MEASUREMENT OF ANTERIOR MAXILLARY ALVEOLAR RIDGE DIMENSION AND ASSESSMENT OF SAGITTAL ROOT POSITION BY CONE BEAM COMPUTERIZED TOMOGRAPHY

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ABSTRACT

Maxillary anterior region is the implant site that may require the most rigorous pre-operative assessment as it will have a direct influence on aesthetic outcome and stability of the dental implant. In the present study, CBCT (cone beam computerized tomography) images were used to evaluate alveolar ridge dimension in the maxillary anterior region. This observational radiographic study was done at Nepal Medical College Teaching Hospital. The width of the alveolar bone was measured from the labial cortex to the palatal cortex of the maxillary anterior teeth in mm at the alveolar crest (L1), mid-root (L2), and apical root region (L3) for each tooth. Alveolar height was also measured from the alveolar crest to the floor of the nasal fossa. The Sagittal Root Position (SRP) of the maxillary anterior teeth was also assessed. Results showed that the maximum width of the alveolar bone was seen at L3 of canine and lateral incisor showed least width of alveolar bone width at L1. Maximum alveolar bone height was seen in canines. Males were seen to have increased width of the alveolar bone as compared to the females in all anterior teeth. The most frequent sagittal root position was class I which was seen in 270 (51.4%) of the total teeth examined, which was followed by class IV observed in 210 (40%) of the teeth examined. It could be concluded that for maxillary anterior region, additional regeneration therapy maybe required since class I is the most frequent SRP observed.

KEYWORDS

Alveolar ridge, anterior maxilla, CBCT, immediate implant, sagittal root position

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INTRODUCTION

Successful implant treatment depends on precise treatment planning. Information on the height and width of alveolar bone surrounding the proposed implant site is very critical for determination of the size of the implant and angle of placement.[1] CBCT provides high-resolution and accurate multiple planar reformatted images.[2]

In the past, conventional radiographic techniques such as intraoral and panoramic images used to be the standard methods for implant treatment planning.[3] However, imaging distortion and superimposition compromise the accuracy of treatment planning with these techniques. The improvement in sectional imaging techniques advocates the use of tomographic technique in the investigation of potential implant sites.[4] The introduction of cone beam computerized tomography (CBCT) in dentistry provided comprehensive preoperative implant site assessment and surgical guide in dental implant placement.[5] The American Academy of Oral and Maxillofacial Radiology recommends CBCT as the imaging modality of choice for implant treatment planning.[6]

Maxillary anterior region may have a direct influence on aesthetic outcome and stability of implant placement. The buccal bone thickness should be at least ≥2 mm to maintain the alveolar bone level.[7] A thinner buccal bone and the occurrence of undercut may increase the risk of fenestration, soft-tissue recession and cortical bone perforation occurring during or after implantation.[8]

Adequate apical bone may influence primary stability by placing the implant deeper apically. The sagittal root position in the alveolar process is classified by the bone thickness and the direction of the root, providing a reference to help avoid bone perforation during implant placement.

In the present study, CBCT images were used to evaluate alveolar ridge dimension in the maxillary anterior region as it aims to provide more quantitative information to help immediate implant treatment at the maxillary anterior area.

MATERIALS AND METHODS

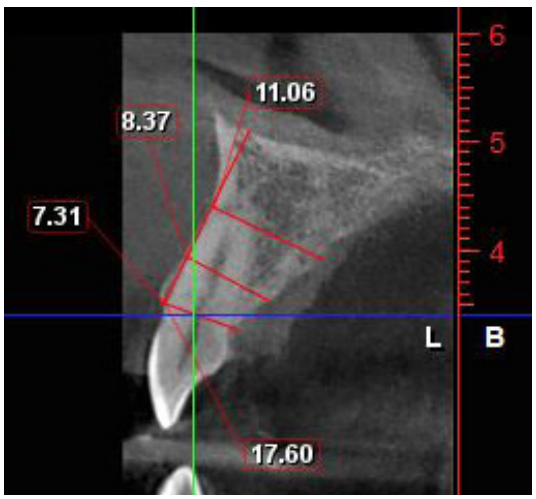
This observational radiographic study was done at Nepal Medical College Teaching Hospital. The limited field CBCTs was extracted from Dento-Facial CBCT Center Pvt. Ltd. in Mahankal, Kathmandu. The duration of the study was from April 2024 - June 2024. The sampling was done by convenient sampling method. The sample size was collected using the formula

$$\frac{Z^2\sigma^2}{e^2}$$

with Z at 1.96 at 95% confidence interval, σ taken as a standard deviation of previous study which was taken as 1.5[9] and e was taken as minimum acceptable degree of error which was set at 5%. Using this formula, the minimum sample size was 172 so we took 175 as our sample size and the total number of teeth analysed was 525.

Before measuring, all the images were realigned parallel to Frankfort-horizontal (FH) plane in the sagittal plane. A curved arch reconstruction were done before measurements to decide the three levels at the alveolar crest (L1), mid-root (L2), and apical region (L3) for each tooth. The alveolar width was measured from the labial cortex to the palatal cortex of each tooth in millimeter (mm). Alveolar bone height was also measured from the alveolar crest to the floor of the nasal fossa. The sagittal root position (SRP) of the maxillary anterior teeth were classified as proposed by Kan *et al.*[10] In class I, the root is positioned against the labial cortical plate. In class II, the root is centered in the middle of the alveolar housing without engaging either the labial or palatal cortical plates at the apical third of the root. In class III, the root is positioned against the palatal cortical plate and in class IV, at least two-thirds of the root engages both the buccal and palatal cortical plates.

Scans that demonstrated the maxillary anterior teeth and subjects older than 18 years were included in the study. The exclusion criteria were, the presence of any tooth or bone anomalies or pathologies in the maxillary anterior region; any CBCT volumes that are



Picture 1: Measurements of alveolar bone width and height

not of diagnostic quality due to implants and metallic restoration; local conditions that affect the quality of the bone (e.g. cysts, tumors, trauma, etc.).

Statistical analysis was done using SPSS-17. One way ANOVA test was performed to compare the result for alveolar bone thickness around maxillary central, lateral incisors and canines at all three levels and the alveolar height was also measured and compared among the genders. Descriptive statistics was done to report the frequency (number and percentage) for classification of sagittal root positions.

RESULTS

The results showed that the maximum width of the alveolar bone was seen at L3 of canine with 10.53 mm. Lateral incisor showed least width of alveolar bone width with 7.16 mm at L1 (Table1). Lateral incisors were seen to have least width of alveolar bone at all three

Table 1: Descriptive statistics for maxillary central, lateral incisors and canine measurements at different levels at different sites for all subject

Variables	Mean	SD	95% Lower confidence interval (CI)	95% Upper confidence interval (CI)
CIBL1	7.52	0.75	7.41	7.64
CIBL2	7.95	1.21	7.77	8.14
CIBL3	8.35	2.16	8.03	8.68
CIH	19.47	2.66	19.07	19.87
LIBL1	7.16	1.05	7.00	7.31
LIBL2	7.59	1.40	7.38	7.80
LIBL3	8.23	2.08	7.92	8.54
LIH	19.45	2.94	19.02	19.89
CBL1	8.88	0.94	8.73	9.02
CBL2	9.48	1.63	9.23	9.72
CBL3	10.53	2.83	10.11	10.95
CH	20.01	2.13	19.69	20.33

(CIB- central incisor alveolar bone width, LIB- lateral incisor bone width, CB- canine bone width,) (L1- at the crest, L2- at mid root area, L3- apical area of the root) (H- alveolar bone height from the crest of alveolar bone to the nasal floor)

Table 2: Descriptive statistics for central incisor, lateral incisor and canine measurements at different levels at different sites for both male and female subjects

	Male				Female				
Variables	Mean	SD	95% Lower CI	95% Upper CI	Mean	SD	95% Lower CI	95% Upper CI	P value
CIL1	7.55	0.78	7.41	7.70	7.46	0.67	7.29	7.64	0.451
CIL2	7.99	1.22	7.77	8.22	7.88	1.19	7.57	8.20	0.586
CIL3*	8.62	2.30	8.20	9.04	7.82	1.76	7.36	8.29	0.022
CIH*	19.80	2.63	19.32	20.28	18.79	2.61	18.10	19.48	0.018
LIL1	7.21	0.98	7.03	7.39	7.05	1.18	6.74	7.36	0.356
LIL2*	7.75	1.46	7.48	8.02	7.27	1.24	6.95	7.60	0.035
LIL3*	8.64	2.25	8.23	9.05	7.40	1.38	7.04	7.77	0.000
LIH	19.36	2.82	18.84	19.87	19.65	3.17	18.82	20.49	0.528
CL1*	9.10	0.89	8.93	9.26	8.43	0.87	8.20	8.66	0.000
CL2*	9.79	1.70	9.47	10.10	8.86	1.227	8.52	9.19	0.000
CL3	10.76	2.85	10.23	11.28	10.07	2.77	9.34	10.80	0.134
CH	20.04	2.16	19.65	20.44	19.95	2.05	19.41	20.49	0.864

(CB- canine buccal, LI- lateral incisor buccal, CI- central incisor buccal) (L1- at the crest, L2- at mid root area, L3- apical area of the root) (H- alveolar bone height from the crest of alveolar bone to the nasal floor) (*statistically significant).

levels as compared to the central incisors and canines (Table 1). Similarly, maximum alveolar bone height was seen in canines with 20.01 mm (Table 1).

The mean of crestal, middle, and apical third alveolar width for maxillary central incisors were 7.52 ± 0.75, 7.95 ± 1.21, 8.35 ± 2.16, lateral incisors were 7.16 ± 1.05, 7.59 ± 1.40, 8.23 ± 2.08 mm and canines were 8.88 ± 0.94, 9.48 ± 1.63, 10.53 ± 2.83 mm, respectively (Table 1).

Males were seen to have more height of the alveolar bone as compared to the females in all anterior teeth except lateral incisors which showed slightly increased height (19.87 mm) in case of females but it was not statistically significant (Table 2). Similarly, statistically significant difference with increased width of alveolar bone was observed in males as compared to females at CIL3, LIL2, LIL3, CL1 and CL2 (Table 2). It was also observed that CIH in males were significantly greater in males as compared to females (Table 2).

Table 3: Overall frequency distribution of sagittal root positions

Class I n (%)	270 (51.4%)
Class II n (%)	42 (8%)
Class III n (%)	3 (0.60)
Class IV n (%)	210 (40%)

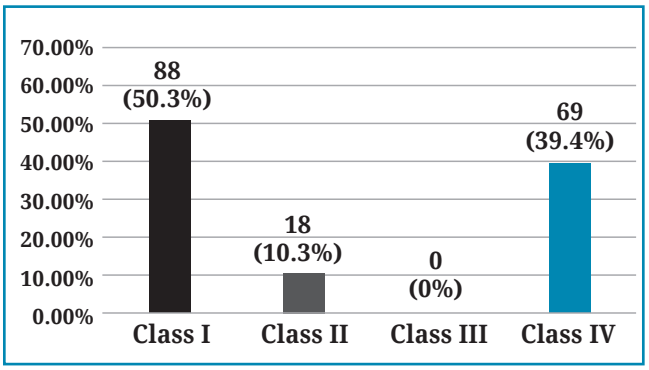


Fig. 1: Sagittal root positions of central incisors

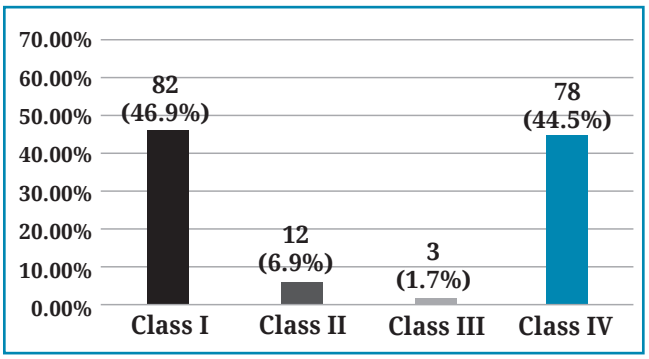


Fig. 2: Sagittal root positions of lateral incisors

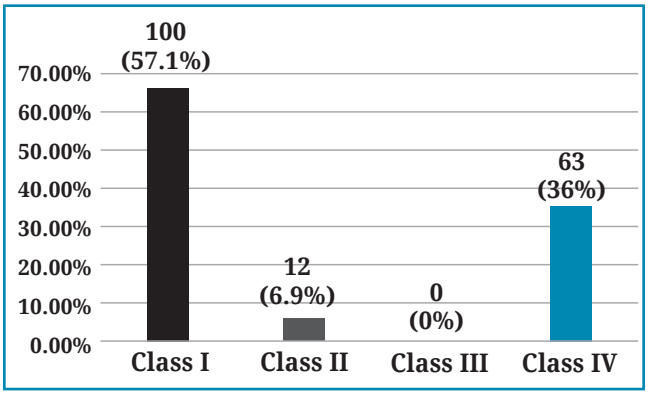


Fig. 3: Sagittal root positions of canines

Our study also showed that the most frequent sagittal root position was class I which was seen in 270 (51.4%) of the total teeth examined, which was followed by class IV observed in 210 (40.0%) of the teeth examined (Table 3). In case of central incisor, the maximum sagittal root position was observed to be class I which was 88 (50.3%) (Fig. 1). Similarly, in case of canine also 100 (57.1%) of the teeth were observed to be at class I sagittal root position (Fig. 3). The least was class II SRP with only 3 (1.7%) in case of lateral incisors (Fig. 2) and none of central incisor (Fig. 1) and canines (Fig. 3) were observed to be in class III SRP.

DISCUSSION

The alveolar dimension prior to tooth extraction is considered one of the prognostic factors in determining the available alveolar volume for implant placement following extraction.[11]

In our study, measurements were done at three levels, L1, L2 and L3, corresponding to the crestal region, mid-root region and apical root region of the respective tooth. Bone height was also measured as sufficient alveolar ridge height is required for the success of the implants as vertical bone augmentation is recommended in case of deficient vertical bone height. Root angulation was also measured as it determines sagittal bone thickness. Excessively inclined or angulated root reduces the bone thickness along the buccal or the palatal aspect, which may affect bone anchorage and, ultimately, long-term implant success.[12]

In our study, we observed that alveolar bone width increased from coronal to apical direction for each tooth and similar findings

were recorded in a study by Zhang *et al*,[13] Banu *et al*[14] and Ahmed *et al*.[15]

In the present study, males demonstrate significant larger ridge width compared to females for all three teeth which was in accordance to other studies.[13,15,16] In this study, the mean width of the central incisor was 7.52 mm, lateral incisor was 7.16 and canine was 8.88 at L1. Similar findings were seen in a study done by Banu *et al*.[14] which showed central incisor 8.1 mm, lateral incisor 7.4 mm and canine 8.9 mm.

In our study, the lateral incisor had a significantly smaller alveolar width than the other anterior teeth which was in accordance to other studies.[13-15] This was probably due to the presence of a lateral fossa which creates the buccal concavity adjacent to lateral incisor.[17]

Alveolar bone height was also seen to be maximum for canine with mean of 20.04 mm but there was no statistically significant differences seen between the genders, similar to studies done by others.[14,15] Our study also showed that the most frequent sagittal root position was class I which was seen in 270 (51.4%) of the total teeth examined. A study by Kan *et al*.[10] showed similar results of maximum teeth examined (81.1%) classified as Class I. Similar results were seen in other studies.[18-20]

Also a study done by López-Jarana *et al*.[21] showed that in the maxilla, 89.4% of incisors, 93.94% of canines had a buccal bone wall thickness less than the ideal 2 mm which coincides with class I SRP similar to our study.

Some CBCT studies have been done in Nepalese population for evaluating the buccal bone wall thickness. A study done by Shrestha *et al*.[23] in Nepal, concluded that the labial bone in the anterior maxilla is mostly thin, with more than 80% of the sites showing less than 1 mm. Another study by Pradhan *et al*.[24] also showed that the average thickness of the labial alveolar bone in maxillary central incisor was found to be thin with only 2 (3.8%) of the total samples had an alveolar thickness of >1 mm. Another study by Dawadi *et al*.[16] which compared the alveolar bone height and width with genders showed that the alveolar height was greater in male than female in anterior teeth which was statistically significant. When they compared alveolar width in male and female, the alveolar width was greater in male than female in all teeth except 11.

Based on the current study, it appears that without additional grafting procedures, implant placement in the lateral incisor region would be at highest risk of perforation of the labial plate, whereas the canine region would be the least likely for such an event. A careful preoperative evaluation of anterior maxilla, especially of the lateral incisor region, is invaluable for selection of the optimal treatment approach and reducing surgical complications. Future investigations with larger sample size would be needed to further validate current findings.

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