Original Article

Evaluation of dehiscence and fenestration in adolescent patients affected by unilateral cleft lip and palate:

A retrospective cone beam computed tomography study

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ABSTRACT

Objective: To evaluate the presence of dehiscence and fenestration defects around anterior teeth in the cleft region and to compare these findings with the noncleft side in the same patients using cone beam computed tomography (CBCT).

Materials and Methods: CBCT scans of 44 patients (26 males, 18 females; mean age, 14.04 ± 3.81 years) with unilateral cleft lip and palate (UCLP) were assessed to define dehiscences and fenestrations of the anterior teeth in both cleft and noncleft sides of the UCLP patients and a control group of noncleft patients (51 patients; 21 males, 30 females; mean age, 14.52 ± 1.16 years). Data were analyzed using Pearson's χ^2 and Student's *t*-test.

Results: The prevalence of dehiscences at the maxillary central incisors, lateral incisors, and canines teeth were 43.2%, 70.6%, and 34.1% on the cleft side and 22.7%, 53.1%, and 27.3% on the noncleft side of UCLP patients, and 13.7%, 7.8%, and 13.7% in controls, respectively (statistically no difference between the sides of cleft patients). The cleft patients had a statistically significantly higher prevalence of dehiscences than did the controls on both the cleft and noncleft sides ($P < .05$), except for the maxillary central incisors. Fenestrations for these teeth were significantly more common on the cleft side in UCLP patients compared with controls ($P < .05$), whereas the difference for maxillary lateral incisors was not statistically significant.

Conclusions: Patients with UCLP showed a higher prevalence of dehiscence and fenestration defects around the maxillary anterior teeth. (*Angle Orthod.* 2016;86:431–436.)

KEY WORDS: Dehiscence; Fenestration; Cleft lip and palate; CBCT

INTRODUCTION

An orofacial cleft is caused by incomplete fusion of the maxillary process. There are many variations in the shape and extent of the deformation, ranging from a simple cleft of the lip to a complex cleft of the lip, alveolar process, and palate.[1] Cleft lip, alveolus, and palatal (CLP) defects are caused by incomplete fusion of the palatal process or nasal process between the late embryonic and early fetal period.[2]

Poorly developed or absent osseous structures in periodontal supportive tissues are widely seen in osseous clefts.[3] Children affected by CLP have several problems, caused by anodontia, tooth malformation, and a deficiency of soft and hard tissue in the cleft region.[4,5] Reductions in bone levels in the areas adjacent to the cleft region are associated with delayed tooth formation and eruption, anatomical defects, and problems with orthodontic movement.[6]

Today, one of the best ways of imaging the alveolar bone is cone beam computed tomography (CBCT). Several advantages of this technique have been reported, such as its ability to evaluate the actual anatomy without superimposition of neighboring tissues

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

and reduced radiation doses and costs compared with conventional CT.[7,8] Visualizing dehiscences and fenestrations is not possible with traditional two-dimensional (2-D) radiographs because of superimposition. CBCT allows the visualization of these defects with more accurate three-dimensional (3-D) images.[9]

Periodontal health in the cleft region is likely to deteriorate over time because of the poorly developed structures and additive trauma to the periodontium during orthodontic treatment.[10] Salvi et al.[2] demonstrated that subjects with orofacial clefts were at high risk for periodontal disease progression, and alveolar cleft sites suffered more periodontal tissue destruction than did control sites. Thus, determining the anatomical defects, including dehiscences and fenestrations, of the teeth in the cleft region is crucial for further conservative therapy to preserve periodontal support and formatting for future orthodontic, surgical, and periodontal therapies.

The aim of this study was to evaluate dehiscence and fenestration around the teeth in the cleft region and to compare these findings with the noncleft side in the same patients using CBCT. Additionally, a matched, noncleft control group was used to compare findings.

MATERIALS AND METHODS

This retrospective study was performed with CBCT images selected from the archives of the Department of Oral and Maxillofacial Radiology, Erciyes University, and was approved by the local ethics committee (2013/724). No patient was contacted and no CBCT was taken for the purpose of this retrospective study.

CBCTs had been taken during the period 2005–13 for orthodontics and orthognathic surgery planning and airway assessment in the unilateral cleft lip and palate (UCLP) group and for impacted tooth localization, temporomandibular joint disorders, and airway assessment in the control group. In total, CBCT images of 95 patients were included. Of these, 44 patients (26 males, 18 females; mean age, 14.04 $\pm$ 3.81 years) who met the following criteria were included in the study group: (1) a diagnosis of complete UCLP and (2) no history of trauma, syndrome, or previous orthodontic or prosthodontic treatment. As a control group, 51 adolescent patients (21 males, 30 females; mean age, 14.52 $\pm$ 1.16 years) were selected as age- and gender-matching patients who had no cleft, syndrome, previous orthodontic treatment, orthognathic surgery, history of trauma, adenoidectomy, or tonsillectomy. All patients were of the same ethnic/racial origin.

All images had been obtained with a NewTom 5G CBCT machine (NewTom 5G, QR, Verona, Italy) using standard operating conditions (CBCT scanning time, 18 seconds; collimation height, 13 cm; exposure time, 3.6 seconds; slice thickness, 0.25 mm; voxel size, 0.15 mm). The images were transformed into DICOM format, and Simplant Pro software (ver. 16.0; Materialise, Leuven, Belgium) was used to determine the presence of dehiscences and fenestrations. The roots of the maxillary anterior teeth (centrals, laterals, and canines) were evaluated in sagittal and axial slices at the buccal and lingual surfaces.

An alveolar bone defect was assessed when there was no cortical bone around a root in at least three sequential CBCT slices. The definitions of dehiscences and fenestrations have been described previously.[11] If the distance between the cementoenamel junction and the alveolar bone crest was more than 2 mm, it was deemed a dehiscence; when the defect did not include the alveolar bone crest, it was deemed a fenestration (Figures 1 and 2). All evaluations were performed at random by an experienced maxillofacial radiologist (AES) blinded to the groups.

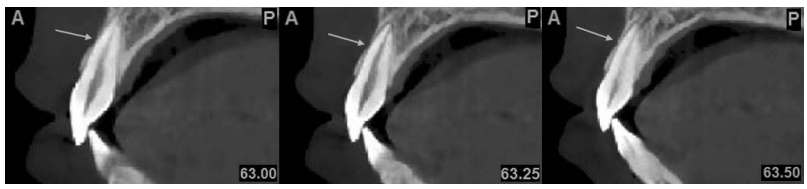


Figure 2. Sagittal cross-sectional views of fenestration (arrows) in the maxilla.

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Table 1. Descriptive Data of Study Patients

	Mean Age (y)	Cleft Side Right/Left	Female/Male
UCLP[a]	14.04 ± 3.81	19/25	18/26
Control	14.52 ± 1.16	–	30/21
P	NS[b]		NS[c]

[a] UCLP indicates unilateral cleft lip and palate.
[b] Indicates results of Student's *t*-test.
[c] Indicates results of Pearson's chi-square test.

Statistical Analysis

To determine random error, 15 radiographs were randomly selected, and the same AES blindly reassessed the data 3 weeks after the first examination. No difference in the degree of agreement was found between the two examinations for the presence of dehiscences or fenestrations, confirming the reliability of the data ($P > .05$).

Data were analyzed using Pearson's χ^2 and Student's *t*-test. Statistical analyses were performed using SPSS software (ver. 12.0 for Windows; SPSS Inc, Chicago, Ill). The level of significance for all tests was set at $P < .05$.

RESULTS

UCLP and control groups were matched with regard to age (Student's *t*-test) and gender distribution (Pearson's χ^2 test; $P > .05$) (Table 1). Distribution of dehiscences in the cleft and noncleft sides of patients and in the controls is presented in Table 2. Comparison of the cleft and noncleft sides of the UCLP patients showed that the anterior teeth on cleft sides had a higher prevalence of dehiscences ($P > .05$). Comparison of the UCLP patients and controls regarding dehiscence presence showed that UCLP patients had a significantly higher prevalence than did controls on both the cleft and noncleft sides, while dehiscence values were found to be almost the same on the noncleft side of the maxillary central incisor and in controls ($P > .05$). The prevalence of dehiscences for maxillary centrals, laterals, and canines was 43.2%, 70.6%, and 34.1% on the cleft side and 22.7%, 53.1%, and 27.3% on the noncleft side of UCLP patients, and 13.7%, 7.8%, and 13.7% in controls, respectively.

Distribution of the dehiscences in relation to the root surfaces in each tooth type is presented in Table 3. For maxillary central incisors on the cleft side, dehiscences were detected on the buccal and palatal sides of eight teeth, only the palatal side of seven teeth, and only the buccal side of six teeth. For maxillary lateral incisors on the cleft side, dehiscences were detected on both the buccal and palatal sides of eight teeth and only on the buccal side of four teeth. Considering the noncleft side of the UCLP patients and controls, dehiscences were commonly observed on the buccal sides and on both the buccal and palatal sides. Patients in the control group had no dehiscences on the palatal side alone.

The number of teeth with dehiscences present is shown in Figure 1. A dehiscence was observed at only one tooth of 11 UCLP patients and at one of the controls. Ten of the 44 UCLP patients had dehiscences associated with at least four teeth, whereas only two of the controls did.

Distribution of fenestrations on the cleft and noncleft sides of UCLP patients and controls is shown in Table 4. Fenestrations at the maxillary central incisors were significantly higher on the cleft side in the UCLP patients compared with controls (7.3% and 0%, respectively; $P < .05$). Fenestrations at the maxillary lateral incisors were higher on the cleft side than on the noncleft side and in controls, but the differences were not statistically significant ($P > .05$).

DISCUSSION

Dehiscences and fenestrations are bony defects that decrease the bone support of teeth. It is well known that under inflammatory conditions (eg, plaque-related periodontitis) or during orthodontic treatment, this decreased bone support can result in deterioration of periodontal health. Thus, it is important to identify the bone support of teeth associated with a cleft before orthodontic treatment. A bibliographic search in Medline using the keywords "dehiscence," "fenestration," "cleft lip and palate," and "CBCT" showed no study having investigated the presence of dehiscences and fenestrations in patients affected by UCLP using CBCT. Thus, this is the first report to evaluate the presence of dehiscence and fenestration defects

Table 2. Dehiscence Distribution in Cleft and Normal Sides of Cleft Patients and Controls

	UCLP Cleft Side		UCLP Normal Side		Control		*P*		
	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	CS[a]-NS	CS-C	NS-C
Maxillary central incisor	19/44 (43.2)	25/44 (56.8)	10/44 (22.7)	34/44 (77.3)	14/102 (13.7)	88/102 (86.3)	NS	***	NS
Maxillary lateral incisor	12/17 (70.6)	5/17 (29.4)	17/32 (53.1)	15/32 (46.9)	8/102 (7.8)	94/102 (92.2)	NS	***	***
Maxillary canine	15/44 (34.1)	29/44 (65.9)	12/44 (27.3)	32/44 (72.7)	14/102 (13.7)	88/102 (86.3)	NS	**	*

* $P < .05$; ** $P < .01$; *** $P < .001$.
[a] CS indicates cleft side; NS, normal side; C, control group.

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Table 3. Distribution of Dehiscences in Relation to Root Surface

	UCLP Cleft Side			UCLP Normal Side			Control		
	B[a]	P	B/P	B	P	B/P	B	P	B/P
Maxillary central incisor	6	7	8	4	3	3	12	0	2
Maxillary lateral incisor	4	0	8	7	6	4	7	0	1
Maxillary canine	6	1	5	12	0	3	5	0	0

[a] B indicates only buccal side; P, only palatal side; B/P, both buccal and palatal sides.

around the teeth in cleft regions and to compare the findings with the noncleft side of the same patients and with noncleft controls.

CBCT imaging provides detailed 3-D information about bone morphology and changes associated with disease and treatment.[12,13] Many studies have assessed the accuracy of CBCT.[14–16] According to one, the diagnostic value of CBCT measurements was found to be equivalent to that of direct measurements and that dehiscences were diagnosed with higher accuracy than were fenestrations.[17] Sun et al.[12] concluded that alveolar bone height and thickness measurements can be obtained from CBCT images with good-to-excellent repeatability. A study by Braun et al.[16] compared the diagnostic value of periodontal bone defect images using conventional 2-D, single-tooth radiographs and 3-D CBCT images. These studies support the conclusion that CBCT is a better diagnostic tool than are conventional 2-D radiographs for the detection of infrabony defects, fenestrations, and dehiscences. Because CBCT has been shown to be a reliable method for assessing dehiscences and fenestrations, we decided to use these images in cleft patients, a technique that has not been reported previously. Consistent with previous studies[4,5,18–24] showing the high reliability of CBCT for 2-D and 3-D measurements, agreement was 100% for the detection of dehiscences and fenestrations. Although Sun et al.[12] reported that this method might overestimate the actual measurements, the technique was reported to have the highest sensitivity and diagnostic accuracy for detecting various periodontal defects.[21]

A few studies[9,25,26] have analyzed dehiscences and fenestrations by CBCT in different malocclusion groups and normal populations. However, no data were available for patients with clefts. Evangelista et al. used CBCT to evaluate dehiscences and fenestrations in patients with Class I and Class II Division 1 malocclusions. They found that dehiscences were more prevalent than fenestrations and were associated with half the teeth (51.9%); the proportion was 36.5% for fenestration.[26] Similarly, dehiscences and fenestrations were assessed with CBCT in skeletal Classes I, II, and III malocclusions.[25] The Class II group had a greater prevalence of fenestrations, and dehiscences were seen with a high frequency in the mandibular incisors of all groups. In another study,[9] these bony defects were examined in terms of vertical growth patterns using CBCT; the prevalence of dehiscences was higher in the hyperdivergent group than in the hypodivergent group. As it was previously reported that patients affected by UCLP had a hyperdivergent growth pattern,[4,27] it confirms our findings. Ercan et al.[28] assessed the alveolar bone support in UCLP patients and showed that the bone supporting the central incisors on the cleft site was significantly thinner than that on the noncleft site. Their results are consistent with those of the present study, in which the dehiscence rate for centrals on the cleft site was significantly higher than that in the control group (43.2% and 13.7%, respectively). In a study[22] that analyzed these defects in different sagittal malocclusion groups, the incidences of fenestrations for maxillary central incisors were 23.1% in Class I, 18.5% in Class II, and 21.1% in Class III malocclusion patients. In another study[9] that evaluated these defects according to vertical growth patterns, the presence of fenestrations for the same tooth were similar in hyperdivergent (21.1%) and normodivergent (22.4%) groups. However, the rate was lower in the hypodivergent group (5.7%). When these results were compared, it was found that approximately half the patients had a dehiscence defect at the maxillary central on the cleft side

Table 4. Fenestration Distribution in Cleft and Normal Sides of Cleft Patients and Controls

	UCLP Cleft Side	UCLP Normal Side	Control	*P*		
	Yes/No (%)	Yes/No (%)	Yes/No (%)	CS[a]-NS	CS-C	NS-C
Maxillary central incisor	3/44 (6.8)	1/44 (2.3)	0/102 (0.0)	NS	*	NS
Maxillary lateral incisor	2/15 (13.3)	0/32 (0.0)	3/99 (2.9)	NS	NS	NS
Maxillary canine	0/44 (0.0)	0/44 (0.0)	3/99 (2.9)	NS	NS	NS

* $P < .05$ according to Yates' chi-square test.

[a] CS indicates cleft side; NS, normal side; C, control group.

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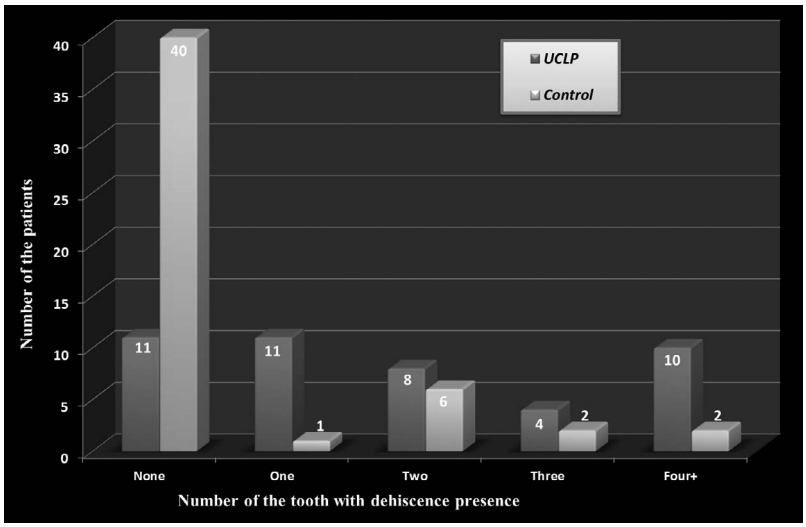


Figure 3. Number of teeth with dehiscences present.

(43.2%). This rate was extremely high compared with patients without clefts but having different malocclusions and growth patterns. The distribution of fenestration defects showed a difference on the cleft side of the UCLP patients and controls only for the maxillary central incisors (7.3% and 0%, respectively). We can conclude that the bony support of maxillary centrals in the cleft region was relatively low. Thus, extra attention should be paid to these teeth during orthodontic treatment.

The percentages of dehiscences at the maxillary lateral incisors were low in noncleft malocclusion groups (17.9%, 14.8%, and 14.1% for Classes I, II, and III, respectively). Similarly, the percentages were 10.5%, 15.5%, and 17.1% for hyper-, normo-, and hypodivergent groups, respectively. In our study, the rate of dehiscence on the cleft side was extremely high in the lateral incisors (70.6%). Thus, the orthodontist should be especially alert for purposeful tooth movement in lateral incisors on the cleft side.

Regarding the canines, the dehiscence rates were similar on the cleft and noncleft sides (34.1% and 27.3%, respectively). These values were also similar in noncleft malocclusion patients (20.5% in Class I, 31.5% in Class II, and 28.2% in Class III) and in hyper-, normo-, and hypodivergent patients (36.8%, 24.1%, and 28.6%, respectively). Ercan et al.[28] analyzed the bone thickness of centrals and canines in cleft and noncleft regions; they found no significant difference between the cleft and noncleft regions for the canines. However, the facial bone thickness of the maxillary central incisors was thinner at the crest and at 2 mm apical to the crest on the cleft side compared with the noncleft side. Thus, the centrals and laterals on the cleft side were the most affected teeth.

During orthodontic movement, bone resorption occurs on the side of tooth movement. The type of tooth movement depends on the line of action of the force, which is related to the center of resistance of the teeth. In cases of reduced bone volume or the presence of defects such as dehiscences or fenestrations, orthodontic treatment should be planned carefully. Before starting treatment, the alveolar bone of cleft patients must be checked by CBCT to identify any fenestrations or dehiscences. The results of this study will help highlight the prevalence of these defects in cleft patients.

On the other hand, this study was hampered by the limitations inherent in the retrospective study design and our not incorporating a sample calculation method prior to the study.

We evaluated only CBCT images of the patients' periodontal tissues but not clinically. Therefore, it might be advisable for those considering future studies to use larger study samples to compare and discuss our findings. Further studies evaluating the periodontal tissues clinically to investigate the relationship of dehiscence and periodontal problems would also be welcome.

CONCLUSIONS

- The prevalence of dehiscences on the noncleft side of UCLP patients was almost as high as that on the cleft side ($P > .05$), while the UCLP patients had a significantly higher prevalence of dehiscences than did the controls ($P < .05$), except for the maxillary central incisors on the noncleft side.
- Fenestrations at maxillary central incisors were significantly more common on the cleft side in UCLP patients compared with controls ($P < .05$), whereas the difference for maxillary lateral incisors was not statistically significant.

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