



The Estimation of Cementoenamel Junction Crestal Bone Distance in Mandibular Anterior Teeth

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Purpose: The study aimed to measure the distance from the cementoenamel junction (CEJ) to the alveolar bone crest on both the buccal and lingual sides of the anterior mandibular teeth utilizing cone beam computed tomography (CBCT).

Materials and Methods: Cone-beam computed tomography (CBCT) was utilized to measure the distance between CEJ and the alveolar bone crest on both the buccal and lingual sides of the mandible's anterior teeth.

Results: The mean of the distance on buccal side for the central, lateral, and canine teeth were (1.6 mm), (1.6 mm), and (1.5 mm) respectively. On the lingual side, the mean for all teeth (central, lateral, and canine) was 1.7 mm. The study demonstrated a significant difference in distance across age groups (<30 and ≥30 years) for all teeth on both the buccal and lingual sides, except for the canine on the buccal side.

Conclusion: The distance from the CEJ to the bone crest on both the buccal and lingual sides varies significantly by age group. This data is essential for developing orthodontic, implant, and periodontal therapies.

Keywords: alveolar bone crest, canines, cementoenamel junction, central incisors, cone-beam computed tomography, lateral incisors

Introduction

Cone beam computed tomography (CBCT) is the principal tool for assessing alveolar bone form in oral diagnostics. Several studies have found no significant difference in CBCT accuracy in evaluating alveolar bone thickness or height vs physical direct bone measurement, the gold standard for reference.^{1,2}

The most recent radiographic technology for the maxillofacial region is CBCT. In contrast to panoramic images, CBCT provides an accurate view of the jawbone. Measurements are unreliable due of the distortion in panoramic photos. In addition, CBCT can generate cross-sectional (buccolingual), axial, coronal, sagittal, and panoramic views. Conventional panorama cameras only produce one-dimensional images, either mesiodistal or anteroposterior, with the option of superimposing photos.³

The advantages of cone beam computed tomography (CBCT) are the ability to assess all possible locations and anatomical features, the absence of superimposition, and uniform magnification. Furthermore, the cost and effective dosage are less than those of multidetector CT (MDCT). In reality, the effective dose of CBCT is over 45 times lower than MDCT.⁴

CBCT has been shown in numerous studies to accurately measure alveolar bone loss.^{5,6} CBCT images were used in several investigations to quantify the thickness of facial bone on anterior teeth as well as the distance between the CEJ and the alveolar bone crest.⁷⁻¹²

Periodontitis is a persistent, host-mediated inflammation defined by dental plaque contamination that results in alveolar bone loss.¹³ According to the consent report from the Classification World Workshop 2017, the loss rate in alveolar bone was used to directly predict the severity and progression of periodontitis.¹⁴ The cementoenamel junction (CEJ) is the anatomical separation of the crown and root surfaces.¹⁵ The distance between the CEJ and

the facial bone crest (FBC) may be an essential factor. Some authors found a direct relationship between the patient's age and this distance.^{7,8} The cementoenamel junction (CEJ) is a static marker used to assess clinical attachment loss (CAL) or periodontal disease.¹⁶

CAL is the most effective measure of periodontal damage, and it has been used to study the major risk factors of periodontal disease in adults.^{17,18} The radiographic measurement of alveolar bone height and clinical attachment loss (CAL) is used to assess the decline of supporting periodontal tissue in periodontitis^{13,19,20} as well as to track disease progression and therapy impact on the periodontium.^{21,22}

Thus, the CEJ is an important marker for periodontists; yet, various challenges arise when measuring the CEJ, such as difficulty probing, particularly when it is subgingival.²³ Periodontal disease is characterized by connective tissue loss and alveolar bone degeneration that begins at the coronal level.²⁴ Assessing the residual alveolar bone prior to periodontal therapy is critical for developing a more accurate treatment plan because it provides trustworthy information on the hard tissue architecture.²⁵

Although cone-beam computed tomography (CBCT) enhances imaging precision and three-dimensional evaluation of bone structures, nothing is known about its specific role in precisely identifying the distance between the cementoenamel junction (CEJ) and the bone crest. This measurement is significant in orthodontics, periodontics, and implantology since bone height and shape influence treatment outcomes as well as problems prevention.^{26,27} However, there is still a lack of robust evidence comparing CBCT to traditional imaging modalities in terms of diagnostic value and clinical decision-making, as well as consensus on standardized protocols for using CBCT for CEJ-bone crest exams. Future study is needed to quantify the benefits of CBCT in identifying bone levels, set criteria for its use in CEJ-bone crest examinations, and determine its usefulness in enhancing treatment regimens across dentistry specialties.²⁸ The present study aimed to evaluate the distance from the cementoenamel junction (CEJ) to the bone crest buccally and the bone crest lingually of mandibular anterior teeth.

Materials and Method

The study's participants underwent CBCT scans for a variety of reasons, including impacted tooth extraction, dental implant therapy, and orthodontic therapy. A total of 104 CBCT images were evaluated. 1248 surface area for the six lower anterior teeth. The G*Power 3.1 software was used to calculate the sample size of teeth surface, with a statistical power of 90% with the adjusted alpha value of (0.0008) was used for Type I error after applying the (Bonferroni correction).

Between 2019 and 2022, all CBCT scans were performed to diagnose or plan a treatment. The images were captured using the same equipment and typical settings. All of the scans were requested as part of normal dental care. This study has been approved by Pedodontics, Orthodontic and Preventive Dentistry scientific committee at College of Dentistry, Mustansiriyah University. Because the study was retrospective in nature, no further approval was required. No patient consent was required by the institutional review board because the data being used does not contain direct identifiers such as name or medical record number and the study complied with the Declaration of Helsinki. A structured study protocol was followed to collect the following data for each patient: sex, age, distance. CEJ-FBC and CEJ-LBC at central incisors (CI), lateral incisors (LI), and canines (C) on both the buccal and lingual sides of mandibular teeth, as well as the right and left sides.

Inclusion and Exclusion Criteria

CBCTs from people over the age of 18 with no history of orthodontic treatment or significant tooth resorption were included. The study excluded people under the age of 18, as well as those who had dental implants, prosthetic or endodontic restorations on their anterior mandibular teeth. Participants who had been traumatized or were undergoing osseous/regenerative surgery were excluded.

Radiographic Image Analysis

The study included CBCT pictures from 64 females and 40 males aged 18 to 60 (mean age 32.3 ± 10.4). A Rotograph Evo 3D CBCT machine was utilized, with the following exposure parameters: 86 kV, 5 mA, 6–8 seconds exposure time, and 0.4 mm voxel size (Figure 1).

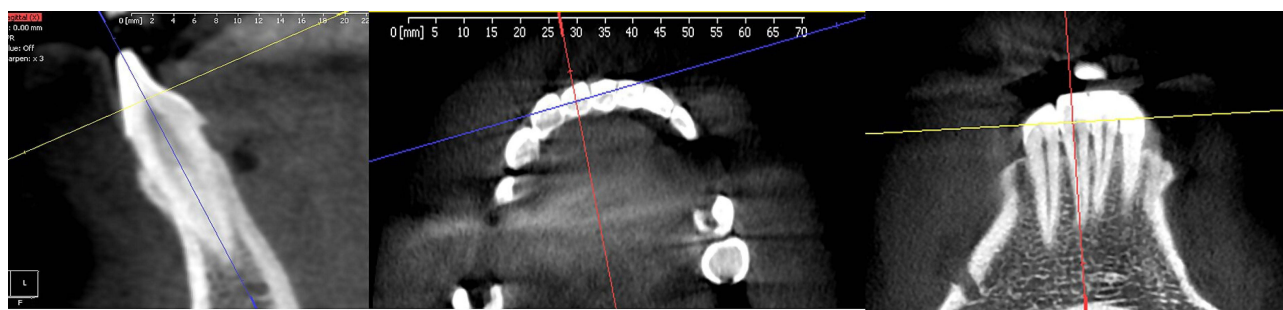


Figure 1 Identifying tooth long axis in the three planes.

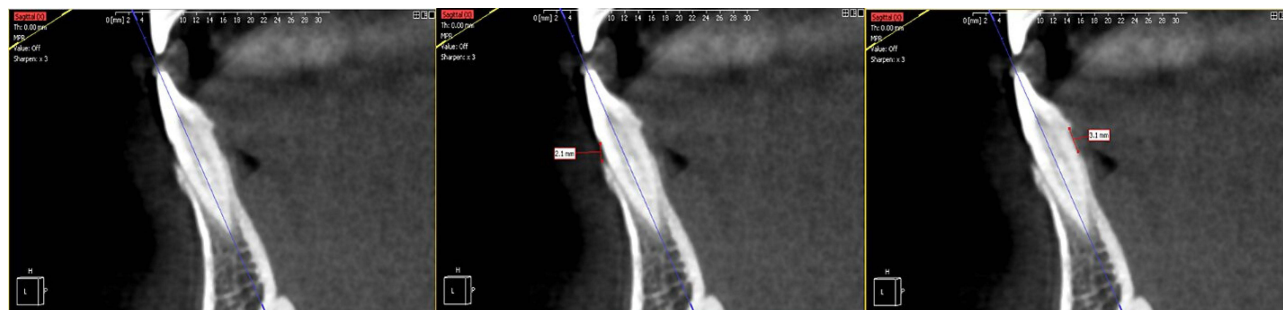


Figure 2 Measurement of BBC-CEJ and LBC-CEJ.

Upper and lower dental arches were captured in an 8 cm x 8 cm cylindrical field of view. The examination focused on the mandibular incisors and canines. First, the Villa 3D planner application was used to create an axial cross-section at the level of dental fissures on the mandibular anterior teeth. Next, a line was drawn at the highest convexity of the tooth's vestibular contour, followed by another at the maximum convexity of its lingual face. The lines were drawn consistently in the middle of the root canal cross-section.

We used the following steps to identify the slice position for the measurements: the roots long axis was identified in the centre of the tooth in axial, coronal and sagittal plane. The alveolar crest was identified in the axial plane, and a buccopalatal slice was traced across the center of the root. The coronal slice was then used to calculate the root's long axis. [Figure 1](#) depicts anatomic sites (FAB, CEJ, and LBC) used as reference points. Measurements were taken from the CEJ to the FBC and the CEJ to the LBC ([Figure 2](#)).

Statistical Analysis

Data was introduced into Microsoft Excel and analyzed using IBM-SPSS Statistics 26 software. Descriptive statistics characterised the data using frequency, percentage, mean, standard deviation, minimum and maximum. The data was examined using the Shapiro–Wilk test, and the Levene's test assessed the normality and homogeneity of the data, which found that it was not normally distributed. Consequently, the Mann–Whitney test was employed to compare the two groups between gender, site, side and age groups. The P-value <0.05 was considered statistically significant. The graph was made using GraphPad-Prism version 10.

The teeth were analyzed using CBCT. After a week, the same radiologist collected and evaluated the data. A paired *t*-test was used on 11 random CBCT scans to measure intraobserver reliability, and no significant differences were discovered.

Result

A total of 104 images of CBCT were used in this study for the six anterior teeth, including images from 40 males and 64 females. 1248 surfaces were included in this study, with age range (18–60) years and a mean of 32.3 years.

Table 1 shows descriptive information, including (mean, SD, Minimum and Maximum) for CEJ-BBC and CEJ-LBC measures on the six anterior teeth. Table 2 and 3 compare the mean (BBC - CEJ) (LBC - CEJ) distance according to gender, tooth side, and age using the Mann–Whitney test.

There was no significant difference across tooth sides, in gender we found a significant difference in (CEJ-BBC) only in laterals, while when comparing the distance according to age, we found a significant difference in (BBC - CEJ) and (LBC - CEJ) in all teeth except in canine when we measure (CEJ-BBC) as in Figures 3 and 4, and when we compare the distances of (CEJ-BBC) and (CEJ-LBC) for the central, lateral and canine, there were significant between them except for lateral; there was no significant difference. As shown in Figure 5.

Table 1 Descriptive Statistics for All Variables Showing Mean Value, Standard Deviation, Minimum and Maximum Values for Each Variable

Variable		Mean Std. deviation	Minimum	Maximum
Age		32.3 ± 10.4	18	60
Right Central incisors	CEJ -BBC	1.6 ± 0.6	0.74	3.9
	CEJ -LBC	1.6 ± 0.5	0.72	3.23
Right Lateral incisors	CEJ -BBC	1.7 ± 0.6	0.58	3.48
	CEJ -LBC	1.7 ± 0.7	0.49	3.69
Right canine	CEJ -BBC	1.5 ± 0.6	0.48	3.85
	CEJ -LBC	1.6 ± 0.7	0.51	4
Left Central incisors	CEJ -BBC	1.6 ± 0.6	0.63	3.47
	CEJ -LBC	1.8 ± 0.6	0.75	3.86
Left Lateral incisors	CEJ -BBC	1.6 ± 0.6	0.72	3.96
	CEJ -LBC	1.6 ± 0.7	0.4	4.71
Left Canines	CEJ -BBC	1.5 ± 0.6	0.54	4
	CEJ -LBC	1.7 ± 0.6	0.64	3.33

Table 2 The Mean Distance Between the CEJ and BBC at Different Variable

variable		Central incisors		Lateral incisors		Canines	
		Mean Std. deviation	P-value	Mean Std. deviation	P-value	Mean Std. deviation	P-value
Gender	Male	1.7 ± 0.07	0.105	1.8 ± 0.08	0.003	1.6 ± 0.07	0.244
	Female	1.5 ± 0.05		1.5 ± 0.04		1.4 ± 0.04	
Tooth side	Right	1.6 ± 0.06	0.773	1.7 ± 0.06	0.28	1.5 ± 0.06	0.367
	Left	1.6 ± 0.06		1.6 ± 0.06		1.5 ± 0.06	
Age range	<30	1.4 ± 0.5	0.00	1.4 ± 0.4	0.004	1.4 ± 0.5	0.065
	≥30	1.8 ± 0.6		1.8 ± 0.7		1.6 ± 0.6	

Note: Mann–Whitney test was used.

Table 3 The Mean Distance Between the CEJ and LBC at Different Variable

variable		Central incisors		Lateral incisors		Canines	
		Mean	Std. deviation	P-value	Mean	Std. deviation	P-value
Gender	Male	1.8 ± 0.07		0.354	1.7 ± 0.08		0.206
	Female	1.7 ± 0.04			1.6 ± 0.05		
Tooth side	Right	1.6 ± 0.05		0.11	1.7 ± 0.07		0.72
	Left	1.8 ± 0.06			1.6 ± 0.07		
Age range	<30	1.5 ± 0.5		0.001	1.3 ± 0.5		0
	≥30	1.9 ± 0.5			1.9 ± 0.7		

Note: Mann–Whitney test was used.

Discussion

The main purpose of this study was to assess the distance from the cementoenamel junction to the buccal bone crest (CEJ-BBC) and from the cementoenamel junction to the lingual bone crest (CEJ-LBC) for the six lower anterior teeth (left canine, lateral, central and right central, lateral, canine).

The biological parameter is the distance between the cementoenamel junction and the bone crest, which includes connective tissue and junctional epithelium.²⁹ Periodontal disease is well known to cause connective tissue loss and alveolar bone degradation, which begins at the coronal level.²⁴ In periodontology, the clinical attachment level is the primary clinical metric, acting as a meaningful standard for both short and long-term evaluation.³⁰ In CBCT, reference points and lines were used to determine alveolar bone changes, including the tooth apex, cementoenamel junction, and long axis. The alveolar crest (AC) is the highest coronal elevation of the alveolar bone.³¹

The loss of alveolar bone gives a decent indicator of the total supporting structures' attachment loss.³² A radiographic examination of periodontal bone loss is crucial for diagnosing, treating, and predicting the outcome of periodontitis.³³ Periapical, bitewing, and panoramic radiographs were commonly used during radiographic examinations.^{33,34} Plain radiography suffers from inherent constraints such as distortion, magnification, and superimposition of surrounding anatomical features^{34–36} These disadvantages frequently restrict the use of these radiographs.³³

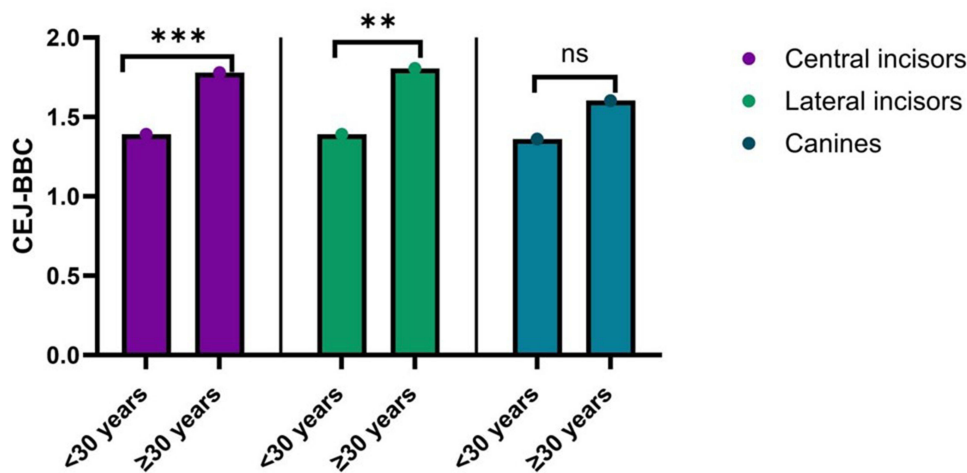


Figure 3 Assessment the distances of (CEJ-BB) between different age groups. Significant difference ** $p < 0.01$, *** $p < 0.001$ using man Whitney test, ns indicate not significant.

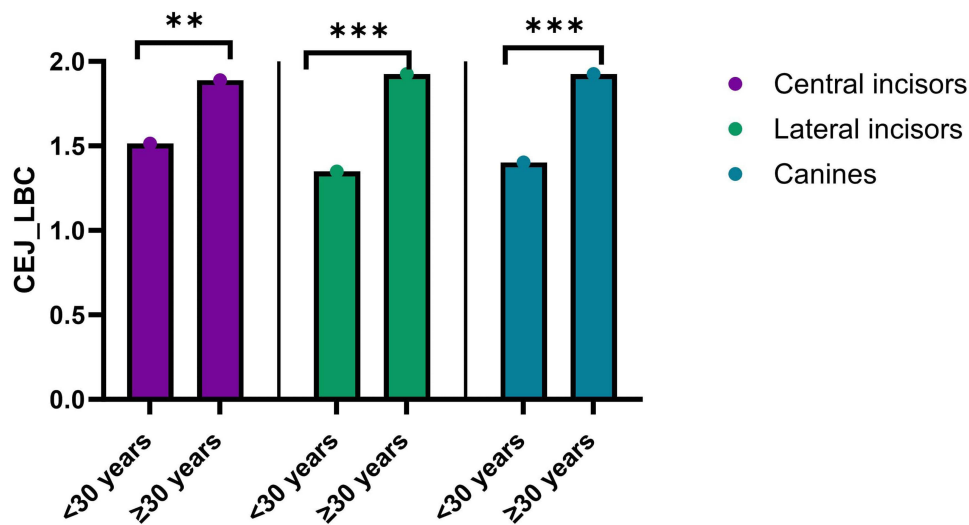


Figure 4 Assessment the distances of (LBJ- CEJ) between different age groups. Significant difference ** p < 0.01, *** p < 0.001 using man Whitney test.

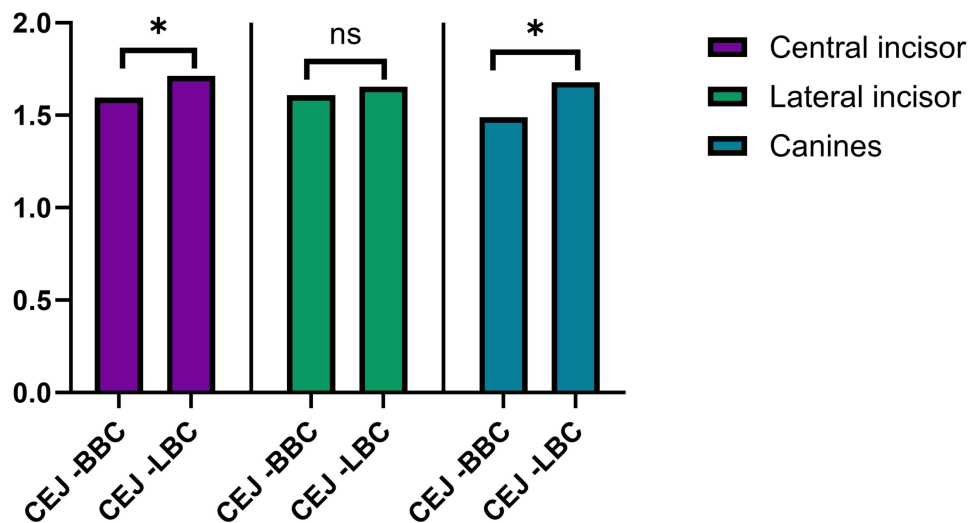


Figure 5 Comparison of the distances between (CEJ-BBC) and (CEJ_LBC) for the (central, lateral incisor and canine). Significant difference * p < 0.05, ns indicate not significant.

According to our study, the estimated distances from the CEJ to BBC for central, lateral and canine (1.6+_{0.6}, 1.6+_{0.6} and 1.5+_{0.6}) and CEJ and LBC (1.7+_{0.6}, 1.7+_{0.7} and 1.8+_{0.6}) and this is less than found in Srebrzyńska-Witek et al study³⁷ in which the mean for CEJ and BBC in central, lateral and canine are (2.26+_{0.08}, 2.29+_{0.08} and 2.34+_{0.09}) and for CEJ and LBC (2.54+_{0.1}, 2.51+_{0.09} and 2.51+_{0.09}). According to previous studies³⁸⁻⁴⁰ the normal range for bone height around the CEJ is 1 to 3 mm.

The studies investigate that people without periodontal disease often have space of 2 mm.⁴¹ For younger individuals, the average height of alveolar bone at the CEJ is 1.4 mm, but the average rises to 3 mm for those over 45 years old.⁴²

According to Armitage, a radiographic measurement of 2 mm or greater from the CEJ to the bone crest is a good cut-off indicating bone loss.⁴³ According to Darby et al 2005, there is no bone loss if the gap between the CEJ and alveolar bone crest level is ≤ 2 mm, while if the distance is >2 and less than 3, consider bone loss and definitive bone loss if the distance is ≥ 3 mm.⁴⁴

Comparing the distance from CEJ to the bone in different age groups revealed statistically significant differences (p = 0.000) between age groups (less than 30 years and ≥ 30 years) in which increased bone loss with increased age, and this is in agreement

with AlTarawneh et al⁴⁵ who found significant differences ($p < 0.05$) in the distance from CEJ to the bone in different age groups for all points of measurement (CEJ-Distal, CEJ-Midlabial, CEJ-Mesial) on all teeth except that for lateral incisors on CEJ-Midlabial, on canines at CEJ-Midlabial, and CEJ-Distal. However, distances increased with age for all points of measurement. These results are consistent with other investigations,^{7,12} other research found no significant variations for these parameters with increasing age.^{11,46} Some investigations have reported increased (CEJ-FBC) distance among adults 50 or older.^{8,12}

Conclusions

CBCT accurately determines the position of the CEJ about the BBC and LBC. There is a statistically significant variation in the distance between the CEJ and the alveolar bone crest both buccally and lingually across age groups (under 30 vs 30+). The collected data is vital for designing orthodontic, implant, and periodontal treatments.

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Disclosure

The authors report no conflicts of interest in this work.

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