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ORIGINAL RESEARCH

A CBCT Analysis of Comparative Evaluation of Root Position and Implant Angulation in Maxillary Region: An Invitro Study

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ABSTRACT

Aim: To determine the position and angulation of maxillary central incisor with reference to alveolus for immediate implant in esthetic zone using CBCT scans.

Material And Method: A total sample size of 100 Digital Imaging and Communications in Medicine (DICOM) files, that fulfilled the selection and exclusion criteria were selected retrospectively from the archives of CBCT centers via two stage sampling method for the study purpose. The scans were assessed using multiplaner reconstruction capabilities of CS 3D Imaging Software to determine thefive aspects were measured. The data obtained was subjected to Statistical Package for the Social Sciences (SPSS) software version 21.

Result: The data from 100 cone beam images were included in the present study. The mean thickness of the buccal bone at the mid-root level was 1.16 ± 0.46mm and at the apical level was 3.16 ± 0.93 mm. The mean thickness of the palatal bone at the mid-root level was 3.96 ± 1.11 mm and at the apical level was 8.00 ± 1.44 mm. The mean apical bone height was 8.20 ± 2.40 mm. The proportion of incisors positioned more buccally (type B) was 73%, 22%, and 5% positioned midway (type M) and more palatally (type P), respectively. Regarding the angulation, 46% were classified as type 2 (toward buccal), 24 % as type 3 (toward buccal, with the long axis anterior to the A point), and 30% were categorized as type 1 (toward palatal or parallel to the alveolus).

Conclusion: Clinicians should consider the socket's three dimensions for optimal results. Cases were classified as levels I to level III based on their difficulty in achieving good results, with recommendations provided and angulation of abutments required.

Keywords: Buccal Bone And Palatal Bone Width, Apical Bone Height, Cone Beam Computed Tomography , Dental Implants ,Classification

INTRODUCTION

Dental implant evolution has a rich and engrossing historical narrative. As early as 2000 B.C., the ancient Chinese civilization used early forms of dental implants.[1] Then, in the year 1000 B.C., an Egyptian pharaoh raised the issue of the metal teeth. With a long-term success rate of up to 97% in dental practices, dental implants are thought to be the most advanced treatment for missing teeth.[2] From a surgical protocol driven by the bone to one driven by restorative and biological factors, implant dentistry has gradually changed.

The aesthetic issue is important to dental practitioners because achieving aesthetics in implant-prosthetic therapy is far more difficult than in tooth-supported restorations.[3] The implant-supported restoration must be consistent with the rest of the smile, face, and individual. Thus, the advantages of immediate over delayed implant placement following extraction include shorter treatment time, fewer units, and a reduced time period of functional and aesthetic deficiency.[4]
The key anatomic factors influencing the outcome of Immediate Implant Placement are facial bone thickness and height, amount of bone beyond the apex, and buccal gap.Still, clinicians face significant challenges when placing immediate implants at the mid root level of the maxillary central incisor because the patient has high aesthetic expectations.. Primary implant stability is determined by implant features such as body shape, thread design, and surface topography, as well as surgical technique and patient head conditions.[5]
Accurate radiographic imaging is critical for obtaining the best diagnosis and management to achieve long-term results.Radiographic techniques such as intraoral, panoramic, and cephalometric imaging have traditionally been used to plan implant treatments. Additionally, the availability of suitable occlusal-apical bone height, as well as buccal-lingual width and angulation, are the most significant parameters for implant selection and success.[6]
CBCT is an excellent tool for assessing available bone and planning the optimal implant shape and position. CBCT is preferred because it provides better image quality and lower radiation exposure than conventional CT. It also provides submillimeter precision for linear measurements, allowing for the determination of a wide range of implant shapes, and thread design enables optimal accommodation of the implant to available bone, both compact and spongy, to achieve sufficient primary stability.[7]
The current study is the first to examine the positions and angulations of the central maxillary incisor in relation to the alveolar bone. Our findings will help clinicians achieve the best long-term aesthetic outcomes. The criteria for implant success are evolving, and aesthetic outcomes are becoming increasingly important.

MATERIAL AND METHOD

The study was conducted in the Department of Prosthodontics and Crown and Bridge of Mithila Minority Dental College and Hospital, Darbhanga, Bihar.

For this retrospective study, a total of 100 CBCT Digital Imaging and Communications in Medicine (DICOM) files that had already been made for diagnostic purposes using CS 9300 CBCT system (Carestream Dental LLC, Atlanta ,GA , USA) was obtained and imported into software CS 3D Imaging v3.5.18 Software (Carestream Health Inc.).

INCLUSION CRITERIA

i. The sagittal section of the chosen incisor was viewed at the center of its mesial-distal dimension
ii. Image was examined to identify a fully formed, intact, and healthy permanent central upper right incisor (tooth 11) for analysis. If the central upper right incisor was missing, the upper left central incisor was selected for analysis.
iii. Images must be of adequate diagnostic quality

EXCLUSION CRITERIA:

The exclusion criteria for selected maxillary central incisor on CBCT scan in this study was as follows:

i. Enamel or dentine defect

ii. Caries
iii. Apical pathological features
iv. Periodontal alveolar bone loss
v. Restoration of any kind
vi. Fracture
vii. Orthodontic correction

All the CBCT Digital Imaging and Communication in medicine (DICOM) files that had already been made for diagnostic purpose using CS 9300 CBCT (Carestream Dental LLC, Atlanta, GA, USA) system was obtained and imported into CS 3D Imaging v3.5.18 Software (Carestream Health Inc.). All the DICOM files was then assessed under optimal viewing condition of the software.

STUDY DESIGN:

A series of 100 cone beam CBCT scan of the maxilla was randomly selected from the computer record. All CBCT scan of maxilla was taken from same machine (CS 9300 Carestream Dental LLC, Atlanta, GA, USA system). The head positions was standardized by aligning the patient's head with horizontal and vertical reference lines, constructed using beam of light. The patient's head was positioned such that the horizontal reference beam was at the level of patient's eye and the vertical reference beam was passing through the patient's facial midline. Once the ideal head position had been located, the patient's head was fixed with head frame.

The CBCT scan of maxilla were viewed and measured by the software provided. All the DICOM files was then assessed under optimal viewing conditions of the CS 3D Imaging Software. The CBCT scans which did not meet the selection criterias was excluded from the sample.

METHOD OF ASSESMENT:

The software based multiplanar reconstruction of CBCT images was used for different measurements. The sagittal section of selected maxillary central incisor and associated anatomical landmark were marked before the measurement. The following anatomical landmark and reference lines were marked, drawn and measured on selected maxillary central incisor on CBCT images in sagittal section.

Landmarks was identified and marked in the computer before the measurements was done. The saggital section of the chosen incisor was viewed at the center of its mesio-distal dimension. The line marked was best-fit to the palatal alveolar surface and buccal alveolar surface.

1. Mid of mesiodistal dimension of selected maxillary central incisor.(Fig1)
2. Line 1- The Buccal Line and Line 2- The Palatal Line along the buccal and palatal alveolar surface of selected maxillary central incisor.(Fig 2)
3. Line 3 as Alveolar Line – A line bisecting the buccal and palatal line to represent the angulation of alveolar process of selected maxillary central incisor in sagittal plane.(Fig 3)
4. Line 4 - Long Axis of Root selected maxillary central incisor was marked by the midpoint of a line drawn from the buccal enamel- dentine junction to its palatal counterpart, the apex of the root.(Fig 4)

These reference lines were used to perform following measurement on the CBCT images of selected maxillary central incisor in the sagittal section.

1. Measurement i – Thickness of buccal bone at mid root level(Fig 5)
2. Measurement ii – Thickness of palatal bone at the mid root level (Fig 6)
3. Measurement iii - Thickness of labial bone at the apical level of the root by a line perpendicular to the long axis of the root, from the apex of the root toward the buccal bone surface (Fig 7)
4. Measurement iv – Thickness of Palatal Bone at the apex by a line perpendicular to long axis of root from the apex of root towards the palatal bone surface.(Fig 8)
5. Measurement v - The Apical Bone Height was measured from the root apex towards the superior bone surface along the long axis of root.(Fig 9)

These measurements were analyzed in relation to alveolar process to determine:

1. The position and angulation of the root of selected maxillary central incisor.
2. The angulation of the alveolar process of the selected maxillary central incisor.
3. The compare the angulation of alveolar process to the long axis of the root of selected maxillary central incisor.

The data obtained was subjected to statistical analysis for variation in position and angulation of root of maxillary central incisor and to compare angulation of alveolar process to the long axis of the root in Indian population.

Statistical Analysis- Data was analyzed using Statistical Package for Social Sciences (SPSS) version 21, IBM Inc. Descriptive data was reported for each variable. Summarized data was presented using Tables and Graphs. Data was normally distributed as tested using the Shaperio-Wilk W test (p-value was less than 0.05) . A level of $p<0.05$ was considered statistically significant.

Figure 1. The selected central incisor

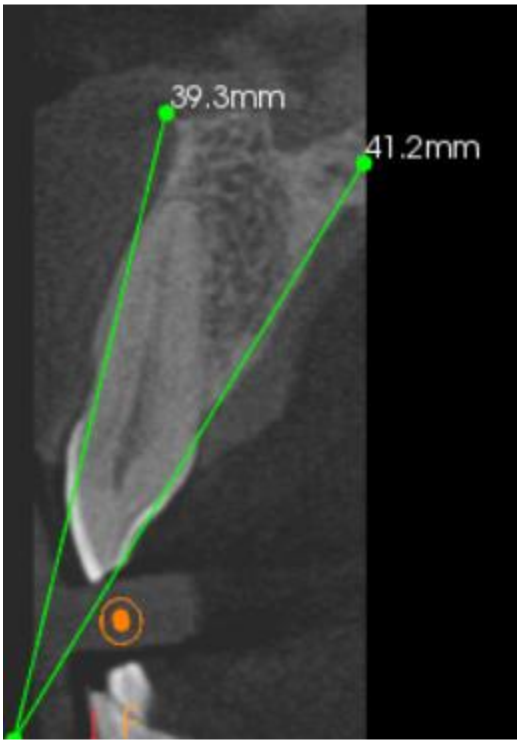
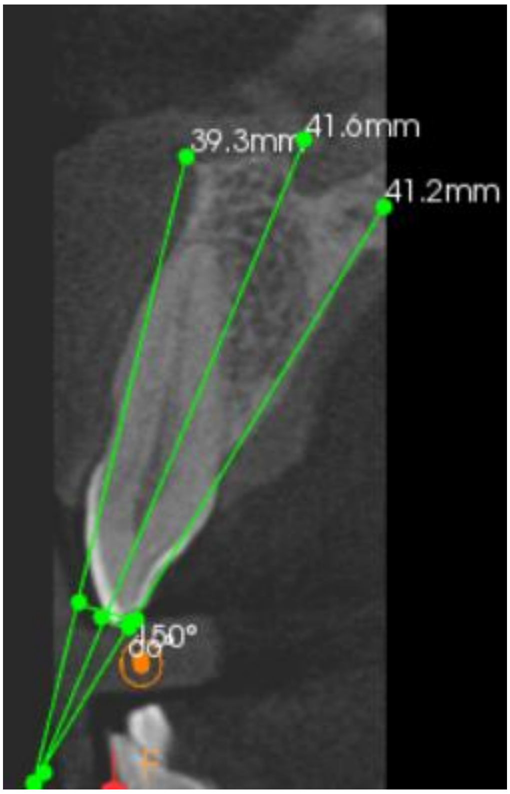


Figure 2. The Buccal Line (line 1 -39.3 mm) and the Palatal Line (line 2-41.2 mm)



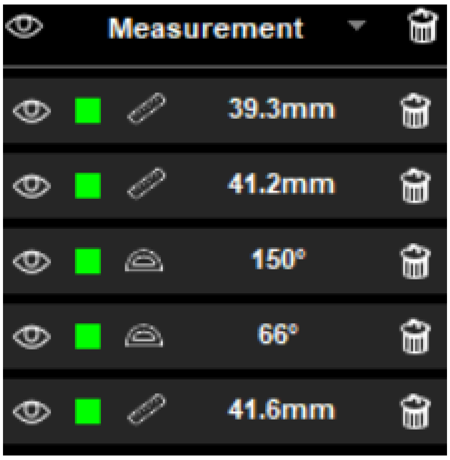


Figure 3: Bisecting line between 1 and 2 = Alevolar line (line 3- 41.6 mm)

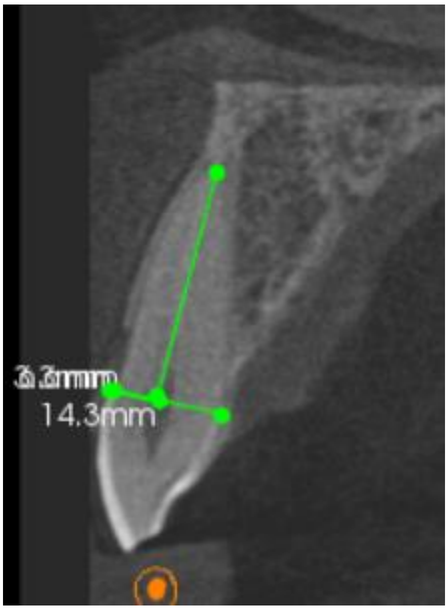


Figure 4: Long axis of the root (line 4- 14.3 mm)

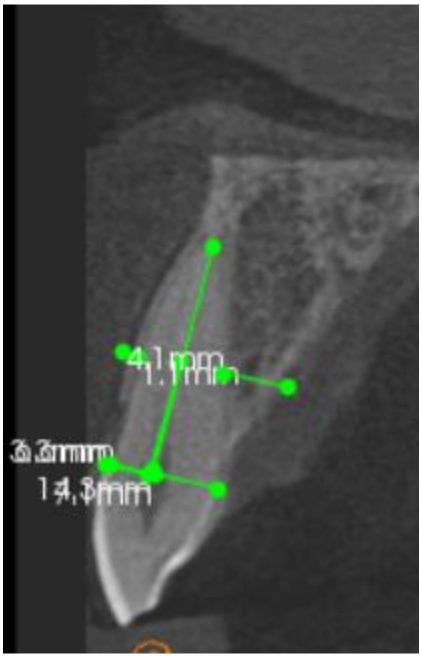


Figure 5 :Thickness of the buccal bone at the mid root level(measurement i =1.1mm)

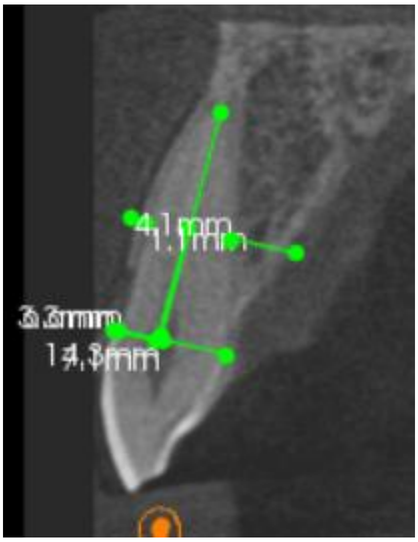


Figure 6: Thickness of the palatal bone at the mid root level (measurement ii= 4.1mm)

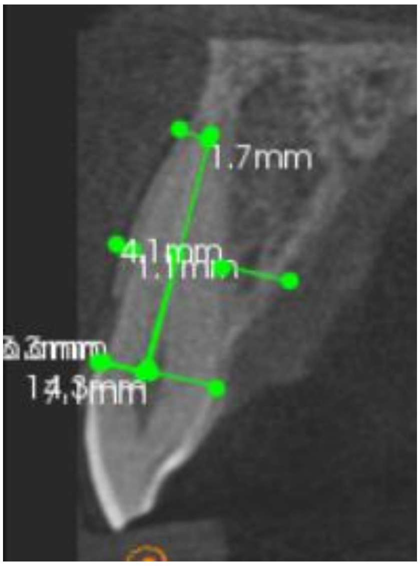


Figure 7: Thickness of labial bone at the apical level(measurement iii =1.7mm)

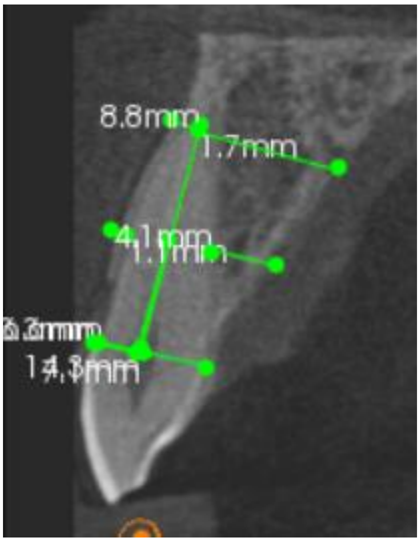


Figure 8: Thickness of palatal bone at the apical level (measurement iv=8.8mm)

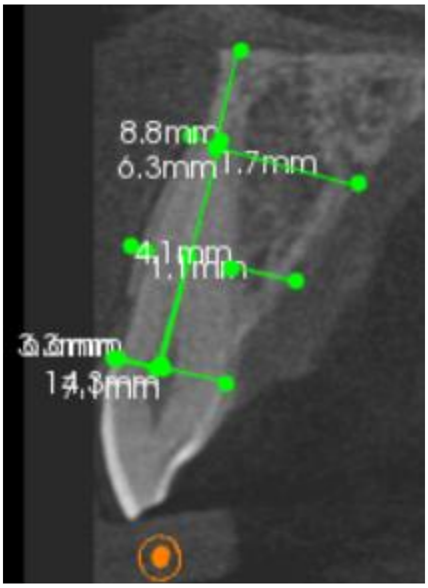


Figure 9: Apical bone height from the root apex towards the superior bone surface(measurement v = 6.3mm)

RESULT:

The present study was designed for a CBCT analysis of comparative evaluation of root position and implant angulation in the maxillary region in the Indian population. The study was conducted in the Department Of Prosthodontics And Crown And Bridge, Mithila Minority Dental College And Hospital, Darbhanga.

STATISTICAL PROCEDURES WERE CARRIED OUT IN TWO STEP:

1. Data Collection:

The data was compiled systematically , and transformed from a pre-coded proforma to a computer, and a master table was prepared in Microsoft Excel. The total data was distributed meaningfully and presented as individual tables as graphs.

2. Statistical Analysis:

The recorded data was compiled and entered into MS Office Excel sheet and then subject to analysis using Statistical Package for Social Sciences (SPSS) version 21, IBM Inc. Descriptive data was reported for each variable. Summarized data was presented using Tables and Graphs. Data was normally distributed as tested using the Shaperio-Wilk W test (p-value was less than 0.05) . A level of $p<0.05$ was considered statistically significant.

	N =100	Mean	Std. Deviation	Std. Error of Mean	Median	Range	Mode	Minimum	Maximum
mid root level thickness	buccal: measurement 1	1.162	.4662	.0466	1.200	1.5	1.8	.3	1.8
	palatal: measurement 2	3.966	1.1133	.1113	4.000	4.1	4.0	1.7	5.8
apical level thickness	buccal: measurement 3	3.162	.9383	.0938	3.100	4.4	3.0[a]	1.6	6.0
	palatal: measurement 4	8.003	1.4462	.1446	7.850	8.9	9.0	3.9	12.8
apical bone height	apical bone height: measurement 5	8.208	2.4061	.2406	7.800	12.0	7.0[a]	4.3	16.3

Table 1: Descriptives Of Measurements

Line 1- Buccal bone thickness at mid-root level.

Line 2- Palatal bone thickness at mid-root level.

Line 3- Labial bone thickness at apical level.

Line 4- Palatal bone thickness at apical level.

Line 5 - Apical bone height along the long axis of the root from the root apex towards the superior bone surface.

Inference:

FOR MEASURMENT 1: The mean was 1.162 with SD of 0.4662, median 1.2 and mode 1.8

FOR MEASURMENT 2: The mean was 3.966 with SD of 1.113, median 4 and mode 4

FOR MEASURMENT 3: The mean was 3.162 with SD of 0.9383, median 3.1 and mode 3

FOR MEASURMENT 4: The mean was 1.4462 with SD of 0.1446, median 7.85 and mode 9

FOR MEASURMENT 5: The mean was 2.4061 with SD of 0.2406 median 7.8 and mode 8

	Thickness(mm)	Frequency	Percent
	<0.5	8	8.0

Buccal bone at Midroot level	<1	24	24.0
	<1.5	37	37.0
	<2	31	31.0
	Total	100	100.0

Table 2: Thickness Of Buccal Bone At Midroot Level (Measurement I)

Inference:

There were 8% whose thickness was less than 0.5mm, 24% with thickness less than 1mm, 37% with thickness less than 1.5mm, 31% with thickness less than 2mm of the buccal bone at the mid-root level.

	Thickness (mm)	Frequency	Percent
Palatal Bone at Mid- Root Level	<2	2	2.0
	<3	17	17.0
	<4	25	25.0
	<5	34	34.0
	<6	22	22.0
	Total	100	100.0

Table 3: Thickness Of Palatal Bone At Mid-Root Level (Measurement II)

Inference:

There were 2% whose thickness was less than 2 mm, 17% with thickness less than 3mm, 25% with thickness less than 4 mm, 34% with thickness less than 5 mm, 22% with thickness less than 6 mm of the palatal bone at mid-root level. Additional analysis of the measurements revealed that 69% of the patients had buccal bone thickness at the mid root level of less than 1.5mm (Table 2), and 44% of patients had a palatal bone thickness at the mid-root level of less than 4mm – up to the 78% of patients had a thickness of less than 5 mm (Table 3).

		Frequency	Percent
Thickness of buccal bone at apical level	<2	7	7.0
	<3	27	27.0
	<4	51	51.0
	<5	6	6.0
	<6	6	6.0
	<7	3	3.0
	Total	100	100.0

Table 4: Thickness Of Buccal Bone At Apical Level (Measurement III)

Inference:

There were 7% whose thickness was less than 2 mm, 27% with thickness less than 3mm, 51% with thickness less than 4 mm, 6% with thickness less than 5 mm, 6% with thickness less than 6 mm, 3% with thickness less than 7 mm of the buccal bone at the apical level.

	Thickness(mm)	Frequency	Percent
Palatal Bone at Apical Level	<5	2	2.0
	<6	2	2.0
	<7	20	20.0
	<8	37	37.0
	<9	25	25.0
	<10	11	11.0
	>12 and <13	3	3.0
	Total	100	100.0

Table 5: Thickness Of Palatal Bone At Apical Level (Measurement IV)

Inference:

There were 2% whose thickness was less than 5 mm, 2% with thickness less than 6mm, 20% with thickness less than 7 mm, 37% with thickness less than 8 mm, 25% with thickness less than 9 mm, 11% with thickness less than 10 mm, 3% with thickness >12 mm and <13 mm of the palatal bone at the apical level.

	Thickness (mm)	Frequency	Percent
Apical bone Height	<5	6	6.0
	<6	8	8.0
	<7	19	19.0
	<8	21	21.0
	<9	20	20.0
	<10	9	9.0
	<11	6	6.0
	<12	6	6.0
	>14 and <15	3	3.0
	>16 and < 17	2	2.0
	Total	100	100.0

Table 6: Apical Bone Height (Measurement V)

Inference:

There were 6% whose thickness was less than 5 mm, 8% with thickness less than 6mm, 19% with thickness less than 7 mm, 21% with thickness less than 8 mm, 20% with thickness less than 9 mm, 9% with thickness less than 10 mm, 6% with thickness less than 11 mm, 6% with thickness less than 12 mm, 3% with thickness >14 and <15 mm, 2% with thickness >16 and <17 mm of apical bone height. Similarly, the buccal bone at the apical level is much thinner than its palatal counterpart. Regarding the apical bone height, measured from the apex of the root from the nasal floor, almost 54% has about 10mm of bone height and 94% more than 5mm of bone height (Table 6).

	BUCCAL		MIDWAY		PALATAL		TOTAL	
TYPE	N	%	N	%	N	%	N	%
1	13	17.8	12	54.5	5	100	30	30

2	36	49.3	10	45.5	0	0	46	46
3	24	32.8	0	0	0	0	24	24
TOTAL	73	100	22	100	5	100	100	100

Table 7: Classification

Inference:

Most of the central incisiors (73%) were positioned more buccally within the alveolar bone (type B), 22% were positioned in midway (type M), and 5% were placed more palatally (type P) table 7. Regarding the incisior angulations, almost half (46%) of the central incisior were classified as type 2, 24% were classified as type 3, and 30% were categorized as type 1 (table 7).

DISCUSSION:

This study aimed to use CB imaging to help plan treatment for immediate implants in the aesthetic zone. Accurate 3-dimensional and volumetric measurements are becoming increasingly important as surgical and imaging techniques advance quickly. CB imaging has become the standard for implant planning, particularly in highly aesthetic areas.[8] CB imaging is widely used in implant dentistry due to its convenience, accuracy, and low radiation dose, as supported by numerous studies. This study evaluated only the roots of the maxillary central incisors, not the entire tooth. The crown-to-root relationships were not measured.[9]

Bryant et al found that normal central maxillary incisors have a mean root-to-crown distance of 1.74 degree and also the labial surface angle was found to have a range of 17 degree.[10]

Placing implants in extraction sockets at the same angulations as the roots inside the alveolar bone would provide an ideal 3-dimensional position for the prosthetic crown, requiring only a simple straight stock abutment. To ensure proper placement, it is crucial to evaluate the root position in three dimensions.

The measurements of buccal and palatal bone thickness at the crestal region was excluded due to a substantial amount of error due to its thinness, despite their potential value. While computer magnification is possible, the resolution is insufficient for precise measurements. Measuring the thickness of the bone at the crestal level is useless due to the presence of a beam hardening effect. It has been confirmed that, irrespective of the placement of a dental implant, bone resorption after extraction will still occur, leading to a loss of bone volume.[11-13]

After extraction, the buccal bone resorbs more than the lingual or palatal bone due to its unique composition of bundle bone. Lingual or palatal bone has a higher resistance to resorption due to its composition of cortical bone, especially on the outer surface.[14] After a year of follow-up, an immediate implant placed in a fresh extraction socket showed mid-buccal recession of 0.55 to 0.75 mm. Long-term data is not available to determine if additional resorption occurs.[15-16]

The tooth root positions and angulations were classified according to the alveolar process using CB measurements. By comparing buccal and palatal bone thickness at the mid-root level, their positions relative to the mid-alveolar line were defined and classified as follows: type B (closer to the buccal alveolar surface); type M (midway between the buccal and palatal alveolar surfaces); and type P (closer to the palatal alveolar surface).

The angulations of the alveolar process with the long axis of the roots were classified as follows: type 1 (root apex angulated towards the palatal side or parallel to the alveolus); type 2 (root apex angulated towards the buccal side with the long axis passing posterior to point A); and type 3 (root apex angulated towards the buccal side with the long axis passing anterior to point A).[17]

However, the key to long-term good esthetic results is to avoid exerting pressure on the crestal bony wall, particularly on the buccal aspect. With respect to the classification reported in the present study, both the position and the angulation types were categorized into different ranks according to their difficulty for achieving ideal esthetic results in immediate implant cases. The classification levels are level I to level III:

As incisor indicated for extraction and rehabilitation with implant which further divided into;

1. Indicated for immediate implant
    i. Level 1(same angulation) including Type M1 & Type P1 with 17%.
    ii. Level 2(modify angulation) including Type B1,B2,M2,M3,P2,P3 with 56%.
    iii. Level 3(extreme angle/socket transformation) including Type B3 with 24%.
2. Not indicated for immediate implant then ridge preservation or grafting.

LEVEL 1:

Level I (M1, P1) indicates that the implant can be placed with the same angulation as the extraction socket without compromising primary stability or long-term aesthetic outcome due to the common characteristics of a thicker buccal bone. A straight stock abutment could be used since there would be no need to modify the drilling angle. These types are the most straightforward for both surgery and restoration at all levels. However, only 17% of patients' extraction sockets were classified as this level.

Type M1 teeth are ideal for immediate implant cases because they are located in the centre of the alveolar bone and root apex, angulated away from the buccal wall. Placing an implant in the extraction socket provides adequate bone support and bone-to-implant contact, resulting in successful osseointegration. Furthermore, the implant angulation is suitable for the superstructure.

Type P1 has enough buccal bone to support soft tissue, making it a viable alternative to Type M1. The palatal side has less bone, but the soft tissue is thicker, and the bone is more resistant to resorption. Palatal tissue recession may be minimal because aesthetic demand is generally low on the palatal side.

LEVEL 2:

Level II (B1, B2, M2, M3, P2, P3) has greater technical requirements. To achieve a long-term stable aesthetic outcome, the implant's angulation should be adjusted to prevent thinning of the buccal bone, which is a common problem with a thin buccal plate. Place the implant more palatally to avoid compressing or drilling the buccal bone, thereby lowering the risk of perforations and fenestration. When the implant angle differs from that of the original tooth, an angled abutment should be used for aesthetic reasons. More than half (56%) of the cases were classified as Level II.

The majority of maxillary central incisors (73% were type B), which resulted in more buccally positioned teeth. Type B1 (13%) is unsuitable for immediate implantation because of its proximity to the buccal wall and thinner buccal bone.

Type B1 is not the most challenging level due to its lack of angulation towards the buccal alveolar depression. This reduces the possibility of further thinning or fenestration in the buccal wall.

A type B2 tooth usually has a thin buccal plate at both the crest and the apex. Immediate implant placement necessitates adequate primary stability, particularly for provisional crowns. Primary stability is typically achieved through pressure on the buccal bone, either at the apex or both. Pressure on this type's thin buccal plate can eventually lead to bone resorption and soft tissue loss. However, the majority of patients (36%) will be type B2. This explains "physiologic" bone and soft tissue loss at the buccal area.

Our findings show that the buccal bone of maxillary incisors was typically thin. The buccal bone had an average thickness of 1.162 mm at the mid-root level (measurement I) and 3.162 mm at the apex (measurement III). According to Table 2, 69% of patients have buccal bone thickness of less than 1.5 mm at the mid-root level and 51.8% at the apical level of less than 4 mm. More than half of the patients had buccal bone thickness less than 4 mm at the apex. Placing implant drills along the axis of extraction sockets raises the risk of perforation, especially when the implant is positioned deeper into the apical bone to achieve primary stability.

The palatal bone at the apical level (measurement IV) is much thicker than its buccal counterpart. The average palatal bone thickness in this region was 8.03 mm, with a maximum of 12.8 mm. Over half of the patients (61%) had a thickness of 8 mm or greater. In contrast, the mean thickness of the palatal bone at the mid-root level (measurement II) was only 3.96 mm, with 44% of patients having a bone thickness of less than 4 mm. To ensure implant stability and prevent buccal wall thinning, position the implant more palatally in the extraction socket, where there is more bone. The implant should be placed palatally at the apex and pivoted around the mid-root level.

In terms of apical bone height (measurement V), 54% of patients had 7mm or more, and 65% had 8mm or more. When placing an immediate implant in an extraction socket, it is best to engage it 3 to 5 mm beyond the apex for maximum primary stability. If primary stability is inadequate, the implant can be positioned deeper due to the abundance of bone in the area. Approximately 50% of patients have at least 10 mm of apical bone height. Choosing the proper implant length is critical because the apical coronal position of the implant shoulder influences both the long-term soft tissue profile and the aesthetic outcome.[18,19,20]

The implant should be optimally long, deep enough to provide good apical stability without perforation, and the shoulder should be aligned with or slightly apical to the buccal marginal bone crest.[21,22,23]The general recommendation for all level II cases is to insert the implants with a modified angulation relative to the extraction socket, in this case, more palatally.

LEVEL III :

Because of its thin buccal plate and angular long axis that runs anterior to the natural contour of the maxillary alveolar bone, the type B3 tooth is the most difficult to achieve good long-term aesthetic results. This condition is frequently seen in patients with maxillary alveolar hyperplasia and Class II division 2 occlusion. The significant angulation difference between the alveolar bone and the tooth means that using a bone-driven or restorative-driven protocol will not improve the implant position. Customised abutments or ceramic abutments can be used depending on the implant's position and angle. In most cases, the implant position is determined by the available bone. Type B3 is a difficult procedure for immediate implant because it requires both bone and prosthetic components.

A socket transformation procedure can be used when there is a high demand for a good aesthetic outcome as well as immediate provisional restoration. This entails grafting the buccal wall in the first stage, followed by the extraction of the problematic tooth and immediate implantation several months later. A type B3 (level III) socket can be iatrogenically converted to a simpler type, such as type B2 (level II) or even type M2 (level II), while still reaping the

benefits of the immediate implant. More evidence is required to support the long-term efficacy of this treatment approach.
The buccal alveolar bone at the mid-root level for central incisors has a mean thickness of 1.06 mm.[24] These results are consistent with the findings of **AlAli et al**.[25] (1.17mm), **Othman et al**.[26] (0.81mm), **Sheerah et al**.[27] (0.96mm), and **Han and Jung et al**.[28] (1.25mm). The average thickness of the buccal alveolar bone at the apical region for central incisors is (1.89mm). These results are consistent with those reported by **Othman et al.** (1.44 mm), **Sheerah et al.** (1.51 mm), and **Han and Jung et al.** (1.72 mm).[24,26,27,28]
Overall, the literature reports a buccal bone thickness of about 1 mm near the mid-root region. The above values for alveolar bone thickness showed that the buccal alveolar bone thickness was greatest at the apical region of the alveolus and thinnest at the mid-root region.

The mean thickness of the palatal alveolar bone at the mid root level for central incisors is (3.18mm). These values are consistent with the studies done by **Al Tarawneh et al.**[29] (1.66mm), **Han and Jung et al**[28](3.89 mm), and **Wang et al.**[30] (3.67 mm). The mean thickness of the palatal alveolar bone at the apical level for central incisors was (6.54 mm) respectively. This data is consistent with **Al Tarawneh et al.** (3.13 mm), **Han and Jung et al** (5.9 mm), and **Wang et al.** (7.57 mm). [24,28,29,30]
This data appears consistent with the literature where the palatal bone is thicker than the buccal bone. The thickness was maximum at the apical region of the alveolus, whereas it was thin at the mid root region. Comparing the buccal and palatal measurements of the alveolus, it was observed that the buccal bone thickness is less compared to the palatal bone, primarily due to the root angulation in the sagittal plane.

CONCLUSION:

The purpose of this study was to use CBCT scans to determine the position and angulation of the maxillary central incisor in relation to the alveolus for immediate implant in the aesthetic zone in an Indian population. We discovered that the labial bone thickness is generally thin, measuring around 1 mm, and that it is narrowest in the mid-root region of the central incisor. Tapered-screw implants are recommended for better extraction socket fit and easy primary stability.
In level I cases, standard drilling protocols can be used to insert the implant at the same angle as the socket.

For level II cases, adjust the implant angulation to be more palatal at the apex, pivoting around the mid-palatal area. The implant should be inserted with good primary stability while avoiding applying pressure to the buccal wall. To relieve pressure on the buccal bone, the operator can leave a space between the implant surface and the bone while maintaining primary stability. Because of the extreme angulations, level III prosthetics necessitate extra precautions. The clinician must understand the various types of abutments, including their dimensions and shapes. To avoid buccal exposure of an angulated abutment's metal margin, the implant can be placed deeper apically.
A traditional protocol, such as grafting or preserving the alveolar ridge prior to implant placement, can result in more predictable long-term outcomes. If the aesthetic requirement is particularly high, a socket transformation procedure may be considered. Immediate implantation can result in unstable aesthetic outcomes over time. However, it is not impossible with the right case selection protocol and experienced operators.

REFERENCES:

1. Abraham CM. A brief historical perspective on dental implants, their surface coatings and treatments. Open Dent J 2014;8:50-55.

2. Raikar S, Talukdar P, Kumari S, Panda SK, Oommen VM, Prasad A. Factors Affecting the Survival Rate of Dental Implants: A Retrospective Study. J Int Soc Prev Community Dent 2017 Nov-Dec;7(6):351-355.
3. Chen J, Cai M, Yang J, Aldhohrah T, Wang Y. Immediate versus early or conventional loading dental implants with fixed prostheses: A systematic review and meta-analysis of randomized controlled clinical trials J Prosthet Dent 2019 Dec;122(6):516-536.
4. Oh KC, Jeon C, Park JM, Shim JS. Digital workflow to provide an immediate interim restoration after single-implant placement by using a surgical guide and a matrix-positioning device J Prosthet Dent 2019 Jan;121(1):17-21.
5. Gluckman H, Pontes CC, Du Toit J. Radial plane tooth position and bone wall dimensions in the anterior maxilla: A CBCT classification for immediate implant placement J Prosthet Dent 2018 Jul;120(1):50-56.
6. Linjawi AI, Marghalani HYA. Relationship between maxillary central incisors and incisive canal: a cone-beam computed tomography study. Folia Morphol (Warsz). 2022;81(2):458-463.
7. Saravanan B, Jayavelu P, Riaz R, Tariqsalam AR. Evaluation of the Accuracy of Cone Beam Computed Tomography for Immediate Implant Placement- A Case Report J Pharm BioalliedSci 2017 Nov; 9(Suppl 1):S274-S280.
8. Mandelaris GA, Rosenfeld AL: The expanding influence of computed tomography and the application of computer-guided implantology. PractProcedAesthet Dent 20:297, 2008.
9. Spector L. Computer-aided dental implant planning. Dent Clin North Am. 2008 Oct;52(4):761-75, vi.
10. Bryant RM, Sadowsky PL, Hazelrig JB. Variability in three morphologic features of the permanent maxillary central incisor Am J Orthod 1984 Jul;86(1):25-32.
11. Vignoletti F, Sanz-Esporrin J, Sanz-Martin I, Nuñez J, Luengo F, Sanz M. Ridge alterations after implant placement in fresh extraction sockets or in healed crests: An experimental in vivo investigation. Clin Oral Implants Res. 2019 Apr;30(4):353-363.
12. Araujo MG, Sukekava F, Wennstrom JL, et al: Ridge alterations following implant placement in fresh extraction sockets: An experimental study in the dog. J ClinPeriodontol 32:645, 2005.
13. Botticelli D, Berglundh T, Lindhe J: Hard-tissue alterations following immediate implant placement in extraction sites. J ClinPeriodontol 31:820, 200.
14. De Rouck T, Collys K, Cosyn J: Single-tooth replacement in the anterior maxilla by means of immediate implantation and provisionalization: A review. Int J Oral Maxillofac Implants 23:897, 2008
15. Kan JY, Rungcharassaeng K, Lozada J: Immediate placement and provisionalization of maxillary anterior single implants: 1-Year prospective study. Int J Oral Maxillofac Implants 18:31, 2003 33.
16. Cornelini R, Cangini F, Covani U, et al: Immediate restoration of implants placed into fresh extraction sockets for single-tooth replacement: A prospective clinical study. Int J Periodontics Restorative Dent 25:439, 2005.
17. Lau SL, Chow J, Li W, Chow LK. Classification of maxillary central incisors-implications for immediate implant in the esthetic zone J Oral MaxillofacSurg 2011 Jan;69(1):142-53.

18. Buser D, Martin W, Belser UC. Optimizing esthetics for implant restorations in the anterior maxilla: anatomic and surgical considerations. Int J Oral Maxillofac Implants. 2004;19 Suppl:43-61.
19. Garber DA: The esthetic dental implant: Letting restoration be the guide. J Am Dent Assoc 126:319, 1995 41.
20. Kois JC: Predictable single tooth peri-implant esthetics: Five diagnostic keys. CompendContinEduc Dent 22:199, 2001.
21. Huynh-Ba G, Pjetursson BE, Sanz M, Cecchinato D, Ferrus J, Lindhe J, Lang NP. Analysis of the socket bone wall dimensions in the upper maxilla in relation to immediate implant placement. Clin Oral Implants Res. 2010 Jan;21(1):37-42.
22. Cochran DL, Douglas HB: Augmentation of osseous tissue around nonsubmergedendosseous dental implants. Int J Periodontics Restorative Dent 13:506, 1993.
23. Langer B, Sullivan DY: Osseointegration: Its impact on the interrelationship of periodontics and restorative dentistry. Part 3. Periodontal prosthesis redefined. Int J Periodontics Restorative Dent 9:240, 1989.
24. Vyas R, Khurana S, Khurana D, et al. (April 20, 2023) Cone Beam Computed Tomography (CBCT) Evaluation of Alveolar Bone Thickness and Root Angulation in Anterior Maxilla for Planning Immediate Implant Placement. Cureus 15(4): e37875.
25. AlAli F, Atieh MA, Hannawi H, Jamal M, Harbi NA, Alsabeeha NH, Shah M: Anterior maxillary labial bone thickness on cone beam computed tomography. Int Dent J. 2023, 73:219-227.
26. Othman B, Zahid T, Khalifa H, Afandi A, Alshehri NA, Sait A, Abdoun S: Measuring the facial plate of bone in the upper anterior teeth utilizing cone beam computed tomography at King Abdulaziz University, Jeddah, Saudi Arabia. Cureus. 2022, 14:e29453.
27. Sheerah H, Othman B, Jaafar A, Alsharif A: Alveolar bone plate measurements of maxillary anterior teeth: a retrospective cone beam computed tomography study, AlMadianh, Saudi Arabia. Saudi Dent J. 2019, 31:437-444.
28. Han JY, Jung GU: Labial and lingual/palatal bone thickness of maxillary and mandibular anteriors in human cadavers in Koreans. J Periodontal Implant Sci. 2011, 41:60-66.
29. AlTarawneh S, AlHadidi A, Hamdan AA, Shaqman M, Habib E: Assessment of bone dimensions in the anterior maxilla: a cone beam computed tomography study. J Prosthodont. 2018, 27:321-328.
30. Wang X, Hu X, Zhang H, Zhang H, Song Z: Analysis of the dimensions of buccal and palatal bone wall in the maxillary anterior esthetic zone: a cone-beam computed tomography study. Res Square. 2022.