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Evaluation of Residual Root Height and Width for The Fabrication of Rai in South India Population

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ABSTRACT

Introduction: The precision and accuracy of the study can be significantly improved by using cone beam computed tomography (CBCT) into the assessment of residual root height and width for the manufacture of ROOT Analogue Implants (RAI) in the South Indian population. Comprehensive study of the residual root anatomy is made possible by the detailed three-dimensional images of the oral and maxillofacial tissues that are provided by CBCT imaging. Researchers can quantify residual root dimensions, such as height and width, with high resolution and little distortion by using CBCT. This makes it possible to precisely plan the placement of implants, accounting for elements including bone density, closeness to surrounding structures, and the best location for stability and aesthetics over the long run.

Materials And Method: A substantial and reliable sample size that can offer important insights into the anatomical features and suitability for implant placement in the South Indian population is the selection of a cohort of 300 patients for CBCT testing in the context of dental implants.

Results: A substantial and reliable sample size that can offer important insights into the anatomical features and suitability for implant placement in the South Indian population is the selection of a cohort of 300 patients for CBCT testing in the context of dental implants.

Conclusion: To sum up, the incorporation of CBCT technology in the assessment of residual root dimensions improves the precision and efficacy of RAI fabrication for the South Indian populace, hence leading to improved clinical results and patient care.

1. INTRODUCTION

The search for tooth replacements that are both aesthetically pleasing and functionally sound has prompted the development of novel methods and materials in modern dental implantology. In an attempt to replicate the anatomical characteristics and functionalities of natural tooth roots, root analogue implants, or RAIs, have become a potentially effective alternative. However, a thorough assessment of the residual root dimensions is necessary for the proper manufacturing and placement of RAIs(1)(2)(3)

After a tooth is extracted or lost, the leftover root forms the basis of the RAI. Its width and height affect the restoration's long-term stability as well as how well it looks. They also determine if implant insertion is feasible. Thus, in order to guarantee the best possible treatment results, a careful evaluation of these characteristics is necessary (4)(5)

The importance of assessing residual root height and width in relation to RAI fabrication is outlined in this work. It seeks to shed light on the crucial procedures that support a successful RAI installation by outlining the major elements of this evaluation process, which include radiographic analysis, prosthetic considerations, and clinical examination(6)(7)

In addition, this article emphasizes how crucial advances in imaging technologies—like computer-aided design (CAD) and cone-beam computed tomography (CBCT)—have been in enabling accurate measurements and personalized implant designs.

Treatment planning has been transformed by the incorporation of these technologies into clinical practice, which allows medical professionals to customize RAI solutions to the distinct anatomical features of each patient.(8)(9)(10)Various surgical considerations, including suture techniques, flap design, and treatment planning, may impact the success of dental and craniofacial implant procedures(11–14)

This research aims to clarify the complex relationship between residual root morphology and RAI manufacturing by thoroughly examining the evaluation procedure. Through the cultivation of a more profound comprehension of these concepts, medical professionals can augment their capacity to provide patient-focused implant therapy that blends in with the natural dentition, consequently elevating patient contentment and treatment results(15)

2. MATERIALS AND METHOD

A cohort of 300 patients cbct is chosen to undergo examination for dental implants.Inclusion criteria: Patients with single-tooth and straight root are required for RAI Exclusion criteria : Individuals whose prior orthodontic treatment changed the shape of their roots, or whose systemic diseases impair the metabolism of bone.Using a suitable CBCT machine (e.g., CS Imaging software), CBCT scans are obtained according to a specified protocol. The parameters are as follows: FOV spanning the entire maxilla and mandible, voxel size ≤ 0.25 mm, 5-10 mA, and 90-120 kVp. Consistent patient positioning involves keeping the Frankfort horizontal plane parallel to the floor. In order to reduce artifacts, image acquisition is carried out under standard settings.(9)

To visualize the morphology, three-dimensional reconstructions of the remaining roots are created. Cross-sectional views are used to measure the height and width of roots at several levels: The length measured along the longitudinal axis of the root from the alveolar crest to the apex (Figure 1). Diameter measured at different levels (coronal, middle, apical) perpendicular to the longitudinal axis. Every residual root has its measurements entered in a length and width from crestal region to root apex. Both pertinent clinical data (tooth position) and demographic information (age, gender) are recorded(16). The distribution of measurements for root height and width is derived using descriptive statistics.The data is shown as mean, standard deviation, and range.Based on variables including patient demographics and tooth location, subgroup analysis may be carried out.

The Institutional Review Board (IRB) or Ethics Committee has given its approval to the research protocol.

Calibration of imaging hardware and software is done on a regular basis to guarantee measurement accuracy and repeatability. In order to evaluate the consistency of measurements over time, random samples of CBCT scans are examined. There is acknowledgement of potential drawbacks, including radiation exposure and picture distortion. Generalizability may be impacted by sample size and selection bias.(17)

The prevailing literature and clinical significance are taken into consideration while interpreting the results. Future research directions are highlighted, along with implications for RAI therapy planning. The assessment of root height and width using CBCT imaging in a sample of 300 patients, following these standardized procedures, offers important insights into the anatomical features pertinent to RAI manufacture and clinical decision making.(18)(9)

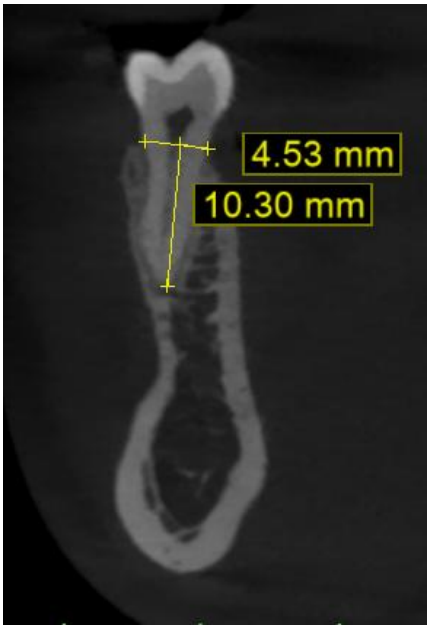

Figure 1: Measurement of cbct image

3. RESULTS

To enable precise treatment planning and implant placement, a thorough assessment of multiple parameters is required when analyzing the findings of 300 CBCT images for root analogue implants. (19)A summary of possible conclusions and things to think about is as follows:

This include totally 145 females and 155 males, age range from 20-70 years

Teeth which are selected for this study includes 15,25,35,45 (Table 1, 2)

Dimensions	Tooth no 15	tooth no 25	tooth no 35	tooth no 45
width	5.5[+/-0.34(300)]	5.4 [+/-0.34(300)]	5.4[+/-0.35(300)]	5.4[+/-0.33(300)]
length	13.1[+/-1.0(300)]	13.2[+/-1.02(300)]	13.3[+/-0.98[300)]	13.3[+/-1.08(300)]

Table 1: Mean standard deviation of cbct analysis for root analogue implants

Width Analysis:

4-5mm	GENDER	Tooth no 15	tooth no 25	tooth no 35	tooth no 45
	1	3.3%	3.3%	1%	2.6%
	2	2%	2%	1.6%	2.6%
5-6mm		Tooth no 15	tooth no 25	tooth no 35	tooth no 45
	1	44%	44%	44%	45.3%
	2	47%	47%	46.3%	47.3%
6-7mm		Tooth no 15	tooth no 25	tooth no 35	tooth no 45
	1	1%	1%	3.3%	0.3%
	2	2.3%	2.3%	3.3%	1.3%

Table 2: width analysis for root analogue implants

In this study we have analyzed the mean width of the root analogue implants which are milled and placed. In studying 300 patients cbct, the results were within the range of 5-6mm width the maximum range of 47.3% found in males, the minimum range of 44% found in females. 0.3% is the minimum range found in males of width ranging from 6-7mm.

Length Analysis:

In this study we have analyzed the mean width of the root analogue implants which are milled and placed. In studying 300 patients cbct, the results were within the range of 13-14mm length, the maximum range of 28.6% found in males, the minimum range of 20% found in females. 0% is the minimum range found in both females and males of various lengths (Table 3).

9-10mm	GENDER	Tooth no 15	tooth no 25	tooth no 35	tooth no 45
	1	0	0.3%	0%	0%
	2	0.6%	0%	0	0
10-11mm		Tooth 15	tooth no 25	tooth no 35	tooth no 45

	1	0.3%	1%	0.6%	0.3%
	2	0	0.6%	0.3%	1%
11-12mm		Tooth no 15	tooth no 25	tooth no 35	tooth no 45
	1	5.6%	3.6%	4.3%	5%
	2	2.6%	4.3%	3.6%	4.6%
12-13mm		Tooth no 15	tooth no 25	tooth no 35	tooth no 45
	1	14.6%	11.6%	12.6%	11.3%
	2	17.6%	15%	9%	12.3%
13-14mm		Tooth no 15	tooth no 25	tooth no 35	tooth no 45
	1	21.6%	25%	20%	25%
	2	23.6%	22.3%	28.6%	23.3%
14-15mm		Tooth no 15	tooth n o 25	tooth no 35	tooth no 45
	1	4%	5.3%	3%	4.3%
	2	4.6%	12%	8%	7%
15-16mm		Tooth no 15	tooth no 25	tooth no 35	tooth no 45
	1	1%	1%	1%	1.6%
	2	1%	1.3%	1.6%	2.6%
16-17mm		Tooth no 15	Tooth no 25	Tooth no 35	Tooth no 45
	1	1%	0.3%	0.3%	0.6%
	2	0.3%	0	0	0.6%

Table 3: Length analysis for root analogue implants

4. DISCUSSION

Implant designs have historically been created using scans of the removed tooth. In order to design implants prior to extraction, dentists can now employ patient CT scans and 3D manipulation software with CAD/CAM (computer-aided design/computer-aided manufacture). More customisation is possible as a result, and possibly better results. (20–22)

The difficulties in deciphering CBCT scans have been discussed in earlier papers, especially in the apical area (tip of the root). The discrepancy between the measured value and the CBCT data gets larger (more than -0.15mm) as you approach the root tip. Data loss in that area is suggested by this.The cause of the data loss was The CBCT may have a tougher time penetrating and obtaining a clear image in the apical region due to denser bone. Where the program separates the tooth from the surrounding bone is called segmentation, and this denser bone throws it off. (23)

The actual measurement and the CBCT data differ by more than 0.15 mm at the cementoenamel junction (CEJ) area, which is where the tooth and root meet. This could be the result of an indentation in the bone from forceps breaking during tooth extraction. This explains the CEJ discrepancy.(24) Next, Effect of CBCT Configurations is explained, several device settings affect the precision of the CBCT image and the resulting reconstruction of the 3D model, including: kVp regulates the energy of X-rays utilized in imaging.(25) mA regulates how much X-ray current is utilized. The region of interest that is being scanned is defined by the field of view (FOV) The 3D image's level of detail is determined by voxel size. Greater detail can be obtained with smaller voxels, but radiation exposure is higher. (26)(27)Suture techniques, flap design, and treatment planning are critical surgical elements that may influence the success of dental and craniofacial implant procedures(28–30).

In summary, the interpretation of CBCT scans necessitates taking into account the possibility of data loss owing to

technological constraints and the influence of CBCT device settings, particularly in areas with substantial bone density.(6)(31)

A comprehensive 3D surface model of the tooth obtained from the CBCT scan is necessary for the creation of a RAI. It's crucial that the root area remains "intact. Damage is a common reason for teeth that require replacement. When there is significant damage to the original tooth, creating a mirrored 3D surface model using the contra-lateral tooth may be able to help. It may be possible to create a mirrored RAI of the contralateral even in cases when teeth have just been extracted. However, it is important to take into account variations between teeth and their contralateral(6)(32)]

5. CONCLUSION

Root analogue implants are the way forward as they mimic the tooth structure. These are a type of Bio-implants that require analyzing the dimensions of the socket for fabrication of root analogue implants. There is a need to analyze the dimensions of the socket for the pre-fabrication of the RAI, this provides the detailed dimensions necessary for the fabrication for the particular population.

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