CHAPTER 5

DISCUSSION

Recently, miniscrew implants have been widely used for orthodontic anchorage because of several advantages, including their usefulness, ease of clinical management, and low cost. Several studies have reported anatomical sites in the dento-alveolar area for safe miniscrew implant placement.[9,11,19-23,69] However, the effects of the characteristic dento-alveolar compensations on the availability of the interadicular space, observed in different dento-skeletal patterns, has not been investigated. Therefore, the purposes of the present study were 1) to assess interradicular space in different dento-skeletal patterns and 2) to evaluate the effects of dento-skeletal patterns on interradicular space.

5.1 Skeletal pattern and dento-alveolar compensation

This study reveals that there were significant differences in dento-skeletal patterns between the patients with skeletal Class I, II, and III relationships. The ANB angles showed significant differences among the skeletal types ($P < 0.01$). The SNB angles showed significant differences between the control group and patients with skeletal Class II and Class III relationships. There was no difference in the SNA angle among the skeletal types. This indicates that the differences in anteroposterior jaw base relationships in this study were mainly due to the differences in the anteroposterior mandibular positions. The patients with skeletal Class III relationships presented with prognathic mandibles, whereas the patients with skeletal Class II relationships presented with retrognathic mandibles when compared with the controls.

Characteristics of dento-alveolar compensation between the different skeletal patterns were observed in the present study. The most pronounced dento-alveolar compensation was observed between the patients with skeletal Class II and III relationships.

In the maxilla, the patients with skeletal Class III relationships presented with significantly more labially inclined incisors and more mesially inclined posterior teeth than did the patients with skeletal Class II relationships ($P < 0.05$). However, there was no significant difference in the dental inclination between the patients with skeletal Class I and II relationships, except for the maxillary second molar. Similarly, no significant difference in the maxillary dental inclination between those with skeletal Class I and III relationships was observed. This indicates a large difference in the sagittal jaw relationships between the patients with skeletal Class II and III relationships. Since the ANB angles of the patients with skeletal Class II and III relationships varied from 7.2° to - 2.6°, the compensatory inclinations of the maxillary teeth were more clearly reflected in these subjects.

In the mandible, the dento-alveolar compensation was mainly observed in the anterior teeth and the premolar regions. The mandibular incisors, canines, and premolars of the patients with skeletal Class III relationships were significantly more lingually and distally inclined than those of the patients with skeletal Class II relationships ($P < 0.01$). The mandibular incisors of the patients with skeletal Class III relationships were also significantly more lingually inclined than those of the patients with skeletal Class I relationships ($P < 0.01$). In contrast, the mandibular incisors and canines of the patients with skeletal Class II relationships were significantly more labially inclined than those of the patients with skeletal Class I relationships ($P < 0.05$). However, there was no significant difference in mesiodistal tooth angulation of the mandibular second premolars and molars among the skeletal types.

These results agree with the previous studies that evaluated the dento-alveolar compensatory changes in the axial inclination of the maxillary and mandibular teeth related to the variation in the anteroposterior jaw base relationships.[33-36,70]

Ceylan et al[71] investigated the relationship between overjet and dento-alveolar compensation in different overjet patterns, and reported that the maxillary incisor inclination was significantly different between the negative and positive overjet groups, whereas there was no statistically significant difference between the normal and positive overjet groups, or between the normal and negative overjet groups. These findings agree with those of the present study, where the axial inclinations of the maxillary teeth were significantly different between the patients with skeletal Class II and III relationships. There was no significant difference in maxillary inclination between the patients with skeletal Class I and II relationships, or between those with skeletal Class I and III relationships.

Ceylan et al[71] also found that the proclination of the lower incisors is similar in normal and positive overjet subjects, whereas in negative overjet subjects those teeth were significantly more upright or retroclined than in the other overjet groups. The data from the present investigation show that the mandibular incisor inclination was significantly different between all three skeletal Classess, Class II having relatively proclined mandibular incisors and Class III relatively retroclined mandibular incisors.

On the other hand, Ishikawa et al[33,34] reported that the maxillary incisors incline more labially and the mandibular incisors more lingually in negative overjet cases. These findings are agree with those of this present study, where the patients with skeletal Class III relationships presented with more labially inclined maxillary incisors and more lingually inclined mandibular incisors. Ishikawa et al[34] also found that the mandibular incisor inclination was strongly influenced by the sagittal jaw relationship, which plays an important role in achieving normal incisal relationships. In the present study, the mandibular incisor inclination was significantly different between all three skeletal Classes.

Interestingly, in the mandibular molar regions, no significant difference in the tooth angulation between the patients with skeletal Class II and Class III relationships was observed. The lack of significant difference might be explained by the fact that the mesial shift of the mandibular first molars may be less influenced by skeletal growth than are the maxillary first molars.[63]

Kim et al[63] investigated maxillary and mandibular growth differences and their effect on the changes in molar relationships from the early transitional dentition to the adult permanent dentition in three different groups. In Group A, 8 males and 2 females, the sagittal mandibular growth was significantly greater than the sagittal maxillary growth. In Group B, 15 females and 5 males, sagittal growth of jaws remained about equal; and in Group C, 7 males and 3 females, sagittal maxillary growth was significantly greater than the sagittal mandibular growth. They reported that the amounts of mesial shift of the mandibular molars were not significantly different among the three groups, whereas the mesial shift of the maxillary molars was significantly different among the groups. In Group A, where mandibular growth exceeded maxillary growth, the maxillary molars moved more mesially than did those in Group C. They also suggested that skeletal growth influences the physiologic mesial shift of all molar teeth, but that the maxillary first molars may be under greater influence than are the mandibular first molars. These findings agree with those of the present study, where that the maxillary posterior teeth were more mesially inclined in the patients with skeletal Class III relationships than in the patients with skeletal Class II relationships. Moreover, there was no statistically significant difference in the mandibular molar inclination among the skeletal types.

5.2 Effects of dento-alveolar compensation on the interradicular space

In the present study, the characteristic dento-alveolar compensation observed in different skeletal patterns played an important role in the availability of the interradicular space.

5.2.1 Angle formed between tooth axes

In general, significantly positive correlations between the angles formed between tooth axes and interradicular areas ($P < 0.001$) were observed at all interradicular sites. The angle formed between the maxillary first and second molars showed the strongest correlation to the interradicular area ($r = 0.72$). These results indicate that the more divergent tooth roots, the more amount of interradicular area can be obtained. In contrast, the less divergent tooth roots presented with the less amount of interradicular area.

5.2.2 Interradicular distance and interradicular area

The present study measured both interradicular distance (mm) and interradicular area (mm^2). The results show that the greatest interradicular distance and interradicular area in the maxilla were between the second premolar and the first molar; the least between the first and second molars. Similar results have been reported by Carano et al,[11] Schnelle et al,[9] Poggio et al,[23] Hu et al,[21] and Lee et al.[21]

Table 5.1 shows the available sites for miniscrew implant placement in the dento-alveolar bone of the posterior regions reported in the reviewed articles. All these reviewed articles measured interradicular distances, by using CT, on both buccal and palatal sides, in subjects with normal occlusion, except for those of Schnelle et al,[9] which used panoramic radiographs, and Hu et al,[21] which used cross sections of human jaws for measurement. Poggio et al[23] also reported that the available interradicular distance on the palatal side was greater than that on the buccal side.

Table 5.1 The available sites for miniscrew implant placement in dento-alveolar bone in the posterior regions reported in the reviewed articles

Authors (Year)	**Available sites for miniscrew placement on the buccal side**	
	Maxilla	**Mandible**
Carano et al[11] 2004	Level form the alveolar crest Between teeth 5 and 6, 2-8 mm	Not mentioned
Schnelle et al[9] 2004	Level from the CEJ (mm) Between teeth 5 and 6, 4.7-10.0 mm	Level from the CEJ (mm) Between teeth 6 and 7, 2.5- 5.3 mm Between teeth 5 and 6, 4.1- 7.0 mm
Poggio et al[23] 2006	Level from the alveolar crest (mm) Between teeth 4 and 5, 5-11 mm Between teeth 3 and 4, 5-11 mm Between teeth 5 and 6, 5-8 mm	Level from the alveolar crest (mm) Between teeth 6 and 7, 2-11 mm Between teeth 5 and 6, 11 mm Between teeth 4 and 5, 2-11 mm Between teeth 3 and 4, 11 mm
Hernández[20] 2008	Not mentioned	Between teeth 6 and 7
Hu et al[21] 2009	Level from the cervical line Between teeth 5 and 6, 6-8 mm	Level from the cervical line Between teeth 6 and 7, less than 5 mm
Lee et al[31] 2009	Level from the CEJ (mm) Between teeth 4 and 5, 4 mm Between teeth 5 and 6, 4 mm	Level from the CEJ (mm) Between teeth 4 and 5, 4 mm Between teeth 5 and 6, 4 mm Between teeth 6 and 7, 4 mm

In the mandible, the greatest amount of interradicular distance and interradicular area was between the first and second premolars. These results support the study of Poggio et al[23], and Lee et al.[31]

On the other hand, Schnelle et al,[9] Hernández et al,[20] and Hu et al[21] reported that the greatest interradicular distance was located between the first and second molars in the mandibular arch.

Although several previous anatomical studies of miniscrew implant placement have been reported, no data are available regarding differences in interradicular space between the different dento-skeletal patterns.

In present study, there were significant differences between skeletal patterns both in interradicular distance and interradicular area between the first and second molars in the maxilla. In the maxilla, the interradicular distances between the first and second molars, at all depths of measurement, of the patients with skeletal Class II and III relationships were less than those of the patients with skeletal Class I relationships.

The interradicular area between the first and second molars of the patients with skeletal Class III relationships was also significantly less than that of the patients with skeletal Class II relationships ($P < 0.05$). However, there was no significant difference in interradicular area between the patients with skeletal Class I and those with skeletal Class II or III relationships.

However, no significant difference was found between skeletal patterns in the interradicular area between the second premolar and the first molar, which is considered the safest site for miniscrew implant placement in the dento-alveolar bone of the maxilla.

In contrast, in the mandible, the interradicular distances between the first and second premolars, at all depths of measurement, and between the second premolar and the first molar, of the patients with skeletal Class III relationships, were greater than those of the patients with skeletal Class II relationships. Similar results were found in the number of divergent tooth roots and interradicular area measurements. The number of divergent tooth roots and interradicular areas between the first and second premolars, and between the second premolar and the first molar, in the patients with skeletal Class III relationships, were significantly greater than those in the patients with skeletal Class II relationships. However, the patients with skeletal Class II relationships presented significantly more interradicular area between the first and second molars than did the patients with skeletal III relationships ($P < 0.05$).

A probable explanation for the result is the difference in dento-alveolar compensation between the patients with skeletal Class II and III relationships. The patients with skeletal Class III relationships presented with relatively mesial tipping of all maxillary teeth, whereas these teeth were relatively upright in the patients with skeletal Class II relationships. In contrast, the patients with skeletal Class III relationships showed relatively upright mandibular teeth, whereas these teeth were proclined or mesially tipped in the patients with skeletal Class II relationships. It is possible to conclude that teeth with greater inclination presented with less interradicular space, whereas more upright teeth presented with more interradicular space. Therefore, the patients with skeletal Class III relationships presented less interradicular space in the maxillary arch, and more interradicular space in the mandibular arch.

5.3 Effects of other factors on the interradicular area

There was no significant difference in interradicular area between the sexes. Relationships between the interradicular area and age, and between the interradicular area and arch length discrepancy were not observed. Dental crowding presents if the space available is less than the space required; arch length discrepancy is less than 0 mm. Dental crowding of the patients in the present study occurred in the anterior region, where the interradicular space was not taken into account. The present study evaluated the interradicular spaces only in the posterior regions, which are the most frequently used for miniscrew implant placement, and the prevalence of dental crowding in these regions was decreased.

A relationship between the interradicular area in the posterior regions and arch length discrepancy was not observed in the present study. It might be concluded that the interradicular areas in the posterior regions were not influenced by dental crowding in the anterior region.

An interesting finding of the present study is that the presence of the maxillary third molars played an important role in the amount of interradicular area between the maxillary first and second molars. A possible explanation is that the eruption of the maxillary third molars altered the axial inclination of the first and second molars, thus influencing the amount of interradicular area.

Fayad et al[72] reported a relationship between eruption of third molars and sagittal inclination of adjacent molars. They reported that the maxillary first and second molars were more mesially inclined in the subjects with erupted third molars than in those with impacted or unerupted third molars. Most of the maxillary third molars of the patients in the present study were unerupted. Therefore, the presence and position of the maxillary third molar influenced the inclination of the maxillary first and second molars and also played an important role in the size of the interradicular area between these teeth.

In contrast, no effect was observed of the presence of the mandibular third molar on interradicular area in the present study. These results suggest that not only the presence of the third molars, but also the path of eruption and positioning are involved in the amount of displacement of the adjacent teeth. These factors should be further evaluated in future studies.

A limitation of this study was the use of 2-dimensional conventional radiographs, the lateral cephalogram and the periapical radiograph. The most important disadvantage of conventional radiographs is the representation of 2-dimensional views of 3-dimensional anatomic structures.[52] Also, the 2-dimensional nature of these conventional radiographic views imposes further limitations, such as overlap, leading to poor visualization of individual structures and errors due to projection.[52]

However, conventional lateral cephalometry is the standard method used in orthodontic treatment planning. Periapical radiographs made using the long-cone paralleling technique, provide images of the teeth with minimal distortion and are commonly used for the diagnosis of bone available for miniscrew implant placement in the alveolar bone.[6] This present study used periapical radiographs made with the long cone paralleling technique for assessment of interradicular spaces because they are more reliable than panoramic radiographs, and they are routinely requested for our orthodontic patients before treatment. Vertical magnification in panoramic radiographs has been reported to be approximately 18-21%, whereas horizontal magnification is more unreliable.[73] In addition, periapical radiographs have inherent magnification estimated to be 5%.[74]

However, the use of computed tomography provides 3-dimensional images and can give more accuracy and reliability. It might be preferable to use computed tomography to assess the amount of interradicular space in different dento-skeletal patterns for a future study, but it might not be justifiable on the bases of cost and radiation exposure.