บทความวิจัย

Buccal Bone Thickness at Infrazygomatic Crest Site in Thai Growing Unilateral Cleft Lip and Palate Patients

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Abstract

Objective: To clarify buccal bone thickness at the infrasygomatic crest site in Thai growing unilateral cleft lip and palate patients, using cone-beam computed tomography (CBCT).

Materials and Methods: The sample consisted of the cone beam computed tomography (CBCT) images of 40 infrasygomatic crest sites obtained from 20 pretreatment Thai unilateral cleft lip and palate patients (age ranged from 7 to 13 years). Buccal bone thickness at mesiobuccal (MB) root, middle of buccal furcation (B) and distobuccal (DB) root of the maxillary first molar in 5 vertical levels (4.8, 6, 7.2, 8.4 and 9.6 mm)

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from buccal cemento-enamel junction (CEJ) of the maxillary first molar were measured.

**Results:** The buccal bone thicknesses at non-cleft side were from $2.23 \pm 1.25$ to $5.34 \pm 3.67$ mm from CEJ to root apex. At cleft side, the measurements were declared from $2.57 \pm 1.42$ to $6.53 \pm 3.40$ mm. At both sides, the measurements at MB section were greater than those at middle of buccal furcation and DB section, respectively. Moreover, some measurements of cleft side were significantly greater than those of non-cleft side.

**Conclusions:** This study clarified that the thickness of buccal bone at infrrazygomatic crest site in both non-cleft and cleft sides increased from the cemento-enamel junction level towards the apical area and increased from mesial to distal area. We found that the safest area was the middle of buccal furcation at 6-9.6 mm from CEJ. However, the othersites could be used with caution. In addition, the miniscrew placement at cleft side seemed to be safer than at non-cleft side.

**Keywords:** buccal bone, infrrazygomatic crest, cleft lip and palate, cone-beam computed tomography
are raised and displaced medially, and frequently posteriorly. The denuded palatal bone is then covered by scar tissue. The effect of the palatal scar tissue is the influence in dentoalveolar structures. The maxillary tooth eruption and vertical development of the dentoalveolar process could be reduced by the scar. The operated patients with unilateral cleft lip and palate (UCLP) are generally characterized by craniofacial deformities especially in the midfacial area, such as a retroposition of the maxilla\(^{(3)}\). Skeletal discrepancy between the maxilla and mandible often creates class III malocclusion. In case of maxillary hypoplasia, maxillary orthopedic protraction is one of the most widely used treatment options in growing patients.

Recently, protraction headgear with skeletal anchorage, such as miniplate and miniscrew, has been reported to minimize unfavorable outcome such as proclination of the maxillary incisors, and loss anchorage of the maxillary molars. The infrrazygomatic crest is also one of the sites for miniscrew implant placement\(^{(4-6)}\). Liou\(^{(5)}\) have found that it is located between the maxillary second premolar and first molar in young patients, but above the maxillary first molar in adults. He also suggested that proper miniscrew implant insertion position at the infrrazygomatic crest in adult patients should be 14.0 to 16.0 mm above the maxillary occlusal plane. Baumgaertel and Hans\(^{(4)}\) in 2009 also reported that the greatest bone depth was located 11.48 mm apical to the buccal cemento-enamel junction of the maxillary first molar in adult dry skulls; however, the anatomy of this site varied considerably.

Accordingly, information from three dimensional cone beam computed tomography (CBCT) at the infrrazygomatic crest site, particularly in growing patient, should be analyzed in order to avoid any injuries to dental roots and tooth buds of maxillary posterior teeth and to provide a reliable determination of proper position and direction for miniscrew placement. Lin\(^{(7)}\) claimed that at least 1.0-2.0 mm initial biting depth of buccal bone was required prior to changing the insertion direction in order to avoid an injury to the maxillary molar roots by miniscrew implant.

However, to date, no study has evaluated the buccal bone thickness of the infrrazygomatic crest area in growing cleft patients. The purpose of this study was to clarify buccal bone thickness at infrrazygomatic crest sites in Thai growing unilateral cleft lip and palate patients.

**Materials and Methods**

**Subjects and image acquisition**

This study was approved by the Human Experimentation Committee, Faculty of Dentistry, Chiang Mai University (NO.59/2016). The samples consisted of the CBCT images of 40 infrrazygomatic crest sites obtained from 20 Thai non-syndromic UCLP patients with age of seven to 13 years old. The images were produced using a DentiScan (NSTDA, Bangkok, Thailand) CBCT unit at 90 kVP, 6mA and a voxel size of 0.4 mm. Inclusion criteria were 1) history of primary lip and palate surgery at the age of 3 months to 2 years 2) Class III skeletal relationship due to maxillary deficiency (ANB<0°, SNA<80°); 3) no posterior teeth missing, excluding third molars, or large metal restoration; 4) no previous orthodontic treatment and 5) no bone-altering medication or disease 6) fully eruption and complete root formation of the maxillary first molar.

**Measurement of the buccal bone thickness**

Using the DentiPlan professional V. 3.0 (NECTEC, Thailand) viewer program, The CBCT images were oriented in all three planes of space. Coronal slice orientation (Figure 1A), the CBCT image was oriented until the maxillary molar occlusal plane was parallel to the yellow horizontal line. Sagittal slice orientation (Figure 1B), the CBCT image was oriented until the functional occlusal
plane was parallel to the yellow horizontal line, and the long axis of the mesiobuccal root of the maxillary first molar was parallel to the blue vertical line. Axial slice orientation (Figure 1C), the CBCT image was oriented to ensure that the blue horizontal line was superimposed to the mesiobuccal root of the maxillary first molar.

On the coronal slice orientation, five cutting lines of 1.2 mm vertical interval from 4.8-9.6 mm from the buccal cemento-enamel junction of the maxillary first molar to the root apex were created. On sagittal slice orientation, three mesiodistal sections including mesiodistal root axis (MB), middle of buccal furcation (B) and distobuccal root axis (DB) of maxillary first molar were created. Then grid pattern of measurements was produced (Figure 2). Each measurement site was named according to the mesiodistal sections and the vertical cut levels. For example, the measurement site marked “x” in Figure 2 would be named B8.4.

Then on axial slice orientation at each measurement site, the buccal bone thicknesses were measured (Figure 3). At mesiobuccal (MB) section, the buccal outmost point of the MB root (point A) was determined. A line (blue horizontal line) parallel to the horizontal line and passed the point A was then drawn. The blue horizontal line intersected the buccal outmost border of the buccal plate at the point X. The A-X distance, or the buccal bone thickness of the MB root of 1st molar, was then measured (yellow arrows). At middle of buccal furcation (B) section, the tangential line from point A to point C was created. The middle of this tangential line was determined as point B. A line (blue horizontal line) parallel to the horizontal line and pass the point B was drawn. The blue horizontal line intersected the buccal outmost border of the buccal plate at the point Y. The B-Y distance, or the buccal bone thickness at the middle of buccal furcation of 1st molar, was then measured (yellow arrows). At distobuccal (DB) section, the buccal outmost point of the DB root (point C) was determined. A line (blue horizontal line) parallel to the horizontal line and passed the point C was

![Figure 1](image1.png)

**Figure 1** Three views of the CBCT image orientations of the right maxillary first molar: A, coronal slice orientation, with the yellow horizontal line being parallel to the maxillary molar occlusal plane; B, sagittal slice orientation, with the blue vertical reference line being superimposed to the long axis of the mesiobuccal root of the maxillary first molar and the functional occlusal plane being parallel to the yellow horizontal line; C, axial slice orientation, with the blue horizontal reference line being superimposed to the mesiobuccal root axis of the maxillary first molar.
then drawn. The blue horizontal line intersected the buccal outermost border of the buccal plate at the point Z. The C-Z distance, or the buccal bone thickness at the DB root of 1st molar, was then measured (yellow arrows). All measurements were repeated in a 4-week interval by the same examiner and average values were calculated.

**Figure 2** Measurement sites of three mesiodistal sections from MB section to DB section of maxillary first molar, and 1.2 mm interval of five vertical cut levels from 4.8-9.6 mm from buccal CEJ toward root apex of maxillary first molar. The measurement site marked “x” was named B8.4.

**Figure 3** Axial slice orientation of CBCT image, the buccal bone thickness was measured at three mesiodistal sections (yellow arrows).

**Statistical analysis**

Data were analyzed using SPSS 17.0 (SPSS Inc., Chicago, III., USA). Intraclass correlation was used to assess intra-examiner variation. Means and standard deviations of the buccal bone thickness were investigated. Paired t-test was used to assess the differences of bone thickness between non-cleft and cleft side.

**Results**

The intra-examiner reliability test for measurements of the buccal bone thickness showed high intraclass correlation (r = 0.993). The buccal bone thicknesses at non-cleft side were from 2.23±1.25 to 5.34±3.67 mm, less at level of 4.8 mm and more toward the apex. The thinnest was found at MB 4.8 site while the thickest was at DB 9.6 site. At cleft side, the measurements were declared from 2.57±1.42 to 6.53±3.40 mm, less at level of 4.8 mm and more toward the apex. The thinnest was found at MB 4.8 site while the thickest was at DB 9.6 site. The buccal bone thickness at DB section was greater than those at MB section at the same vertical level. The
mean and standard deviations of all measurements are shown in Table 1.

All measurements of cleft side were non-statistical significant greater than those of non-cleft side excepted at MB 8.4, MB 9.6, B 6.0, B 8.4, as shown in Table 1.

Discussion

Protraction headgear with skeletal anchorage, such as miniscrew, has been reported to minimize unfavorable outcome such as proclination of the maxillary incisors, and loss anchorage of the maxillary molars.\(^{(8-10)}\) Non-interradicular sites for miniscrew placement were suggested to be safer than interradicular site.\(^{(7)}\) Palatal site of miniscrew placement was not appropriate in UCLP patients due to the cleft at the palate. Recently, the IZ crest is usually used for a single miniscrew. According to Lin\(^{(7)}\), at least 1.0-2.0 mm initial biting depth of buccal bone was required prior to changing the insertion direction in order to avoid an injury to the maxillary molar roots by miniscrew implant. This study clarified that the buccal bone thickness at non-cleft and cleft sides were greater toward the apex (Figure 4). This is consistent with Lin\(^{(7)}\) who studied the series of CT image sections from 1.0 mm to 10.0 mm above cervical line, and summarized that the buccal bone thickness of the upper molar area was tend to be wider toward the apex due to convergence of the upper molar roots and the smaller upper molar root apex. Our study found that the greater values of buccal bone thickness were along the DB root of maxillary first molar (Figure 4). This is consistent with Temple et al.\(^{(11)}\) who studied the buccal plate thickness of both arches using CBCT, and found that Both arches demonstrates increasing buccal plate thickness form anterior to posterior.

Statistically significant differences of the measurements comparing the cleft and non-cleft sides shown that some of values were greater on the cleft side. No other studies are available on searching to equate those findings. For clinical application, we found that the safest area for miniscrew placement at infrrazygomatic crest site were at B6, B7.2, B8.4 and B9.6 sites. The vertical level of 4.8 mm was not recommended because it seemed to be the buccal furcation level. Furthermore, the minicrew placement at the maxillary first molar area on the cleft side considering the buccal bone thickness is safe as same as on the non-cleft side. However,

<table>
<thead>
<tr>
<th>Vertical cut level</th>
<th>MB root of 1st molar</th>
<th>Middle of buccal furcation</th>
<th>DB root of 1st molar</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-cleft side of cleft patients</td>
<td>Cleft side of cleft patients</td>
<td>P</td>
</tr>
<tr>
<td>4.8</td>
<td>2.23±1.25</td>
<td>2.57±1.42</td>
<td>NS</td>
</tr>
<tr>
<td>6</td>
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<tr>
<td>8.4</td>
<td>3.06±2.10</td>
<td>3.92±2.00</td>
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<tr>
<td>9.6</td>
<td>3.83±2.86</td>
<td>4.78±2.47</td>
<td>*</td>
</tr>
</tbody>
</table>

NS: Not significant, *: \(p<0.05\)
Conclusions

This study clarified that the thickness of buccal bone at infrazygomatic crest site in both non-cleft and cleft sides increased at 4.8 mm from the cemento-enamel junction level towards the apical area and increased from mesial to distal area. We found that the safest area were at B6, B7.2, B8.4 and B9.6 sites. However, the other sites could be used with caution. In addition, the miniscrew placement at cleft side seems to be safer than at non-cleft side because the buccal bone thickness tends to be thicker.

Acknowledgements

The authors are grateful to Faculty of Dentistry, Chiang Mai University for grant support, and to National Science and Technology Development Agency (NSTDA) for the CBCT unit and software used in this study. Also Ms. Ratikorn Kitthada for preparing the CBCT images and Dr. Thanapat Sastraruji for statistic consultation.

References


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