ORIGINAL RESEARCH

Digital Radiographic Study on Variations of Alveolar Bone Height among Three Asian Ethnic Groups and its Importance in Periodontal Diagnosis

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Abstract

Purpose: To assess whether anatomical variations exist in the radiographic distance from the cementoenamel junction (CEJ) to the alveolar crest (AC) among various ethnic groups in Malaysia, using digital radiography and if so their relevance in periodontal diagnosis.

Materials and methods: A total of 151 digitized bitewing radiographs of systemically and periodontally healthy students were obtained, after determining their ethnicity by a closed-ended questionnaire. Distances between the CEJ and the alveolar bone crest (CEJ–AC) were measured using a software program (Digora, DfW 2.5) by a single-examiner statistical analysis used: ANOVA and the student *t* test.

Results: The mean distance of the AC from the CEJ was 0.8147 mm across the entire sample, and the Chinese population exhibited the greatest distances compared to Malays and Indians. Sites that showed increased distances between the CEJ and AC were distal aspects of mandibular second premolars equating the total sample.

Conclusion: Among the three Asian ethnic groups, Chinese had a significantly greater distance between the CEJ and the AC. This finding might be influenced by genetic and environmental factors that entail further research in this direction and needs to be considered while diagnosing periodontal disease.

Keywords: Periodontal disease, Periodontitis, Prevalence, Tooth loss, Treatment needs.

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Introduction

The role of the general dentist or periodontist becomes increasingly crucial for the diagnosis and treatment of periodontal diseases at an early stage, providing longevity to the permanent dentition and quality of life to the patient. Although considerable amount of this information can be obtained from clinical examination, radiographs provide additional insight about bone levels and patterns of bone loss.[1] The radiographic signs as evidence of initial periodontal breakdown are (i) Widening of the periodontal ligament space, (ii) Diffuseness or absence of the crest cortical plate, (iii) Thinning or absence of the trabeculae of the crestal alveolar bone, and (iv) Quantitative changes in the distance from the CEJ to the alveolar bone crest (AC).[2]

Epidemiological studies on the prevalence of marginal alveolar bone loss (ABL) are often based on a single range of measurements from the CEJ to AC. This bone loss can be determined either by bone sounding or direct visualization during flap surgery or through radiographic assessment that is the least interceptive method among them. Distances ranging from >2 mm to >3 mm of the AC from the CEJ[3] have long been considered as the beginning of periodontal destruction with 2 mm taken as the threshold value.[4–6] However, earlier studies have established that anatomical variances exist in alveolar bone height among Asians and non-Asians[4,7] as do distinctions in size and morphology of teeth.[8,9] Therefore, for assessing the periodontal status, the widely accepted marginal ABL threshold may not be applicable for all population groups.

Malaysia, being a land of diverse cultures, embraces three distinct Asian ethnic groups, namely, Chinese, Malay, and Indians. So far the available data pertaining to variations of alveolar bone height among Asians are limited. Hence, the aim of this study was to establish the anatomical variations in CEJ–AC distances among the three ethnic groups in Malaysia using digitized radiographs.

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Materials and Methods

A total of 151 students of AIMST University, Malaysia, aged 17–25 years, belonging to the three ethnic backgrounds (Indian, Chinese, and Malay), were included in this cross-sectional,

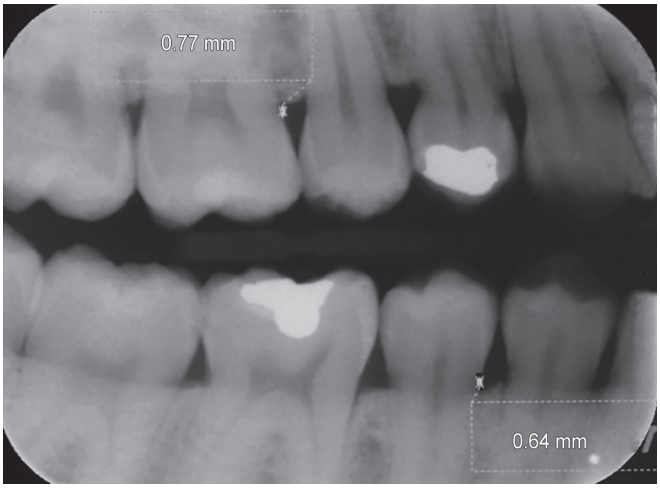

Fig. 1: Digital radiograph with measurements

observation study. Following approval from the AIMST Ethics Committee, a pilot study was conducted by three examiners, with 10% of the total sample size to ensure its feasibility. A closed-ended questionnaire requesting details of age, gender, and ethnicity of parents and grandparents was completed by the participants along with an informed consent that met the requirements of the Declaration of Helsinki. Periodontal examination was performed and only those students with gingival index (GI) score of "0" and basic periodontal examination (BPE) score of "0" were subjected to the radiographic assessment. Students with malocclusion or history of orthodontic treatment were excluded from the study. One digital bitewing radiograph of the posterior sextant (first premolar to first molar) was taken for each participant, by a qualified radiographer using photostimulable phosphor (PSP) plates held with a bitewing holder and a beam alignment device. All exposures were made with the settings of 70 kV, 6 mA for 0.08 seconds, using a single X-ray machine (Progeny Preva). Bitewing radiographs were preferred as they have been documented to be ideal for such measurements.[10,11] Each digital image of an individual participant was stored in the patient's digital file using a digital image processor (Digora, Soredex) and coded, to avoid bias while performing radiographic measurements. All radiographic assessments were carried out by a single qualified examiner who was unaware of the participant details. In accordance with Hausmann et al. criteria,[12] only "ideal" AC and CEJ were considered and measurements were made between the two points (AC–CEJ) using a software program (Digora, DfW 2.5). The measurements were recorded on the mesial and distal aspects of the first and second premolars and first molars of both upper and lower arches (Fig. 1). Areas with proximal restorations and caries extending to the CEJ were excluded from the measurement.

The statistical analysis was done using ANOVA to determine the overall and individual mean differences and the student *t* test was used to analyze the statistical significance of the paired samples. α was set at 0.05 and the confidence interval was considered at 95%.

Results

The mean age of the study sample was 21.54 (SD 2.131; range 17–25 years) and consisted of near equal numbers of Indians, Chinese, and Malays. In 151 participants, a total of 1,812 sites were assessed, accounting to 12 sites per participant. The overall mean distance between the CEJ and AC was 0.8147 with the highest values seen in Chinese followed by Malays and Indians (Table 1).

Table 1: Mean CEJ–alveolar crest distances for different ethnic groups

Ethnic group	*n*	*Mean CEJ–AC distance (95% CI)*
Chinese	50	0.9712 ± 0.2616
Indian	50	0.6568 ± 0.1854
Malay	51	0.8159 ± 0.1974

n, sample size

Table 2: Distribution of sites measured and the mean CEJ–alveolar crest distances for each site of three ethnic groups

Sites measured	*Chinese (n-50)*	*Indian (n-50)*	*Malay (n-51)*
14(M)	0.8186	0.5574	0.6078
14(D)	1.1594	0.8334	0.9737
15(M)	1.0894	0.7436	0.8071
15(D)	1.1806	0.8164	1.0049
16(M)	0.9318	0.5954	0.7504
16(D)	0.5410	0.3230	0.5675
44(M)	0.9406	0.4490	0.6625
44(D)	1.5172	0.7414	1.0706
45(M)	1.0704	0.6010	0.7776
45(D)	1.3888	0.8760	1.1476
46(M)	0.8902	0.5890	0.8761
46(D)	0.5382	0.3444	0.5451

Table 3: Distribution of sites measured and the overall mean CEJ–alveolar crest distances for each site

Sites measured	*n*	*Mean CEJ–AC distance (95% CI)*
Mesial of maxillary first premolar—14(M)	151	0.6609
Distal of maxillary first premolar—14(D)	151	0.9887
Mesial of maxillary second premolar—15(M)	151	0.8795
Distal of maxillary second premolar—15(D)	151	1.0007
Mesial of maxillary first molar—16(M)	151	0.7591
Distal of maxillary first molar—16(D)	151	0.4777
Mesial of mandibular first premolar—44(M)	151	0.6839
Distal of mandibular first premolar—44(D)	151	1.1095
Mesial of mandibular second premolar—45(M)	151	0.8161
Distal of mandibular second premolar—45(D)	151	1.1375
Mesial of mandibular first molar—46(M)	151	0.7857
Distal of mandibular first molar—46(D)	151	0.4764

n, number of sites assessed

The sites measured and the mean CEJ–AC distances for each of those sites in the three ethnic groups are furnished in Table 2. The highest CEJ–AC distances were seen on the distal surfaces of mandibular second premolars 45(D) for Indians and Malays and on the distal surfaces of mandibular first premolars 44(D) for Chinese. The data were also analyzed pertaining to the overall sample of 1,812 sites, which showed the distal aspect of mandibular second

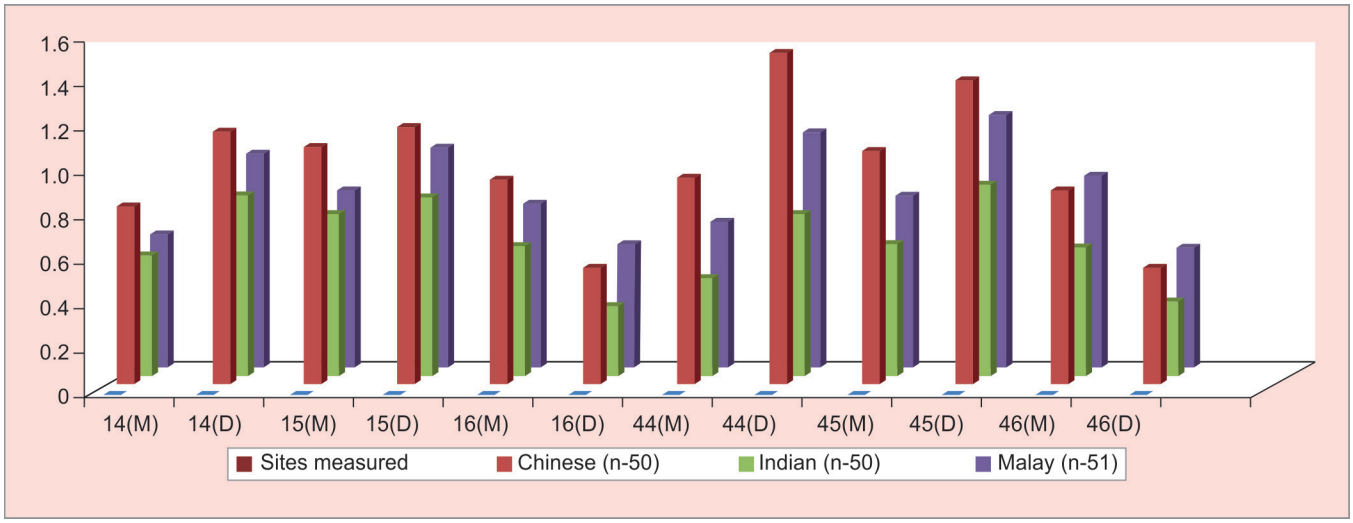

Fig. 2: Comparative graph showing the mean CEJ–alveolar crest distances between the different sites measured among the three ethnic groups

Table 4: Paired samples—test for significance—group I

	Chinese		*Indians*		*Malays*	
Pairs	*df*	*Sig.*	*df*	*Sig.*	*df*	*Sig.*
14(M) and 14(D)	49	0.000	49	0.000	50	0.000
15(M) and 15(D)	49	0.257	49	0.238	50	0.005
16(M) and 16(D)	49	0.000	49	0.000	50	0.022
44(M) and 44(D)	49	0.000	49	0.000	50	0.000
45(M) and 45(D)	49	0.000	49	0.000	50	0.000
46(M) and 46(D)	49	0.000	49	0.000	50	0.000

Table 5: Paired samples—test for significance (maxillary with mandibular sites)—group II

	Chinese		*Indians*		*Malays*	
Pairs	*df*	*Sig.*	*df*	*Sig.*	*df*	*Sig.*
14(M) and 44(M)	49	0.189	49	0.164	50	0.574
14(D) and 44(D)	49	0.004	49	0.305	50	0.28
15(M) and 45(M)	49	0.812	49	0.049	50	0.706
15(D) and 45(D)	49	0.062	49	0.395	50	0.076
16(M) and 46(M)	49	0.641	49	0.934	50	0.162
16(D) and 46(D)	49	0.973	49	0.427	50	0.721

premolars 45(D) with the highest CEJ–AC distances and the lowest values being recorded on the mesial aspect of maxillary first premolars 14(M) (Table 3 and Fig. 2).

The data were conceptualized further by pairing the mesial and distal sites of each of the maxillary and mandibular teeth examined, which was categorized as group I. Similar pairing was done for the mesial and distal sites of each tooth in the maxillary arch with its corresponding antagonist in the mandibular arch, which was categorized as group II, and both groups were assessed for any significant differences within the pairs. The maxillary and mandibular sites were grouped into six pairs corresponding to the 12 sites that were measured. Comparison of the paired samples in group I showed significant differences among all pairs except between mesial and distal sites of maxillary second premolar in both Chinese and Indians (Table 4). However, comparisons in group II illustrated no significant differences in any of the pairs except between distal sites of maxillary and mandibular first premolars in Chinese and mesial sites of maxillary and mandibular second premolars in Indians (Table 5).

An overall comparison of the mean CEJ–AC distances in group I showed statistically significant difference in all the pairs but in group II, except for the distal sites of maxillary and mandibular first and second premolars, none of the pairs were statistically significant.

Discussion

The groups of samples studied were distinctly different and comprised of systemically healthy young adults. Gender differences were not considered in accordance with earlier studies that found no association between gender and periodontal disease.[13–17] Sites that were clinically healthy at the time of examination were selected without any particular preference to the left or right side of the dentition, as existing data show no statistically significant differences between the two sides.[5,18,19]

The overall mean CEJ–AC distance in our study was 0.8174, which lies well within 2 mm threshold of periodontal health and correlated with the fact that our participants did not exhibit any clinical attachment loss at the time of examination. However, other confounding variables such as continuing tooth eruption and a general pattern of bone height reduction of 0.1 mm annually from the age of 20[20] cannot be ruled out and might have influenced the outcome of our results. Chinese population had the highest CEJ–AC distances compared to their Indian and Malay counterparts, which might have been associated to genetic and environmental factors such as dietary habits.

Interestingly, distal surfaces of mandibular second premolars recorded greatest distances of the CEJ from AC in our study. This finding contradicts earlier studies that have shown maxillary first molars with the highest prevalence of measurements.[18,21] A plausible explanation for this could be the fact that mandibular teeth exhibit more passive eruption compared to maxillary teeth owing to attrition.[22,23] Since our study sample consisted of individuals from 17 years to 25 years of age, passive eruption might have played a significant role in the outcome of our results.

However, the present study did not include dietary habits of the three ethnic groups that could have had a direct bearing on attrition and thereby passive eruption.

The distal surfaces of premolars had higher CEJ–AC distances compared to the mesial sites in our study. This result could be attributed to the fact that maintaining oral hygiene is more difficult on distal sites compared to mesial areas.[24] Nevertheless, mesial sites of first molars showed greater AC–CEJ distances compared to distal sites, which could be explained considering the verity that they are the first teeth to erupt and mesial sites erupt before distal sites, possibly exposing them to a prolonged period of insult.

Significant differences were seen in group I between the mesial and distal sites as expected but conversely in group II there was no differences seen. This unusual finding might have affected the overall results of the present study.

Although the clinical effectiveness of radiographs in the management of periodontal patients has not been established, their potential role in routine diagnosis and treatment planning cannot be overlooked.

Conclusion

Over the years, distances ranging from >2 mm to >3 mm of AC from CEJ have been conceived as an indicator of beginning periodontal disease for the general population. However, data show that anatomical and genetic variances exist among different races,[4] which have not been considered while making clinical inferences. The present study is directed toward this fact and has shown that anatomical variances in CEJ–AC distances exist between Chinese, Malay, and Indian communities and need to be considered while making a diagnosis and planning treatment for the patients. So far no such studies are available that recognize differences in Asian ethnicities and this is first of its kind.

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