Buccal cortical bone thickness of hyperdivergent and hypodivergent Bengali subjects in mandibular posterior region

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ABSTRACT

Forms and functions of structures are two interrelated things in the human body. Bones adapt to functional forces according to Wolff’s law. Our jaw bones also follow the same law. Facial divergence has been related to forces of masticatory muscles. Whereas muscle forces have been related to the cortical thickness and facial divergence, limited research has been conducted relating cortical bone thickness to facial divergence. Objectives include to assess differences in dentoalveolar buccal cortical bone thickness between hyperdivergent and hypodivergent Bengali population in the mandibular posterior region. The aim is to provide reference data for orthodontists placing mini-screw implants for treatment purpose. No of subjects 40. Subjects with Frankfort mandibular plane angle more than 29° were classified as hyperdivergent and less than 21° were classified as hypodivergent. Age group is between 14 to 26 yrs.

Keywords— Buccal cortical bone, Mandibular posterior region, Facial type, Bengali subjects, CBCT, Miniscrew placement

1. INTRODUCTION

Orthodontic treatment depends highly on anchorage. Over the years skeletal anchorage has gained popularity in daily clinical practice over conventional anchorage Orthodontic mini implants are simple easy to use, cost-effective, and convenient for achieving absolute skeletal anchorage with an estimated success rate of 80% - 90%.

These parameters can be thoroughly evaluated by contemporary imaging techniques such as CT (Computed Tomography) and CBCT (Cone Beam Computed Tomography). These 3D methods present advantages over conventional 2D radiographic techniques e.g. cephalometric and panoramic radiographs by providing accurate reliable 3D information, which is mandatory for research purpose. High definition images of dent alveolar structures can be obtained at a significantly lower radiation dose compared to conventional imaging techniques. Unlike conventional X-ray (due to the divergence of the beam) CBCT (Cone Beam Computed Tomography) gives images without superimposition or distortion.

In recent years 3-dimensional analyses and measurement of jaws have become more common, especially for the morphology and cortical bone, the width of the cortical plate in the mandible. However, there is still a very small number of comprehensive studies showing how the width of cortical plates in maxilla and mandible as related to mini implant sites are affected by the different vertical patterns of the face. Most of the previous CBCT (Cone Beam Computed Tomography) studies were done at maxillary and mandibular posterior regions (distal to the canine). Again most of the previous CBCT (Cone Beam Computed Tomography) studies comparing vertical facial types have measured bone thickness at a single horizontal level from the alveolar crest. There is only one study done by Swasty et al. that investigated cortical bone thickness at different horizontal levels from the alveolar crest in live patients with respect to different vertical facial dimensions. But they did not measure cortical thickness from any standard site, but just divided the distance from the height of the base of the mandible to the top of the alveolar crest, and measured from one third and two-thirds of this length.

2. AIMS AND OBJECTIVES

The objective of the study is to:
- Measure the thickness of buccal cortical bone at specified sites of the mandibular posterior region in Bengali hypodivergent and hyperdivergent subjects
- Compare subjects classified as hyperdivergent to subjects classified as hypodivergent.
- If cortical bone thickness varies between hyper and hypodivergent individuals, miniscrew implant placement procedure might also need to vary. If the bone is thinner in certain areas, then different treatment modalities can be considered, so that there is no loss of mini implants if they are an important part of the treatment plan.

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3. MATERIALS AND METHODS

3.1 Study area
This cephalometric radiographic study was carried out in the Department of Orthodontics and Dentofacial Orthopaedics, Guru Nanak Institute of Dental Sciences and Research of Panihati, Kolkata - 114.

3.2 Study population
Samples selected from image archive of the institution.

3.3 Sample size
40

3.4 Sample selection

Inclusion criteria: Bengali patients aged between 14yrs to 26yrs. Patients have been divided into 2 groups (hypodivergent & hyperdivergent). Hypodivergent patients characterized by Frankfort mandibular plane angle < 21°. Hyperdivergent patients characterized by Frankfort mandibular plane angle > 29°.

Exclusion criteria
(i) No facial asymmetries
(ii) No cleft lip / palate
(iii) No impacted / missing teeth in measurement site
(iv) No periapical or periradicular pathologies or radio-lucencies of either periodontal or endodontic origin
(v) No severe facial or dental asymmetries
(vi) No vertical or horizontal alveolar bone loss
(vii) No significant medical history

3.5 Study Design
Cross-sectional.

3.6 Parameters studied
The buccal cortical bone thickness of mandible between
- Right first premolar and second premolar
- Right second premolar and first molar
- Right first molar and second molar

All parameters have been measured in every 1mm starting from 2mm from the highest point of the alveolar crest as only cortical bone is seen at the height of alveolar crest to the lower border of the mandible. Comparison between hypodivergent and hyperdivergent patients have been done in 3 specified sites- 5mm, 10mm, and 15mm from the alveolar crest.

3.7 Study period
January 2015 to August 2016

3.8 Study tools
- CBCT (Myray Blue sky Machine, Conical, Variable-Field, H.R. Zoom, 90 Kvp, 10 Ma(max), Pulsed Emission).
- Nnt Viewer software.

3.9 Study techniques
CBCT images have been analysed using above mentioned software. Measurements were reassessed after 1 month at 5mm, 10mm, and 15mm from the alveolar crest.

Head orientation- FH plane parallel to the horizontal plane.

Vertical sections are taken in each interproximal region at the midpoint between two adjacent teeth. All distances measured are perpendicular to the vertical plane.

Fig. 1: Orientation
4. STATISTICAL ANALYSIS

For statistical analysis, data were entered into a Microsoft excel spreadsheet and then analyzed by SPSS 20.0.1 and GraphPad Prism version 5. Data have been summarized as mean and standard deviation for numerical variables and count and percentages for categorical variables. The median and the interquartile range have been stated for numerical variables that are not normally distributed. Student’s independent sample’s t-test was applied to compare normally distributed numerical variables.

Explicit expressions that can be used to carry out various t-tests are given below. In each case, the formula for a test statistic that either exactly follows or closely approximates a t-distribution under the null hypothesis is given. Also, the appropriate degrees of freedom are given in each case. Each of these statistics can be used to carry out either a one-tailed test or a two-tailed test. Once a t value is determined, a p-value can be found using a table of values from Student's t-distribution. If the calculated p-value is below the threshold chosen for statistical significance (usually the 0.10, the 0.05, or 0.01 level), then the null hypothesis is rejected in favor of the alternative hypothesis. p-value ≤ 0.05 was considered for statistically significant.

Distribution of MEAN cortical bone thickness at the sites 1, 2 and 3 in two groups
(1 = 5mm from alveolar crest, 2 = 10mm from alveolar crest, 3 = 15 mm from alveolar crest)

Table 1: Distribution of MEAN cortical bone thickness in the interproximal region between right mandibular 1st & 2nd premolar

<table>
<thead>
<tr>
<th>Buccal 45</th>
<th>Group</th>
<th>Number</th>
<th>Mean</th>
<th>SD</th>
<th>p-value</th>
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<td>1</td>
<td>Hyper</td>
<td>20</td>
<td>1.4200</td>
<td>.2707</td>
<td>&lt; 0.0001</td>
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<tr>
<td></td>
<td>Hypo</td>
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<td>2.0650</td>
<td>.1755</td>
<td></td>
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<tr>
<td>2</td>
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<tr>
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</tr>
<tr>
<td>3</td>
<td>Hyper</td>
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<td>1.9300</td>
<td>.2755</td>
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<td></td>
<td>Hypo</td>
<td>20</td>
<td>2.2000</td>
<td>.2052</td>
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Table 2: Distribution of MEAN cortical bone thickness in the interproximal region between right mandibular 2nd premolar & 1st molar

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<th>Buccal 56</th>
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<th>Mean</th>
<th>SD</th>
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<td>Hypo</td>
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<td>2.4700</td>
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<td>Hyper</td>
<td>20</td>
<td>2.0600</td>
<td>.3347</td>
<td>&lt;0.0001</td>
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<td>Hypo</td>
<td>20</td>
<td>2.6400</td>
<td>.2234</td>
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</table>

Table 3: Distribution of MEAN cortical bone thickness in the interproximal region between right mandibular 1st & 2nd molar

<table>
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<tr>
<th>Buccal 67</th>
<th>Group</th>
<th>Number</th>
<th>Mean</th>
<th>SD</th>
<th>p-value</th>
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<tr>
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<td>1.8400</td>
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5. DISCUSSION

The present study found that buccal cortical bone thickness of the mandible is closely related to vertical facial types. In all measurement sites—cortical bone thickness in the low-angle subjects was significantly higher than in the high-angle subjects. Most of the previous CBCT studies comparing vertical facial types have measured bone thickness at a single horizontal level from...
alveolar crest- while in the current study the buccal cortical bone thickness of hypodivergent and hyperdivergent individuals have been compared at 5mm, 10mm, and 15mm from the alveolar crest. The only study\textsuperscript{28} that investigated cortical bone thickness at different horizontal levels from alveolar crest in live patients with respect to different vertical facial dimensions, unfortunately, did not measure cortical thickness from any standard site, but just divided the distance from the height of the base of the mandible to the top of the alveolar crest, and measured from one third and two thirds of this length, probably measuring the cortical thickness from a different height in each patient. In a study conducted by Horner et al\textsuperscript{1}, cortical bone thickness, alveolar ridge thickness, and medullary bone thickness had been measured only at 5 mm from alveolar crest in the interproximal region between right canine & 1\textsuperscript{st} premolar, right 1\textsuperscript{st}& 2\textsuperscript{nd} premolar, right 2\textsuperscript{nd} premolar & 1\textsuperscript{st} molar, right 1\textsuperscript{st} and 2\textsuperscript{nd} molar- both in maxilla and mandible. They have found that mean buccal cortical bone thickness to be significantly higher in the interproximal region between maxillary 3-4; 4-5; 6-7 and mandibular 6-7; 5-6; 4-5. In the present study, the same regions in the mandible at 5 mm from alveolar crest have shown a statistically significant difference between hyperdivergent and hypodivergent individuals.

In the current study in general, the buccal cortical bone was thicker in hypodivergent than in hyperdivergent individuals.

### 5.1 In hypodivergent subjects

In the interproximal region between first and second premolar, buccal cortical bone and the alveolar ridge were found to be significantly thicker at all 3 sites. Again between second premolar and first molar both buccal cortical bone and the alveolar ridge was significantly thicker in hypodivergent individuals. Lingual cortical bone was significantly thicker only at 5mm from the alveolar crest.

Between first and second molar, the buccal cortical bone was significantly thicker in hypodivergent subjects at all three sites. The differences of cortical bone thickness at different sites may be explained by masticatory function. Vertical facial development has been related to weak masticatory muscles\textsuperscript{37}. Weakened masticatory muscles produce smaller bite forces, which leads to less strain on the associated bones\textsuperscript{29,30,31,32,33}.

Reason for the inconsistencies with other studies might be racial differences, use of cadavers, dry skulls, live patients, or different measurement sites. In the current study, the alveolar cortical bone thickness was measured from a height of 2 mm from the alveolar crest up to - in mandible-lower border of mandible on the CBCT data of live Bengali patients and compared at 5mm, 10mm and 15 mm from the alveolar crest.

Since cortical thickness is reported to be a major factor in the success of mini-implants, it is important to use an accurate and reproducible method to measure it, taking mini-implant placement sites into consideration.\textsuperscript{2, 34} Masumoto et al\textsuperscript{25} measured the cortical bone width at 10 vertical levels starting from the lower border of the mandible and showed that some of these variables changed with each facial type, whereas other variables showed no change with differing facial characteristics. To be able to evaluate cortical bone thickness for the purpose of the suitability of mini-implant sites, measurements should be made from the clinically favourable area for the mini-implants. This favourable area lies in the attached gingiva,\textsuperscript{35} considering the lower probability of inflammation, and is approximately 4 to 6 mm from the alveolar crest or the cementoenamel Junction.\textsuperscript{18,36,37,38} Ono et al deduced that the distance from the alveolar crest to the mucogingival junction could be 2 to 4 mm in the maxilla, and this height should be the border so as not to irritate the nonkeratinized tissue and cause inflammation around the mini-implant. In the current study, the alveolar cortical bone thickness was measured from a height of 2 mm from the alveolar crest.

### 6. LIMITATIONS

- This study involved the limited sample size-subjects were limited to the patients in the dental records archive from Guru Nanak Institute of Dental Science and Research.
- Sex differences were not studied.
- All measurements were taken at the right side only, as the previous study has shown no difference between right and left side\textsuperscript{24,26,28}.

### 7. CONCLUSION

This study used the improved imaging capability of the CBCT to investigate the relationship between vertical facial patterns and mandibular posterior region tooth-alveolar morphology in the Bengali population. Overall, statistically significant differences were found between the facial types. The present study confirms that buccal cortical bone thickness at mini-implant sites is lower in high-angle patients than in low-angle patients; this would bring a higher risk of loss of implants in these patients. So, it is an orthodontists’ responsibility to take precautions in patients with less cortical bone thickness (i.e.hypodivergents) so that they do not lose their mini-implants if they are an important part of our treatment plan. These precautions could be to use thicker miniscrews, to emphasize and monitor oral hygiene more strictly, possibly to place the miniscrews in a more angled position to take advantage of the longer diagonal bone surface or to use miniplates.

### 8. BIBLIOGRAPHY


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