Radius Trio Plus, Italy) of all patients were evaluated by a dentomaxillofacial radiologist with 6 years of experience. The voxel size of the tomography device is 68 μm and its FOV is 130x160mm. The device works at 90kVp and 10mA. CBCT images were recorded in DICOM (Digital Imaging and Communications in Medicine) format.

ITK-SNAP 3.8.0 (Penn Image Computing and Science Laboratory, Philadelphia, U.S.A.) program was used for the measurements.[15]

The diameter of the nasolacrimal canal at the level of the infraorbital rim was measured as transverse and anteroposterior in the axial section. [Figure 1A and 1B]

The length of the nasolacrimal canal was measured in the sagittal plane. [Figure 1C]

The angle between the nasolacrimal canal and the line parallel to the base of nasal cavity was measured in the sagittal plane. [Figure 1D]

In addition, the nasolacrimal canal was marked separately in each axial section and formed in 3D and its volume was measured. [Figure 2]

Figure 1: Transverse diameter (A) and anteroposterior diameter(B) in axial section. The length of the nasolacrimal canal (C), the angle between the nasolacrimal canal and the line parallel to the base of nasal cavity in the sagittal plane (D).

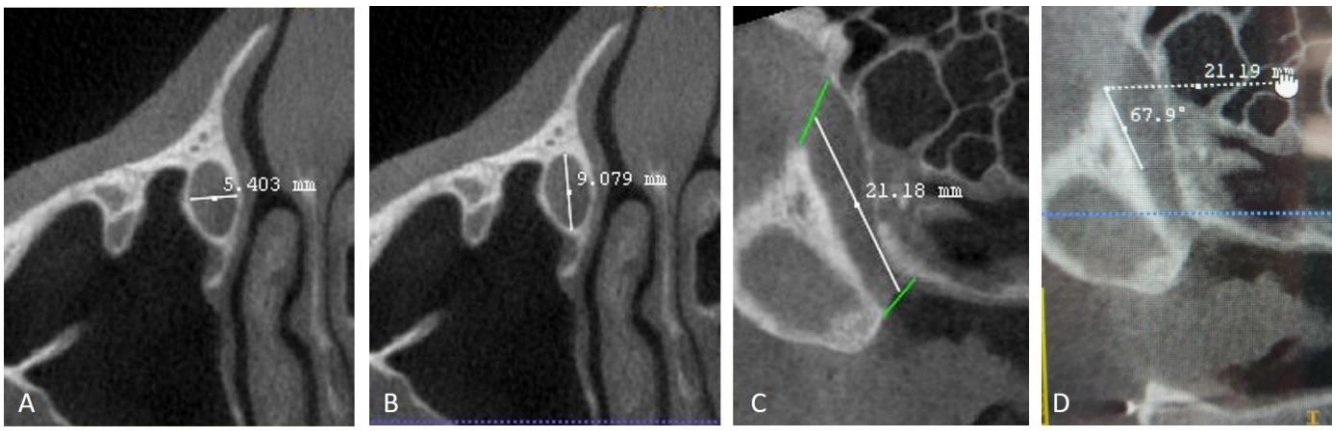
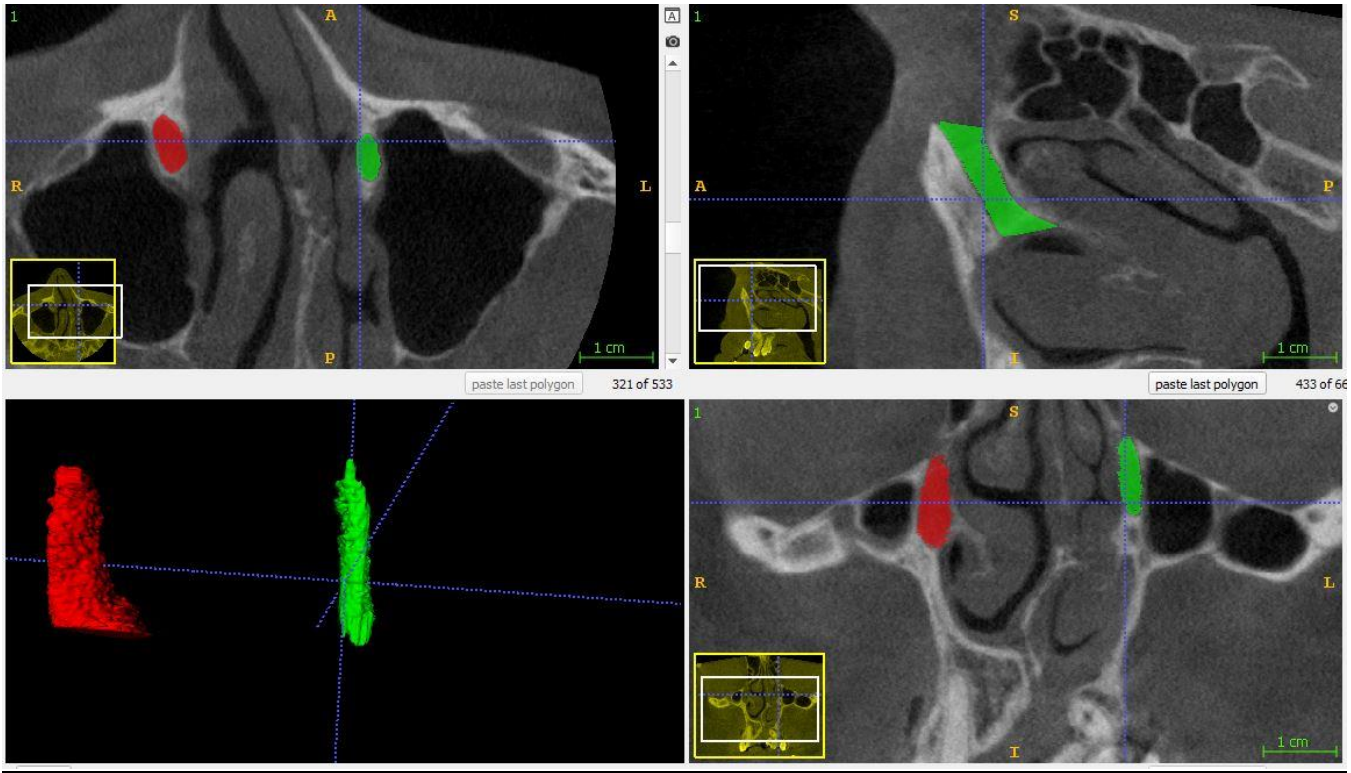


Figure 2: 3D formed nasolacrimal duct



Statistical Analysis

Statistical analysis was performed with SigmaPlot 12.5 (Systat Software Inc, San Jose, CA, USA) software. The normality of the distribution was evaluated with the Shapiro–Wilk test. If the distribution was normal, the paired-t test was used. If not, the Wilcoxon test was used. The significance level was accepted as $P < .05$.

RESULTS

29 patients (16 female and 13 male) and 58 nasolacrimal canals were examined for this study. The patients' age was varying between 18 and 45, with a mean of 26.17±8.89. CLP were present in 22 patients on the left side and 7 patients on the right side.

The mean nasolacrimal canal volume was 619.04±235.55 mm3 on noncleft side and 548.63±247.99 mm3 on cleft side. A significant difference was found. (P = 0.003) (Table 1)

Table 1. Measurement of anteroposterior diameter, transverse diameter, length, angle and volume values of the nasolacrimal canal.

	The non-cleft side Mean ± SD	The cleft side Mean ± SD	P
Anteroposterior diameter [mm]	6,50±1,35	6,38±1,36	P = 0,415
Transverse diameter [mm]	4,81±1,29	4,49±1,18	P = 0,009*
Length of the nasolacrimal canal [mm]	18,99±5,42	20,79±4,87	P = 0,100
Angle [°]	69,85±10,05	68,27±12,75	P = 0,469
Volume [mm^3]	619,04±235,55	548,63±247,99	P = 0,003*

* Values with $p < 0.05$ were considered statistically significant.

The mean transverse diameter was 4.81±1.29 mm on noncleft side and 4.49±1.18 mm on cleft side. A significant difference was found among them. (P = 0.009)

The mean anteroposterior diameter was 6.50±1.35 mm on noncleft side and 6.38±1.36 mm on cleft side. there was no statistically significant difference among them. (P = 0.415).

The mean length of the nasolacrimal canal was 18.99±5.42 mm on noncleft side and 20.79±4.87 mm on cleft side. there was no significant difference among them. (P = 0.100).

The mean angle between the nasolacrimal canal and the nasal floor was 69.85±10.05° on noncleft side and 68.27±12.75° on cleft side. there was no significant difference among them. (P = 0.469)

DISCUSSION

Both genetic and environmental factors contribute to the development of CLP.[16]

CLP include oronasal, paranasal sinus, and midface development problems. CBCT gives successful results while imaging.[17,18]

Since the development of the midface is affected in patients with CLP, there is a possibility that the nasolacrimal duct in this region may also be affected.

Okumus[8] evaluated the angle between the nasal floor and the nasolacrimal bone canal in the study using CBCT images on healthy patients and found it higher in women than men.

Shigeta et al.[19] reported that the anteroposterior diameter of the nasolacrimal canal is larger in men than in women in their study on healthy patients. Janssen et al.[20] compared the transverse diameter of patients with nasolacrimal duct obstruction and the control group. In the control group, the canal diameter was wider in men than in women. In addition, the canal diameter was narrower in patients with obstruction compared to the control group.

Bulbul et al.[12] used CT images and compared the nasolacrimal duct volume in patients with nasolacrimal duct obstruction and the control group. In their study, when the groups with and without PANDO were compared, they did not find a statistically significant difference, although the nasolacrimal duct volume was higher in the group without PANDO.

Wang et al.[21] evaluated the maxilla volume on the affected and unaffected sides in patients with unilateral CLP. They reported that the volume was significantly larger on the unaffected side.

In this study, when the angle among the nasal floor and the nasolacrimal bone canal was compared among cleft side and noncleft side, no statistically significant difference was found. Also, no statistically significant difference was found among the groups when the anteroposterior diameters were compared. However, the transverse diameter was wider on noncleft side. The nasolacrimal canal volume was significantly larger on noncleft side than on cleft side.

The difference in nasolacrimal duct diameter, angle and volume among men and women may be due to the difference among midfacial structures, and the wider duct diameter and larger canal volume in men may be due to larger midfacial structures. In patients with CLP, maxillary retardation occurs on the affected side. This could be the reason why the volume of the nasolacrimal canal was large and the transverse diameter was wide on the unaffected side in our study.

In their study, Altun et al.[14] evaluated the nasolacrimal duct's transverse diameter and length in unilateral CLP patients. They reported that the diameter of the nasolacrimal duct on the affected side was narrower than on the unaffected side. However, when the nasolacrimal duct length was compared, they could not find a statistically significant difference.

Similar to this study, we found that the transverse diameter of cleft side was narrower than unaffected side. There was no statistically significant length difference among cleft and noncleft sides. We found that

the nasolacrimal canal volume was larger on the unaffected side. The reason for that could be the wider transverse diameter on the unaffected side.

Due to the retrospective nature of our study, there are certain limitations. The number of patients and their races is limited in this study. Different numbers of patients and different races may have different results.

CONCLUSION

This study showed that cleft lip and palate patients had a difference in transverse diameter and canal volume, even though there were no difference among the nasolacrimal canal length and anteroposterior diameter. As a result, it can be thought that patients with unilateral CLP are more likely to have PANDO on the affected side than the unaffected side. This information could be useful for clinicians performing treatment procedures CLP patients. However, more studies on this subject may be required.

Ethics Committee Approval: The study was approved by the Ankara Medipol University Health Sciences Non-Interventional Research Ethics Committee (2022/03-94).

Financial Support: The authors declare that this study received no financial support.

Conflict of Interest: The authors deny any conflicts of interest related to this study.

Author Contributions: Design: A.Y.G Data collection or processing: S.G Analysis or interpretation: A.Y.G, S.G Literature search: S.G Writing: A.Y.G

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