ISSN: 0974-5823 Vol. 7 No. 1 January, 2022

International Journal of Mechanical Engineering

Assessment of dehiscence and fenestration in cleft lip and palate patients using CBCT

First Author:
Dr. Nitu Gautam , Associate Professor, Dept. Of Orthodontics,
Institute Of Dental Sciences, Bhubaneswar, SOA University
Second Author:
Dr. Swati Acharya, Professor, Dept. Of Orthodontics,
Institute Of Dental Sciences, Bhubaneswar, SOA University
Third Author:
Dr. Subhrajeet Sahoo , Associate Professor, Dept. Of Orthodontics,
Institute Of Dental Sciences, Bhubaneswar, SOA University
Fourth Author:
Dr. Saibalini Pani, Assistant Professor, Dept. Of Orthodontics,
Institute Of Dental Sciences, Bhubaneswar, SOA University
Fifth Author:
Dr. Shweta Dixit , Orthodontist, Private practioner
Sixth Author:
Dr. Aishwarya Raj, Orthodontist, Private practioner

Abstract:

Introduction: Fenestrations, Dehiscences and alveolar defects in the maxillary and mandibular anterior teeth of cleft lip and palate (CLP) patients were assessed and their findings compared with those from the non-cleft group.

Methods: 80 patients were selected and divided into 2 groups – Group 1 having 40 patients (mean age 14.52 ± 2.89 years) affected by CLP and group 2 consisting of 40 patients (mean age 14.12 ± 1.05 years) as non-cleft controls. CBCT images were collected from these patients and evaluated for dehiscence, fenestration and alveolar defects. The data obtained were then analysed with student t test, chi-square test and Fischer exact test.

Results: Dehiscence was found to be prevalent in 60.1% of maxillary and 49.4% of mandibular anterior teeth, whereas, in non-cleft group, they were 7.75% and 16.65% respectively ($P < 0.001$). Fenestration was found to be more prevalent in the maxillary central incisors of CLP group when compared with control group ($P < 0.05$). Other teeth also showed similar rates without any significant differences ($P < 0.05$).

Conclusions: Patients with CLP have increased incidence of dehiscence in the maxillary as well as mandibular anterior teeth, whereas, fenestration in the maxillary central incisors.

Keywords: cleft lip and palate, cone beam computed tomography, dehiscence, fenestration

Introduction:

Alveolar dehiscence are certain bony defects in which exposure of the root surface occurs due to a lowering of the margin of the alveolar crest.[1] Fenestrations are isolated areas on the root surface where the overlying bone is denuded, leaving the root surface to be covered by only periosteum and gingiva.[2-5] A common craniofacial birth defect which occurs due to various genetic and environmental factors is cleft lip and palate. The anomaly presents with a variety of functional as well as esthetically challenging conditions such as – mouth breathing, hypopnoea during sleep, snoring, problems with feeding, hearing, speaking and esthetic problems.[6,7] Studies have reported that anterior and posterior crossbite, midface deficiency with class III malocclusion, increased vertical dimensions and decreased pharyngeal airway volume were commonly seen in these group of patients.[8]A decreased alveolar support of teeth during orthodontic treatment enhances the risk for fenestration and dehiscence.[9-12] Although studies have been conducted on fenestration and dehiscence in patients with vertical and sagittal malocclusions, such studies on cleft lip and palate patients (CLP) are still lacking.[13-15] Thus, the aim of our study was to evaluate fenestration and dehiscence in the maxillary and mandibular anterior teeth of CLP patients with the use of CBCT.

Materials and methods:

CBCT images taken for orthodontic diagnosis of patients having CLP, localization of impacted third molars, assessment of pharyngeal airway and Temporomandibular joint disorders were collected. A power analysis was performed to detect the presence of a clinically meaningful dehiscence (30%) in maxillary central incisors. The power analysis suggested the need of 80 patients for the study.

The CBCT images were collected of the 80 patients selected for this study and divided into 2 groups – Group 1 consisting of 40 patients (22 girls and 18 boys with mean age 14.52 ± 2.89 years) affected by CLP and Group 2 consisting of 40 patients (18 girls and 22 boys with mean age 14.12 ± 1.05) as control group without clefts. Patients affected by CLP had no previous history of orthodontic treatment and their CLP were operated before the age of 3 years **(Table I)**. Standard operating conditions (scanning time: 18 seconds; collimation height: 13 cm; exposure time: 3.6 seconds; slice thickness: 0.25 mm; voxel size: 0.15 mm) in supine position were followedin a Carestream, Kodak; CBCT 9000 3d machine to obtain the CBCT. The images were oriented using Frankfort Horizontal plane as reference plane, constructed from portion, situated in the most latero-superior point of external auditory meatus along with right and left orbitale, inferior most point at the lower margin of orbit. The sagittal reference plane from nasion to midorbital point was drawn perpendicular to the horizontal reference plane. The perpendicular from nasion to the horizontal and sagittal planes was taken as the axial plane. The images taken were converted to DICOM and the software Simplant pro was used to evaluate dehiscence and fenestration in the roots of the maxillary and mandibular anterior teeth from the sagittal and axial slices at the lingual as well as buccal surfaces. The buccal and lingual surfaces of all the maxillary and mandibular anterior teeth used in the study (40 patients, 215 teeth) and control group (40 patients, 350 teeth) were assessed. When the alveolar bone height was greater than 2 mm from CEJ, it was termed as 'dehiscence' **(Figure 1)**. When the alveolar crest did not get involved in the defect, it was termed as 'fenestration' **(Figure 2)**. The assessments were all done by orthodontist and periodontist. Orthodontists, in addition, also assessed the vertical and sagittal growth pattern of patients using SN-MP and ANB parameters in both the study and control groups.

Fig 1. Sagittal cross-sectional views of dehiscence (arrows) in maxilla.

Fig 2. Sagittal cross-sectional views of fenestration (arrows) in maxilla.

Table I : Criteria for sample selection

	Inclusion Criteria	**Exclusion Criteria**
CLP Group	Complete CLP Surgical closure of lip and palate before 3 years of age Good quality images	Previous orthodontic treatment Previous orthognathic surgery History of trauma
Control Group	Normal Healthy subjects Good quality images	Presence of cleft Presence of Syndrome Previous orthognathic surgery History of trauma

Statistical analysis:

4 weeks after an initial examination by an experienced maxillofacial radiologist, they were blindly evaluated again. There was 100% agreement between the two readings on randomly selected images for the presence of fenestration and dehiscence. ANB and SN-MP parameters were measured and their reliability tested with Houston test. The chi-square test and student t tests were done to compare the incidence of alveolar defect and chronological age distribution statistically. The Fischer exact test was used to compare distribution among different sexes. SPSS software for windows (version 15.0) was used for all the statistical analysis and $P < 0.05$ was considered to be statistically significant.

Results:

The intra-examiner and inter-examiner scores assessed both fenestration and dehiscence with 100% accuracy. The Houston test confirmed the accuracy of measurements in growth patterns ($r > 0.950$). The chronologic ages and sex distribution between the two groups, when compared using student t test and chi-square test were well-matched ($P < 0.05$). The patients in CLP group mostly had skeletal class III malocclusions and horizontal growth patterns (10 patients each), whereas, the control group patients commonly had class I malocclusion and average growth patterns (24 and 26 patients respectively) **(Table II)**. There were significant differences, however, between CLP and control groups for maxillary and mandibular anteriors ($P < 0.001$). 31 out of 40 (75.15%) of maxillary centrals, 3 out of 6 (50%) of laterals and 19 out of 42 (45.6%) of canines showed dehiscences. These rates were significantly higher than those of the control groups at 13.3%, 6.6% and 3.35% respectively ($P < 0.001$) **(Table III)**. The CLP group also had higher values of 28 out of 42 (66.65%), 18 out of 42 (42.85%) and 15 out of 42 (35.7%) for mandibular centrals, laterals and canines respectively compared with their control counterparts at 38.3%, 10% and 1.65% respectively. Dehiscence was observed in both the buccal and lingual surfaces of the maxillary anteriors at 50.1% compared to only the buccal surface (57.5%) of the mandibular anterior teeth in CLP group. Dehiscence was found to be more predominant on the lingual surface of the maxillary and mandibular anterior teeth at 92.5% and 83% for control group. CLP group also had significantly higher prevalence of fenestration at 11.5% for maxillary centrals compared to 1.65% for control group ($P < 0.05$). Other teeth also showed similar values without any statistically significant differences **(Table IV)**. Fenestration was found to be more common on the buccal surface of the maxillary anteriors at 55.14% as well as on the mandibular anteriors at 100% and on all maxillary and mandibular control group.

Table II: Distribution of chronologic ages, sexes and growth patterns of groups

			Sagittal growth pattern	Vertical growth pattern
	Mean age (y)	Female/Male	Class I/Class II/Class III	H-A/L-A/N-A
CLP group (n = 20)	14.52 +2.89	2/18	2/8/10	5/10/7
Control group (n=30)	14.12+1.05	8/22	24/6/0	1/3/26
P	0.555*	0.318		

H-A, High angle; L-A, Low angle; N-A, normal angle.

*Results of Student t-test; results of Fisher exact test.

Table III. Comparison of the dehiscence prevalence between CLP and control groups

		CLP GROUP		CONTROL GROUP		
		Dehiscence presence		Dehiscence presence		
	Tooth type	Yes (%)	No (%)	Yes (%)	No (%)	P*
	Maxillary central incisor	31/42 (75.15)	11/42 (23.81)	8/60 (13.30)	52/60 (66.67)	0.000
	Maxillary lateral incisor	3/6 (50.0)	3/6 (50.0)	4/60 (6.60)	56/60 (93.33)	0.000
	Maxillary canine	19/42 (45.60)	23/42 (52.18)	2/60 (3.35)	58/60 (66.66)	0.000
	Total	53/90 (60.11)	37/90 (38.89)	14/180 (7.78)	166/180 (92.22)	0.000
	Mandibular central incisor	28/42 (66.65)	14/42 (33.33)	23/60 (38.30)	37/60 (51.67)	0.000
	Mandibular lateral incisor	18/42 (42.85)	24/42 (57.14)	6/60 (10.0)	54/60 (90.0)	0.000
	Mandibular canine	15/42 (35.70)	27/42 (64.29)	1/60 (1.65)	59/60 (100.0)	0.000
	Total	61/126 (48.40)	65/126(51.59)	30/180 (16.65)	150/180 (83.33)	0.000

*Results of Pearson-chi square test.

Table IV. Comparison of fenestration prevalence between CLP and control groups

		CLP GROUP		CONTROL GROUP		
		Fenestration presence		Fenestration presence		
	Tooth type	Yes (%)	No (%)	Yes (%)	No (%)	P*
	Maxillary central incisor	5/42 (11.5)	37/42 (97.62)	1/60 (1.65)	59/60 (98.33)	0.030
	Maxillary lateral incisor	1/6 (16.67)	5/6 (83.33)	3/60 (5.0)	57/60 (95.0)	0.250
	Maxillary canine	1/42 (2.38)	41/42 (97.62)	2/60 (3.30)	58/60 (3.30)	0.779
	Total	7/90 (7.78)	83/90 (92.22)	6/180 (3.30)	174/180 (96.67)	0.108
	Mandibular central incisor	3/42 (7.14)	39/42 (92.86)	3/60 (5.0)	57/60 (95.0)	0.650
	Mandibular lateral incisor	1/42 (2.38)	41/42 (97.62)	2/60 (3.30)	58/60 (96.67)	0.775
	Mandibular canine	0/42 (0.0)	42/42 (100.0)	1/60 (1.65)	59/60 (98.35)	0.401
	Total	4/126 (3.17)	122/126(96.85)	6/180 (3.33)	174/180 (96.65)	0.935

*Results of Pearson-chi square test.

Discussion:

The alveolar dehiscence and fenestration are commonly associated with various types of malocclusions. Their presence causes gingival recession and bone loss during orthodontic treatment with a higher risk of relapse.[16-19] Till now, investigations on alveolar bone dehiscence and fenestration in CLP patients is lacking, thus, this study was undertaken

retrospectively to evaluate alveolar defects in CLP patients.[20] The evaluation was done using CBCT because of its accuracy in identifying alveolar defects, and also lacking the disadvantages associated with conventional radiographs.[21,22]The reproducibility of the study can be confirmed from the good intra-examiner and inter-examiner reliability scores. Buyuk et al had previously used CBCT images for evaluation of alveolar defects with 100% agreement. Previous studies on various ethnic groups for dehiscence and fenestration have given values ranging from 0.99% - 13.4% and from 0.23% - 16.9%.[23-28]

The rates of alveolar defects were also reported to be higher for bimaxillary protrusion. Evangelista et al in a previous study had reported the incidences of dehiscence at 51.09% and fenestration at 36.51% and more frequent with class I malocclusions as compared to class II division 1 malocclusions.[29] The difference in the rates of alveolar defects involves several factors such as – ethnic differences, decreased buccal or lingual cortical bone thickness, skeletal and dental malocclusions, crowding, visualization of pdl and inclination of teeth.[30,31]In our study, dehiscence was prevalent in 60.11% and 45.41% in the maxillary and mandibular anteriors respectively in patients affected by CLP. Those in the non-cleft group, whereas, had rates of 7.75% and 16.65% for the same teeth. Previous studies had reported the clinical features of CLP patients in terms of – retruded maxilla and mandible, decreased maxillary and mandibular lengths, vertical growth pattern and lesser number of maxillary incisors when compared with the non-cleft individuals.[32-36]Ercan et al had reported a decreased thickness in the cortical bone of maxillary anteriors adjacent to the cleft site.[37] The same conclusions were made independently by Garip et al with the decreased bony support being the vital reason behind alveolar defects.[38,39]

A previous study on UCLP patients using CBCT had only assessed the maxillary anterior teeth and reported a higher dehiscence rate in both the cleft as well as the non-cleft side when compared with the non-cleft group.[40] The findings from our study are in good agreement with those of Buyuk et al. Apart from the maxillary anterior teeth, we have also found a higher prevalence of dehiscence in the mandibular anterior teeth, being 65.66%, 40.86% and 35.7% for the centrals, laterals and canines respectively; when compared with the 35.33%, 10% and 1.65% rates of the control group ($P < 0.01$). Although previous literature had reported the fenestration to be more in the maxillary teeth for non-cleft group, our findings have contradicted this, obtaining similar rates for both the arches.[41-45] In the CLP group, the presence of fenestration was found to be markedly higher in the maxillary central incisors ($P < 0.05$) without any significant difference in the rates for other teeth. The findings from our study on the alveolar defects and their prevalence in the maxillary and mandibular anterior teeth should motivate the clinicians to treat CLP patients with utmost care during orthodontic treatment. They should prefer to use CBCT in such patients and assess the teeth for dehiscence and fenestration and plan tooth movement in such teeth accordingly.

A limitation in this retrospective study would be the fact that the periodontal health of patients from neither groups were assessed clinically, which might have affected our findings. Further studies can be undertaken clinically to evaluate the relationship between alveolar defects and periodontal problems. Also, we have used CBCT images with 0.25 mm slices to detect the thin layers of bone present in the anterior dental region. Future studies can be encouraged with 0.20 mm slices to compare with the results from our study.

Conclusion:

From this retrospective study, the following conclusions can be made:

i. Dehiscence had a significantly higher presence in the maxillary (60.1%) and mandibular (49.4%) anterior teeth in the CLP group compared with their control group counterparts at 7.75% and 16.65% respectively ($P < 0.001$).

ii. Fenestrations were found to be more significant in the maxillary central incisors of CLP group ($P < 0.05$) with similar rates for other teeth as well.

However, further and more elaborate studies would be needed in this area to confirm these findings.

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