Digital radiographic study on variations of alveolar bone height among three Asian ethnic groups and its clinical importance in periodontal assessment and treatment planning.

**Abstract**

**Background:** The purpose of this study was to establish any anatomical variations that might exist in the radiographic distance between the alveolar crest and the cemento–enamel junction, among various ethnic groups in Malaysia, using digital radiography.   
  
**Methods:** 151 digitized bitewing radiographs of systemically and periodontally healthy students were obtained, after determining their ethnicity by a closed ended questionnaire. Distances between cemento–enamel junction to the alveolar bone crest (CEJ-AC) was measured using a software program (Digora, DfW 2.5) by a single examiner.   
  
**Results:** The mean distances of the alveolar crest from the cemento-enamel junction was 0.8147mm across the entire sample and 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:** Amongst the three Asian ethnic groups, Chinese had a significantly greater distance between the cemento-enamel junction and the alveolar crest. This finding might be influenced by genetic and environmental factors that entail further research in this direction and needs to be considered while assessing the periodontal status of the patient.  
  
Key words: *Alveolar bone level, Digital radiography, Ethnic groups*

**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 amountof 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 cementoenamel junction (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 which is the least interceptive method amongst them. Distances ranging from >2mm to >3mm of the AC from the CEJ3, have long been considered as the beginning of periodontal destruction with 2mm taken as the threshold value.4,5,6 However earlier studies have established that anatomical variances exist in alveolar bone height among Asians and non-Asians4,7 as do distinctions in size and morphology of teeth.8,9 Therefore for assessing the periodontal status, the widely accepted marginal alveolar bone loss 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 is 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.

**Materials & 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 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 & ethnicity of parents & grandparents was completed by the participants along with an informed consent. Periodontal examination was performed and only those students with GI Score of “0” & BPE score of “0” were subjected to radiographic assessment. Students with malocclusion or history of orthodontic treatment were excluded from the study. One digital bitewing radiograph of the posterior sextant (1st premolar to 1st molar) was taken for each participant, by a qualified radiographer using photostimulable phosphor (PSP) plates held with a bitewing holder and beam alignment device. All exposures were made with the settings of 70KV, 6mA for 0.08sec, using single x-ray machine (Progeny Preva™). 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 criteria10, 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.

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. Alpha was set at 0.05 and confidence interval was considered at 95%.

**Results**

The mean age of the study sample was 21.54 (S.D 2.131; range, 17-25 years) and consisted of near equal numbers of Indians, Chinese and Malays. In 151 participants, a total of 1812 sites were assessed, accounting to 12 sites per participant. The overall mean distances between the CEJ and AC was 0.8147 with the highest values seen in Chinese followed by Malays and Indians (Table 1).

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 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 was also analyzed pertaining to the overall sample of 1812 sites which showed the distal aspect of mandibular second 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).

The data was conceptualized further by pairing the mesial and distal sites of each of the maxillary and mandibular teeth examined, which was categorized as group 1. 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 2 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 twelve sites that were measured. Comparison of the paired samples in group 1 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 2 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 1 showed statistically significant difference in all the pairs but in group 2 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.11,12,13,14,15 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 shows no statistically significant differences between the two sides.5,16,17

The overall mean CEJ-AC distances in our study was 0.8174, which lies well within 2mm 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 twenty18,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.16,19 A plausible explanation for this could be the fact that mandibular teeth exhibit more passive eruption compared to maxillary teeth owing to attrition.20,21 Since our study sample consisted of individuals from 17-25 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 self administered oral hygiene is difficult on distal sites compared to mesial areas.22 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 prolonged period of insult.

Significant differences were seen in group 1 between the mesial and distal sites as expected but conversely in group 2 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, its potential role in routine diagnosis and treatment planning cannot be overlooked.23 Over the years, distances ranging from >2 mm to >3mm of AC from CEJ has been conceived as an indicator of beginning periodontal disease for the general population. However data shows that anatomical and genetic variances exist among different races [4] which have not been considered while making clinical inferences. The present study is directed towards 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 patient.

**Conclusion**

Within the limitations of this study, Chinese population exhibited the highest radiographic CEJ-AC distances compared to Indian and Malay ethnic groups amongst the Asian community. Further research is necessary to assess any genetic influences on alveolar crest heights among these ethnic groups.

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**Table 1. Mean CEJ – AC distances for different ethnic groups**

|  |  |  |
| --- | --- | --- |
| **Ethnic group** | **N** | **Mean CEJ-AC distance (95%CI)** |
| Chinese | 50 | 0.9712±.02616 |
| Indian | 50 | 0.6568±.01854 |
| Malay | 51 | 0.8159±.01974 |

***N- Sample size***

**Table 2. Distribution of sites measured and the mean CEJ-AC 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 | .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-AC distances for each site**

|  |  |  |
| --- | --- | --- |
| **Sites measured** | **N** | **Mean CEJ-AC distance (95%CI)** |
| Mesial of Maxillary 1st Premolar- 14(M) | 151 | 0.6609 |
| Distal of Maxillary 1st Premolar -14(D) | 151 | 0.9887 |
| Mesial of Maxillary 2nd Premolar- 15(M) | 151 | 0.8795 |
| Distal of Maxillary 2nd Premolar- 15(D) | 151 | 1.0007 |
| Mesial of Maxillary 1st molar - 16(M) | 151 | 0.7591 |
| Distal of Maxillary 1st molar- 16(D) | 151 | 0.4777 |
| Mesial of Mandibular 1st premolar- 44(M) | 151 | 0.6839 |
| Distal of Mandibular 1st premolar- 44(D) | 151 | 1.1095 |
| Mesial of Mandibular 2nd premolar- 45(M) | 151 | 0.8161 |
| Distal of Mandibular 2nd premolar- 45(D) | 151 | 1.1375 |
| Mesial of Mandibular 1st molar- 46(M) | 151 | 0.7857 |
| Distal of Mandibular 1st molar-46(D) | 151 | 0.4764 |

***N- Number of sites assessed***

**Table 4: Paired Samples – Test for significance – Group 1**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Pairs** | **Chinese** | | | **Indians** | | | **Malays** | | |
|  | df | sig |  | df | sig |  | df | sig |
| 14(M) & 14(D) | 49 | 0.000 | 49 | 0.000 | 50 | 0.000 |
| 15(M) & 15(D) | 49 | **0.257** | 49 | **0.238** | 50 | 0.005 |
| 16(M) & 16(D) | 49 | 0.000 | 49 | 0.000 | 50 | 0.022 |
| 44(M) & 44(D) | 49 | 0.000 | 49 | 0.000 | 50 | 0.000 |
| 45(M) & 45(D) | 49 | 0.000 | 49 | 0.000 | 50 | 0.000 |
| 46(M) & 46(D) | 49 | 0.000 | 49 | 0.000 | 50 | 0.000 |

**Table 5: Paired Samples – Test for significance {Maxillary with Mandibular sites}- Group 2**

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

**Legends**

Figure 1: Digital Radiograph with measurements

Table 1: Mean CEJ – AC distances for different ethnic groups

Table 2: Distribution of sites measured and the mean CEJ-AC distances for each site of three ethnic groups

Table 3: Distribution of sites measured and the overall mean CEJ-AC distances for each site

Table 4: Paired Samples – Test for significance – Group 1

Table 5. Paired Samples – Test for significance {Maxillary with Mandibular sites}- Group 2