Sagittal Root Position of Maxillary Anterior Teeth in Nepalese Population Using Cone Beam Computed Tomography

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ABSTRACT

Background

There are no radiographic studies in Nepalese population for determination of sagittal root positioning in maxillary anterior teeth. The sagittal root positioning and root angulation plays a vital role for case selection in immediate implant placement.

Objective

To evaluate, classify and compare sagittal root position between different maxillary anterior teeth.

Method

A 2-year retrospective study was conducted on 100 patients (53 males and 47 females) who fulfilled the inclusion criteria using cone beam computed tomographic images. The relationship of root of tooth to its alveolar housing were recorded as Class I to IV. In addition, the root angulation relative to the alveolar process was also measured.

Result

The sagittal root position (SRP) calculated on six maxillary anterior teeth on average was found to be 87.83% for Class I, 6.67% for Class II, 0.67% for Class III and 5.17% for Class IV respectively. The mean root angulation was found to be higher with canines on both side whereas lateral incisors had lesser mean root angulation. Root angulation of maximum teeth were between 10-20 degrees where immediate implant placement is possible.

Conclusion

Within the limitations of this study, the sagittal root positioning and root angulation in Nepalese population showed a favorable result for immediate implant placement. Maximum teeth were found to be close to the alveolar process with the exception of few teeth.

KEY WORDS

Immediate implant, Root angulation, Sagittal root positioning

INTRODUCTION

Immediate implant placement has become a major choice in modern implant practice. Both dentists and patients usually prefer this method because of shortened treatment time in this fast-moving era, reduction in number of surgeries required and preservation of the remaining hard and soft tissues.[1]

Achieving primary stability in immediate implant is a challenging task which is highly influenced by available bone after tooth extraction. In general, implant is engaged in the palatal bone and beyond the root apex about 4-5 mm to achieve primary stability in maxilla.[2] The remaining palatal bone volume is determined by sagittal root position and relationship of tooth root to alveolar housing is determined by root angulation which plays a significant role in dental implant placement timing.[3]

The Cone Beam Computed Tomography (CBCT) study for sagittal root positioning and root angulation in Nepalese population hasn't been performed previously. Hence, this study was conducted to facilitate clinicians to provide reference regarding the root position and angulation for immediate implant placement.

METHODS

A two years observational retrospective radiographic study was planned within a period between January 2019 to December 2020. The study protocol was approved by institutional review committee of Kathmandu university school of medical sciences (20/2021). All the three-dimensional radiographs were taken using Dentium rainbow CT as per standard volume protocol:

a. Scan time: 17 seconds

b. Peak voltage: 80 kVp

c. Tube current: 7 mA

d. Voxel size: 300 µm

e. Patient position: Standing, incisors held on the bite fork

Inclusion criteria[4]

• Patients age at least 18 years of age at the time of the cone-beam CT scan

• All anterior maxillary and mandibular teeth were present with at least two posterior occluding teeth

Exclusion criteria[4]

• No rotation or malposition of anterior teeth

• No radiographic evidence of infection, root resorption, or trauma to maxillary anterior dentition; and no history of orthodontic and surgical treatment in the maxillary anterior dentition

CBCT views were analyzed using rainbow™ Image Viewer (Dentium Korea) software. The sagittal root positions were determined as per classification by Kan et al. in 2011.[2] For root angulation, angle measurement was done using the same sagittal section from CBCT between the tooth's long axis and axial bone inclination.[5]

Definitions of different types of SRP[2]

• Class I- Root is placed towards the buccal cortical plate.

• Class II- Root is positioned at the center without engaging the buccal or palatal cortical plate.

• Class III- Root is placed towards the palatal cortical plate.

• Class IV- At least 2/3rd of the roots is engaged with buccal and palatal cortices.

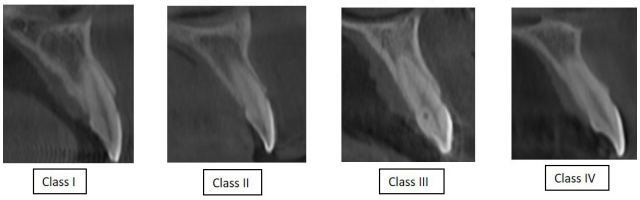

Figure 1. Different sagittal root positionings as per Kan et al.[2]

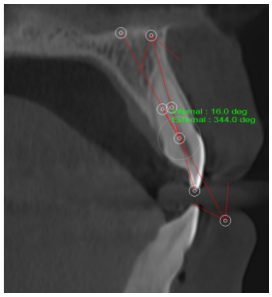

Figure 2. Measurement of root angulation from rainbow™ viewer

The descriptive analysis was done for both sagittal root positioning and root angulation. Data were expressed as mean, standard deviation and percentage. The statistical difference was set at p value < 0.05. Independent t-test was used to compare gender and tooth angles.

RESULTS

A total of 600 teeth were evaluated from 100 patients for sagittal root positioning and root angulation. The result of the study showed male sample were 53% and female were 47%. Regarding the frequency distribution, the sagittal root positioning among the maxillary anteriors showed Class I SRP (87.83%) with greatest prevalence followed by Class II SRP (6.67%) and Class IV SRP (5.17%). The least SRP was Class III (0.67) that was only observed in upper right lateral incisors.

Among the different teeth, maximum Class I SRP were found in canines followed by central and lateral incisors.

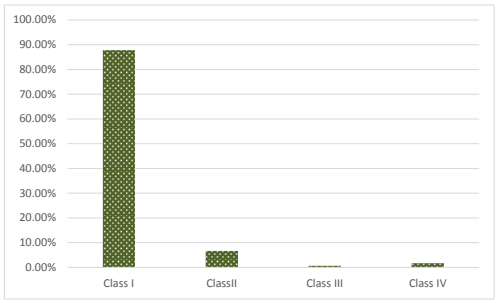

Figure 3. Percentage distribution of sagittal root positioning

Table 1. Frequency distribution of sagittal root positioning based on tooth type and gender

		Class I	Class II	Class III	Class IV
13	Female	44	1	0	2
	Male	52	0	0	1
	Total n (%)	96 (96)	1 (1)	0 (0)	3 (3)
12	Female	36	4	1	6
	Male	42	4	1	6
	Total n (%)	78 (78)	8 (8)	2 (2)	12 (12)
11	Female	42	4	0	1
	Male	47	5	0	1
	Total n (%)	89 (89)	9 (9)	0 (0)	2 (2)
21	Female	43	4	0	0
	Male	46	6	0	1
	Total n (%)	89 (89)	10 (10)	0 (0)	1 (1)
22	Female	35	5	0	7
	Male	42	6	0	5
	Total n (%)	77 (77)	11 (11)	0 (0)	12 (12)
23	Female	45	1	0	1
	Male	53	0	0	1
	Total n (%)	98 (98)	1 (1)	0(0)	1 (1)

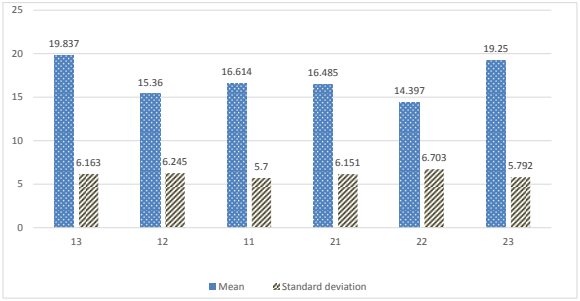

Figure 4. Mean root angulation of maxillary anteriors

The root angulation ranged from 0 to 48 degrees. The mean root angulation was greatest on the tooth #13 (19.84±6.16) whereas the least angulation was observed on tooth #22 (14.40±6.70).

The mean sagittal angle in female was greater in 12, 11, 21, 22. However, the sagittal angle was less in female in 13 and 23. In order to assess the differences in sagittal root angulation between male and female, independent sample t-test was utilized. The results revealed no significant difference ($p > 0.05$) in the root angulations among gender.

Table 2. Independent t-test comparing gender and tooth angles

	Gender	Mean	Std. Deviation	t	p-value
13	Female	18.862	4.961	-1.499	0.137
	Male	20.702	6.995	-1.529	0.13
12	Female	15.598	6.478	0.357	0.722
	Male	15.15	6.086	0.355	0.723
11	Female	17.426	5.896	1.346	0.181
	Male	15.894	5.475	1.34	0.183
21	Female	16.689	5.637	0.311	0.756
	Male	16.304	6.622	0.314	0.754
22	Female	14.455	6.979	0.082	0.935
	Male	14.345	6.515	0.081	0.935
23	Female	18.406	4.893	-1.378	0.171
	Male	19.998	6.44	-1.4	0.165

P value- significant at < 0.05

Maximum teeth had their angulations between 10-20 degree whereas very few teeth had angulations greater than 30 degrees.

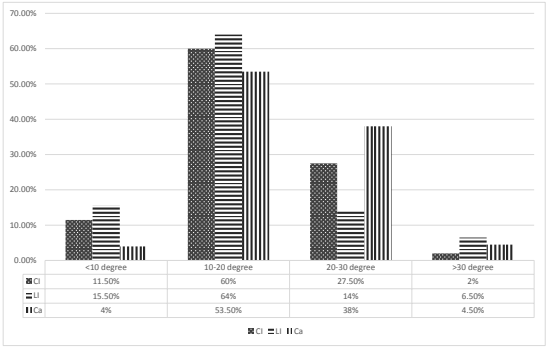

Figure 5. Frequency distribution of sagittal root angulation

DISCUSSION

Immediate implant placement is commonly a first choice in current implantology trend. It has gained popularity as conventional implants were only placed in completely healed sockets.[6] Immediate implant is done on the same day of tooth extraction but loading can be deferred to early and late phases for achieving more success.[7]

Immediate implant is often challenging and requires understanding of the biology of both hard and soft tissues. The frequent complication that can invariably occur with immediate implant is the presence of mid-facial recession which may require covering the peri-implant soft tissue dehiscence with autologous grafts.[8] So, implant dentistry has changed from a conventional bone driven surgical technique to more of a restoratively and biologically driven protocol.[9]

The sagittal root position and sagittal root angulation plays an important role in guiding the clinicians for choosing immediate implant therapy. Different scientific literatures are available worldwide but to our best knowledge, there is a lack of studies regarding the current topic in Nepalese

population. CBCT (cone beam computed tomography) is preferable over conventional radiography to study both root position and angulation in sagittal direction as it yields three dimensional images without superimposition, good resolution and low dosages of radiations.[10]

In our current study, more patients have Class I sagittal root position (87.83%) wherein sufficient amount of palatal bone is present for achieving primary stability in immediate implant placement. The similar percentages of Class I SRP were shown in the studies conducted by Kan et al. (81.1%) in California and Kong (81.1%) in Korea.[2,3] The SRP in ascending order was found to be Class III < Class IV < Class II < Class I in our study which is similar to studies done by Kong 2020 and Giglou et al. 2017 whereas study by Kan et al. found a bit different SRP classes.[2,3,11] The following SRP classes in ascending order Class III < Class II < Class IV < Class I was reported by Kan et al. in 2011.[2] The class III SRP was the least prevalent types in many studies.[3] But, prevalence of Class III was found around 4.7% in a study done in Egyptian population by Issa N in 2020.[4]

The labial cortical plate is thin and primarily composed of bundle bone only which is the reason for more amount of labial bone loss following the tooth extraction. The preservation of labial bone is important. The CBCT analysis will allow the clinicians to differentiate between various types of sagittal root positions wherein SRP Class I is considered as ideal, SRP Class II and III are more technique sensitive and SRP Class IV is contraindicated for immediate implant placement. As Class I is found more and Class IV is found less in our study, the sagittal root position in Nepalese population is ideal for immediate implant placement.

Regarding the root angulations, in a restoratively driven concept, the implant should be placed in the same direction or angulation as the extraction socket for correct three dimensional position and long term stability.[5] The root angulation were found to be greatest around 60% in between 10-20 degrees in our study which is similar to the results obtained in studies done by Kong et al. in 2020 and dos Santos et al. in 2019.[3,12] Almost 90% of teeth had angulations > 10 degrees in a study done by Wang et al. which is similar to the results in this current study.[5] But in contrary, ≥ 30 degrees angles were found at 40% of canine sites5 which was only 4.33% in Nepalese population which also favors the immediate implant placement.

Less than 10 degrees root angulation is the easiest condition for immediate implant placement as the implant direction is near to parallel to the direction of extraction sockets. The angulations between 10-20 degrees also allows for immediate implant placement but through a greater level of difficulty.[11] The implant angulation at maximum of 30 degrees to a last extent is acceptable that also requires a wider ridge. But in narrow ridges, the acceptable angulation is 20 degrees form the axis of adjacent clinical crown or a line perpendicular to the occlusal plane as increase in implant angulation in narrow ridges will result in increased stress concentration in crestal bone.[12]

The implant if placed as closer to the extraction socket enables the clinicians to easily use the stock abutments provided by implant companies. Whereas, the incorrect angulation might either require the stock angled abutments or customized abutments that can increase the overall cost of the treatment and will also increase the overall stress at the crestal level. The angled abutments have their limitations for correction of the misaligned implant. Angled abutment of 15 degrees can correct 1-1.5 mm and 25 degrees can correct about 2-2.5 mm at the maximum level towards the occlusal plane.[13]

This study in Nepalese population suggests that both the sagittal root position and root angulation favors the immediate implant placement. The tooth having the greater degree sagittal root angulation should be converted to a shallow angled before or during implant placement by bone grafting procedures to ensure a biologically and restoratively driven implant concept.

There are certain limitations in this study owing to a relatively small sample size, considerations regarding different skeletal classes of malocclusion weren't considered and a small range of error than can occur with cone beam computed tomography.[14] So, a multicenter study in large population in different provinces of Nepal would be required in future to further authenticate the current findings.

CONCLUSION

Pre-operative CBCT analysis is recommended for implant planning in maxillary anterior region. Both the sagittal root positioning and root angulation in Nepalese population showed a favorable result for immediate implant placement. Maximum teeth were found closer to the alveolar process with the exception of few teeth. Bone grafting procedures are suggested for the teeth having greater angulation to ensure long term success of implant therapy.

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