

# Assessment of the Asymmetry of the Lower Jaw, Face, and Palate in Patients with Unilateral Cleft Lip and Palate

## Abstract

**Background:** This study aimed to assess the asymmetry of the lower jaw, face, and palate in patients with unilateral cleft lip and palate (UCLP) using photography, cone-beam computed tomography (CBCT), and digitized three-dimensional casts. **Methods:** This case-control study was conducted on photographic, CBCT, and digital cast records of 14 UCLP patients and 24 healthy controls between 10 and 16 years. Totally, 65 variables were measured on photographs, CBCT scans, and on digitized casts. Measurements were compared between the two groups and within each group between the two sides. For easier measurement, in patients who had right side CLP, the cleft was transferred to the left side and in subjects without cleft, mild chin deviation was transferred to the left side. **Results:** The anteroposterior dimensions of the two condyles in the UCLP group were greater than those in the control group, while the mediolateral dimensions of the left condyle and ramus height, mandibular body length, and total length of the mandible in the control group were greater than those in the UCLP group. Right ocular, nasal, and angular variables were greater in the UCLP group. Other variables except for the palatal width from the right canine to midline were greater in the control group. **Conclusion:** Our findings highlighted the presence of asymmetry in the nasal and palatal areas in patients with UCLP while these patients had no significant difference with healthy controls in the relationship of condyles with the temporomandibular fossa.

**Keywords:** *Asymmetry, cleft lip palate, cone-beam computed tomography*

## Introduction

Orofacial clefts including the cleft lip, cleft palate, and cleft lip and palate (CLP) are the most common congenital orofacial anomalies with variable prevalence rates in different countries, socioeconomic classes, and races.<sup>[1,2]</sup> Children with cleft anomalies have serious problems in breathing, speech, deglutition, mastication, and occlusion.<sup>[3-5]</sup> They also have significant variations in facial appearance depending on the type of cleft and technique of reparative surgery.<sup>[6,7]</sup>

Asymmetry is common manifestation of oral clefts,<sup>[8-12]</sup> which often remains after corrective surgery.<sup>[10]</sup>

On the other hand, facial attractiveness plays an important role in social communication, and CLP patients often have negative experiences in social communication due to their unattractive facial appearance.<sup>[7]</sup>

Minimizing facial asymmetry to improve the facial appearance is among the

major treatment goals in CLP patients. Knowledge about the craniofacial growth and morphology in these patients can help in designing an efficient treatment plan.<sup>[13,14]</sup> Several methods are used for the evaluation of malformations caused by clefts, which include qualitative and quantitative methods.<sup>[15]</sup> Qualitative methods are simple and fast but are relatively cognitive and are mainly based on personal experience. In contrast, quantitative methods yield more reliable results.<sup>[15]</sup> Several tools are also available for soft- and hard-tissue assessments including radiography, photography, and scanned plaster casts.<sup>[16-19]</sup>

Hard tissue can be evaluated radiographically. Cone-beam computed tomography (CBCT) has become increasingly popular. It has lower patient radiation dose than the computed tomography.<sup>[20]</sup>

Soft-tissue assessment can be performed directly on living individuals or indirectly on two-dimensional (2D) and three-dimensional (3D) photographs or scanned plaster casts. Although direct

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measurement on living individuals is the gold standard of soft-tissue assessment, it is time-consuming, needs patient cooperation, and may traumatize the facial components, especially around the eyes and is, therefore, less commonly practiced.<sup>[21,22]</sup>

Kim *et al.*,<sup>[23]</sup> Yang *et al.*,<sup>[19]</sup> Lin *et al.*,<sup>[24]</sup> Choi *et al.*,<sup>[16]</sup> Paknahad *et al.*,<sup>[9]</sup> Tziavaras *et al.*,<sup>[11]</sup> and Celikoglu *et al.*<sup>[25]</sup> evaluated maxillofacial asymmetry in patients with CLP compared with healthy controls using CBCT. Desmedt *et al.*,<sup>[14]</sup> Bugaighis *et al.*,<sup>[8,17,26]</sup> and Othman and Aidil Koay<sup>[15]</sup> performed similar studies using 3D photographs. Ruskova *et al.*<sup>[18]</sup> evaluated the morphological variations of the palate using laser scanned plaster casts. Bonanthaya *et al.*<sup>[27]</sup> evaluated the correlation of asymmetry of the vermilion and alveolar defect using plaster casts and frontal view photographs of patients with CLP.

However, to the best of the authors' knowledge, no previous study has evaluated facial asymmetry in unilateral CLP (UCLP) patients using radiography, photography, and scanned plaster casts altogether. Thus, this study aimed to assess the asymmetry of the lower jaw, face, and palate in patients with UCLP in comparison with healthy controls using photography, CBCT, and virtual dental casts.

## Methods

This observational case-control study was performed on 38 patients between 10 and 16 years, including 14 UCLP patients as the patient group and 24 noncleft controls. Subjects were chosen using convenience sampling.

The minimum sample size was calculated to be 10 samples in the cleft group and 15 samples in the control group according to a study by Othman and Aidil Koay<sup>[15]</sup> assuming the mean  $\pm$  standard deviation of the distance from the left otobasion inferius to the left subalar in the UCLP and control groups to be  $88.82 \pm 3.27$  and  $95.69 \pm 6.84$ , respectively,  $\alpha = 0.05$ , power of 90% and ratio (Nhealthy control/NUCLP patients) of 1.5. Thus, 10 UCLP patients and 15 controls were evaluated. Since there are many variables in this study, more samples were used than estimated samples. The study was approved by the Ethics Committee of Kermanshah University of Medical Sciences (Ir.kums.rec. 1396.642).

Definitions of facial asymmetry and CLP were adopted from previous studies.<sup>[28,29]</sup>

All participants were Persian and were chosen according to the following criteria: patients with UCLP had to have undergone corrective surgery of the lip and palate under 1 year of age and at 2 years of age, respectively. Those with syndromic CLP, incomplete lip or palatal cleft, history of orthodontic treatment, orthognathic surgery, bone grafting, corrective nasal surgery, history of facial trauma, degenerative diseases of the temporomandibular joint, and physical or mental retardation were excluded. Patients were

selected among those presenting to a private dental office in Kermanshah to receive orthodontic treatment. These patients required CBCT scans for orthodontic diagnosis, and imaging was not performed for the purpose of this study.

Control subjects had class I occlusion, symmetrical face, and normal growth and development. Those with a remarkable medical history, history of trauma, orthodontic treatment, rhinoplasty, significant crowding, or craniofacial abnormality were excluded. They were selected among patient records available in a private dental office in Kermanshah. Controls already had CBCT scans taken for purposes not related to this study. CBCT scans of both groups had been taken in the same radiology center with the same exposure settings.

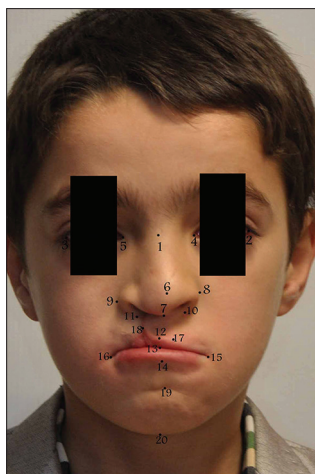
To compare facial asymmetry between the two groups, facial dimensions and angles of patients and controls were measured and compared using CBCT scans, facial photographs, and digitized plaster casts in the sagittal, coronal, and axial planes. Written informed consent was obtained from patients or their legal guardians before the study.

Frontal view and right and left profile view photographs were obtained of subjects in natural head position, while the light was irradiated to the face from the top (equally to the right and left sides). The photograph was obtained with a digital camera (Canon EOS 5DS R) with 51-megapixel resolution ( $8688 \times 5792$  pixels), 72 dpi, and external flash (Canon Speedlite 600EX II External Flash). The camera was positioned at 100–130 cm distance from the patient. Photographs were taken against a white background. Linear and angular measurements were made on photographs according to the definitions provided in Table 1 using Photoshop software (Adobe Photoshop CS4, Adobe System Inc., CA, USA) [Figure 1].

Next, alginate (Orthoprint, Zhermack Spa, Italy) impressions were made of the maxilla and poured with dental stone (Orthodontic model mix stone, Kerr, Switzerland). Dental casts were laser scanned (Maestro MDS 400, Italy) to obtain virtual dental casts using the respective software (3D Easy Dental Scan V.6.2; Maestro, Italy). The casts were scanned perpendicular to the occlusal plane and the data were collected [Figure 2].

Next, CBCT scans were taken in maximum intercuspation with the Frankfurt plane parallel to the ground using the NewTom VGI CBCT system (Quantitative Radiology, Verona, Italy). All scans were obtained using the following exposure settings: 300  $\mu$ m spatial resolution, 110 kVp, 59.78 mA/s, and 15 cm  $\times$  15 cm field of view. Data were converted to DICOM format using NNT Viewer V7.2.0.0 software (QR s.r.l, Verona, Italy).

For easier measurement in patients who had right side CLP, the cleft was transferred to the left side and in subjects



**Figure 1:** Photographic landmarks (1) soft-tissue nasion, (2 and 3) lateral canthus, (4 and 5) medial canthus, (6) pronasale, (7) subnasale, (8 and 9) alare, (10 and 11) subalare, (12) midpoint of upper vermillion, (13) stomion, (14) midpoint of lower vermillion, (15 and 16) cheilion, (17 and 18) crista philtra, (19) soft-tissue point B, (20) gnathion

without a cleft, mild chin deviation was transferred to the left side. This was done by changing the X-axis.

The reconstructed craniofacial structures were oriented according to the Frankfurt, mid-sagittal, and coronal reference planes.

Eventually, for analysis of the soft and hard tissues and the palate, the landmarks were identified and marked on photographs, laser scans of the casts, and CBCT scans according to the reference soft and hard tissues [Table 1 and Figures 3, 4].

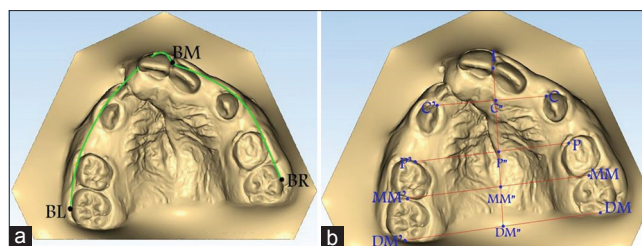
To locate the center of the condyle [Figure 5] in the temporomandibular fossa, the following formula suggested by Pullinger and Hollender<sup>[30]</sup> was used:

$$\text{Condylar center} = \log_e \frac{\text{posterior articular space}}{\text{Anterior articular space}}$$

If the obtained value is  $>0.25$ , the condyle is located anteriorly. If the value is  $<-0.25$ , the condyle is located posteriorly. If the value is between  $+0.25$  and  $-0.25$ , the condyle is in the correct position relative to the temporomandibular fossa in the anteroposterior dimension. Measurements were done by one orthodontist and one maxillofacial radiologist. Measurements made on 10 images by the two observers were compared to assess interexaminer reliability. To evaluate intraexaminer reliability, each observer was asked to re-analyze the same 10 images after 1 week and the values were compared with the first-time measurements. The intraclass correlation coefficient was analyzed and interpreted according to Cicchetti.<sup>[31]</sup>

### Statistical analysis

Normal distribution of data was assessed using the Shapiro–Wilk test. Since the data were normally distributed ( $P > 0.05$ ), independent  $t$ -test and paired  $t$ -test were used to compare the two groups and the right and



**Figure 2:** (a) Landmarks and longitudinal distances on the digitized cast. BL and BR: Most buccal point of the first molar; BM: Most buccal point of the interincisal papilla. (b) Landmarks and transverse and deep distances on the digitized cast. DM and DM': The most distal point of the first molar; DM'': Midpoint of the line connecting DM and DM'; MM and MM': Most prominent point of the mesial papilla of the first molar; P and P': Most prominent point of the mesial papilla of premolar or primary second molar; C and C': Most prominent point of the mesial papilla of canine; I: Most prominent point of interincisal papilla; MM'': Midpoint of the line connecting the mesial surface of first molars at midline; P'': Midpoint of the line connecting the mesial of premolars or primary second molars at midline; C'': Midpoint of the line connecting canine teeth at the midline

left sides. The intra- and interclass correlation coefficients were calculated as well. Data were analyzed using SPSS version 18 (SPSS Inc., IL, USA). The level of significance was set at 0.05.

### Results

A total of 38 participants were evaluated including 13 males (34.2%) and 25 females (65.8%). The mean age of participants was  $14.32 \pm 6.48$  years.

The lowest ICC values obtained between observer and expert and within observer were 0.911 and 0.919, respectively, which are considered excellent. The two groups of UCLP and control were not significantly different in terms of gender distribution (Fisher's exact test,  $P = 0.163$ ) or age (independent samples  $t$ -test,  $P = 0.116$ ).

Table 2 shows the mean and standard deviation of condylar measurements made on sagittal and axial CBCT sections in the two groups that show There was no significant difference between the two groups in variables on sagittal CBCT sections but different in the anteroposterior diameter of condyle at the right and left. The mean of these variables in the control group was less than that in the UCLP group. Furthermore, the two groups were significantly different in mediolateral diameter of the condyle at the left side such that the mean of this variable was smaller in the UCLP group than the control group.

The mean vertical difference of the condylar process in the coronal view was not significant between the two groups.

Table 3 shows the mean and standard deviation of mandibular measurements made on reconstructed 3D CBCT scans in the two groups. The two groups were significantly different in ramal height at the right, ramal height at the left, mandibular body length at the right and left, and mandibular total length at the right and left side. The mean

**Table 1: Description of variables, landmarks, and reference planes**

Reference point	Abbreviation	Definition
Soft-tissue reference points on photographs		
Unilateral reference points		
Soft-tissue nasion	N	Deepest point of the frontonasion suture
Pronasale	Prn	Most prominent point in the facial midline on nose tip
Subnasale	Sn	A point in the facial midline at the conjunction of the columella and upper lip
Labrale inferius	Li	Midpoint of lower vermilion
Soft-tissue B point	B	Deepest point on the facial midline on the anterior mandible
Soft-tissue gnathion	Gn	Most inferior point of the facial midline on the chin
Bilateral reference points		
Endocanthion	En	Medial canthus of the eye
Exocanthion	Ex	Lateral canthus of the eye
Alare	Ala	Most external point on the alar contour
Subalare	Sbal	A point on the inferior border of the nasal alar base where alar disappears in the upper lip skin
Crista philtri	Cph	The junction of the vermilion of the upper lip and lateral crest of the philtrum
Cheilion	Ch	Lateral corner of the lip
Hard-tissue reference points on CBCT scans		
Unilateral reference points		
Sella	S	Center of sella turcica of the sphenoid bone
Basion	Ba	Median (midline) point of the anterior margin of the foramen magnum
Menton	Me	Most inferior point of mandibular symphysis at the midline
Bilateral reference points		
Orbitale	Or	Most inferior point of the inferior border of the orbit
Porion	Po	Most superior point on the upper margin of the external auditory meatus
Gonion	Go	A point located at the most inferior, posterior, and lateral point on the external angle of the mandible
Center of condyle	Cocen	Intersection of mediolateral and anteroposterior axes of the condyle in the axial plane
Condylion superius	Cosup	Uppermost point of the condyle head
Condylion posterius	Copost	Most posterior point of the condyle head
Reference planes		
Frankfurt plane	FH plane	A horizontal line extending from the right porion to the right and left orbitale, which is parallel to the ground
Midsagittal plane	MSP	A line passing through sella and basion perpendicular to the Frankfurt plane
Coronal plane	-	A line passing from basion and perpendicular to both FH and MSP planes
Reference planes for the temporomandibular joint		
Axial plane	-	A plane parallel to FH showing the greatest area of condyle cross section
Sagittal plane	-	A plane passing through the anteroposterior axis of the condyle perpendicular to the FH plane
Coronal plane	-	A plane passing through the mediolateral axis of condyle perpendicular to the FH plane

FH: Frankfurt plane; MSP: Midsagittal plane; CBCT: Cone-beam computed tomography

of these variables in the UCLP group was smaller than that in the control group.

Table 4 shows the mean and standard deviation of ocular measurements made on photographs in the two groups. The two groups were significantly different in the intercanthal width, endocanthion to nasion at the right and left side such that the mean of these variables was smaller in UCLP patients compared with controls.

Table 5 shows the mean and standard deviation of nasal measurements made on photographs in the two groups.

Alar base width, pronasale to alar base at the left side, alar base root width, and subnasale to alar base root at the right and left side were significantly different between the two groups such that the mean of these variables in the UCLP group was higher than that in the control group.

Table 6 presents the mean and standard deviation of oral measurements made on photographs. The upper lip length, upper lateral lip length at the right side, and upper vermilion thickness were different in the two groups and



**Table 2: Mean and standard deviation of condylar measurements made on sagittal and axial cone-beam computed tomography sections in the two groups**

	Group, mean±SD		P <sup>†</sup>
	UCLP group	Control group	
Right superior joint space	2.64±0.87	2.73±0.59	0.731
Left superior joint space	2.81±1.26	2.71±0.46	0.766
P <sup>‡</sup>	0.454	0.885	
Right anterior joint space	1.94±0.57	1.85±0.51	0.626
Left anterior joint space	1.84±0.52	1.85±0.41	0.948
P <sup>‡</sup>	0.474	0.926	
Right posterior joint space	2.59±0.61	2.20±0.61	0.067
Left posterior joint space	2.53±1.08	2.17±0.56	0.185
P	0.755	0.811	
Right condylar concentricity	0.28±0.51	0.16±0.45	0.452
Left condylar concentricity	0.30±0.60	0.16±0.33	0.347
P <sup>‡</sup>	0.886	0.968	
Right anteroposterior diameter of condyle	7.96±0.89	7.26±0.97	0.034
Left anteroposterior diameter of condyle	7.99±0.81	7.28±0.92	0.023
P <sup>‡</sup>	0.868	0.799	
Right mediolateral diameter of condyle	14.56±2.48	15.80±2.60	0.156
Left mediolateral diameter of condyle	13.97±1.98	15.65±2.24	0.026
P <sup>‡</sup>	0.077	0.465	
Right axial angle	68.80±7.27	64.77±9.01	0.163
Left axial angle	66.00±11.29	64.24±8.42	0.587
P <sup>‡</sup>	0.347	0.646	
Right condylar center distance to MSP	47.78±4.33	47.79±3.49	0.992
Left condylar center distance to MSP	48.56±7.42	47.03±2.96	0.373
P <sup>‡</sup>	0.488	0.010	
Anteroposterior difference of condylar process	0.61±4.69	0.72±2.23	0.931

<sup>†</sup>Independent samples *t*-test; <sup>‡</sup>Paired *t*-test. MSP: Midsagittal plane; SD: Standard deviation; UCLP: Unilateral cleft lip and palate

**Table 3: Mean and standard deviation of mandibular measurements made on reconstructed three-dimensional cone-beam computed tomography scans in the two groups**

	Group, mean±SD		P <sup>†</sup>
	UCLP group	Control group	
Ramal height at the right	47.36±5.27	53.79±7.05	0.005
Ramal height at the left	48.06±5.55	54.75±6.75	0.003
P <sup>‡</sup>	0.290	0.085	
Body length at the right	69.06±10.74	76.17±7.39	0.021
Body length at the left	69.45±11.33	75.63±6.66	0.041
P <sup>‡</sup>	0.764	0.257	
Total length at the right	107.44±12.97	117.88±10.67	0.011
Total length at the left	107.41±13.58	117.58±10.55	0.014
P <sup>‡</sup>	0.983	0.749	
Gonial angle at the right	123.73±28.05	128.72±6.45	0.522
Gonial angle at the left	120.44±28.55	128.45±5.53	0.317
P <sup>‡</sup>	0.002	0.655	
Chin deviation	1.41±0.74	1.21±2.51	0.778

<sup>†</sup>Independent samples *t*-test; <sup>‡</sup>Paired *t*-test. SD: Standard deviation; UCLP: Unilateral cleft lip and palate

the upper vermilion thickness and upper lip length were greater in the control group compared with the UCLP group.

Table 7 presents the mean and standard deviation of facial ratios assessed on photographs in the two groups. As shown, the two groups were significantly different in terms of lower facial height, lower facial height/total facial height percentage, and nose/mouth width ratio, and the mean lower facial height and lower facial height/total facial height percentage were smaller in the UCLP group than the control group.

Table 8 shows the mean and standard deviation of palatal surface assessments on digitized casts in the two groups. As shown, the two groups were significantly different in intermolar palatal width, interpremolar palatal width, intercanine palatal width, palatal depth, molar distance to MSP at the right and left side, premolar distance to MSP at the right and left side, canine distance to MSP at the left side, palatal length at the right side left side, and total palatal length.

No significant association was noted between chin deviation and condylar measurements made on sagittal CBCT scans. A significant inverse correlation was noted between chin deviation and anteroposterior diameter of the condyle at the right and anteroposterior diameter of condyle difference in the UCLP group. Chin deviation was significantly correlated with anteroposterior difference of condylar

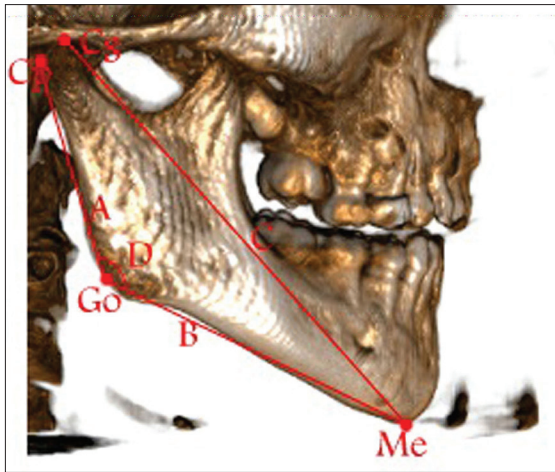


Figure 3: Me (Menton): Lowermost point on the mandibular symphysis  
Go, (Gonion): Most posterior inferior point on the angle of the mandible.  
Cs: Most superior point of the condyle. Cp: Most posterior point of the condyle. A: Ramus height. B: Mandibular body length. C: Total mandibular length. D: Gonial angle

process in the control group and body length difference and vertical difference of the condylar process in UCLP group

A significant difference was noted in the condylar center distance to MSP in the right and left sides in the control group. The mean of this variable in the left side was lower than that in the right side. A significant difference was noted in the gonial angle between the right and left sides in the UCLP group. The mean of this variable in the left side was less than that in the right side. A significant difference existed in pronasale and subnasal to alar base root in the right and left sides in the UCLP group such that the mean of this variable in the left side was greater than that in the right side. The difference in the premolar and canine distance to MSP in the right and left sides was also significant in the UCLP group such that the mean of these variables in the left side was smaller than that in the right side.

## Discussion

This study assessed the asymmetry of the lower jaw, face, and palate in patients with UCLP. The results showed changes in areas close to the cleft such as the nasal area, upper lip, and anterior palate in patients with UCLP compared with controls.

Patients with CLP have significant developmental defects in the maxilla.<sup>[32]</sup> Asymmetry of the face has been extensively evaluated in patients with orofacial clefts, and several tools such as 2D and 3D radiography, facial scanning, and plaster casts of the alveolar arch have been used for this purpose.<sup>[13-19,24,27]</sup> However, no previous study has used radiography, photography, and plaster casts altogether for this purpose. Besides, knowledge about hard- and soft-tissue asymmetries in CLP patients can help in treatment planning.

Asymmetries can also be found in noncleft normal individuals, which necessitates the need for the comparison of asymmetries in UCLP patients and healthy controls and

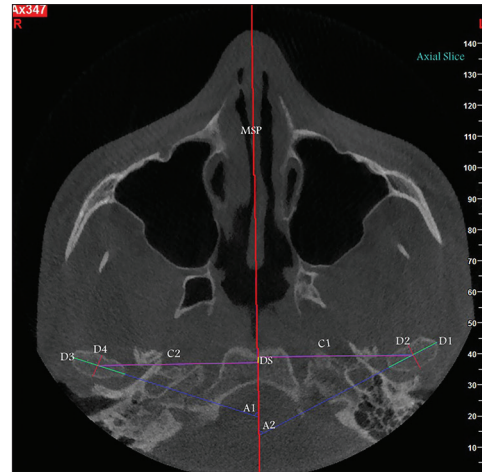


Figure 4: Dimensions and position of condyles on the axial section. D1 and D3: Mediolateral diameter of condyles; D2 and D4: Anteroposterior diameter of condyles; Ds: Sagittal difference of condyle centers at the two sides; C1 and C2: Distance of condyle center from the midsagittal plane; A1 and A2: Angle between the mediolateral axis of the condyles and midsagittal plane

indicates the superiority of case-control studies over those with cross-sectional designs.

In this study, we used photography, CBCT, and virtual dental casts and our cephalometric reference planes were Frankfurt plane, sella, and basion.

In our study, no significant difference was found between the UCLP and control groups in the assessment of upper joint spaces. No previous study has measured and compared the size of this space between the UCLP and control groups. Condyles of both sides in the two groups were symmetrical. Similarly, previous studies found symmetrical temporomandibular fossa in the right and left sides in non-cleft subjects with normal occlusion or different malocclusions.<sup>[24,33]</sup> Furthermore, our study showed that in the control group, condyles were at the center, while previous studies show that the anterior joint space was significantly larger than the posterior joint space.<sup>[24,33]</sup> These findings are in contrast to ours, which may be due to different methods of assessment of the concentricity of condyles and differences in age, gender, race, and type of occlusion of patients. In UCLP patients in our study, the findings showed anterior positioning of the condyles in the fossa at both sides. These findings were in agreement with Lin *et al.*<sup>[24]</sup>

In our study, the anteroposterior dimension of the condyles at both sides and the mediolateral dimension in the left (cleft) side in UCLP patients were significantly larger and smaller than the corresponding values in the control group, respectively. Other linear and angular measurements on the axial section were not significantly different between the two groups. No previous study has compared these values between UCLP patients and healthy controls.

The anteroposterior and mediolateral dimensions of the condyles and the gonial angle and the anteroposterior

**Table 4: Mean and standard deviation of ocular measurements made on photographs in the two groups**

	Group, mean±SD		P <sup>†</sup>
	UCLP group	Control group	
Biocular width	87.54±6.11	87.25±4.50	0.870
Ocular width at the right	27.00±2.59	28.42±2.22	0.083
Ocular width at the left	27.32±2.57	28.13±1.98	0.287
P <sup>‡</sup>	0.069	0.070	
Intercanthal width	33.21±2.52	31.10±2.53	0.018
Endocanthion to nasion at the right	16.54±1.49	15.60±1.26	0.047
Endocanthion to nasion at the left	16.68±1.53	15.50±1.55	0.029
P	0.751	0.691	

<sup>†</sup>Independent samples *t*-test; <sup>‡</sup>Paired *t*-test. SD: Standard deviation; UCLP: Unilateral cleft lip and palate

**Table 5: Mean and standard deviation of nasal measurements made on photographs in the two groups**

	Group, mean±SD		P <sup>†</sup>
	UCLP group	Control group	
Alar base width	38.04±4.72	34.77±3.50	0.020
Pronasale to alar base root at the right	16.18±2.39	17.46±2.11	0.095
Pronasale to alar base root at the left	21.71±3.29	17.31±1.72	<0.001
P <sup>‡</sup>	0.000	0.660	
Alar base root width	26.36±3.95	18.96±3.02	<0.001
Subnasal to alar base root at the right	11.25±2.39	9.44±1.92	0.015
Subnasal to alar base root at the left	15.11±2.64	9.52±1.39	<0.001
P <sup>‡</sup>	0.000	0.784	
Nose dorsum length	45.46±6.34	45.98±5.14	0.786

<sup>†</sup>Independent samples *t*-test; <sup>‡</sup>Paired *t*-test. SD: Standard deviation; UCLP: Unilateral cleft lip and palate

**Table 6: Mean and standard deviation of oral measurements made on photographs**

	Group, mean±SD		P <sup>†</sup>
	UCLP group	Control group	
Mouth width	48.36±7.17	50.58±6.08	0.315
Upper lip length	17.36±2.68	20.92±2.07	<0.001
Lower lip length	15.43±2.22	15.38±1.95	0.938
Upper vermilion thickness	4.83±2.25	6.35±1.79	0.027
Lower vermilion thickness	7.66±1.57	8.67±1.81	0.091
Upper lateral lip length at the right	14.36±2.04	12.35±2.43	0.014
Upper lateral lip length at the left	12.71±3.56	12.55±2.47	0.869

<sup>†</sup>Independent samples *t*-test. SD: Standard deviation; UCLP: Unilateral cleft lip and palate

**Table 7: Mean and standard deviation of facial ratios assessed on photographs in the two group**

	Group, mean±SD		P <sup>†</sup>
	UCLP group	Control group	
Lower facial height	58.54±7.15	65.02±6.33	0.006
Upper facial height	47.96±6.34	48.48±5.14	0.786
Total facial height	105.29±10.85	112.19±9.78	0.051
Lower facial height/total facial height percentage	55.00±2.86	57.48±3.07	0.019
Nose/mouth width ratio	0.78±0.07	0.69±0.07	<0.001

<sup>†</sup>Independent samples *t*-test. SD: Standard deviation; UCLP: Unilateral cleft lip and palate

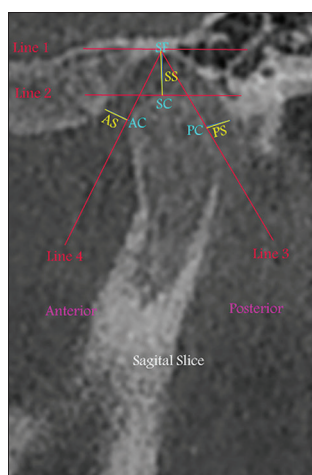
and vertical difference of the two condylar centers were symmetrical in both groups, which was in line with the results of Lin *et al.*<sup>[24]</sup> Also, moreover, the two groups of UCLP and controls were not significantly different in this respect. No such a comparison has been made in previous studies.

In our study, the ramus height, body length, and total length of the mandible measured on CBCT scans at both sides were smaller in UCLP patients than controls. These results were similar to those of other studies,<sup>[9,19,23,25]</sup> except for the total length of the mandible, which was not different between the two groups.

**Table 8: Mean and standard deviation of palatal surface assessments on digitized casts in the two groups**

	Group, mean±SD		P*
	UCLP group	Control group	
Intermolar palatal width	40.51±3.84	44.00±4.10	0.014
Interpremolar palatal width	34.24±4.14	39.06±3.54	0.001
Intercanine palatal width	24.52±4.30	27.13±1.94	0.048
Palatal depth	32.91±4.14	39.61±2.86	<0.001
Molar distance to MSP at the right	24.04±2.73	26.27±2.13	0.008
Molar distance to MSP at the left	23.12±3.22	26.27±1.95	0.001
P*	0.168	0.985	
Premolar distance to MSP at the right	21.50±2.89	23.88±1.80	0.003
Premolar distance to MSP at the left	19.04±3.60	23.83±1.54	<0.001
P*	0.014	0.782	
Canine distance to MSP at the right	13.90±2.03	13.89±1.11	0.983
Canine distance to MSP at the left	11.01±3.64	13.94±1.20	0.011
P*	0.014	0.797	
Palatal length at the right	40.79±4.25	45.92±2.87	<0.001
Palatal length at the left	38.29±5.40	45.75±3.45	<0.001
P*	0.141	0.807	
Total palatal length	79.07±7.66	92.08±5.27	<0.001

†Independent samples *t*-test; ‡Paired *t*-test. MSP: Midsagittal plane; SD: Standard deviation; UCLP: Unilateral cleft lip and palate



**Figure 5: Dimensions and position of condyles on the sagittal section.** SC: Most superior point of the condyle. SF: Most superior point of the temporomandibular fossa. AC: Most anterior point of the condyle. PC: Most posterior point of the condyle. Line 1: Line tangent to SF and parallel to the Frankfurt horizontal plane. Line 2: Line tangent to SC and parallel to the Frankfurt horizontal plane. Line 3: Line starting from SF and SC and tangent to PC. Line 4: Line starting from SF and SC and tangent to AC. SS (superior joint space): Distance between SF and SC in millimeters. PS (posterior joint space): The lowest distance between PC and temporomandibular fossa. AS (anterior joint space): The lowest distance between AC and temporomandibular fossa

The gonial angle of UCLP patients at the left side was significantly smaller. Other variables were symmetrical in both groups. These findings were in agreement with those of previous studies,<sup>[9,19,23,25]</sup> except for asymmetries in mandibular body length in the study by Kim *et al.*,<sup>[23]</sup> and the ramus height in the study by Celikoglu *et al.*<sup>[25]</sup>

Assessment of chin deviation revealed that the two groups were not significantly different in this regard and this finding was in line with that of previous studies.<sup>[19,23,24]</sup> Our

study also showed a significant correlation between chin deviation and anteroposterior difference in condylar centers in both groups (inverse correlation), and vertical difference in condylar angles and difference in mandibular body length at both sides in UCLP patients (direct correlation). Furthermore, chin deviation was correlated with mandibular body length and total length of the mandible in the control group.

3D photographs have higher accuracy and reliability for soft-tissue assessment since they enable assessment in all three spatial planes; however, they were not available for us in this study. Thus, we had to use frontal and profile view 2D photography for this purpose. Evaluation of ocular asymmetry revealed that the right and left medial canthal distance and consequently the intercanthal width in UCLP patients were significantly greater than the corresponding values in the control group. However, no significant difference was noted between the right and left sides in each group. These findings indicate no significant effect of UCLP on ocular asymmetry, which are in consonant with the results of Othman and Aidil Koay<sup>[15]</sup> in China.

Assessment of nasal asymmetry revealed that the alar base width, alar root width, distance from pronasale to the left alar base, and distance from subnasale to alar root width in the right and left sides in the UCLP group were significantly greater than the corresponding values in the control group. These findings indicated larger nasal horizontal dimensions in the UCLP group. The same finding has been reported in some other studies.<sup>[11,15,17]</sup>

Comparison of the right and left nasal dimensions in patients revealed that the distance from pronasale to the alar base and subnasale to alar root base in the UCLP group was



significantly asymmetrical and these values were greater at the cleft side. Furthermore, these findings indicate that the nasal septum in the lower parts is significantly deviated toward the noncleft side in UCLP patients, which is in agreement with previous findings.<sup>[11,13,14,20,30]</sup>

Comparison of oral dimensions showed that upper lip length and upper vermilion thickness in the control group were greater than those in the UCLP group, but the right lateral lip length was greater in the UCLP group, which was the same as the results of Othman and Aidil Koay.<sup>[15]</sup> The lower facial height and its ratio to overall facial height in UCLP patients were smaller than those in healthy controls, which was in contrast to the findings of Othman and Aidil Koay.<sup>[15]</sup>

Assessment of palatal asymmetries in our study was done using digitized casts. The results showed significantly smaller intermolar palatal width, interpremolar palatal width, intercanine palatal width, palatal depth, molar distance to MSP at the right and left sides, premolar distance to MSP at the right and left sides, canine distance to MSP at the left side, palatal length at the right and left sides, and total palatal length in UCLP group, which were expected considering the narrowing and decreased surface of the palate and maxillary retrusion in UCLP patients.<sup>[18,34]</sup> Ruskova *et al.*<sup>[18]</sup> in Czechoslovakia concluded that UCLP patients have a shallower, narrower, and shorter palate than healthy controls. These findings confirm our results.

In our study, canine width and interpremolar width to the midline in UCLP patients in the cleft side were significantly smaller than the values in the noncleft side, which was in accordance with the findings of Ruskova *et al.*<sup>[18]</sup> Furthermore, our results showed that palatal asymmetry in UCLP patients was more severe in the more anterior regions.

Although using facial photographs, digitized cast, and CBCT scan together is very useful in the assessment of the asymmetry of the lower jaw, face, and palate in UCLP patients, our study limitations were small sample size and absence of 3D photography. Future studies are required on a larger sample size to more accurately assess the effect of age and gender on the results. Studies with more observers can also be helpful in future studies.

Furthermore, more accurate assessments using 3D photography and evaluation of asymmetry in other regions such as the airways, sinuses, and nasopalatine area in UCLP and bilateral CLP patients are recommended.

## Conclusion

Our findings showed the presence of asymmetry in the nasal and palatal areas and gonial angle in patients with UCLP and asymmetry of condylar center distance to MSP in healthy controls.

Furthermore, the findings of this study indicated increased width of the nasal base and decreased palatal dimensions in

patients with UCLP, while these patients had no significant difference with healthy controls in the relationship of condyles with the temporomandibular fossa.

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## Conflicts of interest

There are no conflicts of interest.

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