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Evaluation of frontal and axial morphology in repaired unilateral cleft lip and palate patients

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Abstract
Aim: To evaluate the extent of maxillary arch collapse on cleft vis-a-vis non-cleft side in the same individual presenting with unilateral cleft lip and palate (UCLP) using cone-beam computed tomography (CBCT).
Material and methods: 22 children with surgically repaired UCLP who met the inclusion criteria were selected. Following the acquisition of CBCT scans, 14 bilateral landmarks were selected. The distance of the bilateral landmark was calculated from the midsagittal plane on the cleft and non-cleft side for both frontal and axial view. Tracings were done, data obtained was subjected to statistical analysis.
Results: In the axial view, zygomatic arch, malar and porion were non-significant but the alveolar crest at the premolar region ($p<.003$) and molar ($p<.007$) region were significantly decreased. In frontal analysis, pyriforme and alveolar crest above the maxillary 1st molar and in axial view, premolar and molar widths showed significant reduction when comparing the cleft vis-a-vis non-cleft sides.
Conclusion: In frontal analysis, the area encompassing the cleft region showed significant reduction when compared to the non-cleft side along with pyriforme and the alveolar crest over the maxillary first molar. In axial view, when comparing the cleft vis-a-vis non-cleft sides, premolar and molar widths were significantly reduced.

Keywords: Cleft, Morphology, CBCT, Asymmetry

Introduction
The greatest cause for hypoplastic maxilla in these patients is probably iatrogenic ramifications induced by unsatisfactory surgical outcomes, as untreated cleft patients often show wonted growth potential [1]. Almost 3/4th of CL±P patients, have a cleft alveolus in addition, which may lead to anatomic and dental challenges including impacted teeth, supernumerary teeth, crowding, the tendency toward a Class III malocclusion, and crossbites which often necessitate orthodontic intervention [2].
Owing to the distortion of reference points and planes in CLP patients, detection of anatomical variations is complex and arduous. However, 3-dimensional computed tomography (3D-CT) has been found to be beneficial in craniofacial asymmetry diagnosis because, in 3D-CT regional anatomy is shown in a series of cross-sectional axial images, unobstructed by other anatomic features [3].
In lieu of the advantages of cone-beam computed tomography (CBCT) such as reduced scanning time, and diminished radiation exposure compared to conventional CT, CBCT is used to identify root resorption caused by impacted or supernumerary teeth, craniofacial clefts and syndromes, temporomandibular joint as well as asymmetry assessment [4].
Requisite for comprehensive treatment in UCLP patients is not only treatment of sagittal discrepancy but also transverse dimension, because in the end symmetrical morphological outcome is desired. However, there is a scarcity of data available on using CBCT for asymmetry evaluation of the cleft and non-cleft side in the same patient. Therefore, the aim of this study was to quantitatively assess the extent of maxillary arch collapse on the cleft vis-a-vis non-cleft side using CBCT.

Materials and Methods
22 children with surgically repaired UCLP who met the inclusion criteria were selected. Those

having no secondary alveolar bone grafts done with primary CLP repair performed before 18 months of age, same primary surgical techniques (modified Millard procedure), performed by different doctors, no prior orthodontic/orthopaedic appliance intervention and recommended for comprehensive orthodontic treatment in the most recent assessment were selected. Patients with any craniofacial anomalies, syndromes or mental retardation were excluded. Informed consent and willingness to participate was obtained.

Following the acquisition of CBCT scans that were performed as an investigation for comprehensive evaluation and treatment of cleft lip and palate in the patients using an i-CAT next-generation machine, (Imaging Sciences International, Hatfield, Pa (field of view: 17*22 cm) the data was saved in DICOM (version 1.7) format with an isometric voxel size of 0.25 to 0.30 mm and then reoriented utilizing InVivoDental 5.0 (Anatomage, anatomy imaging software San Jose, CA). For standardization the volumes were reoriented. The landmarks were chosen referring to the previous published studies along with the landmarks which are inline or near the cleft portion of the maxilla and frequently present morphological and anatomical variation.

Each of the images was imported into the nemoceph NX software (Visiodent, Saint-Denis France) for linear measurements. The distance of the bilateral landmark was calculated from the midsagittal plane on the cleft and non-cleft side for both frontal and axial view. Data obtained was subjected to statistical analysis.

Statistical analysis

All the measurements were subjected to paired t-tests at the 95% level of significance using SPSS software version 24.

Results

In the frontal view, the small differences between the cleft and non-cleft sides for the zygomaticofrontal suture, infraorbital margin, malare, lower 1st molar, mental foramen, antegonial notch and gonion, measured with respect to the midsagittal plane, were not statistically significant (P >0.05).

A highly significant reduction in the transverse position of pyriforme was noted on the cleft side (P <0.001). A highly significant reduction was seen in the alveolar crest above of maxillary 1st molar on the cleft side (P <0.001). In the axial view the point on the zygomatic arch, malar and porion were non-significant but the alveolar crest at the premolar region on cleft and non-cleft side showed a significant reduction (p<0.003) so did the alveolar crest at molar region (p<0.007).

Table 1: Comparison of the values between cleft and non-cleft side

Variables	Cleft		Non-Cleft		p-value
	Mean	SD	Mean	SD	
	Frontal View				
Zygomatico frontal suture	24.74	5.57	24.48	5.66	0.116
Infra orbital foramen	13.61	3.03	13.70	2.84	0.765
Alveolar crest over maxillary molar	11.44	2.67	13.60	3.64	<0.001
Antegonial notch	19.97	6.09	19.70	5.81	0.336
Gonion	24.16	7.44	24.41	7.67	0.575
Pyriforme	7.72	2.21	5.25	1.45	<0.001
Malare	10.80	1.90	11.19	1.98	0.34
Alveolar crest on mandibular first molar	9.99	1.84	10.49	1.95	0.812
Mental foramen	8.29	2.66	8.52	2.51	0.723
	Axial view				
Point of zygomatic arch	29.81	8.11	30.37	7.99	0.306
Alveolar crest at maxillary pre molar region	7.51	3.84	9.02	3.89	0.003
Alveolar crest at maxillary molar region	8.49	2.06	10.03	2.34	0.007
Malare	9.44	1.83	9.61	1.55	0.401
Porion	25.63	5.09	25.97	4.99	0.516

Discussion

In the landmark study on unilateral cleft lip and palate asymmetry, Mølsted and Dahl [4] found trifling findings in the region of lateral orbital margin but feebly significant findings on medial orbital margin. These results were in agreement with the present study where transverse analysis of cleft and non-cleft sides for the zygomaticofrontal suture and infra-orbital foramen revealed statistically insignificant differences. Duffy *et al*. 2000 [5] and Hood *et al*. [6] also suggested insignificant craniofacial asymmetry of deeper midfacial regions. In consensus, Patel *et al*. [7] further advocated this as they found significant differences that not only included the nasal pyriforme region but also the zygoma and mandible.

In the present study, a highly significant reduction in the transverse position of pyriforme was observed on the cleft side (p<0.001). This finding was in unanimity with Mølsted and Dahl [4] and Mølsted *et al*. [8], who also compared the cleft and non-cleft sides and discerned decreased nasal cavity dimensions. A highly significant reduction was witnessed in alveolar crests above the maxillary 1st molar on the cleft side (p < 0.001) in the frontal view in the current study. Processus-alveolaris, the most prominent point on the alveolar process, presented significant differences between unilateral CLP versus cleft lip patients [8, 10].

In the present study antegonial notch and gonion, measured with respect to the mid sagittal plane, were not statistically significant. Mølsted *et al*. [8] also presented with similar findings in a multicenter examination. The Gonion–Gnation angleis a very useful diagnostic parameter to consider beforestarting an orthodontic treatment because it evaluates the facial pattern of a subject and reflects thevariability of the mandibular plane in relation to the anterior cranial base [9]. Kyrkanides and Richter [10] inferred that antegonial notching, though statistically insignificant between cleft and non-cleft individuals, provided a preliminary manifestation of developing mandibular and lower facial asymmetry.

In the axial view, when the cleft and non-cleft side were juxtaposed, the deeper structures presented with non-statistical differences in the present study, however in contrast with Harikrishnan *et al*. [3] and Patel [7] findings.

Points malare and zygomatic arch showed non-significant finding in axial view. Choi *et al*. [11] gauged positional

symmetry of porion and external auditory meatus in facial asymmetry patients and suggested that porion tends to have symmetrical vertical locations in symmetrical and asymmetrical subjects.

In the axial view, the alveolar crest at the premolar and molar regions showed significant findings in the present study. In agreement, but not statistically significant, were the results by Gopinath VK *et al.* where they found narrower maxillary arch width in the inter canines and the inter first premolar regions in UCLP group [12]. Generali *et al*. 2017, found no significant reduction of the intermolar widths in the mixed dentition phase, however the differences were significant only for the intercanine widths between the UCLP and non-cleft groups. They postulated the more substantial hypoplasia with constriction of the anterior compared to the posterior portion of the maxilla to be responsible for the less pronounced narrowing of intermolar widths in the maxillaryarch [13].

Conclusions

In frontal analysis, the area encompassing the cleft region showed significant reduction when compared to the non-cleft side along with pyriforme and the alveolar crest over the maxillary first molar. In axial view, when comparing the cleft vis-a-vis non-cleft sides, premolar and molar widths were significantly reduced.

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