ANTHROPOMETRIC EVALUATION OF BUCCAL ALVEOLAR BONE DIMENSION OF MAXILLARY ANTERIOR TEETH IN INDIAN POPULATION: A CONE BEAM COMPUTED TOMOGRAPHY STUDY

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ABSTRACT

Purpose
To analyze the anatomical dimensions of the buccal bone wall of the anterior maxillary region based upon (CBCT) scans in Indian population.

Methods
100 subjects with intact maxillary dentition who got CBCT done for diagnostic purposes were selected. The dimension from the radiographic (CEJ) to the buccal alveolar bone crest (A) was recorded. The thickness of the buccal bone plate perpendicular to the long axis of the tooth root was measured in three locations: (1) 1 mm apical to the buccal alveolar bone crest (B), (2) midroot (C), and (3) 1 mm coronal to the root apex (D). The measurements for all the four locations were grouped into 3 groups: missing bone (0 mm), bone < 1 mm, and bone > 1 mm.

Results
At the CEJ and 1mm apical to CEJ, most of the teeth showed no existing bone, the least dimension is seen for the left canine region and maximum for left central incisor. As the apical region is approached, the width of the buccal wall increases drastically. Around 80% of the teeth on the right side showed <1mm of bone while 20% showed >1mm facial wall width. At the apex, maximum width was seen for the right canine region (76% had >1mm bone and rest of the patients showed varied thicknesses (0.7-0.8mm).

Conclusions
Only 10% of the maxillary anterior teeth showed buccal alveolar bone thickness of 2mm. For the percentage of cases with buccal bone thickness >2 mm, it was noticed that a high prevalence were in the central incisors (23%), lateral incisors (16%) and canines (20%).

KEYWORDS: Buccal Bone, Immediate Implant Placement, Implant Esthetics, Anterior Maxillary Teeth, CBCT

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INTRODUCTION

In today’s world of modern Implantology, the success of anterior implants has switched from implant survival to more elaborate parameters like biological, functional and esthetic. Implant position is one of the most important determinants for long-term maintenance of implant esthetics and function. These mesiodistal, apicocoronal, and orofacial dimensions are well described, defining "comfort" and "danger" zones for proper implant position in the anterior maxilla.[1]

The positioning of implant in relation to the bucco-oral dimensions of the alveolar ridge is thought to influence the degree of bone remodeling following implant placement.[2] Such bone remodeling in turn, may have a negative influence on the soft-tissue morphology and esthetic outcome.[3] Several clinical guidelines describing the correct implant position in relation to the bucco-oral bone dimension suggested that it is crucial to have a buccal bone plate of at least 2 mm.(4-6) This buccal bone thickness was advocated to ensure proper soft-tissue support, reduce its resorption following restoration and thus minimize the risk for peri-implant soft-tissue recession.[7]

The dimensions of the buccal bone wall have gained importance with the advent of immediate implants. Botticelli and colleagues measured buccal bone walls of human extraction sockets prior to immediate implant placements by using caliper & found the mean widths of buccal walls to be 1.4mm[8,9]. Nowzari had found a thin facial bone in 202 teeth, only 3% of maxillary anterior teeth had 2mm of buccal thickness [10]. Brauthas also found 0.5-0.7mm of thickness in anterior maxilla [11].

Thus, during treatment planning for an immediate implant, it would be of great interest to know the dimension of the buccal bone & how often actually the requirement of 2mm is met in Indian population.

So, a retrospective study was planned to evaluate the thickness of buccal alveolar bone of maxillary anterior teeth using a CBCT. The results of this study will provide valuable guidelines for choosing proper implant fixture with regards to diameter, length and need of augmentation for immediate implantation.

MATERIALS AND METHODOLOGY

A total of 100 patients who visited Subharti Dental College and Hospital, Meerut, India from June 2015 to December 2015 were included in the study. Subjects with intact maxillary dentition who got CBCT done for diagnostic purposes were selected. Their ages ranged from 20 to 39 years (26.3 ± 4.79 years). Patients with moderate to severe periodontitis, severe crowding, alveolar bone deformities, root canal treatment or extensive restorations, any pathosis that could lead to changes in the root and alveolar bone, any radiographic evidence of infection, any radiographic evidence of surgical (guided bone/ tissue regeneration) treatment in the anterior maxillary dentition, patients undergoing orthodontic treatments, CT images with artifacts were excluded from the study. All subjects included in this study were recruited under an institutional review board approved protocol in accordance with Helsinki’s principles of medical ethics (SDC/CER/2015).

CBCT Evaluation

Patients were scanned using a Galileos Comfort CBCT (Version 2.6, Sirona Dental Systems, Bonsheim, Germany) and a Sidexissoftware was used to format all images. Galaxis/Galileos Implant Software (DualCoreprocessor with 2 GHz RAM, Hard disks: > 500 GB Operating system: Windows XP Professional SP3 or Windows 7 Professional
External drive: 1x DVD-ROM, dual-layer) was used to complete all the measurements. A single examiner (a well experienced oral and maxillofacial radiologist with acceptable experience) secured the CBCT images which were projected on a 21.5” desktop monitor with 1,920 × 1,080 pixels under room lighting. The distance between the examiner and the monitor was approximately 25cm. For obtaining the measurements, the sectioning window was aimed to pass through the center of the respective root, perpendicular to the alveolar ridge. The long axis of the root subsequently dictated the vertical orientation of the image. The measurements were done using the measurement tool on the display panel of the 2D reconstruction in the sagittal section.

Measurements were made in the following manner (Figure 1). The dimension from the radiographic cementoenameljunction (CEJ) to the buccal alveolar bone crest (A) was recorded. The thickness of the buccal bone plate in the buccopalatal direction perpendicular to the long axis of the tooth root was measured in three locations: (1) 1 mm apical to the buccal alveolar bone crest (measurement B), (2) midroot (measurement C), and (3) 1 mm coronal to the root apex (measurement D). All measurements were done by a single operator under uniform lighting and distance from the monitor. Where bone was not visualized, no value was recorded.

Image analysis was done by means of an image processing software. Excel (Microsoft) was used to obtain descriptive statistics. The entire data was subjected to descriptive analysis using SPSS software analysis v. 20.0 (SPSS Inc., Chicago, IL, USA) which has a significance level of P<0.05. The bone thickness mean and standard deviation per tooth was recorded. The measurements for all the four locations in all the six teeth were grouped into the following categories for descriptive analysis: missing bone wall (thickness = 0 mm), bone wall thickness < 1 mm, and bone wall thickness > 1 mm.

Figure 1: Analyses of Buccal Bone Wall Thickness in a Sagittal Cut of a CBCT Scan at the Labelled Parallel Lines. the Dimension from the Radiographic Cementoenameljunction (CEJ) to the Buccal Alveolar Bone Crest (A) was, the Thickness of the Buccal Bone Plate in the Buccopalatal Direction Perpendicular to the Long Axis of the Tooth Root was Measured in Three Locations: (1) 1 mm Apical to the Buccal Alveolar Bone Crest (Measurement B), (2) Midroot (Measurement C), and (3) 1 mm Coronal to the Root Apex (Measurement D)

RESULTS

The study includes 100 subjects with ages ranging from 20-39 years. The means and standard deviations of the buccal bone thicknesses of each tooth at each line measurement are summarized in Table 1.
The dimension (A) - the distance from the radiographic CEJ to the buccal alveolar bone crest parallel to the long axis of the tooth) was measured on all maxillary anterior teeth present in 100 subjects (table 1 and figure 2). The mean thickness of the facial bone wall for all analyzed teeth was in the range 0.0 - 0.05 mm. No existing bone wall was found in more than 90% of all the examined teeth. Maximum bone at this area (1.05 mm) was found in the left central incisor (2% had bone >1 mm), on the contrary, left canine showed no facial bone at the CEJ in any of the samples.

The dimension (B) - 1 mm apical to the buccal alveolar bone crest was measured on all maxillary anterior teeth present in 100 subjects (table 1 and figure 3). The mean thickness of the facial bone wall for all analyzed teeth was in the range 0 - 0.1 mm. 75 - 85% samples showed no existing bone wall at this region. Maximum bone at this area (1.20 mm) was found in the left central incisor (20% showed <1 mm bone and 4% showed >1 mm bone). Right canine showed the least width of facial bone (94% showed no bone) at this region in all the samples.

The dimension C (the thickness of the buccal plate measured midroot) varied significantly between the anterior maxillary teeth (table 1 and figure 4). The right central, lateral incisor and canine region showed no existing facial bone in >90% of samples, however, >80% of the teeth on the contralateral side showed <1 mm bone. The mean thickness of the facial bone wall for all analyzed teeth was in the range 0.6 - 0.8 mm. Maximum bone at this area (1.63 mm) was found in the
left canine region (74% showed <1mm bone and 26% showed >1mm bone). Right central incisor on the other hand showed the least width of facial bone (98% showed no bone) at this region in all the samples.

The dimension D (the thickness of the buccal plate measured 1mm from apex) varied between the anterior maxillary teeth (table 1 and figure 5). The mean thickness of the facial bone wall for all analyzed teeth was in the range 0.7-0.8 mm. All the teeth showed <1mm of bone in 70-90% of samples and 10-20% showed >1mm of facial bone at this area. Maximum bone was seen in right canine (2.06mm) and minimum for right canine (0.30mm).
DISCUSSIONS

Placement of implants in a correct 3-dimensional position is a key to an esthetic treatment outcome regardless of the implant system used. Long-term esthetic stability including harmonious gingival margins around implants and adjacent teeth can be guaranteed by facial bone with sufficient width and height.[12] The height of the bone wall influences the position of the mucosal margin on the facial aspect, whereas the thickness has an influence on the facial convexity of the alveolar process at the emerging implant crown [11]. Studies have shown that atleast 1mm [13] or 2mm [14,15] should be present to ensure adequate soft-tissue support and enough buccal plate present for achieving reasonably esthetic results.

The fate of the buccal bone is often less understood. Following tooth extraction, the alveolar bone suffers a resorption in width and height during the first few months [16-18] with a reduction in an almost 50% of cases [19]. An additional 1-2 mm resorbs during the socket healing process [20]. Thus, the degree and resorption pattern of the buccal bone wall is directly related to its thickness. This is mainly because the marginal portion of buccal wall contains proportionally higher amounts of bundle bone than the palatal wall. Thus, it is important to define the buccal wall thickness of human maxillary alveolar bone buccal to existing teeth that offers valuable information regarding bone volume and the morphology of the future implant site [18].

Hence, it is of great importance to measure the facial wall thickness of tooth prior to extraction which is replaced with an immediate implant. The limited data concerning about the facial wall thickness in the anterior maxilla could preclude accurate treatment planning.

In the present study, the thickness of the buccal bone at four levels in the maxillary aesthetic region was determined in the Indian population through CBCT. The thickness of the facial wall was measured and divided into three groups: missing buccal wall, thin buccal wall (< 1 mm), and thick buccal wall (> 1 mm). At the CEJ and 1mm apical to CEJ, most of the teeth showed no existing bone, the least dimension is seen for the left canine region and maximum for left central incisor (2% had >1mm). As the apical region is approached, the width of the buccal wall increases drastically. Around 80% of the teeth on the right side showed <1mm of bone while 20% showed >1mm facial wall width. At the apex, maximum width was seen for the right canine region (76% had >1mm bone and rest of the patients showed varied thicknesses (0.7-0.8mm).
The rationale for measuring at four different levels was to determine the labial bone thickness at different apico-occlusal positions that could affect the placement of immediate implants, which may help clinicians to identify whether a more apical position of an implant would provide adequate labial bone thickness. This study describes mean of buccal wall thicknesses observed in a sample of Indian population, for both incisors and canines, ranging from 0mm to 2.06 mm, which are comparable with values reported in the literature. Nowzari et al. in the assessment of 101 CBCT scans, stated a mean value of 1.12 mm for the central incisors at 3 mm below the alveolar ridge, similar to our study [10]. Han et al evaluated five Korean human cadavers, reporting similar values for buccal plate thicknesses from the lateral incisor region (0.98 mm), but lower for the central incisors (0.82 mm) and canines (0.72 mm) [20]. Huynh-Ba G et al evaluated the width of the buccal and palatal bony walls in 93 extraction sites in cases for immediate implant placement and concluded that for the anterior sites (canine to canine), the mean width of the buccal bony wall was 0.8 mm. 87% of the buccal bony walls had a width < or = 1 mm and 3% of the walls were 2 mm wide [21]. Vera C et al in the assessment of 43 CBCT scans concluded that very few maxillary teeth displayed buccal alveolar bone thickness greater than 1mm [22].

For the percentage of cases with buccal bone thickness >2 mm, it was noticed that a high prevalence were in the central incisors (23%), lateral incisors (16%) and canines (20%). These thickness values were observed generally at the most apical point related to the root. On the contrary, >90% cases observed no bone in the cervical region. Thus, from a clinical point of view, a missing thin facial wall is unfavourable, since, a thin wall will be resorbed due to remodeling after extraction. Thus, in cases with thin buccal bone walls (<2mm), clinicians must consider augmentation to build up the bony contour for adequate support of esthetically pleasing soft tissues.

This present study provides valuable data on buccal wall thicknesses of the maxillary region in Indian population, to understand how critical this thickness may be for aesthetically pleasing long-term results. However, further studies with a larger sample size can be done, to determine the buccal wall bone thickness and soft tissue biotypes using CBCT.

The limitations of the study include less sample size, any instrumentation error involved, motion artifact, scatter artifact and the inherent low voxel size of the system. The results may show bias as the readings were done by a single investigator and a single methodology was followed.

CONCLUSIONS

Within the limitations of this study, only 10% of the maxillary anterior teeth displayed buccal alveolar bone thickness of 2mm. For the percentage of cases with buccal bone thickness >2 mm, it was noticed that a high prevalence were in the central incisors (23%), lateral incisors (16%) and canines (20%). Nevertheless, this research highlighted the great predominance of thin buccal bone thickness in the aesthetic maxillary region in the Indian population.

REFERENCES


