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Assessment of Labial Alveolar Bone Thickness in Maxillary Central Incisor using Cone Beam Computed Tomography

Dr. Shaili Pradhan,[1] Dr. Rejina Shrestha,[1] Dr. Ranjita Shrestha Gorkhali,[1] Dr. Pramod Kumar Koirala[1]

[1]*Periodontology and Oral Implantology Unit, Department of Dental Surgery, National Academy of Medical Sciences, Bir Hospital, Mahabouddha, Kathmandu, Nepal.*

ABSTRACT

Introduction: The maxillary anterior region is becoming a major concern due to its aesthetic relevance. The buccal bone thickness is important for implant placement, orthodontic treatment, and restorative treatment.

Objective: To assess the thickness of alveolar bone in the maxillary central incisor using cone beam computed tomography (CBCT).

Methods: A cross-sectional observational study was conducted at Department of Dental Surgery, Bir Hospital where CBCT of 53 samples from July 2019 till December 2019, the archived CBCT images was assessed retrospectively. The thickness of the labial bone in a direction perpendicular to the outer surface of the tooth root was measured at a distance of 2 mm from the cementoenamel junction (CEJ). The measurement was taken thrice and the mean measurement was considered.

Results: The labial alveolar bone thickness in maxillary central incisor was found to be 0.55±0.27 mm at a distance of 2 mm from the CEJ. Only 2 (3.8%) of the samples had an alveolar thickness of >1 mm. No statistically significant difference was found with respect to gender and age.

Conclusion: The average thickness of the labial alveolar bone in maxillary central incisor using cone beam computed tomography was found to be thin.

Keywords: Aesthetic; implant; labial bone.

INTRODUCTION

The introduction of implants in dentistry has caused a major paradigm shift in treatment planning.[1] For the successful result of the treatment, preoperative study and planning is very important. This is particularly important in cases of anterior aesthetic zone.

The maxillary anterior region is becoming a major concern due to its aesthetic relevance. The buccal bone thickness is important for implant placement, periodontal treatment, orthodontic treatment, and restorative treatment. Alveolar morphology is determined by race, ethnicity, occlusal pattern, facial skeletal types, and periodontal biotypes.[2]

Adequate height and thickness of labial alveolar bone are important for longer stability of mucosal margins around implants.[3] In the case of implant bed preparation, the labial alveolar bone wall should measure at least 2 mm in thickness.[4] This thickness provides support to the soft tissue and prevents resorption of the facial bone wall.[4] Presence of thinner buccal bone may lead to fenestration, soft-tissue recession and cortical bone perforation during or after implantation.[2] The aim of this study was to assess the thickness of alveolar bone on the labial surfaces of the maxillary anterior teeth using CBCT in a selected Nepalese sample.

Correspondence
Dr. Rejina Shrestha
Email: rejinashrestha811@gmail.com

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METHODS

A cross-sectional observational study was conducted where CBCT of patients from the archived CBCT images from Department of Dental Surgery, Bir Hospital, Kathmandu, Nepal were assessed retrospectively. The CBCT images were obtained from July 2019 till December 2019 for dental investigation for different dental purposes, such as oral surgery, dental implant, endodontic, and orthodontic purpose. Ethical approval (Ref. 499/2077/78) was obtained from Institutional Review Board, Ethical Committee of National Academy of Medical Sciences, Bir Hospital, Kathmandu, Nepal.

Cone beam computed tomography (CBCT) of anterior maxillary compartment with presence of central incisor that was advised for any dental reasons (such as implant therapy

and restorative care, endodontic treatment, or orthodontic diagnostic and treatment) were included in the study. The exclusion criteria included abnormality that would alter the bone thickness like maxillary fractures, tumours, bone disease, tooth loss, evidence of periodontal bone loss or growth alterations, previous surgeries, developmental anomalies and root resorption. Maxillary anterior teeth that are impacted, overlapped, extracted, lacked clear bony boundaries, or have not erupted were excluded from the study.

The thickness of the labial alveolar bone of the maxillary central incisor was measured in the CBCTs by a single examiner (RS). Measurement was done using Sirona Galaxis/ Galileos Implant software from Orthophos-SL which was installed in the department. The images were obtained at 85 kV, 5–7 mA, and 14 s with a voxel size of 0.3 mm and field of vision (FOV) of 15×15×15.

Demographic variables such as age and gender were noted from the record. The thickness of the labial bone in direction perpendicular to the outer surface of the tooth root was measured at a distance of 2 mm from the cementoenamel junction (CEJ) in the sagittal section (Figure 1). The measurement was taken thrice and the mean measurement was considered. The measurement was filled in the proforma and tabulated in SPSS Statistics for Windows, version 16.0 (SPSS Inc., Chicago, Ill., USA) for further analysis. P value was calculated under the predetermined level of significance and CI (confidence interval) of 95% was constructed. Unpaired t-test and analysis of variance (ANOVA) were performed for quantitative variable for gender and age.

RESULTS

Total of 53 patients were enrolled in the study. There were 32 (60.3%) males and 21 (39.7%) females with mean age of 36.6 years. The mean labial alveolar bone thickness in maxillary central incisor at a distance of 2 mm from the CEJ was found to be 0.55± 0.27 mm with a range 0.00 to 1.09 mm. There was no statistically significant difference in the mean labial bone thickness according to gender (Table 1).

Table 1: Mean labial bone thickness according to gender.

Gender	Mean± SD	P value
Male	0.57±0.22	0.616
Female	0.54±0.34	

Unpaired t-test

Table 2: Mean labial bone thickness according to age.

Age (years)	Mean±SD	P value
<30	0.58±0.20	0.691
30-45	0.57±0.31	
>45	0.49±0.31	

One-way ANOVA

According to the age group, there were 15 (28.3%) patients under the age of 30 years, 24 (45.3%) in 31-45 years age group and 14 (26.4%) above 45 years. There was no statistically significant difference in the mean labial bone thickness according to age (Table 2).

Majority of the patients (96.2%) showed alveolar bone thickness less than 1 mm. Only 3.8% patients showed buccal bone which was more than 1 mm.

DISCUSSION

In the present study, the mean alveolar buccal bone thickness in the maxillary central incisor was measured with cone beam computed tomography. The accuracy and reliability for linear and angular measurements of cone beam computed tomography images is reported to be high.[5] Two-dimensional imaging have a lot of intrinsic disadvantages such as distortion and superimposition.[5] Cone beam computed tomography images are preferably used because they overcomes such errors and also provides planar measurements. thus, it is used for a lot of purposes such as implant site assessment, temporomandibular joint examination, visualisation of periodontal osseous situation and identification of periodontal ligament spaces. The craniofacial complex is accurately measured by CBCT due to its property of measuring isotropic voxels.[5] CBCT can be used to quantitatively assess buccal bone height and buccal bone thickness with high precision and accuracy.[6]

Cone beam computed tomography (CBCT) was the method of choice in the study due to advantages that include low radiation dose, low cost, and the ability to view a detailed three-dimensional image of the regions of interest. CBCT scans help in the guidance of treatment planning for the maxillary aesthetic region; specifically, for implant placement, it can contribute to the evaluation of some possible pre or post-surgical soft or hard tissue complications.[7]

The result of the study shows thin labial alveolar bone thickness in the Nepalese sample. This is important in terms

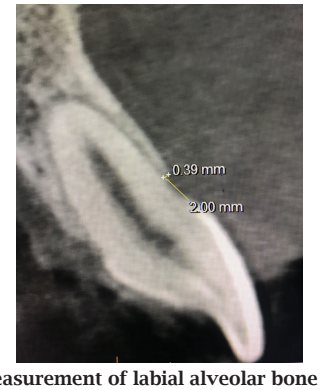

Figure 1: Measurement of labial alveolar bone thickness 2 mm from cementoenamel junction in a cone beam computed tomography image.

of implant placement. After tooth extraction, dimensional changes occur in the alveolar bone. The width of the ridge is reduced approximately 50% and most changes occur during the first three months of healing.[8] More pronounced resorption is observed on the buccal than on the lingual/palatal aspects of the ridge.[9] Resorption of the bundle bone leads to loss of bone height of the facial alveolar bony wall ultimately resulting in increased risk of midfacial mucosal recession and discoloration after implant placement.

The facial bone profile is affected by the dentoskeletal relationships and the presence of malocclusion. Bimaxillary protrusion is one such malocclusion and is commonly observed in Asians and less prevalent in Europe.[10] This may have an impact on the outcome in the present study compared with other studies performed in various populations.

Various studies have been done to assess the labial alveolar thickness in the anterior maxillary region where similar results have been described. In a systematic review and meta-analysis done by Tsigarida in 2020,[11] among the 50 included studies, buccal bone thickness greater than 1 mm was seen in few maxillary anterior teeth. Alveolar ridge preservation a part of delayed approach or contour augmentation at early or immediate implant placement was advocated to minimise the tissue loss following extraction.

In a study done by Shrestha et al.[12] in 2019 in Nepal among 150 Nepalese adults, 3.3% of the central incisor (CI), 10.7% of the lateral incisor (LI), and 13.3% of the canine (C) showed a thick labial bone (1-2 mm) at the crestal level. 75.3% of the CI, 64.5% of LI, and 70% C showed a thin bony wall at 1 mm level. At the L5 level, very thin osseous wall was observed in most of the LIs and Cs. The findings are similar to the current studies.

In a study done by Prakash et al. in India in 2018 among 200 subjects, the mean thickness of labial cortical bone for central incisor was 0.58±0.19, 0.68±0.29, and 0.82±0.19 mm in the cervical, middle, and apical regions, respectively.[4] A statistically significant difference ($P < 0.05$) was observed between the labial cortical bone thicknesses in the various surfaces.

Chen et al. in 2017[3] did a study in Taiwan among 11 adults and found that the thickness of the facial alveolar bone of the central incisors, lateral incisors, and canines ranged from 0.5 to 1.5 mm and concluded that it is common for teeth in the anterior maxilla to have thin facial bone walls.

Alsaffar et al. did a study in Saudi Arabia in 2016 to find the thickness and vertical bone height of the labial and palatal alveolar bone.[13] Measurements were performed using, Galileos CBCT, in 108 maxillary anterior teeth at three levels cervical, middle and apical region. They reported remarkably thinner bone (approximately 0.1–0.6 mm) around the canine tooth in comparison to the central and lateral incisors.

Similar results were observed in a study in 2014 by Januário et al.,[14] who determined the thickness of the facial bone wall in the anterior dentition of the maxilla and at different locations apical to the CEJ. In this study, measurements demonstrated that most teeth sites in the anterior maxilla of measured Saudi sample had a thin facial bone wall that may undergo a marked dimensional decrease following tooth extraction. The average buccal plate thickness in the anterior maxilla was about 0.5 to 0.7 mm, and <1 mm wall thickness was noted in 85% of sites.

Zekry et al.[10] conducted a retrospective study with 200 images in Hong Kong in 2012. The vertical distance from the alveolar crest (BC) – CEJ was measured. The width of the facial alveolar bone wall was measured at three locations: 1, 3, and 5 mm apical to BC. The mean width of the facial alveolar bone wall at anterior teeth was 0.9 mm and increased toward posterior regions. Rarely, a width of 2 mm was yielded (0.6–1.8% for anterior teeth, 0.7–30.8% for posterior teeth). A thin facial alveolar bone wall was usually present in both jaws.

Similar results were seen in a study done by in 2012 in Italy by Ghassemian et al.[15] where tomographic scans of intact anterior maxilla were randomly selected and evaluated. The average bone thickness at 3 mm from the CEJ for the maxillary right central incisor was 1.41 mm and for the maxillary left central incisor was 1.45 mm. For the maxillary right and left lateral incisors, the crestal bone thickness averaged 1.73 and 1.59 mm, respectively.

Nowzari et al. in 2012[7] used cone beam computed tomography to measure horizontal width of facial alveolar bone overlying healthy maxillary central incisors in 101 randomly selected patients at levels 1.0 to 10.0 mm apical to the bone crest. The percentage of teeth with facial bone >2 mm at levels 1, 2, 3, 4, and 5 mm from the bone crest was 0%, 1.5%, 2.0%, 3.0%, and 2.5%, respectively. Overall mean thickness of the bone was 1.05 mm for right and left central incisors.

Studies have also been done using calipers in cadavers and in humans after extraction. A study by Katranji et al. in USA in 2007 measured (at the alveolar crest and 3 mm apical to the alveolar crest) in 28 human cadaver heads with a Boley gauge and recorded mean facial cortical plate thickness.[16] The thinnest area was observed in the lower anterior region and the thickest area in the upper posterior region. The range of the buccal bone of the maxilla and mandible ranged from 1.6

to 2.2 mm in thickness. In another study done by Botticelli et al. in Sweden in 2004, the facial bone wall (1 mm apical to the bone crest) was measured with a caliper immediately after 21 extractions.[17] The study included both maxillary anterior teeth and premolars, and a mean bone width of 1.4 – 0.04 mm was reported.

The study showed no statistically significant difference in the mean labial bone thickness according to gender. Similar result was seen in a study done by Zekry et al. Studies done by Alsaffar et al.,[13] Usui et al.[18] showed a thicker buccal bone in males. This could probably be because male have heavier biting forces and stronger masticatory muscles. On the other hand, Jin et al.[19] reported thicker buccal bone in females. This was attributed to lesser buccolingual dimensions of teeth in female patients. The variation may also be due to the difference in skeletal growth between males and females.

The study showed no statistically significant difference in the mean labial bone thickness according to age. The result is consistent with studies done by Januario et al.[14] and Nowzari et al.[7] The thickness of alveolar bone was found to decrease with increasing age in a research done by Fuentes et al. 2015.[20]

For aesthetic results, proper treatment plan should be followed and the clinician should also consider options of ridge augmentation, soft tissue augmentation and prosthesis modification. Implants and abutments with specific configurations to sustain hard and soft tissues, provisionalisation techniques to restore the soft-tissue contour and introduction of ceramic-customised abutments and ceramic implant crowns should also be comsidered.[21]

The limitations of the study are population heterogeneity and underestimation of actual measurements and small range of errors due to CBCT. The errors have been reported in studies comparing direct measurements on cadavers using calipers with measurements obtained from CBCT images.[22] Another limitation is the standardisation of the distance of the CEJ to the bone crest as 2 mm. Some studies have assessed the distance from the CEJ to the bone crest, describing values between 2.5 and 2.8 mm.[7,15,23] Studies have also shown smokers to have a greater CEJ–bone crest distance[24] and an increase in CEJ–BC distance in older individuals.[25]

The authors recommend further researches with larger sample size with homogenous population. Studies should also incorporate measurements at different distance with the exclusion of smokers.

CONCLUSION

The average thickness of the labial alveolar bone in maxillary central incisor using cone beam computed tomography was found to be thin. The clinician should anticipate possible complications in the aesthetic area and plan the treatment accordingly. The authors recommend further researches with larger sample size with homogenous population. Studies should also incorporate measurements at different distance with the exclusion of smokers.

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Conflict of Interest: None.

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