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The Precision of Cone-Beam Computed Tomography in Assessing the Structural Foundation of Teeth in Individuals with A One-Sided Cleft of The Lip and Palate Within the Iraqi Population

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Abstract

Background: This study aimed to assess the bone structure supporting teeth near the cleft region in individuals with a unilateral cleft lip and palate. The study also aimed to compare these measurements with the corresponding teeth on the non-cleft side using cone-beam computed tomography (CBCT).
Materials and Methods: Thirty individuals with unilateral cleft lip and/or palate had their CBCT scans analyzed. Cleft-adjacent teeth had their alveolar bone support measured and compared to non-cleft-adjacent teeth. The buccal bone plate thickness was measured at 0-, 1-, 2-, and 4-mm depths, as was the distance between the cementoenamel junction (CEJ) and the alveolar crest (AC) on the buccal side.
Results: The central incisor's bony support was notably thinner in cleft regions compared to non-cleft areas at apical depths of zero and one millimeter. The CEJ-AC space for central teeth near the cleft was significantly greater than that in non-cleft regions. Similar trends were observed for canine teeth at 0, 1, 2, and 4 millimeters, resembling the results for central teeth at 0 and 1 millimeters. The CEJ-AC space for canine teeth adjacent to the cleft was significantly developed compared to non-cleft regions.
Conclusion: Individuals with a unilateral cleft lip and palate exhibited diminished alveolar bone support for teeth near the cleft area compared to controls. This discrepancy could lead to future complications, underscoring the importance of professional dental care to maintain optimal periodontal health in these patients.

Keywords: *Alveolar cleft; Cone-beam computed tomography (CBCT); Cleft lip and palate; Unilateral.*

1. INTRODUCTION

One of the prevalent facial and oral cavity malformations that emerge early in pregnancy is a whole cleft involving the lip, alveolar bone, and palate (CLAP). Children affected by CLAP typically exhibit deficiencies in soft tissue and alveolar bone and deformities in the cleft region and dental elements [1]. As a result, various challenges arise, including speech, hearing, feeding, aesthetics, and potential psychological issues [2]. Furthermore, youngsters with CLAP are prone to experiencing periodontitis and mucogingival problems [3] due to several factors: Persistent soft tissue folds can persist before closure, impeding effective cleaning. Prolonged orthodontic treatment might inadvertently lead to trauma to the periodontium.

Underdeveloped osseous structures can exacerbate the issue [4]. Individuals with CLAP often exhibit substantial periodontal attachment loss, with visible plaque and bleeding upon probing. The bony structures in the supportive periodontal tissues need to be more adequately formed or present in the affected area. This significantly reduces bony support compared to their non-cleft counterparts on the opposite side [5, 6].

The degree of bone loss is evaluated using periapical radiographs with the parallel approach in patients of UCLP and those with CP, it becomes evident that patients with UCLP experience inferior

periodontal health characterized by greater alveolar bone loss compared to individuals with CP alone [7, 8, 9]. It is important to note that lip and palate development can occur independently, meaning a cleft of the lip might occur without a cleft, or vice versa, or both could occur together. This condition, known as cleft lip and palate (CLAP), results in deformities within the cleft region and dental structures.

To date, there has been a prior investigation that examined alveolar bone support in individuals with cleft lip and palate using CBCT. This advanced technology provides true-to-size images (1:1 scale) that eliminate the potential for magnification. CBCT also demonstrates strong consistency between different observers and repeated measurements, surpassing conventional radiographs regarding reliability [10, 11].

This current study aimed to elucidate the effectiveness of CBCT in evaluating the quality of alveolar bone around teeth in patients with unilateral cleft lip and/or palate (CLAP). Analysis results also aimed to compare these CBCT measurements with the measurements of the corresponding teeth on the non-affected side.

2. MATERIALS AND METHODS

An analysis was conducted on retrospective CBCT scans of 30 adult patients from Iraq (18 males and 12 females), aged between 14 and 25 years. The study participants were sourced from individuals seeking diagnostic assessments at the AL-Sadar Specialized Dental Center. These patients provided informed consent, permitting the utilization of their data for scientific purposes.

For this research, CBCT scans were utilized from patients with an unrepaired UCLP, all exhibiting satisfactory oral hygiene and periodontal health. The images were captured using a standardized CBCT device (CBCT KODAK 9500) and processed using CS 3D imaging software, employing specific parameters (voxel size: 300, 90 kV, 10 mA). The data acquired was then reconstructed with slices spaced at 0.25 mm intervals, placed such that they are perpendicular to the long axis of the alveolar bone (see Figure 1).

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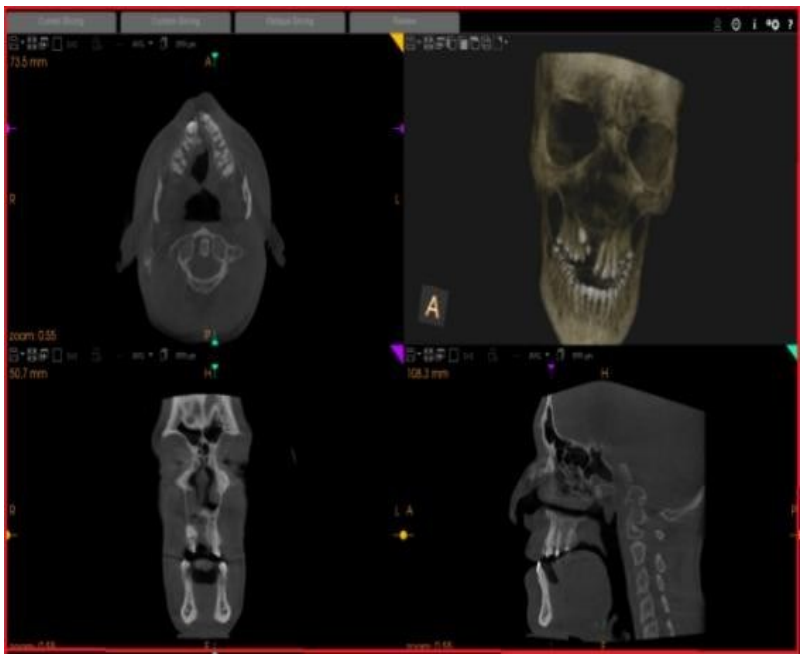

Figure 1. 3D models as well as axial, coronal, and sagittal perspectives generated through the utilization of the CS 3D imaging software.

All patients were healthy and had never before undergone chemotherapy or radiation. Patients whose pictures were distorted because of things like fillings, root canals, root resorption, or apical surgery were also not included. Within this investigation, a total of four teeth per 30 patients affected by a unilateral cleft lip and palate were subjected to analysis. Specifically, data from central teeth and canines located proximate to the cleft region were utilized for testing, while their corresponding contralateral central teeth and canines served as controls. Notably, due to the absence of two teeth in the cleft area, evaluation of contralateral lateral teeth could not be conducted, as indicated in Table 1.

Table 1: The total Number teeth and the Position of the analyzed Teeth

Number	**Central**		**Canine**	
	Cleft-Side	Normal-Side	Cleft-Side	Normal-Side
	30	30	30	30

Central teeth, canine teeth, and teeth on the side without the cleft were all measured for the examination. This was done by measuring how far away from the alveolar bone crest (AC) the cementoenamel junction (CEJ) is, and how thick the buccal plate is at 0, 1, 2, and 4 mm apical to the AC. The collected measurements were then compared by a skilled operator**.** Refer to Figures 2 and 3 for a visual representation of the process.

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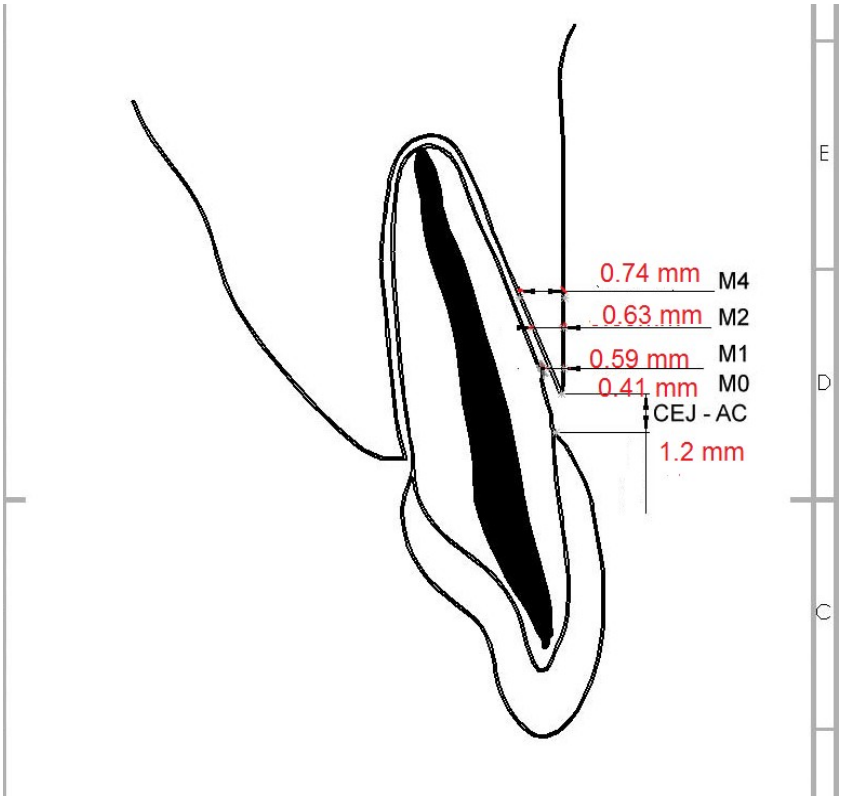

Fig. 2 The measurements conducted on CBCT scans, specifically on a sagittal image. These measurements were taken at the alveolar bone crest and at sites located 1, 2, and 4 mm apical to the crest.

2.1 Statistical Analysis

Levene's test for homogeneity of variances was used to look at the data distribution and it exhibited that the data monitored a normal distribution ($p > 0.05$). The buccal bone thickness of the central teeth and the canine teeth was compared between the healthy and cleft sides using a parametric paired t-test. Table 2 displays the results of a (student's t-test) done to examine the differences between the groups.

Fifteen photos (at random) were chosen for the evaluation of random error. Four weeks following the initial checkup, the same operator who hadn't been involved in the first measures took all of them.

Table 2: Bony Thickness Distribution at Varying Levels in Cleft and Non-Cleft Regions of 1 and 3 Teeth

Bone Thickness	Central				P Value	Canine				P Value
	Cleft Side		Normal Side			Cleft Side		Normal Side		
	Mean	S. D	Mean	S. D		Mean	S. D	Mean	S. D	
M0	0.353	0.127	0.560	0.161	0.00(S)	0.446	0.206	0.680	0.229	0.00(S)
M1	0.553	0.209	0.880	0.280	0.00(S)	0.673	0.311	1.060	0.290	0.00(S)
M2	0.833	0.327	0.960	0.226	0.086(NS)	0.880	0.285	1.340	0.312	0.00(S)
M4	1.033	0.446	1.260	0.422	0.071(NS)	1.123	0.332	1.740	0.457	0.00(S)

- Buccal bone thickness at 0, 1, 2, and 4 mm is denoted by the symbols M0, M1, and M2, respectively.
- Pairwise *t-test* for determining significance levels.

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3. RESULTS

In total, 60 central teeth (30 in the cleft region and 30 in the contralateral non-cleft region), as well as 60 canine teeth (30 in the cleft region and 30 in the contralateral non-cleft region), were subjected to analysis Table 1 displays the results. Buccal bone thickness is compared in Table 2 for both central and canine teeth.

The average buccal bone width of central teeth at the alveolar bone crest (M0) was 0.353 mm in the cleft region and 0.560 mm in the non-cleft region. This disparity was statistically significant (p = 0.00). Similarly, at 1 mm apically to the alveolar bone crest (M1), the central teeth exhibited thinner bone thickness in the cleft region, measuring 0.553 mm, compared to 0.880 mm in the non-cleft region (p = 0.00). However, the bone thickness at levels M2 and M4 for central teeth remained comparable between the cleft and non-cleft areas.

For canine teeth, the bone width means values at levels M0, M1, M2, and M4 were also found to be thinner in the cleft region compared to the non-cleft region, with a statistically significant difference (p = 0.00).

Table 3 explains the distances among the CEJ and the AC. For central teeth, the mean CEJ-AC distance in the cleft region was 2.753 mm, while in the non-cleft areas, it was 1.280 mm, indicating a significant difference (p = 0.00). This suggests that the alveolar bone crest of central teeth is situated more apically in the cleft region. Similarly, the mean CEJ-AC distance for canine teeth was 3.700 mm in the cleft region and 1.446 mm in the non-cleft region, with a statistically significant difference (p = 0.00).

Table 3: Comparison of CEJ-AC at central and canine teeth in cleft and non cleft regions

	Central					Canine				
	Cleft Side		Normal Side		P Value	Cleft Side		Normal Side		Value
CEJ -AC	Mean	S. D	Mean	S. D		Mean	S. D	Mean	S. D	
	2.753mm	0.695	1.280mm	0.171	0.00(S)	3.700mm	1.11	1.446mm	0.267	0.00(S)

- ❖ CEJ-AC the space between the cement enamel junction and the alveolar bone crest
- ❖ P-value calculated by student's t-test

4. Discussion

Using radiographic techniques, researchers [12, 13, 14, and 15] have previously evaluated the level of bone loss in teeth next to cleft sites. The existence of a periodontal attachment structure defined by a prolonged suprarenal connective tissue attachment was detected by the authors in ref. [12] in the cleft area, despite identical clinical attachment levels in controls. in the prior work of Mutthineni et al. [11] used standardized periapical radiographs to evaluate periodontal diseases and alveolar bone levels in individuals with unilateral cleft lip and/or palate. Bone loss was seen on the mesial and distal surfaces of central teeth in the vicinity of the fissure. In contrast, canine teeth showed no regional variation in

cleft vs non-cleft areas. When the gap between the CEJ and the AC was more than 1.5 mm, bone loss was detected in a study of 75 patients with UCLP conducted by Quirynen et al. (2). Consistent with our findings, they found that bone loss was much greater in teeth that were positioned within the cleft region. However, our research uses CBCT to assess bone support around cleft regions.

Our study's outcomes revealed that the bone thickness of central teeth at levels M0 and M1 was thinner in cleft regions compared to non-cleft areas. Additionally, the CEJ-AC distance of central teeth adjacent to cleft regions was notably higher, suggesting further bone loss, periodontal inflammation, and gingival recession. Similar trends were observed for canine teeth at M0, M1, M2, and M4 levels, consistent with central teeth at M0 and M2 levels. The CEJ-AC distance for canine teeth near the cleft area also significantly increased.

In a non-cleft study, Papapanou et al. [19] found a higher prevalence of advanced bone loss in incisors, potentially due to the delayed eruption of canines compared to central incisors. Additionally, several studies have reported worsened periodontal conditions in teeth near cleft areas, marked by increased attachment loss, pocket depth, and gingival inflammation compared to controls.

Wehrbein and Diedrich [7] examined various cleft types, including UCLP, CP, and bilateral CLP. Bilateral CLP and UCLP patients exhibited more significant periodontal lesions in maxillary anterior teeth compared to the general population. In contrast, studies by Lages et al. (3) suggested comparable periodontal tissue conditions in cleft and non-cleft individuals, attributing variations to factors such as education, oral hygiene, and socioeconomic status.

Due to oronasal communication, maintaining good oral hygiene proves challenging for individuals with CLP. Stec et al. [20] reported higher plaque indices in cleft patients compared to non-cleft individuals. According to the work in [12], the cleft region is a developmental abnormality defined by incomplete bone growth and an extended suprarenal connective tissue connection [21, 22, 23]. High plaque scores in cleft regions and worsening mean full-mouth pocket profundity and clinical attachment level scores after 25 years [18, 19, 20] were cited as evidence that this attachment does not impede the course of periodontal inflammation.

5. Conclusions

The bony width of the central incisor and canine teeth at crest levels (M0 and M1) was significantly thinner in cleft areas compared to controls (p=0.00). Thickness at M3 and M4 levels was similar between cleft and non-cleft areas for central incisors. The mean CEJ-AC distance was significantly higher in cleft areas for both central and canine teeth (p=0.00). Reduced bony support could lead to future issues, highlighting the need for regular professional dental care to maintain good periodontal health in these patients.

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