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Distribution of Radial Root Position of Maxillary Central Incisors on Cone Beam Computerized Tomography

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ABSTRACT

Knowledge about the radial root position before possible replacement of central incisors for immediate implant is of pivotal importance to clinician. It varies among different populations. **Objective:** To determine distribution of radial/sagittal root position in maxillary central incisors in patients reporting to 2 tertiary care hospitals of Lahore, Pakistan using CBCT. **Methods:** Sample size of 110 individuals between 20-50 years, strictly falling in inclusion criteria was used. Cross sectional study with non-probability consecutive sampling technique was applied in Department of Periodontology at Fatima Memorial Hospital and University college of Medicine and Dentistry, from Jan 2023 to Sep 2023. The position of maxillary central incisor roots was determined using CBCT. Chi-square test was used for stratification based on age and gender. **Results:** The mean age was 33.67 ± 8.68 and sample consisted of females 50 (45.45%) and males 60 (54.55%). The most common root position was class I, 79 (71.82%), followed by class II, 20 (18.18%), then class IV, 7 (6.36%) and least was class III, 4 (3.64%). The difference among genders (p=0.272) and age (p=0.161) were insignificant statistically. **Conclusions:** Most common incidence of radial root spatial position for maxillary central incisor is buccal (class 1), followed by II (middle) but class IV and III also existed and must analyzed CBCT to determine the radial root position before any immediate implant in esthetic zone for optimal esthetic and functional outcome.

INTRODUCTION

When a single tooth has to be replaced in anterior maxilla, immediate dental implant is a popular treatment of choice after it was introduced in 1990s. Loss of both soft and hard tissue can be prevented by immediate implant placement [1]. Restoration with Immediate implant placement is the most patient friendly procedure as this not only reduces the treatment time but also protects the alveolar bone and soft tissues and yields superior esthetic results [2]. But immediate placement of implant in pre-maxilla is a challenging modality of treatment as it has more chances of complications. Incorrect angulation of drill during osteotomy preparation may lead to facial/palatal wall perforation, dehiscence or bony defects, misplaced implant and incorrect emergence profile [3]. Thus, the osteotomy preparation and implant placement has to be in accordance to the root morphology (width and length), radial root position, and the osseous housing morphology so that the implant is placed in palatal or buccal wall and 4-

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5mm beyond the root apex, thus achieving primary stability [4]. Current guidelines suggest the placement of implant in the sloping palatal wall of socket [5]. This guideline is not applicable to every clinical situations as root can be placed close to the palatal wall yielding a thin palatal wall. So, the radial or sagittal root position must be known before hand in order to make a decision. Cone beam computerized tomography is the method of choice to check the sagittal root position before immediate implant placement [6]. The landmark study by Joseph Kan was reported in 2011, predominantly in a Caucasian ethnic population [7]. They categorized the relationship between the alveolar process and radicular tooth structures as class I (root positioned against labial cortex), II (root positioned between buccal and palatal cortex), III (root is positioned against the palatal cortical plate), and IV (At least two thirds of the root engaging both the labial and palatal cortical plates). Out of 100 CBCT examinations meeting the inclusion criteria, he found that majority of central incisors to be type I (86.5%). Type II, type III and type IV were found to be 5%, 0.5% and 8%. Another study was conducted by Lau *et al.*, in 2011 in Hong Kong. He reported buccal type to be 78.8%, palatal to be 1.8% and middle to be 19.4% [8]. Similar study was done in 2014 by Chung *et al.*, in Korean population concluded buccal type to be 94%, middle to be 5.6% and palatal to be 0.4% [9]. Issa N studies also showed significant variations among various populations. Issa *et al.*, in 2020 found that in Egyptian population, the prevalence of the 4 types and were found to be 60.7% for class I, 33%, 4.7 % and 1.7% for class II, III and IV [10]. Jung *et al.*, in Korean population found that 92.2 % of population had buccal type sagittal root position, 7.8% had middle root position and 0% had palatally positioned root for central incisor [11]. In 2016, Radzewski R and Osmola K studied radial root position in Chinese population and found buccal type predominant 95.4%. The middle type was 4.4% and 0.2 % had palatal type radial root position [12]. In 2019, Petaibunlue et al., studied Thai population and found 79.6% population had buccally placed root (type I), rest of the population had type II radial root position and found the types III and IV to be non-existent [13].The radial/sagittal root position distribution varies significantly among different populations in the studies done in past.This factor is vital for treatment planning with immediate implant. Each type of sagittal/radial root position poses ease and difficulties in immediate implant placement.CBCT is the only and the most reliable tool for its assessment and determination. Computerized tomographic scans are another option but CBCT produced images of greater resolutions with lesser radiation doses to patient.The distribution of central incisor roots in Pakistani population is different than the previously studied populations of Americans, Chinese, Korean and Egyptians and the Sagittal distribution of these populations cannot be applied to Pakistani Population. Therefore, this study aimed to determine the distribution of sagittal/radial root position in central incisors for immediate implant placement using CBCT in patients reporting to tertiary care hospital.

METHODS

It was a cross-sectional study with non-probability consecutive sampling technique conducted at Department of Periodontology at Fatima memorial Dental hospital Lahore and University College of Medicine and Dentistry, The University of Lahore from Jan 2023 to Sep 2023. A sample size of 110 cases was calculated with 95% confident level, 5% margins of errors and expected percentage of middle root position as 7.8% [14]. Approval from Institutional Review board (IRB) of Fatima Memorial Hospital was taken. A detailed synopsis including study design, sample size, inclusion and exclusion criteria was sent to Research Evaluation Unit of College of Physicians and Surgeons Pakistan. The synopsis was approved with reference no CPSP/REU/DSG-2019-060-2752. Only the patients falling into the inclusion criteria were included in the study. The demographics of all subjects were recorded and every subject was asked to sign a consent form. Inclusion criteria was as follows; Individuals between age 20-50 years with no history of tooth root manipulation i.e., no orthodontic treatment, no fixed prosthesis and no history or radiographic signs of trauma in anterior segment of maxilla. ALADA Principle was followed. No subject was exposed to unnecessary radiations. Subjects prescribed cone beam CT scan as dictated by their treatment plan and subjects who had not undergone CBCT in past 6 months. Female patients were excluded if they were Pregnant or lactating. Secondly patients were also excluded if they had history of previous surgery in maxilla such as orthognathic surgery, apicectomies or internal fixation following trauma to maxilla. Patients with developmental disorders/Growth anomalies and history of chemotherapy and radiotherapy were also excluded. Radiology department of dental hospital has Planmeca Romexis 3D machine for CBCT. Cone beam computed tomography (CBCT) was taken in Planmeca Romexis 3D Mid (60-120 kV; 9-33 s; 200µm voxel size) of all subjects. As per existing literature, buccally positioned roots (class I), middle positioned roots (class II), palatally positioned roots (class III) and pedunculated roots (class IV) was recorded in each patient. In order to address any bias, all readings were taken by only one doctor and CBCT from only one system was included in the study. All data analysis was done in SPSS 22 qualitative variables like gender and position of maxillary central incisor (bucally placed, middle positioned, palatally placed, and pedunculated) was presented as frequency and

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percentages. Quantative variable like age was presented as mean ± SD. Data were stratified as age and gender. Chi-square test was used taking p-value less than or equal to 0.05 as significant level.

RESULTS

The mean age of the participants were 33.67 ± 8.68 years with range from 20 to 50 years. The females were 50 (45.45%) and males were 60 (54.55%). The common age group was 20-30 years 46 (41.82%) followed by 31-40 years 33 (30.00%) and least was 41-50 years 31 (28.18%). The most common root position was class I (buccally positioned root) found in 79 (71.80%), followed by class II (middle position root) in 20 (18.18%), then class IV (pedunculated maxillary base) in 7 (6.36%) and least was class III (palatally placed root) in 4 (3.64%) (Figure 1).

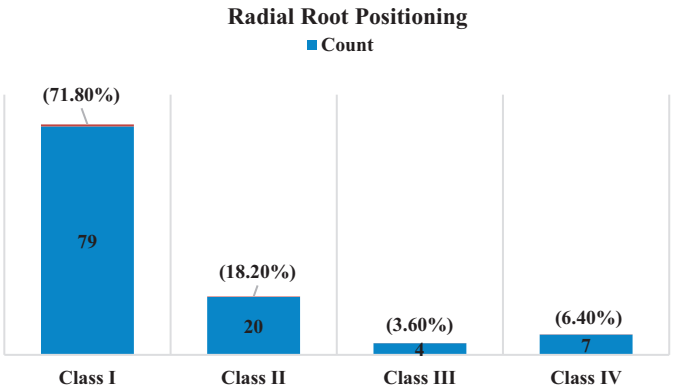

Figure 1: Distribution of Radial Root Positioning

Class III of radial root position of maxillary central incisor was 3 (5%) in males and in females was 1 (2%). Class IV was 6 (10%) and in females was 1 (2%). The distribution of radial root positions of the maxillary central incisor among genders showed no statistically significant difference (p=0.272), indicating that gender does not influence the root position (Table 1).

Table 1: Comparison of Radial Root Position of Maxillary Central Incisor among Genders

Characteristics	Radial Root Position of Maxillary Central Incisor Frequency (%)		p-Value[2]
	Female N = 50[1]	Male N = 60[1]	
Class I	39 (78.00%)	40 (66.67%)	0.272
Class II	9 (18.00%)	11 (18.33%)	
Class III	1 (2.00%)	3 (5.00%)	
Class IV	1 (2.00%)	6 (10.00%)	

[1]n (%), [2]Fisher's Exact Test

There was no statistically significant association between age groups and radial root position of the maxillary central incisor (p=0.161), suggesting that age does not significantly impact root positioning. Class III was found in only age group 20-30 years 4 (8.7%). Class I (buccally positioned root) was the most common radial root position overall, found in 71.82% of participants, regardless of gender or age group (Table 2).

Table 2: Comparison of Radial Root Position of Maxillary Central Incisor Among Age Groups

Characteristics	Radial Root Position of Maxillary Central Incisor Frequency (%)/Range			p-Value[2]
	20-30, N = 46[1]	31-40, N = 33[1]	41-50, N = 31[1]	
Class I	30 (65.22%)	24 (72.73%)	25 (80.65%)	0.161
Class II	10 (21.74%)	5 (15.15%)	5 (16.13%)	
Class III	4 (8.70%)	0 (0.00%)	0 (0.00%)	
Class IV	2 (4.35%)	4 (12.12%)	1 (3.23%)	

[1]n (%), [2] Fisher's exact test

DISCUSSION

These findings showed that the most common root position was class I (buccally positioned root) found in 79 (71.82%), followed by class II (middle position root) in 20 (18.18%), then class IV (pedunculated maxillary base) in 7 (6.36%) and least was class III (palatally placed root) in 4 (3.64%). There was no statistical difference among age groups and gender for the type of /radial root position in central incisors for immediate implant placement. Biologically, the palatal part of alveolar bone of the maxillary anterior teeth, is thicker in quantity also qualitatively it has a cortical nature [15-17]. So, it presents a superior site both qualitatively and quantitatively for implant placement than the labial bone. Class I sagittal root position (SRP) provides these ideal conditions. This also leads to minimum insult in the labial bone leading to lesser resorption of labial bone which is critical for esthetic outcome and the gap between implant and the buccal socket wall can be grafted using bone substitutes [18]. Kan *et al.*, classification for root spatial distribution in relation to osseous housing was used in this study [7]. The classification is as follows; Class I: The root is found along the labial cortical plate leaving a thick palatal bone and apical bone. Class II: The root lies in the middle of the alveolar housing. It does not engage buccal/palatal cortices in the apical third. Class III: the entire radicular apparatus runs along the palatal alveolar cortex and there is thick buccal bone. Class IV: two thirds of the root are engaging both labial and palatal cortical plates and apical bone is insufficient for primary stability. The study reported greater incidence of class I radial root position (71.82% population). These results supported that mostly teeth were suitable contenders for implant and provisional loading. 95% incidence of sagittal root position was found in another study done on Chinese population, further supporting the motion [19]. A similar study was done by Issa *et al.*, in Egyptian population. 100 patients both male and female underwent CBCT were included in study sample. Root positions were classified into Classes I-IV. The results were similar to previous studies indicating the

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predominance of class I (60.7%), and others reported were class II (33%), class III (4.7 %) and class IV (1.7%). The cross sectional root position in relation to alveolar process of anterior upper teeth (canine to canine) on CBCT was further assessed in another study and reported. A sample size of 100 included both genders with mean age 53.1 was selected and the results were interpreted as Class I, II, III, or IV. Out of sample size of 600, 81.1%, 6.5%, 0.7%, and 11.7% were reported as Class I, II, III, and IV. Class IV radial root position reported in Kawala B *et al.*, studies in which these results had a remarkable prevalence of 11.7%.This challenging situation has two thirds of the root is engaging both labial and palatal cortical plates and apical bone is thin [20].The socket enclosing the root is pedunculated from alveolar bone proper. Such cases are a contradiction for immediate implant placement.It is necessary to augment the hard tissues with bone substitutes prior to implant placement and during the placement to increase the predictability of the treatment [21] Treatment trends today demand dental implant with optimal esthetics.To meet this increasing demand, treatment planning considerations are extremely important.CBCT evaluation prior to these cases and such classifications are pivotal in interpretation of literature guidelines before planning these cases [22-24]. Gluckman H *et al.*,studies indicated a greater incidence of mechanical and biological complication if CBCT is not done before implant placement [25].

CONCLUSIONS

It can be concluded that most common class for radial root locality of upper central incisor is class I (The root is found along the labial cortical plate leaving a thick palatal bone and apical bone) followed by II (root position is in the middle of the osseous housing without engaging the labial and palatal cortical plates at the apical third). Increasing demand of immediate implant treatment to shorten treatment time increase the importance of knowledge about sagittal root position on CBCT for treatment planning in the anterior maxilla.

Authors Contribution

Conceptualization: KA
Methodology: AD, MK, TA, UM
Formal analysis: MH, ZAK, KA
Writing, review and editing: AD, MH, ZAK, MM, KA

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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