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The interdental gingiva, a visible guide for placement of mini-implants

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Structured Abstract

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Objectives – To determine whether the tip of the interdental gingiva can serve as a visible guide for placement of mini-implants.

Setting and Sample population – Computer tomography (CT) images from 15 males and 15 females (mean age 27 years, range: 23–35 years) were used to evaluate the distance from the tip of the interdental gingiva to the alveolar crest from the central incisor to the 1st molar. The distance from a reference point to the tip of interdental gingiva was recorded from study models using a caliper. The distance between the reference point and the alveolar crest was recorded using CT and added to the model recordings thus providing the distance from the tip of interdental gingiva to the alveolar crest for the various interdental sites. Two-way ANOVA and Student–Newman–Keuls test for multiple comparisons were used for the statistical analysis.

Results – There was no significant difference in the distance from the tip of interdental gingiva to the alveolar crest between maxilla and mandible. The distance between the tip of interdental gingiva and the alveolar crest at the central/lateral incisors was the shortest compared with that of other sites. There was also a statistically significant difference between the male and female groups except for the maxillary 2nd premolar/1st molar interradicular site.

Conclusion – The tip of interdental gingiva appears a reasonable visual guide for the placement of mini-implants for orthodontic anchorage.

Key words: alveolar crest; interdental gingiva; mini-implants; orthodontic anchorage procedures; orthodontics

Introduction

Mini-implants for orthodontic anchorage have received popular acceptance because of simplified clinical protocol and low cost. Anatomical structures demand precise selection of location for implant placement (1). Commonly used anatomical landmarks and measures for placement of mini-implants include the cemento-enamel junction (CEJ), the alveolar crest and the distance between roots as appreciated from radiographs. A visible reference line drawn parallel to the long axis of the teeth bisecting the interradicular gingiva using a periodontal probe is a commonly used clinical measure to provide guidance for implant placement (2).

To obtain a visible reference necessitates normal range of distance between the alveolar crest and the CEJ, the contact point or the tip of the interdental gingiva. It is suggested that the alveolar crest normally is located approximately 1 mm below the CEJ (3). The distance between the CEJ and the alveolar crest ranges between 0.4 and 1.9 mm in adults with no crestal bone loss as estimated from bitewing radiographs (3). The distance between the CEJ and the alveolar crest in young adults ranges between 0.8 and 1.5 mm with an average distance of 1.1 mm that increases to 2.8 mm with age (4).

Conventional dental radiographs are routinely used to measure the distance between the CEJ and the alveolar crest. However, radiographs have shortcomings relative to a precise estimation of relationships between anatomical structures. For example, distortion resulting from beam alterations in the vertical plane will cause an incorrect appreciation of the distance between the CEJ and the alveolar crest (5). Periapical radiographs are usually not used if the distance between roots in panoramic radiographs appears sufficient to place mini-implants.

Nevertheless, identification of the alveolar crest appears to be important for placement of a mini-implant. The frequently used method, the line connecting the CEJ on adjacent teeth as a visible guide seems to have limitations because the CEJ is not visible all the time. Thus, the interdental gingiva appears a reasonable visible guide for identification of the alveolar crest. To obtain the normal range of the distance from the tip of the interdental gingiva to the alveolar crest will provide the clinician with valuable information to identify the alveolar crest for mini-implant placement. The objective of this study was to determine the distance from the tip of the interdental gingiva relative to the alveolar crest to provide a visible guide for placement of mini-implants.

Materials and methods

Thirty subjects (15 males and 15 females; mean age 27 years, range: 23–35 years) were included in this study after informed consent. All subjects exhibited intact, healthy interdental gingival tissues. The dental papilla was deemed to be intact if no space was visible apical to the contact point. Exclusion criteria included: previous periodontal and/or orthodontic treatment, presence of oedema or inflammation, severe skeletal discrepancy, asymmetric occlusion, absence of permanent teeth (except 3rd molars), impacted teeth, crowding and spacing. The Gingival index (6) and the sulcus bleeding index (7) were used to measure a status absent of inflammation. The protocol was approved by the Ewha Womans University, Mokdong Hospital Ethics Committee.

Recordings were alternated between left and right sides in subsequent subjects. A 0.5-mm thick Tru-tain type appliance (Biolon, DreveDentamid GmbH, Unna, Germany) produced from individual study models was used to provide reference points for the recordings. Radiopaque, 0.5×0.5-mm stainless steel wire (Unitek/3M, Monrovia, CA, USA) was bonded onto the Tru-tain appliance to mark the reference points (Fig. 1). The subject's head was adjusted so that the Frankfort horizontal plane would be perpendicular to the floor on the scanner. Computer tomography (CT) images (SOMATOM Sensation, Siemens, Erlangen, Germany)

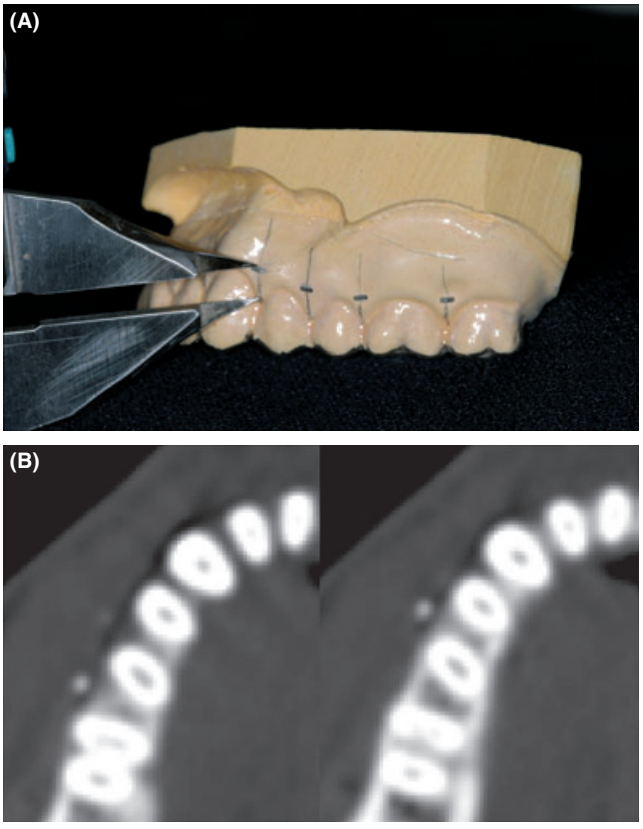

Fig. 1. (A) Interradicular 0.5×0.5 mm^2 stainless-steel wire markers bonded onto the Tru-tain type appliance served as reference points. The distance from a reference point to the tip of interdental gingiva was measured using a caliper with a 0.01-mm resolution. (B) Images were moved apically in 1-mm increments from the reference point to the first appearance of the alveolar crest.

of each subject wearing the Tru-tain appliance were obtained at 200-mm field of view, 120 kV, 200 mAs, scanning time 0.5 s/rotation, average radiation exposure dose 31.32 CTDIvol, slice thickness 1.0 mm, high-resolution mode. CT images were saved as Digital Imaging and Communications in Medicine (DICOM) files. Images at the occlusal plane on picture archiving and communication system view were moved apically in 1-mm increments from the reference point to the first appearance of interradicular bone, defined as the alveolar crest (Fig. 1). The distance from a reference point to the tip of interdental gingiva was measured on the study model using a caliper with 0.01-mm resolution (Absolute Digimatic Caliper; Mitutoyo UK Ltd, Andover, Hampshire, UK) (Fig. 1). The calculated distance between the reference point and the alveolar crest was added to the distance between the reference point and the tip of interdental papilla to generate the total distance between the tip of the interdental gingiva and the alveolar crest.

Two-way ANOVA and Student–Newman–Keuls test for multiple comparisons were used at the level of $p < 0.05$ to identify differences between the maxilla and mandible, interdental sites and between males and females. Five randomly selected sites were re-measured by the same examiner following a 2-week interval to evaluate intraexaminer reproducibility using the *t*-test. There was no statistically significant difference between repeat measurements.

Results

The distances between the tip of interdental gingiva and radiographic location of the alveolar crest for the male and the female group are shown in Table 1. The mean (±SD) distances ranged from 4.06 ± 0.66 to 5.12 ± 1.24 mm in males and from 3.82 ± 1.00 to 4.66 ± 0.81 mm in females. There were no significant intragroup differences between maxilla and mandible in both males and females. In contrast, there were statistically significant differences between interdental sites. The distance between the tip of interdental gingiva and the alveolar crest at the central/lateral incisor interdental site was significantly smaller compared to that at all other sites ($p < 0.05$) (Table 1 and Fig. 2). This particular characteristic was observed for both males and females (Fig. 3). There was also a statistically significant difference between males and females except for the maxillary 2nd premolar/1st molar interdental site (Fig. 4). Males generally showed greater mean values for most interdental sites in both jaws ($p < 0.05$).

Discussion

The present study is the first to evaluate the distance from the tip of interdental gingiva to the alveolar crest as identified on CT images. The distance between the tip of gingiva and the alveolar crest was measured at

Table 1. **Distance (mean ± SD and range in mm) between the tip of the interradicular gingiva and the alveolar crest for maxillary and mandibular sites in male and female subjects**

	Interradicular site	Males		Females		Statistical significance
		Mean ± SD	Range	Mean ± SD	Range	
Maxilla	1–2	4.22 ± 0.95	3.45–5.55	3.94 ± 0.65	3.20–5.00	1–2 < 2–3, 3–4, 4–5, 5–6
	2–3	4.57 ± 0.94	3.40–5.75	4.16 ± 0.63	3.45–5.00	
	3–4	5.12 ± 1.24	4.10–6.15	4.66 ± 0.81	3.75–5.85	Male > female (except for 5–6)
	4–5	4.63 ± 1.12	3.35–5.90	4.46 ± 0.67	3.95–5.30	
	5–6	4.38 ± 1.09	3.35–6.15	4.63 ± 0.79	4.00–5.30	
Mandible	1–2	4.06 ± 0.66	3.05–4.70	3.82 ± 1.00	2.90–4.80	1–2 < 2–3, 3–4, 4–5, 5–6
	2–3	4.54 ± 0.69	3.45–5.50	4.23 ± 0.72	3.40–5.25	
	3–4	4.82 ± 0.65	4.30–5.75	4.22 ± 0.57	3.70–5.05	Male > female
	4–5	4.58 ± 0.76	3.60–5.25	4.19 ± 0.71	3.15–5.00	
	5–6	4.76 ± 0.97	3.60–6.25	4.59 ± 1.03	3.10–5.70	

Numbers 1 through 6 represent the central incisor (1), lateral incisor (2), cuspid (3), 1st premolar (4), 2nd premolar (5) and 1st molar (6) interradicular sites.

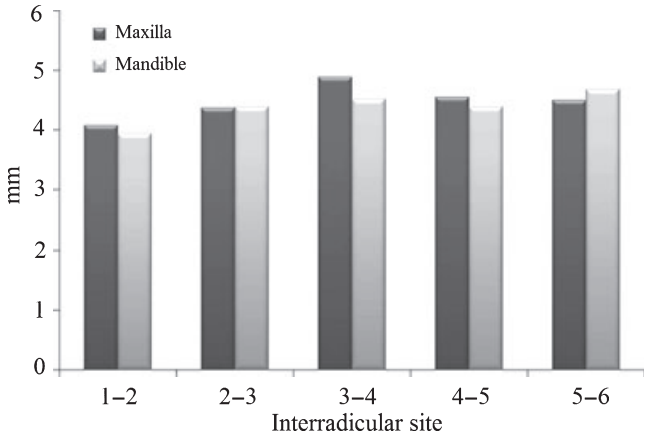

Fig. 2. Mean values (male and female together) of distance between the tip of interdental gingiva and the alveolar crest. Numbers 1 through 6 represent the central incisor (1), lateral incisor (2), cuspid (3), 1st premolar (4), 2nd premolar (5) and 1st molar (6) interradicular sites.

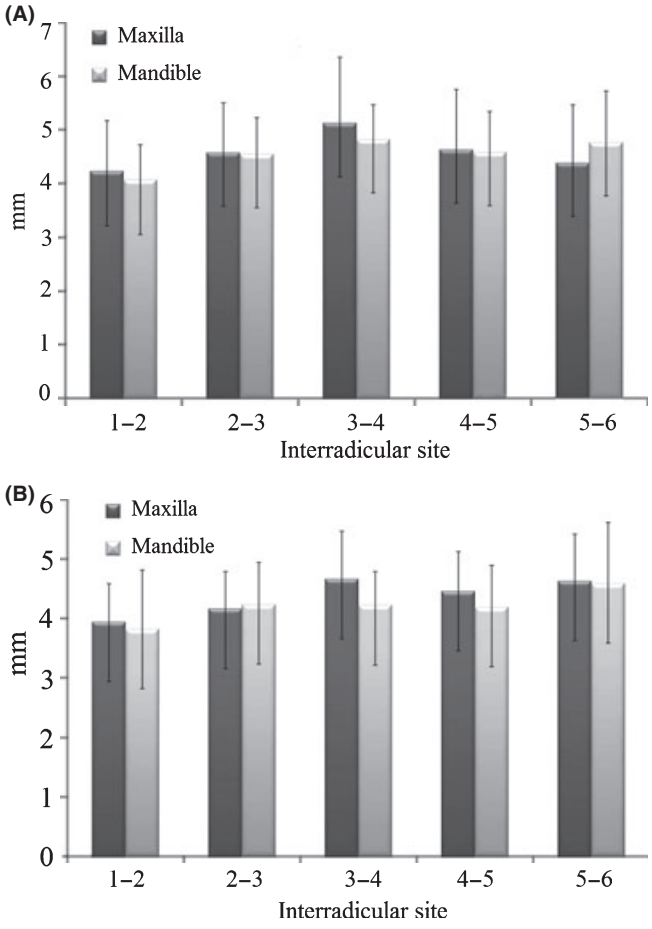

Fig. 3. (A) Distance between the tip of interdental gingiva and the alveolar crest in males and (B) females. Numbers 1 through 6 represent the central incisor (1), lateral incisor (2), cuspid (3), 1st premolar (4), 2nd premolar (5) and 1st molar (6) interradicular sites.

the interdental sites from the central incisor to the 1st molar in the maxilla and the mandible. The mean distance between the tip of interdental gingiva and the

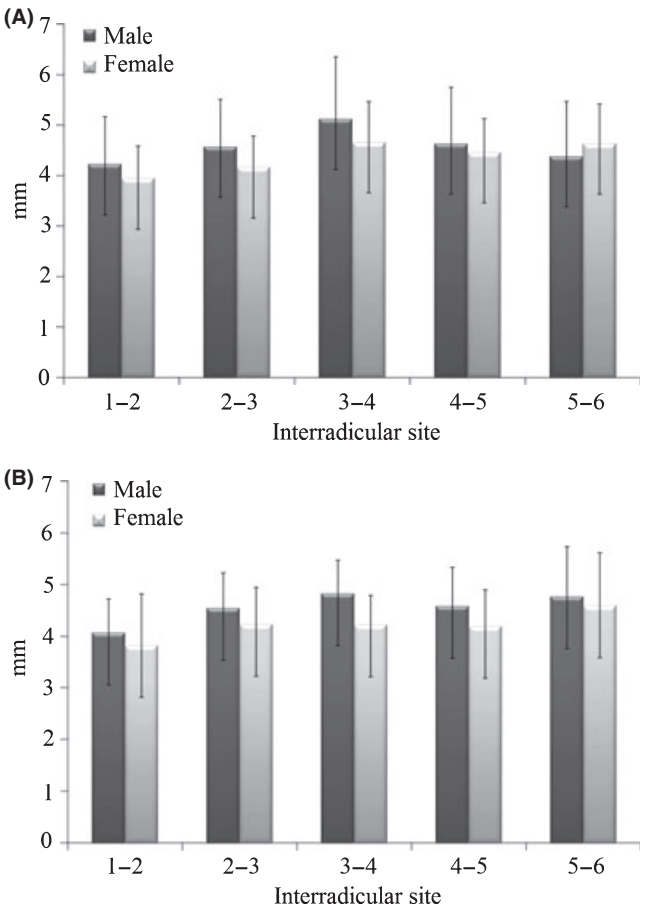

Fig. 4. (A) Distance between the tip of interdental gingiva and the alveolar crest in the maxilla and (B) the mandible. Numbers 1 through 6 represent the central incisor (1), lateral incisor (2), cuspid (3), 1st premolar (4), 2nd premolar (5) and 1st molar (6) interradicular sites.

alveolar crest varied according to location and gender, but not between maxillary vs. mandibular sites. Distances from the tip of interdental gingiva to the alveolar crest in the maxilla were not statistically significant compared with those in the mandible, inconsistent with the observation that the distances between the CEJ and the alveolar crest are greater in the maxilla than in the mandible (8).

Differences in distance between the tip of the interdental gingiva and the alveolar crest were observed at various sites. The smallest mean distance was observed at the central/lateral incisor site. The distance at the maxillary canine/1st premolar site appeared greater compared with all other sites, although this difference did not reach statistical significance. In consideration to that observed in this study, it has been shown that the mandibular 1st premolar exhibits the smallest distance between CEJ and the alveolar crest (9).

The observations in this study also suggest gender differences. Males exhibited a greater interdental gingiva to alveolar crest distance than females. These differences were statistically significant in a majority of the sites. It has also been shown that the attachment and alveolar bone level is different among races (8). The mean distance between the CEJ and the alveolar crest appears greater in Asian immigrants than in subjects of European origin (10).

Intraoral radiographs are routinely used for placement of mini-implants to assess potential implant sites. To obtain an accurate reproduction of the object necessitates 'parallel technique' with the X-ray beam perpendicular to the object. There are, however, anatomical limitations including the depth of the palate and curving of the mandibular arch preventing an ideal 90° projection angle. It has been reported that the radiographic alveolar crest may range up to 18% with 20° angular deviation from the perpendicular plane in the molar area (11). Moreover, differences in the distance between the CEJ and the alveolar crest have been observed when bitewing and periapical radiographs were compared (12). Thus, caution of these shortcomings appears required when assessing the distance between the CEJ and the alveolar crest from intraoral radiographs for placement of mini-implants. Within the limit of this study, the highest value among the observed distances from the interdental gingiva and the alveolar crest was 6.25. Using guidance from this study, mini-implants placed 7 mm from the tip of the interdental gingiva would be anchored in bone. Careful attention appears required when assessing the distance in the presence of inflammation and/or recession around gingiva. Irrespective of treatment planning approach, clinical sounding of the selected implant site appears a safe measure prior to actual mini-implant installation. In conclusion, the tip of interdental gingiva appears a reasonable visual guide for the placement of mini-implants for orthodontic anchorage. Observed distances between the tip of interdental gingiva and the alveolar crest may be taken into consideration in the identification of the alveolar crest for placement of mini-implants.

Clinical relevance

The interdental gingival seems to be a reasonable visible guide for identification of the alveolar crest, which appears to be important for placement of a mini-implant. Using guidance from this study, mini-implants placed 7 mm from the tip of the interdental gingival would be anchored in bone.

References

1. Schnelle MA, Beck FM, Jaynes RM, Huja SS. A radiographic evaluation of the availability of bone for placement of miniscrew. *Angle Orthod* 2004;74:832–7.
2. Park YC, Kim CK, Lee JS. *Atlas of Contemporary Orthodontics*, 3rd edn. Seoul: Shinheung International; 2006. pp. 111–2.
3. Hausmann E, Allen K, Clerehugh V. What alveolar crest level on a bitewing radiograph represents bone loss? *J Periodontol* 1991;62:570–2.
4. Carranza F, Newman N. *Clinical Periodontology*, 8th edn. Philadelphia: Saunders; 1996. 44 pp.
5. Benn DK. A review of the reliability of radiographic measurements in estimating alveolar bone changes. *J Clin Periodontol* 1990;17:14–21.
6. Loe H, Silness J. Periodontal disease in pregnancy. I. Prevalence and severity. *Acta Odontol Scand* 1963;21:533–51.
7. Mühlemann HR, Son S. Gingival sulcus bleeding – a leading symptom in initial gingivitis. *Helv Odontol Acta* 1971;15:107–13.
8. Shapira L, Tarazi E, Rosen L, Bimstein E. The relationship between alveolar bone height and age in the primary dentition. A retrospective longitudinal radiographic study. *J Clin Periodontol* 1995;22:408–12.
9. Källestål C, Matsson L. Criteria for assessment of interproximal bone loss on bitewing radiographs in adolescents. *J Clin Periodontol* 1989;16:300–4.
10. Sjödin B, Matsson L. Marginal bone level in the normal primary dentition. *J Clin Periodontol* 1992;19:672–8.
11. Hausmann E, Allen K, Christersson L, Genco RJ. Effect of X-ray beam vertical angulation on radiographic alveolar crest level measurement. *J Periodont Res* 1989;24:8–19.
12. Reed BE, Polson AM. Relationship between bitewing and periapical radiographs in assessing crestal alveolar bone levels. *J Periodontol* 1984;63:1032–6.