บทวิทยาการ

Original Article

การเปรียบเทียบความหนาสันกระดูกโหนกแก้มส่วนใต้ระหว่างผู้ป่วยไทยที่มีโครงสร้างกระดูกขากรรไกรแบบที่ 1 และแบบที่ 2 โดยใช้โคนบีมคอมพิวเตดโทโมกราฟี

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บทคัดย่อ

วัตถุประสงค์: งานวิจัยนี้มุ่งประเมินและเปรียบเทียบลักษณะทางกายวิภาคทั้งสามมิติของความหนาสันกระดูกโหนกแก้มส่วนใต้ ในผู้ป่วยไทยที่มีโครงสร้างกระดูกขากรรไกรแบบที่ 1 และในผู้ป่วยไทยที่มีโครงสร้างกระดูกขากรรไกรแบบที่ 2

วัสดุอุปกรณ์และวิธีการ: จากภาพรังสีโคนบีมคอมพิวเตดโทโมกราฟีบริเวณสันกระดูกโหนกแก้มจำนวน 48 ภาพ ของผู้ป่วยก่อนเริ่มการรักษาทางทันตกรรมจัดฟันจำนวน 24 ราย (กลุ่มที่มีโครงสร้างกระดูกขากรรไกรแบบที่ 1 จำนวน 12 ราย และกลุ่มที่มีโครงสร้างกระดูกขากรรไกรแบบที่ 2 จำนวน 12 ราย) ทำการวัดค่าความหนาของกระดูกทึบด้านแก้มที่จุดกึ่งกลางระหว่างฟันกรามแท้บนซี่ที่หนึ่งและซี่ที่สอง ค่าความหนาของกระดูกด้านแก้มบริเวณรากด้านแก้ม-ไกลกลางของฟันกรามแท้ซี่ที่หนึ่ง และบริเวณรากด้านแก้ม-ใกล้กลางของฟันกรามแท้บนซี่ที่สอง ที่ระดับความสูงแนวดิ่งที่แตกต่างกัน 4 ระดับ (5.0 6.0 7.0 และ 8.0 มม. จากรอยต่อเคลือบฟันกับเคลือบรากฟันของฟันกรามแท้บนซี่ที่หนึ่ง) สำหรับค่าความหนาของสันกระดูกโหนกแก้มถูกทำการวัดโดยการตั้งสมมุติฐานว่า วัสดุฝังเกลียวขนาดเล็กถูกปักโดยใช้ข้อบ่งชี้ร่วมกันของระดับความสูงแนวดิ่งที่แตกต่างกัน 4 ระดับ และมุมของการปักที่แตกต่างกัน 4 แนว (55° 60° 65° และ 70°) โดยใช้ระนาบบดเคี้ยวฟันกรามแท้บนเป็นระนาบอ้างอิง

ผลการศึกษา: ในกลุ่มที่มีโครงสร้างกระดูกขากรรไกรแบบที่ 1 ความหนาของกระดูกทึบด้านแก้มอยู่ในช่วงตั้งแต่ 1.18±0.09 ถึง 1.31±0.76 มม. และ ในกลุ่มที่มีโครงสร้างกระดูกขากรรไกรแบบที่ 2 ตั้งแต่ 1.21±0.33 ถึง 1.37±0.38 มม. ในกลุ่มที่มีโครงสร้างกระดูกขากรรไกรแบบที่ 1 ความหนาของกระดูกด้านแก้มอยู่ในช่วงตั้งแต่ 2.91±0.74 ถึง 3.82±1.25 มม. และ ในกลุ่มที่มีโครงสร้างกระดูกขากรรไกรแบบที่ 2 ตั้งแต่ 2.98±1.20 ถึง 4.18±1.40 มม. ในกลุ่มที่มีโครงสร้างกระดูกขากรรไกรแบบที่ 1 ความหนาสันกระดูกโหนกแก้มอยู่ในช่วงตั้งแต่ 5.27±2.63 ถึง 8.77±2.85 มม. และ ในกลุ่มที่มีโครงสร้างกระดูกขากรรไกรแบบที่ 2 ตั้งแต่ 4.94±0.41 ถึง 7.77±0.47 มม.

สรุป: ไม่พบความแตกต่างอย่างมีนัยสำคัญทางสถิติสำหรับค่าตัวแปรสันกระดูกโหนกแก้มทุกตัวระหว่างโครงสร้างกระดูกขากรรไกรแบบที่ 1 และแบบที่ 2 ($P>0.05$)

คำสำคัญ: สันกระดูกโหนกแก้ม กระดูกทึบด้านแก้ม กระดูกด้านแก้ม ความหนาสันกระดูกโหนกแก้ม โครงสร้างกระดูกขากรรไกรแบบที่ 1 โครงสร้างกระดูกขากรรไกรแบบที่ 2

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Comparison of Infrazygomatic Crest Thicknesses between Thai Patients with Class I and Class II Skeletal Pattern Using Cone Beam Computed Tomography

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Abstract

Objectives: This study was aimed to evaluate and compare three-dimensional anatomical structures of infrazygomatic (IZ) crest site in Thai patients with Class I and Class II skeletal pattern.

Materials and Methods: 48 cone beam computed tomographic (CBCT) images of IZ crest sites from 24 Thai orthodontic patients (12 with Class I, and 12 with Class II skeletal pattern) were measured. Buccal cortical bone thickness between the maxillary first and second molars, buccal plate thickness at distobuccal root of the maxillary first molar and mesiobuccal root of the maxillary second molar in 4 vertical levels (5.0, 6.0, 7.0 and 8.0 mm from buccal cementoenamel junction of the maxillary first molar) were measured. The IZ crest thickness were measured by postulating that the miniscrew implant (MI) would be inserted using a combination of 4 different vertical levels and 4 different directions (55°, 60°, 65° and 70°) to the maxillary molar occlusal plane as clinical guideline.

Results: In Class I skeletal pattern, the buccal cortical bone thickness ranged from 1.18 ± 0.09 to 1.31 ± 0.76 mm, and in Class II ranged from 1.21 ± 0.33 to 1.37 ± 0.38 mm. In Class I skeletal pattern group, buccal plate thickness ranged from 2.91 ± 0.74 to 3.82 ± 1.25 mm, and in Class II ranged from 2.98 ± 1.20 to 4.18 ± 1.40 mm. In Class I skeletal pattern group, IZ crest thickness ranged from 5.27 ± 2.63 to 8.77 ± 2.85 mm and in Class II ranged from 4.94 ± 0.41 to 7.77 ± 0.47 mm.

Conclusions: There was no statistically significant difference for all measured IZ variables between Class I and Class II skeletal patterns ($P>0.05$).

Key words: Infrazygomatic crest site, Buccal cortical bone thickness, Buccal bone thickness, Infrazygomatic crest thickness, Class I skeletal pattern, Class II skeletal pattern

Introduction

Miniscrew implant (MI) played an important role in modern orthodontic treatment for providing absolute anchorage in both maxilla and mandible.[1-6] Many studies reported successful cases in which MIs were placed in various sites such as interradicular, tuberosity, midpalatal, paramedian areas and infrazygomatic (IZ) crest.[2-7] Anatomically, IZ crest is an area of cortical bone at the zygomatic process of the maxilla. It is a palpable bony ridge running along the curvature between the alveolar and zygomatic processes of the maxilla. In young patient, it is located between maxillary second premolar and first molar, or above maxillary first molar in adults.[3, 4, 7] MI placement at IZ crest site provided better opportunity especially for group distal movement of maxillary posterior teeth, in comparison with that at the interradicular area, because the tip of the MI did not interfere with dental root movement.[3, 6]

Liou *et al.*[4] studied IZ crest thickness above mesiobuccal root of maxillary first molar by using computed tomographic (CT) images, and suggested that proper MI insertion position at IZ crest in adult patient should be 14.0 to 16.0 mm above maxillary occlusal plane, and that insertion direction should be 55° to 70° to maxillary occlusal plane.

Recently, Lin[8] suggested a new site for MI placement called 'modified infrazygomatic crest site' which was located on buccal bone between distobuccal root of maxillary first molar and mesiobuccal root of maxillary second molar. It was suggested that this site was a safe zone. The study using cone beam computed tomographic (CBCT) images confirmed that buccal bone over mesiobuccal root area in this site was much thicker than that over mesiobuccal root area of the maxillary first molar. Vertically, MI insertion position at the 'modified infrazygomatic crest site' should be from 5.0 to 6.0 mm above buccal cemento-enamel junction (CEJ) of maxillary first molar. Proper positions and directions for MI placement at modified infrazygomatic crest site should be determined in order to avoid any injuries to dental roots of maxillary molars[4] and to simultaneously provide adequate biting depth for MI stability.[8] Accordingly, information from three-dimensional CBCT at IZ crest site should be analyzed in order to provide a reliable determination of MI placement. We hypothesized that the IZ crest thicknesses in Thai patients with Class I and Class II skeletal were different. The purposes of this study were to evaluate and compare 3-dimensional anatomical structures of the IZ crest site, and to suggest proper combinations of insertion positions and directions for MI placement at the IZ crest site in Thai patients with Class I and Class II skeletal pattern.

Materials and Methods

CBCT images of 48 IZ crest sites from 12 patients with Class I skeletal pattern (ANB angle = 2±2 deg) and 12 patients with Class II skeletal pattern (ANB angle > 4 deg) were taken with a ProMax 3D (Planmeca OY, Helsinki, Finland) CBCT unit at 80 kVp, 10 mA, scanning time 12.5 seconds and voxel size 160 µm, at the Division of Oral and Maxillofacial Radiology, Department of Oral Biology and Diagnostic Sciences, Faculty of Dentistry, Chiang Mai University. The patients provided consent and participated in this study. Patients with severe craniofacial disorder, severe crowding or spacing in posterior teeth, missing of any permanent teeth except third molars, radiographic signs of periodontal disease, or any systemic disease were excluded.

CBCT images were analyzed and measured using Software Romexis Viewer program. Before measurement, each IZ crest site was orientated in all 3 planes, Coronal view (Figure 1A), CBCT image was oriented until maxillary molar occlusal plane (a plane between mesiobuccal cusp and mesiolingual cusp of maxillary first molar) was parallel to the blue horizontal line. Sagittal view (Figure 1B) was used to

Figure 1. Three views of CBCT image orientation of left maxillary first molar: A, coronal view, with the blue horizontal line being parallel to maxillary first molar occlusal plane; B, sagittal view, with the green vertical reference line along the long axis of mesiobuccal root of maxillary first molar and the functional occlusal plane being parallel to the blue horizontal line; C, axial view, with the green horizontal reference line being superimposed to mesiobuccal root of maxillary first molar.

orient the green vertical reference line along long axis of mesiobuccal root of maxillary first molar, and Axial view (Figure 1C) was used to ensure that the green horizontal line was superimposed to mesiobuccal root of maxillary first molar.

CBCT image was then oriented for measuring interradicular space of maxillary first and second molars. On coronal view (Figure 2A), the CBCT image was cut vertically by moving the blue horizontal line along the ruler (red vertical line) that has one-millimeter interval. On sagittal view (Figure 2B) was used to locate interradicular space of maxillary first and second molars. The CBCT image was oriented until the vertical slice (green vertical line) bisects the interradicular space. On axial view (Figure 2C), the CBCT image was oriented to ensure that the line bisecting the mesiodistal interradicular space between maxillary first and second molars is superimposed to the green horizontal reference line.

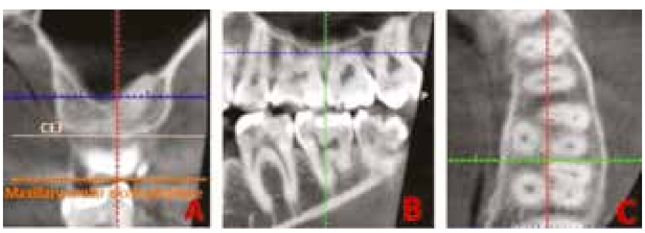

Figure 2. Three views of the CBCT image of interradicular space of left maxillary first and second molars: A, coronal view, with the blue horizontal line at 6.0 mm from buccal CEJ of maxillary first molar; B, sagittal view, with the green vertical reference line bisecting interradicular space; C, axial view, with the green horizontal reference line bisecting mesiodistal interradicular space between maxillary first and second molars.

On coronal view, four cutting lines of 1.0 mm vertical interval (from 5.0 to 8.0 mm) from buccal CEJ of maxillary first molar were created. For each axial view, buccal cortical bone thickness (Figure 3A), buccal

Figure 3. CBCT measurements: A, axial view, buccal cortical bone thickness (red arrow); B, axial view, buccal plate thickness at distobuccal root of first maxillary molar and mesiobuccal root of second maxillary molar (blue arrow); C, coronal view, IZ crest thickness (or biting depth for MI implant) (green arrow).

plate thickness at distobuccal root of maxillary first molar (A-X distance) and mesiobuccal root of maxillary second molar (B-Y distance) were measured (Figure 3B). On coronal view, IZ crest thickness (or biting depth for MI implant) above middle plane between distobuccal root of maxillary first molar and mesiobuccal root of maxillary second molar for each combination of vertical insertion position and insertion direction for MI placement were measured (Figure 3C). Vertical insertion positions include 5.0, 6.0, 7.0 and 8.0 mm levels from buccal CEJ of maxillary first molar. Insertion directions include 55°, 60°, 65° and 70° in relation to maxillary molar occlusal plane. To evaluate intra-examiner reproducibility, the same examiner re-measured all subjects following a 4 week interval.

Criteria for achieving proper position and direction for MI placement were as follows: 1) Buccal cortical bone thickness was at least 1.0 mm[9], 2) Buccal plate thickness at distobuccal root of the first maxillary molar and mesiobuccal root of the second maxillary molar was at least 2.0 mm[8], and 3) Bone thickness of IZ crest was at least 6.0 mm[4]. Each combination of vertical insertion position and direction for MI placement that achieved all 3 above mentioned criteria was determined and described.

Results

Measurement error

There was no statistically significant difference between the first and the second measurements of the CBCT from all patients as calculated by a paired *t*-test ($P<0.05$).

Statistical analysis

The data were analyzed using the Statistical Package for Social Sciences version 15 for Windows (SPSS Inc., Chicago, Illinois, USA). The right and left measurements of buccal cortical bone thickness, of buccal plate thickness at distobuccal root of maxillary first molar and mesiobuccal root of maxillary second molar at each vertical level from buccal CEJ of maxillary first molar, and of IZ crest thickness for each combination of vertical insertion position and direction were not significantly different ($P<0.05$). The right and left measurements were therefore pooled.

Buccal cortical bone thickness

In Class I skeletal pattern, the thickness ranged from 1.18 ± 0.09 to 1.31 ± 0.76 mm, and in Class II skeletal pattern, the thickness ranged from 1.21 ± 0.33 to 1.37 ± 0.38 mm (Table 1). The highest buccal cortical bone thickness in both groups were located at the 8.0 mm vertical cut level, and it tended to increase from CEJ to the apex. There was no statistically significant difference between Class I and Class II group for all vertical cut levels.

Buccal plate thickness

Buccal plate thickness at distobuccal root of maxillary first molar and at mesiobuccal root of maxillary second molar were reported in Table 2. In Class I skeletal pattern group, buccal plate thickness ranged from 2.91 ± 0.74 to 3.82 ± 1.25 mm. The highest buccal plate thickness at distobuccal root of maxillary first molar was 3.16 ± 0.81 mm at the 5.0 mm vertical cut level, and the lowest buccal plate thickness was 2.91 ± 0.74 mm at the 7.0 mm vertical cut level. The highest buccal plate thickness at mesiobuccal root of maxillary second molar was 3.82 ± 1.25 mm at the 8.0 mm vertical cut level, and the lowest buccal plate thickness was 2.91 ± 0.75 mm at the 5.0 mm vertical cut level. In Class II skeletal pattern group, buccal plate thickness ranged from 2.98 ± 1.20 to 4.18± 1.40 mm. The highest buccal plate thickness at distobuccal root of maxillary first molar was 3.10 ± 0.88 mm at the 6.0 mm vertical cut level, and the lowest buccal plate thickness was 2.98 ± 1.20 mm at the 8.0 mm vertical cut level. The highest buccal plate thickness at mesiobuccal root of maxillary second molar was 4.18 ± 1.40 mm at the 8.0 mm vertical cut level, and the lowest buccal plate thickness was 3.06 ± 1.09 mm at the 5.0 mm vertical cut level. However, the buccal

Table 1. Means and standard deviations of buccal cortical bone thickness (mm) at each vertical cut level (mm) from buccal CEJ of maxillary first molar in Class I and Class II skeletal pattern groups.

Vertical cut level	Class I skeletal pattern group	Class II skeletal pattern group	P
5.0	1.18 ± 0.09	1.22± 0.33	.905
6.0	1.20 ± 0.76	1.21 ± 0.33	.570
7.0	1.25 ± 0.65	1.22 ± 0.32	.613
8.0	1.31 ± 0.76	1.37 ± 0.38	.735

NS, not significant

plate thickness of both right and left sides in Class I and Class II skeletal pattern group in each and every vertical cut level was not significantly different.

Table 2. Means and standard deviations of buccal plate thickness (mm) at distobuccal root of maxillary first molar and mesiobuccal root of maxillary second molar at each vertical cut level (mm) from buccal CEJ of maxillary first molar in Class I and Class II skeletal pattern groups.

Vertical cut level (mm)	DB root 1st molar			MB root 2nd molar		
	Class I	Class II	*P*	Class I	Class II	*P*
5.0	3.16 ± 0.81	3.04 ± 0.82	.634	2.91 ± 0.75	3.06 ± 1.09	.568
6.0	2.94 ± 0.76	3.10 ± 0.88	.501	3.16 ± 0.81	3.50 ± 1.10	.234
7.0	2.91 ± 0.74	3.05 ± 0.96	.549	3.42 ± 1.04	3.80 ± 1.20	.244
8.0	2.99 ± 0.79	2.98 ± 1.20	.971	3.82 ± 1.25	4.18 ± 1.40	.350

NS, not significant

Infrazygomatic (IZ) Crest thickness

In Class I skeletal pattern group, IZ crest thickness ranged from 5.27 ± 2.63 to 8.77 ± 2.85 mm. The greatest bone thickness was 8.77 ± 2.85 mm at the 5.0 mm vertical cut level with 55°insertion direction, and the lowest bone thickness was 5.27 ± 2.63 mm at 8.0 mm vertical cut level with 65° insertion direction (Table 3). In Class II skeletal pattern group, the IZ crest thickness ranged from 4.94 ± 0.41 to 7.77 ± 0.47 mm. The greatest bone thickness was 7.77 ± 0.47 mm at the 5.0 mm vertical cut level with 55° insertion direction, and the lowest bone thickness was 4.94 ± 0.41 mm at 8.0 mm vertical cut level with 55° insertion direction. There was no significant difference for each combination of vertical insertion position and insertion direction between Class I and Class II skeletal pattern groups.

Table 3. Means and standard deviations of the IZ crest thickness at each combination of vertical insertion position (vertical cut level) (mm) and direction (°) in Class I and Class II skeletal pattern groups.

Direction (°) / Vertical cut level (mm)	55			60			65			70		
	Class I	Class II	P	Class I	Class II	P	Class I	Class II	P	Class I	Class II	P
5.0	8.77±2.85	7.77±0.47	NS	8.43±2.80	7.57±0.44	NS	8.21±3.08	7.41±0.04	NS	8.14±3.16	7.44±0.42	NS
6.0	7.74±2.90	6.74±0.43	NS	7.30±3.07	6.65±0.41	NS	7.27±3.37	6.65±0.41	NS	7.04±2.91	6.72±0.43	NS
7.0	6.59±3.10	5.89±0.41	NS	6.37±3.29	5.86±0.41	NS	6.23±3.03	5.84±0.42	NS	6.11±2.64	5.87±0.44	NS
8.0	5.54±3.21	4.94±0.41	NS	5.56±3.53	4.96±0.42	NS	5.27±2.63	5.03±0.43	NS	5.32±2.53	5.13±0.46	NS

NS, not significant

Discussion

Many factors could affect success rates and effectiveness of MI which was used as absolute anchorage. Primary stability of MI was a key to overall success. Cortical bone quality and quantity were major factors associated with primary stability of MI placement.[10-14] Greater cortical bone thickness facilitated primary stability after MI placement.[9] Our present study revealed that buccal cortical bone thickness was greater than 1.0 mm in each and every vertical cut level in both recruited groups. That was consistent with Park and Cho who reported that 1.0 mm or more cortical bone thickness could be found in maxillary posterior tooth area.[13] However, our results are different from those of Laursen *et al*.[15] which reported that the buccal cortical bone thickness in the entire maxilla was less than 1.0 mm.

In our present study, buccal cortical bone thickness was gradually increased from cementoenamel junction to the apex. Our results are not consistent with Hu *et al*.[12] who showed that the buccal cortical bone thickness in maxilla was similar from cervical line to the root apex, and with Baumgaertel *et al*.[16] who showed that cortical bone thickness at maxillary posterior tooth area decreased at the 4 mm vertical cut level, and then it increased again at the 6 mm vertical cut level from the alveolar crest. Motoyoshi *et al*. suggested that MI placement site should have a cortical bone thickness of at least 1.0 mm in order to provide primary stability.[9] Our results showed that cortical bone thickness in Thai patients with either Class I or Class II skeletal pattern provided adequate bone thickness for primary stability of MI in each and every vertical cut level.

Our present study revealed that buccal plate thickness at distobuccal root of maxillary first molar and that at mesiobuccal root of maxillary second molar in both groups, in each and every vertical cut level, were greater than or equal to 2.91 mm. At mesiobuccal root of maxillary second molar, buccal plate thickness was thicker toward the apex. That was consistent with Lin[8] who studied the series of CT image sections from 1.0 mm to 10.0 mm above cervical line, and summarized that buccal plate thickness of maxillary molar area was tend to be wider toward the apex due to convergence of maxillary molar roots and smaller maxillary molar root apex. On the other hand, at distobuccal root of maxillary first molar, we found that the buccal plate thickness was thinner toward the apex, and this was inconsistent with that reported by Lin[8]. According to Lin[8], at least 1.0 - 2.0 mm initial biting depth of buccal bone was required prior to changing insertion direction in order to avoid injury to maxillary molar roots by MI. Therefore, maxillary buccal plate thickness in each and every vertical cut level of our Thai patients with either Class I or Class II skeletal pattern was adequate for MI placement. Our present study showed that there was no significant difference between buccal plate thickness at distobuccal root of maxillary first molar and that at mesiobuccal root of maxillary second molar in both recruited groups.

It was suggested that thicker bone allowed greater biting depth and greater bone contact, and also improved primary stability of MI.[17] Liou *et al*. also reported that the MI biting depth of 6.0 mm at IZ crest was sufficient for stability throughout treatment.[4] Based on our present study, the combinations of insertion position at either 5.0 or 6.0 or 7.0 mm and of insertion direction ranging from 55° to 70° in Class I group, and the combinations of insertion position at either 5.0 or 6.0 mm with direction ranging from 55° to 70° in Class II group should therefore provide adequate IZ crest thickness (or biting depth for MI). The IZ crest thickness (or biting depth for MI) that were measured in all of these combinations were greater than 6.0 mm. The combinations of positions and insertion directions in Class II skeletal pattern group were consistent with Lin[8] who recommended that the safe zone for MI placement at the modified IZ crest should be at 5.0

to 6.0 mm above cervical line with direction ranging from 55° to 70°. However, Lin[9] used maxillary occlusal plane as a reference plane for insertion direction, but the maxillary molar occlusal plane was used in our present study.

In our present study, the CEJ was used as starting point for measurements, and this was different from other studies that alveolar crest was used.[10, 11, 18, 19] The alveolar crest could be affected by periodontal problem. Maxillary molar occlusal plane was used as a reference plane for insertion direction because it was easier for clinicians to identify in comparison to maxillary occlusal plane.

For clinical implication, we suggested that proper positions for MI placement should be at 7.0 mm above the CEJ with insertion directions ranging from 55° to 70° in Class I skeletal pattern, and at 5.0, and at 6.0 mm vertical cut levels with directions ranging from 55° to 70° in Class II skeletal pattern. The reasons were that, at each combination of these vertical positions and insertion directions, 1) buccal cortical bone thickness was equal to or greater than 1.0 mm[9]; 2) buccal plate thickness was equal to or greater than 2.0 mm[8]; and 3) IZ crest thickness (or biting depth for MI) was equal to or greater than 6.0 mm[4]. Therefore, these combinations of positions and insertion directions for MI placement should be recommended as safe in Thai patients with either Class I and or Class II skeletal pattern.

Many studies showed that non-keratinized mucosa was a risk factor for MI dislodgement. Lower survival rate was found for MI placed at high levels in movable non-keratinized mucosa. Peri-implant soft tissue inflammation was associated with MI failure. It was recommended that MI should be placed in keratinized gingiva to reduce development of hypertrophic tissues and inflammation.[20-24] Therefore, zone of attached gingiva should be considered prior to determining proper MI placement site as well.[1, 8, 19, 20, 23] Further study pertaining width of attached or keratinized gingiva in various skeletal patterns should also be investigated.

There are some studies that reported the dental compensation related to variations in sagittal skeletal patterns.[25] In Class II malocclusion, lower incisors are more proclined and occlusal plane steeper to achieve normal dentoalveolar relationships. In our studies, we did not find any differences of IZ crest parameters between Class I and Class II skeletal patterns. Probably the variables which were measured in this present study were related to buccolingual inclinations of the posterior teeth. Janson *et al.* reported significant difference of buccolingual inclinations of maxillary posterior teeth between different vertical facial patterns.[26] We, therefore, suggested further study pertaining to comparison of IZ crest parameters between the subjects with different vertical growth patterns.

Conclusions

In Class I skeletal pattern, the buccal cortical bone thickness ranged from 1.18 ± 0.09 to 1.31 ± 0.76 mm, and in Class II ranged from 1.21 ± 0.33 to 1.37 ± 0.38 mm. In Class I skeletal pattern group, buccal plate thickness ranged from 2.91 ± 0.74 to 3.82 ± 1.25 mm, and in Class II ranged from 2.98 ± 1.20 to 4.18± 1.40 mm. In Class I skeletal pattern group, IZ crest thickness ranged from 5.27 ± 2.63 to 8.77 ± 2.85 mm and in Class II ranged from 4.94 ± 0.41 to 7.77 ± 0.47 mm. There was no statistically significant difference for all measured variables between Class I and Class II skeletal patterns ($P>0.05$). Some combination of vertical insertion position and direction were also suggested as appropriate for MI placement.

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