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A Comparative Measurement of Edentulous Bone Between Cone Beam Computed Tomography vs. Dentascan CT in Implant Patients: In Vivo Study

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Abstract

Aim: To compare the linear and mesiodistal measurement of alveolar edentulous bone between CBCT and Dentascan CT. Vivo-comparative study. **Materials and Methods:** 30 implant patients were selected among the partially edentulous ridge in pre-maxillary region. After using a radiographic stent splint (3×3 mm square), a CBCT and Dentascan was scanned. Linear and mesiodistal radiographic evaluations were performed from a built-in software tool. The student unpaired t-test was used for finding significant difference in between and within group. P-value less than 0.05 was considered to be statistically significant. **Results:** Linear Radiographic Evaluation by Dentascan was 20.75 ± 2.14 and by CBCT was 20.86 ± 2.18, Mesiodistal Radiographic Evaluation by Dentascan was 6.71 ± 0.70 and by CBCT was 6.79 ± 0.70. **Conclusion:** The linear assessment of the implant site taken on Dentascan was almost similar to that recorded on CBCT and P-value is not significant (>0.05).

Keywords: Cone Beam Computed Tomography (CBCT), Dentascan CT, Mesiodistal and Sagital Buccolingual Measurement and Pre-maxilla

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1. Introduction

Dental implants are becoming more well-known and accepted as they are the conservative way of replacing lost teeth, restoring function with proprioception and restoring esthetics[1], For success with long-term, it is necessary to position the implants in the mandible and maxilla with a high degree of precision[2], The growing prevalence of edentulism among the elderly has resulted in an increase in the number of imaging investigations conducted to assess the dental implant site[3], Radiographic assessment is very crucial for the evaluation of bone support for endosseous dental implants. Various radiographic intraoral and extraoral techniques such as periapical radiography, occlusal radiography, panoramic radiography and motion tomography are utilized for the evaluation of implant recipient site[4]. Pre-implant bone examination with the best imaging technology should have features such as visualizing implant site in the superior-inferior, mesiodistal and buccolingual dimensions which should aid in evaluating bone density, accessibility and minimal radiation risk[3].

Presently, the preferred technique for linear measurement of dental implant site is Dental Computed Tomography (Dentascan) and CBCT. Multiplanar CT and CBCT express the amount of bone in three dimensions and assess the location of critical anatomic structures like mental foramen, inferior alveolar nerve, mandibular canal, maxillary sinus, incisive foramen and base of nasal cavity. It also assesses the quality of bone with minimal distortion. It eliminates the drawbacks of conventional X-ray techniques, such as superimposing the anatomic structures and distortion, injury of the neurovascular bundle and perforation of the maxillary sinus[3].

Determining the correct three-dimensional position, this is one of the important steps in planning for dental

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implants. Radiographic guides are an indispensable part of dental implant therapy. Their precision is essential for preparing the final implant site and the subsequent reconstruction[5]. The existing study compared CBCT and Dentascan Computed Tomography for measuring alveolar edentulous bone linearly.

2. Material and Methods

The existing cross-sectional in-vivo study was conducted in Department of Prosthodontics. A total of 30 implant patients were selected which satisfied the inclusion and exclusion parameters. The cross-sectional sampling method was taken from the OPD attendance of implant patients.

2.1 Inclusion Criteria

Patients with partially edentulous ridge in pre-maxillary region.

2.2 Exclusion Criteria

Fractured Maxilla, localized periapical pathologies and General systemic condition relating to bone pathology and metabolic system.

2.3 Clinical and Laboratory Procedure

The patients with lost Left CI (Central Incisor) were chosen for the study (Figure 1A). The diagnostic imprint of edentulous ridge was made from irreversible hydrocolloid (Algitek, DPI, Mumbai) impression material. Dental stone (Kalabhai, Mumbai) was mixed using vacuum mixing machine and the impression was poured on the dental vibrator. The cast obtained was trimmed and finished. Cold mould seal (Acryton, Orthoplast, khurja) was applied over the model and left to dry. The autopolymerising acrylic resin (Pyrax, Roorkee, UK) stent was fabricated along with missing teeth to be replaced. Using a digital calliper, a pre-measured channel with dimension of 3 × 3 mm was made along the labiolingual and mesiodistal centre of the tooth. The gutta-percha marker was obturated in this channel using endodontic condenser. The stent was finished and polished (Figure 1B). Then, it was placed in the patient's mouth (Figure 1C). The Dentascan images (GE Healthcare Japan Corporation-Tokyo, Japan) (Figure 2A) and the CBCT images (CS 9300, Carestream Dental, France) (Figure 2B) of the implant site were scanned. Analysis of Dentascan images was done by Dentascan software (RadiAnt DICOM viewer) while the analysis of CBCT images was done using CBCT software (Cs 3D imaging software). The built-in tool was used to evaluate linear (Figure 3A, Figure 4A) and mesiodistal (Figure 3B, Figure 4B) radiographic dimensions in Dentascan and CBCT where gutta-percha markers were visible. The data was recorded by calibrating the bone length starting with crest of alveolar ridge to anterior nasal spine.

3. Results

The data were tabulated and statistical analysis is done with Statistical Package for Social Sciences (SPSS) version 22. The result was present in the form of mean and standard deviation. The student unpaired t-test was used to find significant difference in between and within the group at different visits. The gained P-value less than 0.05 was measured statistically significant.

Patients mean age was 31.53 ± 10.32 years. Out of 30 patients 56.7% were male and 43.3% were female. Linear Radiographic Evaluation by Dentascan was 20.75 ± 2.14 mm and by CBCT was 20.86 ± 2.18 mm, Mesiodistal Radiographic Evaluation by Dentascan was 6.71 ± 0.70 mm and by CBCT was 6.79 ± 0.70 mm (Table 1).

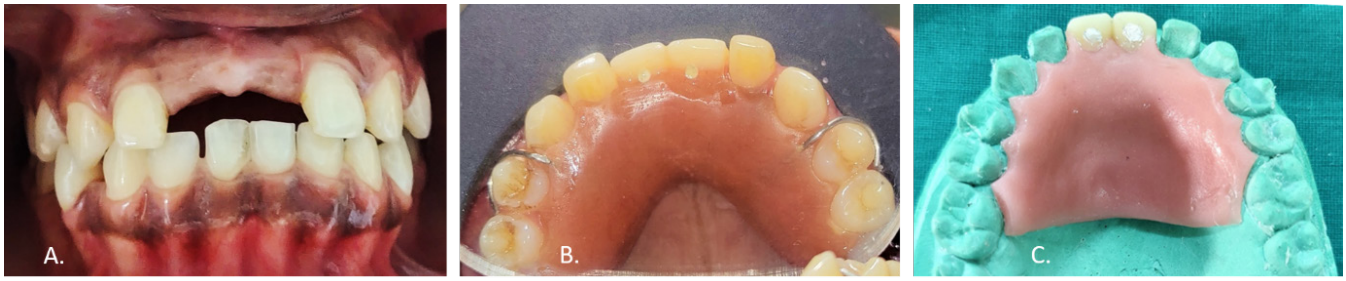


Figure 1. A. Intraoral view of patient with missing central incisors; B. Stent in patient's mouth. C. Stent with radiographic marker.



Figure 2. A. CT (Dentascan) Machine GE Healthcare Japan Corporation, Tokyo, Japan; B. CBCT Machine CS 9300, Carestream Dental, Atlanta, GA.

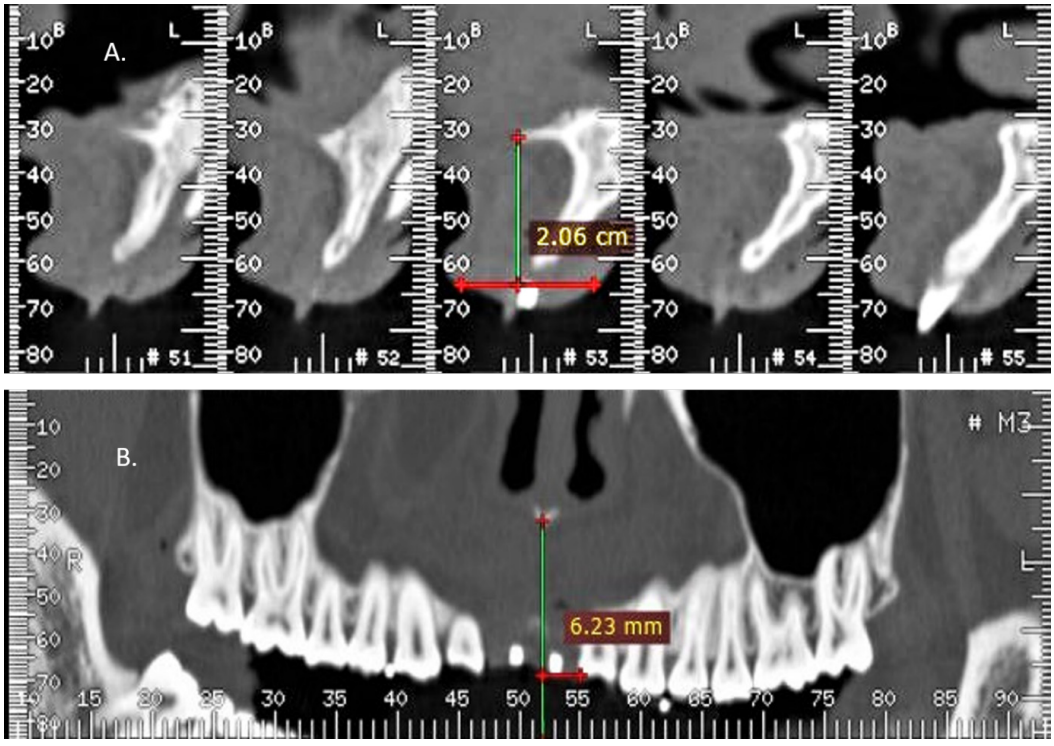


Figure 3. **A.** Linear radiographic evaluation in Dentascan; B. Mesiodistal radiographic evaluation in Dentascan.

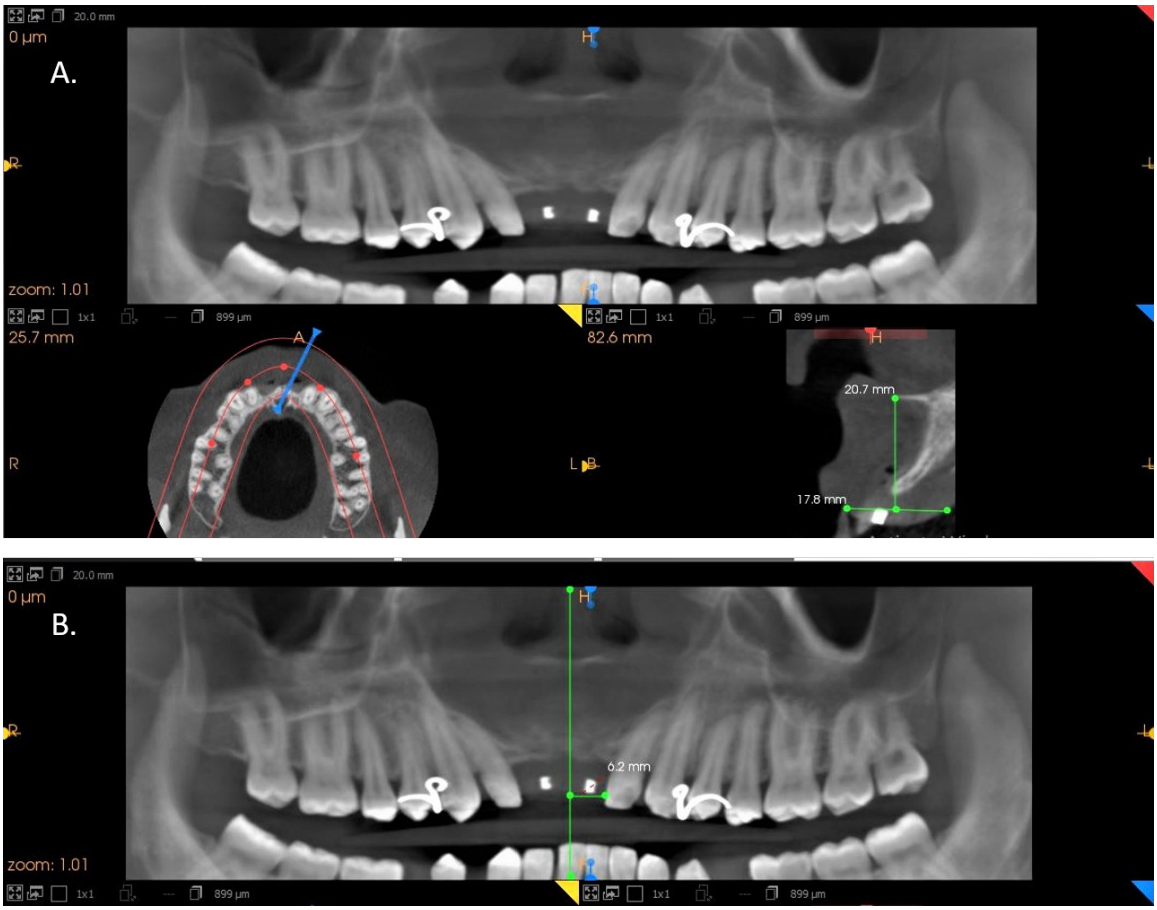


Figure 4. A. Linear radiographic evaluation in CBCT; B. Mesiodistal radiographic evaluation in CBCT.

Table 1. Descriptive data for linear and Mesiodistal measurement, Dentascan and CBCT

Variables	Mean ± SD
Age(in years)	31.53 ± 10.32
sex	**Nunber (%)**
Male	17(56.7%)
Female	13(43.3%)
Linear Radiographic Evaluation	**Mean ± SD**
Dentascan	20.75 ± 2.14
CBCT	20.86 ± 2.18
Mesiodistal Radiographic Evaluation	**Mean ± SD**
Dentascan	6.71 ± 0.70
CBCT	6.79 ± 0.70

Table 2. Comparison of Linear Radiographic Evaluation in Dentascan and CBCT

	Linear Radiographic Evaluation		
	Mean ± SD	**t-value**	**p-value**
Dentascan	20.75 ± 2.14	0.1893	0.850#
CBCT	20.86 ± 2.18		

#statistically not significant.

Table 3. Comparison of Mesiodistal Radiographic Evaluation inDentascan and CBCT

	Mesiodistal Radiographic Evaluation		
	Mean ± SD	**t-value**	**p-value**
Dentascan	6.71 ± 0.70	0.4733	0.085#
CBCT	6.79 ± 0.70		

#statistically not significant.

Linear Radiographic Evaluation by Dentascan was 20.75 ± 2.14 mm and by CBCT was 20.86 ± 2.18 mm, Linear Radiographic Evaluation was almost same by both Dentascan and by CBCT and there was no significant difference in linear radiographic evaluation between Dentascan and CBCT (Table 2, Figure 5A).

Mesiodistal Radiographic Evaluation by Dentascan was 6.71 ± 0.70 mm and by CBCT was 6.79 ± 0.70 mm, Mesiodistal Radiographic Evaluation was almost same by both Dentascan and by CBCT and there was no significant

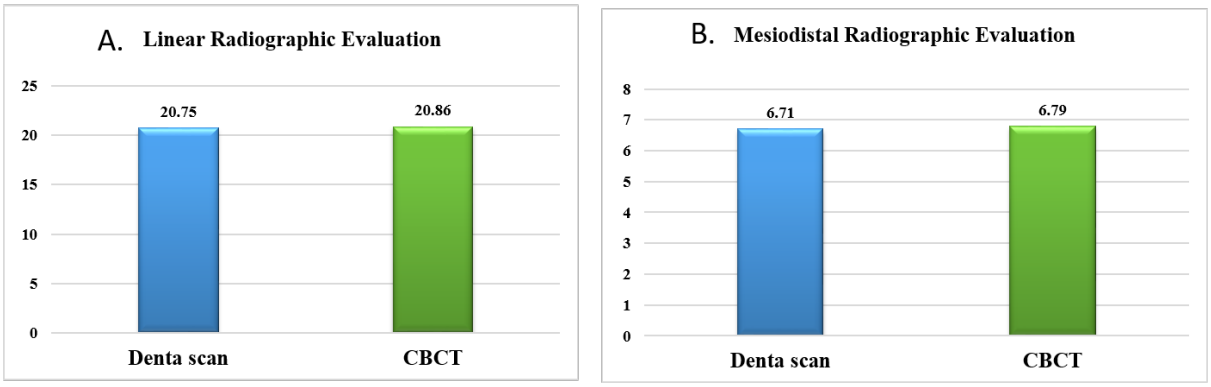


Figure 5. A. Graph depicts comparative A. Linear and B. Mesio-distal Radiographic Evaluation by Dentascan and by CBCT, no significant difference found.

difference in mesiodistal radiographic evaluation in Dentascan and CBCT (Table 3, Figure 5B).

4. Discussion

Implant dentistry is retaining attention for the past few years due to its clinical competence and the current scientific and surgical advancement[7]. The successful placement of an implant requires a thorough clinical and radiographic evaluation[6]. Abrahams JJCT suggested that it is essential to do the imaging techniques that precisely determine the size and location of incisive canals, nasal fossa, maxillary sinus, mandibular canal and bone density at implant site[8]. Modern technology has allowed the implantologists to accurately assess the implant recipient site and plan successful surgical treatment with an appropriate prosthesis[7].

Radiographs with occlusal, periapical and panoramic view all been used to help in implant diagnosis and treatment planning. The drawback of these modalities is to provide a 2D representation of the 3 Dimensional (3D) structures[9]. Several types of implant modules use computerized imaging technology for the propose of proper positioning of the implant[7],. A three-dimensional assessment is essential to identify anatomical structures[10], Visconti *et al.* proposed that the opening of CBCT in dento-maxillofacial radiology has established in fundamental change from planar two-dimensional to volumetric three-dimensional radiographic visualization[11,12].

As the radiographic technique preference differs among the implantologist, the advocated technique compares Dentascan with CBCT. The cross-sectional study was processed to compare the linear and mesiodistal dimensions for determining the accuracy of both techniques. By this tool, implantologist can choose the required imaging technique depending on the availability.

In advocated research study, the mapping of the bone which is available is measured from crest of edentulous ridge to anatomic landmarks as nasal crest that restrict placement of implant. The evaluation and measurement of the length of implant should allow for an appropriate safety margin of 2 mm approximately, especially since many drills are made to prepare the implant site for a little longer than the chosen implant. At least bone of 2 mm should be present in between apical end of the implant and neurovascular structures[1]. Most importantly anatomical structures should be observed before planning implant length as in maxilla are maxillary sinus floor, floor of nose, anterior nasal spine. While in mandible are mental foramen, roof of inferior alveolar canal, submandibular fossa. The adjacent teeth root would be considered for proper space management.

In this study, mean length of alveolar bone, as measured in Dentascan, was found to be 20.75 mm while mean length of alveolar bone as measured on CBCT scans was found to be 20.86 mm. There was no statistically significant difference in mean length between the two study groups, as the p-value was found to be 0.850. This implies that the linear dimension, as measured in Dentascan, was almost similar to the dimension measured on CBCT. From adjacent teeth the implant should be at least 1.5 mm away and from adjacent implant at least 3 mm away[13].

In this study, the mean mesio-distal length as measured in Dentascan was 6.71 mm while on CBCT scans was to be 6.79 mm. There was no significant difference statistically in the mean length between the two study groups, as the p-value was found to be 0.085 mm. This means that the

mesio-distal dimension, as measured in Dentascan, was almost similar to the dimension measured on CBCT.

In the current study, the surgical splint with markers which are radiopaque (Gutta-percha stick) was used as a reference point. It is assumed that surgical guides should be made after the proper diagnosis and prosthetic planning as it helps in guiding the surgeon for precise location and angulations of the implant during placement in accordance to natural dentition which is remaining and residual alveolar ridges. The surgical template can fulfil dual purposes as a radiograph measuring device and a surgical stent[14].

In acceptance to this study, Loubele *et al.* Evaluated precision of CBCT and Multislice CT for linear jaw bone measurement and found that there was no difference present statistically between the measurements on CBCT and MSCT[15]. Pena de Andrade *et al.* (2016), Freire-Maia *et al.* (2017), found there were no differences significantly in accuracy between CBCT imaging and MSCT regarding accuracy of linear measurements and reported sub-millimetre error ranges for both radiographic techniques[16]. In their study it is concluded that fan beam CT delivers superior pictures than cone beam CT scanners while exposing the patient to significantly less radiation[16].

Based on these studies, it is obvious that each of the imaging technologies has various benefits and drawbacks, depending on the area to be evaluated, linear measurement accuracy, radiation dose and bone mineral density. CBCT offers a remarkable approach if intra-osseous anatomic landmarks, such as mandibular canal ornasopalatine canal have to be assessed[15].

Finally, the current study does not exhibit a difference significantly between the linear and mesiodistal measurements recorded on CBCT (Cone-beam Computed Tomography) and CT (Computed Tomography).

5. Conclusion

In this current study, Dentascan Computed Tomography has been compared with the CBCT to measure the length starting with crest of alveolar ridge to anterior nasal spine. A stent was fabricated with radiopaque markers of dimension 3 × 3 mm and it was measured by Vernier caliper. The stent showed no distortion when viewed in Dentascan and CBCT.

The following points it can be concluded from present study that:

- There is no difference significantly between the stent's physical measurements taken by verniercaliper and the radiographic measurements of the stent recorded on Dentascan and CBCT.
- The linear dimension of implant site taken on Dentascan was almost similar to that recorded on CBCT and P-value is not significant (>0 .05).
- The mesiodistal dimensions showed high similarity in Dentascan and CBCT and P-value is same (P >0.05).

Dentascan and CBCT provide valuable information in the preoperative evaluation of jaw for implants. It aids in evaluating the height and angulation of the alveolar ridge, its buccolingual dimension, relation with adjacent structures and quantitative evaluation of bone density at the implant site. Accurate preoperative planning may prevent implant failures, thus preventing mental trauma to the patient. The CBCT provides the rapid achievement of data with very less radiation exposure. The considering the socio-economic scenario and availability of the CBCT machine in India, both the Dentascan CT and CBCT can be used for the radiographic assessment of implant site.

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