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*Original Research*

# *Comparison between Condyles in Affected and Unaffected Sides of Patients with and without Clefts by Cone-Beam Computed Tomography*

*Abdolreza Jamilian[1,2], Rana Mahjoobi Acsil[3], Ahmad Reza Tallaeipoor[4], Sandra Mehralizadeh[5], Korosh Majidi[6], Vincenzo Grassia[7], Ludovica Nucci[8]*

*[1]Module leader, City of London Dental School, University of Bolton, London, UK, [2]Professor, Orthodontic Department, [3]Faculty of Dentistry, [4]Ahmad Reza Tallaeipoor, Department of Oral and Maxillofacial Radiology, [5]Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Tehran University of Medical Sciences, Islamic Azad University, [6]Orthodontics, Private Practice Smile Tailor, [7,8]Multidisciplinary Department of Medical-Surgical and Dental Specialties, University of Campania Luigi Vanvitelli, Naples, Italy.*

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**ABSTRACT**

**Objective**: This study aimed to evaluate the impact of cleft lip and palate (CLP) on the volume and dimensions of the mandibular condyle utilizing cone-beam computed tomography (CBCT).

**Methods and Materials**: This cross-sectional study was conducted on the head, neck, and temporomandibular joint (TMJ) CBCT scans of 18 patients with unilateral CLP (UCLP) and 18 non-cleft controls with class I occlusion. The ITK-SNAP 3.8.0 software measured the mediolateral and anteroposterior dimensions and the height and volume of the right and left condyles. Comparisons were made by T-test and paired sample t-test (alpha=0.05).

**Results:** The mediolateral dimension of the condyle of the affected side in patients with UCLP was significantly smaller than the counterpart condyles in control controls, with a mean difference of 2.33 mm, P=0.002. This value on the unaffected side of patients with UCLP was also significantly smaller than the right and left condyles in control controls, with a mean difference of 2.05, P=0.005. Anteroposterior dimension, condylar height, and volume at the affected and unaffected sides of patients with UCLP were not significantly different within the group or when compared with healthy controls.

**Conclusions:** According to the present results, only the mediolateral width of the condyle at both sides in patients with UCLP was significantly smaller than the values in the right and left condyles of non-cleft controls. No other significant within-group or inter-group differences were found.

**Keywords**: Cleft lip; Radiography; Orthodontics.

***Address for Correspondence:***
*Dr Abdolreza Jamilian*
*Assistant Professor and Consultant of Orthodontics,*
*Department of Orthodontics,*
*No 14, Pesiyan St., Vali Asr St. Tehran 1986944768, Iran*
*Email: info@jamilian.net*
*Phone No: 0098-21-22011892*

## INTRODUCTION

Cleft lip and palate (CLP) are among the most common congenital anomalies that occur due to genetic and environmental factors. [1] Its global prevalence rate is 1 per 1000 births. [2] Patients with CLP suffer significant impairments in maxillofacial and dental growth and development, which cause malocclusion and esthetic problems. [3] In general, the morphology of the craniofacial structures, such as the maxilla and mandible, in patients with CLP is different from that in healthy individuals due to a different growth pattern and the implemented treatments. [4] Evidence shows that anterior and posterior cross-bites are common in such patients [5], and such occlusal interferences especially unilateral posterior cross-bite cause over-function of the muscles at the site, which changes the center of temporomandibular joint (TMJ) growth over time. The reason is that the mandibular condyle is among the most sensitive areas to occlusal changes and interferences. [6] Loads applied to the TMJ cause bone remodeling and change the thickness and shape of the bony components such as the condyle and glenoid fossa. Such changes increase the risk of asymmetry of the mandible, and subsequent esthetic problems and temporomandibular disorders. [7] Auricular pain, masticatory muscle pain, mandibular movement limitation, mouth opening limitation, articular sounds, headache, and orofacial pain are among the signs and symptoms of temporomandibular disorders.[8]

Several studies have assessed the dimensions and volume of the condyle in patients with CLP. For instance, Kim et al[9] found no significant difference in condylar volume of the affected and unaffected sides in patients with CLP. Shrestha et al [10] detected no significant difference in the volume of the mandible in patients with CLP and healthy controls. However, Celikoglu et al [11] reported smaller mandibular volume in patients with CLP than in healthy controls. Uçar et al [12] showed smaller condylar volume in patients with bilateral CLP compared with the control group.

Considering the existing controversy in the literature and the absence of studies comparing the condylar volume of the affected and unaffected sides in patients with unilateral CLP (UCLP) or with a healthy control group, this study aimed to evaluate the condylar volume and dimensions in subjects with UCLP and compare with healthy controls using cone-beam computed tomography (CBCT).

## METHODS AND MATERIALS

### Study population:

This study was approved by the Institutional Research Ethics Committee before the experiment was started (IR.IAU.DENTAL.REC.1400.117), and it was conducted in accordance with the principles outlined in the Helsinki Declaration. This cross-sectional study was conducted on 18 head, neck, and TMJ CBCT scans of patients taken at the Radiology Department of the School of Dentistry, Tehran University of Medical Sciences, Islamic Azad University, and a private radiology center between 2011 and 2018 with a definite diagnosis of UCLP. Eighteen CBCT scans of healthy controls were also selected, taken for other indications, such as assessment of an impacted tooth or orthodontic treatment.

**Eligibility criteria:**

The inclusion criteria were age between 15-22 years and having undergone surgical closure of the lip and hard tissue before the age of 3.5 years for patients with UCLP.

The exclusion criteria were a history of previous orthodontic treatment, history of orthognathic surgery, history of trauma, systemic diseases, and syndromic conditions, history of an articular degenerative disease, and bilateral CLP cases. The patients were selected by targeted sampling.

**Sample size:**

The minimum sample size for condylar volume was calculated to be 18 individuals in each group according to a study by Uçar et al [12] assuming alpha=0.05, beta=0.10, the mean, standard deviation of condylar volume to be 38.5 $mm^3$ and effect size of 0.85. The sample size for other variables was calculated to be lower than 18.

**Measurements:**

All CBCT scans were taken with NewTom VGi CBCT scanner (Verona, Italy) with the exposure settings of 110 kVp, 2-29 mA, and 15 x 15 cm field of view, and Rotograph Evo 3D scanner (Villa Sistemi Medicali, Buccinasco, Italy) with the exposure settings of 88 kVp, 9 mA, and 5.8 x 5.8 cm field of view, with patients in upright position and teeth in maximum intercuspation. The images were then converted to DICOM format by NNT Viewer software version 2.21 (Quantitative Radiology, Verona, Italy). The images were three-dimensionally reconstructed by the ITK-SNAP 3.8.0 software (Paul A. Yushkevich, Guido Gerig, Chapell Hill, North Carolina, USA) and evaluated in coronal, sagittal, and axial sections.

On the cross-sectional slices of each condyle with 1 mm slice thickness in the axial view, the innermost and outermost points of the condylar head were identified, and the distance between them was recorded as the mediolateral width of the condyle in a tenth of a millimeter. On the axial view, the most anterior and most posterior points of the condylar head were identified. The distance between them was recorded as the anteroposterior dimension of the condyle at each side. Of different slices in the coronal view, the slice showing the uppermost point of the condyle was selected, and its vertical distance from the condylar plane was recorded as the condylar height. The condylar plane is the inferior limit of the condyle, which is parallel to the horizon and passes through the deepest point of the sigmoid notch. All measurements were made using the ITK-SNAP software's ruler feature (Figure 1). [9,12]

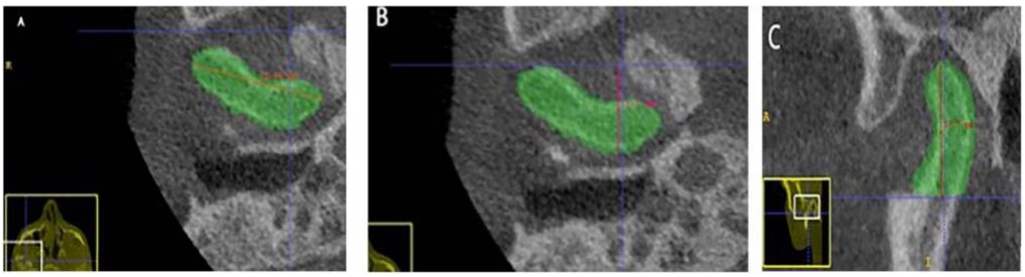


**Figure 1:** Measuring the (A) mediolateral dimension of the condyle, (B) anteroposterior dimension of the condyle, (C) condylar length.

Part of the condyle superior to the condylar plane was considered to quantify the condylar volume. The Snake tool, also known as an active contour model, was used to outline the condyle's superior, inferior, anterior, posterior, medial, and lateral borders on multiplanar images to determine the region of interest. The snake tool is a robust image-processing algorithm used for detecting and outlining structures within images. Following segmentation, bubbles were manually created at different parts of the condyle in the coronal, sagittal, and axial planes to determine its primary contour. Next, the software designed a semi-automatic 3D model of the condyle, and its volume was quantified in cubic millimetres ($mm^3$).[13] CBCT scans (head, neck, TMJ) were taken for a single patient (Figure 2).

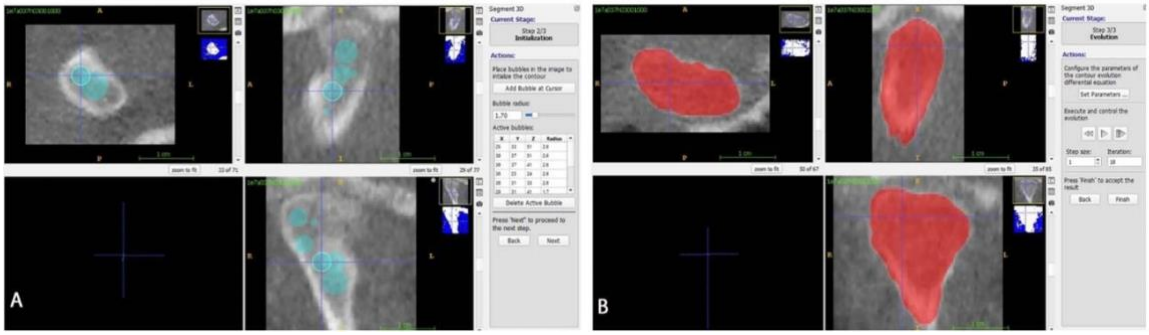


**Figure 2:** (A) Manual creation of bubbles at different points of the condyle to determine its primary contour; (B) determination of contour and final volume of the condyle by the software.

**Statistical analysis:**

T-test was applied to compare the UCLP and control groups regarding the condylar volume and dimensions. Paired sample t-test was used to compare the values between the affected and unaffected sides in patients with UCLP. $P<0.05$ was considered statistically significant.

## RESULTS

Table 1 presents the condylar dimensions and volume in patients with UCLP and the non-cleft control group.

**Table 1: Comparison between cleft and non-cleft patients**

| **Difference between 2 groups, cleft and non-cleft** | Mean | SD | P Value |
|---|---|---|---|
| **Condyle's mediolateral dimension on the unaffected side** | 2.05 | 0.68 | 0.005 |
| **Condyle's mediolateral dimension on the affected side** | 2.33 | 0.70 | 0.002 |
| **Condyle's anteroposterior dimension on the unaffected side** | 0.05 | 0.40 | 0.9 |
| **Condyle's anteroposterior dimension on the affected side** | 0.34 | 0.54 | 0.5 |
| **Condyle's length on unaffected side** | 0.43 | 1.14 | 0.7 |
| **Condyle's length on affected side** | 0.21 | 1.29 | 0.8 |
| **Condyle's volume on unaffected side** | 200.91 | 164.09 | 0.2 |
| **Condyle's volume on affected side** | 207.96 | 168.06 | 0.2 |

**Mediolateral dimension of the condyle:**

Patients with UCLP had a significantly smaller mediolateral condylar dimension at the affected side than the healthy control group's right and left condyles, with a mean difference of 2.33 mm, P=0.002. This parameter in the unaffected condyle of patients with UCLP was also significantly smaller than that in their counterpart condyles of the healthy control group, with a mean difference of 2.05 mm, P=0.005.

**Anteroposterior dimension of the condyle:**

This parameter in the affected side of patients with UCLP had no significant difference with the right and left condyles of the healthy control group (P=0.5). This parameter in the unaffected condyle of patients with UCLP was not significantly different from that in the right and left condyles of the healthy control group (P=0.9).

**Condylar height:**

In patients with UCLP, this parameter in the affected side had no significant difference with the right and left condyles of the healthy control group (P=0.8). This parameter in the unaffected condyle of patients with UCLP was not significantly different from that in the right and left condyles of the healthy control group (P=0.7).

**Condylar volume:**

In patients with UCLP, this parameter in the affected side had no significant difference with the right and left condyles of the healthy control group (P=0.2). This parameter in the unaffected condyle of patients with UCLP was not significantly different from that in the right and left condyles of the healthy control group (P=0.2).

Table 2 compares condylar dimensions and volume between the affected and unaffected sides in patients with UCLP. As shown, no significant difference existed in the affected and unaffected sides regarding mediolateral condylar dimension (P=0.6), anteroposterior condylar dimension (P=0.6), condylar length (P=0.6), or condylar volume (P=0.6).

**TABLE 2: Comparison of affected and unaffected side's condition in cleft patients group.**

| | Mean | S.D. | P Value |
|---|---|---|---|
| The condyle's mediolateral dimension on the affected and non-affected side | 1.81 | 0.22 | 0.6 |
| The condyle's anteroposterior dimension on the affected and non-affected side | 0.97 | 0.11 | 0.6 |
| The condyle's length on the affected and non-affected side | 2.96 | 0.30 | 0.6 |
| The condyle's volume on the affected and non-affected side | 556.50 | 52.95 | 0.6 |

**DISCUSSION**

This study assessed the effect of UCLP on the condylar volume and dimensions compared to healthy controls using CBCT. The use of CBCT for data collection in the present study was due to its 3D nature and the fact that it can provide valuable information regarding malocclusion and endoskeletal problems in patients with CLP. [10,14-15] Two-dimensional imaging modalities have distortion and magnification errors and cannot provide accurate information.[16,17] The present results showed that patients with UCLP had significantly smaller mediolateral condylar dimensions in both the affected and unaffected sides compared with the control group. Condylar height refers to the vertical dimension of the condyle, which is a rounded protrusion at the end of the mandible (lower jawbone) that articulates with the skull's temporal bone, forming the temporomandibular joint (TMJ). The condyle plays a crucial role in jaw movement and function, including chewing, speaking, and opening and closing the mouth. Veli et al [14] evaluated 15 patients with UCLP and found no significant difference in the mediolateral width of the condyle and condylar height of the affected and unaffected sides of patients with UCLP and healthy controls. Similarly, Uçar et al [12] found no significant difference in the mediolateral condylar width of bilateral patients with CLP and the healthy control group. Their results differed from the present findings, which may be due to the evaluation of patients with bilateral CLP in the latter study or different reference points used for the measurements. In the present study, the anteroposterior condylar dimension in the affected and unaffected sides in patients with UCLP had no significant difference from the corresponding values in the control group. The difference in condylar height was not significant either, which was in agreement with the findings of Veli et al [14], who calculated the condylar height from the uppermost point of the condyle to the lowermost point of the mandibular foramen. Celikoglu et al [11] performed linear measurements on cephalograms and showed that condylar and ramus height (Co-Go) in patients with UCLP was shorter than that in healthy controls.

The present study found no significant difference in the condylar volume of affected and unaffected sites in patients with UCLP compared with healthy controls. Shrestha et al [10] found no significant difference between patients with cleft palate and healthy controls in condylar volume of affected and unaffected sides. Celikoglu et al [11] reported that the total mandibular volume in patients with UCLP was slightly, but not significantly, smaller than that in healthy controls. According to Uçar et al, [12] condylar volume was not significantly different between bilateral patients with CLP and healthy controls. Definitions of parameters for condylar measurements in their study were similar to those in the present study.

Comparison of condylar parameters between the affected and unaffected sides in patients with UCLP in the present study revealed no significant difference in any parameter. Kim et al [9] evaluated 28 patients with UCLP and found no significant difference in condylar height, volume, and mediolateral width between the affected and unaffected sides, which agreed with the present findings. Similarly, Veli et al [14] found no significant difference between the affected and unaffected sides in condylar height and mediolateral width. Wahaj et al [18] evaluated the panoramic radiographs of patients with CLP and reported greater condylar height at the affected side. Celikoglu et al [6] reported smaller ramus height and ramus and condylar height at the cleft side. Lo et al [19] evaluated the CT scans of infants with UCLP before corrective surgery of the cleft and showed that the volume of the semi-mandible from the symphysis was greater at the cleft side than the non-cleft side.

Some studies evaluated vertical asymmetry of the mandible according to the method described by Habets et al. [20] For instance, Paknahad et al [21] and Celikoglu et al [6] showed that patients with UCLP had a more asymmetrical mandible than healthy controls in terms of the vertical height of the condyle along with ramus.

Due to the retrospective design of the present study and evaluations only based on a chart review, the effect of possible confounders on the results could not be analyzed. The healthy control group used in the present study and most relevant previous investigations had normal growth with class I occlusion. However, since skeletal class III malocclusion is the dominant occlusion in patients with CLP, having a control group with class III malocclusion may provide more accurate results. Also, both patients with UCLP and BCLP should be compared with healthy controls in future studies to find more comprehensive results regarding the effects of CLP and its unilateral or bilateral type on condylar dimensions and volume.

## CONCLUSIONS

Based on the current findings, the only significant difference observed was that the mediolateral width of the condyle on both sides was smaller in patients with UCLP compared to the corresponding sides in the control group. No other notable differences were detected within or between the groups.

## CONSENT FOR PUBLICATION

The authors warrant that the article is original, is not under consideration for publication by another journal, and has not been previously published. The authors approve the publication.

## AVAILABILITY OF DATA AND MATERIAL

The datasets generated during and analyzed during the current study are available from the corresponding author upon reasonable request.

## COMPETING INTERESTS

The authors declare that they have no competing interests in this study.

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This research received no external funding.

## REFERENCES

1. Dixon MJ, Marazita ML, Beaty TH, Murray JC. Cleft lip and palate: understanding genetic and environmental influences. *Nat Rev Genet*. 2011;12(3):167-178.
2. A Oner D, Tastan H. Cleft lip and palate: Epidemiology and etiology. *Otorhinolaryngol Head Neck Surg*. 2020;5(4).

3. Jiang C, Yin N, Zheng Y, Song T. Characteristics of Maxillary Morphology in Unilateral Cleft Lip and Palate Patients Compared to Normal Subjects and Skeletal Class III Patients. *J Craniofac Surg*. 2015;26(6):e517-e523.
4. Doğan S, Önçağ G, Akın Y. Craniofacial development in children with unilateral cleft lip and palate. *British J Oral Maxillofac Surg*. 2006;44(1):28-33.
5. Capelozza L Jr, Taniguchi SM, Da Silva OG Jr. Craniofacial Morphology of Adult Unoperated Complete Unilateral Cleft Lip and Palate Patients. *Cleft Palate Craniofac J*, 1993;30(4):376-381.
6. Celikoglu M, Halicioglu K, Buyuk SK, Sekerci AE, Ucar FI. Condylar and ramal vertical asymmetry in adolescent patients with cleft lip and palate evaluated with cone-beam computed tomography. *Am J Orthod Dentofacial Orthop*. 2013;144(5):691-697.
7. Katsavrias EG, Dibbets JMH. The Growth of Articular Eminence Height During Craniofacial Growth Period. *Cranio*®. 2001;19(1):13-20.
8. Chang C, Wang D, Yang M, Hsu W, Hsu M. Functional disorders of the temporomandibular joints: Internal derangement of the temporomandibular joint. *The Kaohsiung J of Med Scie*. 2018;34(4):223-230.
9. Uslu-Akcam O, Memikoglu U, Akcam M, Ozel M. Mandibular symmetry in participants with a unilateral cleft lip and palate. *J Cleft Lip Palate Craniofac Anomal*. 2017;4(1):15.
10. Shrestha A, Takahashi M, Yamaguchi T, Adel M, Furuhata M, Hikita Y, Yoshida H, Nakawaki T, Maki K. Three-dimensional evaluation of mandibular volume in patients with cleft lip and palate during the deciduous dentition period. *Angle Orthod*. 2020 Jan;90(1):85-91.
11. Celikoglu M, Ucar FI, Buyuk SK, Celik S, Sekerci AE, Akin M. Evaluation of the mandibular volume and correlating variables in patients affected by unilateral and bilateral cleft lip and palate: a cone-beam computed tomography study. *Clin Oral Invest*. 2015;20(7):1741-1746.
12. Uçar FI, Buyuk SK, Şekerci AE, Celikoglu M. Evaluation of temporomandibular fossa and mandibular condyle in adolescent patients affected by bilateral cleft lip and palate using cone beam computed tomography. *Scanning*. 2016;38(6):720-726.
13. Gomes AF, Brasil DM, Silva AIV, Freitas DQ, Haiter-Neto F, Groppo FC. Accuracy of ITK-SNAP software for 3D analysis of a non-regular topography structure. *Oral Radiol*. 2019;36(2):183-189.
14. Veli I, Uysal T, Ozer T, Ucar FI, Eruz M. Mandibular asymmetry in unilateral and bilateral posterior crossbite patients using cone-beam computed tomography. *Angle Orthod*. 2011;81(6):966-974.
15. Schlueter B, Kim KB, Oliver D, Sortiropoulos G. Cone Beam Computed Tomography 3D Reconstruction of the Mandibular Condyle. *Angle Orthod*. 2008;78(5):880-888.
16. Hwang HS, Hwang CH, Lee KH, Kang BC. Maxillofacial 3-dimensional image analysis for the diagnosis of facial asymmetry. *Am J Orthod Dentofacial Orthop*. 2006;130(6):779-785.
17. Van Elslande DC, Russett SJ, Major PW, Flores-Mir C. Mandibular asymmetry diagnosis with panoramic imaging. *Am J Orthod Dentofacial Orthop*. 2008;134(2):183-192.
18. Kurt G, Bayram M, Uysal T, Ozer M. Mandibular asymmetry in cleft lip and palate patients. *Eur J Orthod*. 2009;32(1):19-23.

19. Ozturk T, Soylu S, Coban G, Turker G. Mandibular Radiomorphometric Characteristics of Individuals with Bilateral or Unilateral Cleft Lip and Palate. *Cleft Palate Craniofac J*. May 2023:105566562311785.
20. Habets Llmh, Bezuur Jn, Naeiji M, Hansson Tl. The Orthopantomogram®, an aid in diagnosis of temporomandibular joint problems. *J Oral Rehab*. 1988;15(5):465-471.
21. Paknahad M, Shahidi S, Bahrampour E, Beladi AS, Khojastepour L. Cone Beam Computed Tomographic Evaluation of Mandibular Asymmetry in Patients with Cleft Lip and Palate. *Cleft Palate Craniofac J*. 2018;55(7):919-924.

**FIGURE LEGENDS**

Figure 1. Measuring the (A) mediolateral dimension of the condyle, (B) anteroposterior dimension of the condyle, (C) condylar length.

Figure 2. (A) Manual creation of bubbles at different points of the condyle to determine its primary contour; (B) determination of contour and final volume of the condyle by the software.

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