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EVALUATION OF THE ACCURACY OF CONE BEAM COMPUTED TOMOGRAPHY IN MEASURING THE WIDTH OF THE ALVEOLAR RIDGE IN A PARTIALLY EDENTULOUS REGION

Dental Science

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ABSTRACT

The accuracy of CBCT measurements is questionable due to the various errors incorporated during the imaging process. An investigation needed to be carried out to study the extent of these errors in measuring ridge width. Hence this study was designed to investigate the accuracy of ridge measurements obtained through Cone Beam Computed Tomography by comparing these values to those obtained through ridge mapping using a modified digital Vernier caliper. *Materials and Method:* 15 patients were selected that required replacement of a missing. mandibular first molar with implants. A radiographic stent was fabricated over the edentulous span resulting from a missing mandibular 1st molar. A CBCT was taken with this stent in place and the same stent was used as a guide for ridge mapping. The resultant reading were tabulated and compared. *Results:* Therefore this study shows measurements obtained via CBCT do not accurately represent the actual width of the ridge in a majority of the cases. The practitioner should keep a margin of error of approximately 0.1-0.2mm while planning implant surgeries when relying solely on a CBCT, according to the results of this study.

KEYWORDS

Implant- CBCT, Ridge Mapping, Implant, Digital Caliper, Ridge Width

Introduction:
With the advent of CBCT, dental implant planning has become simpler and more accessible to a wider array of practitioners. The simplicity and convenience that 3D imaging provides has led practitioners to become totally reliant on them for implant planning.

The measurement of alveolar ridge dimensions can also be accomplished using ridge-mapping or direct caliper measurements. Being a direct physical measurement, this method is considered the most accurate.

Hence this study was designed to investigate the accuracy of ridge measurements obtained through Cone Beam Computed Tomography by comparing these values to those obtained through ridge mapping using a modified digital Vernier caliper.

MATERIALS AND METHOD:
The materials used for the study are divided into the following:
1. Materials, instruments and equipment for obtaining working models

a) Irreversible hydrocolloid impression material.
b) Type III Gypsum Dental Stone
c) Flexible rubber bowl
d) Rigid rubber bowl
e) Straight and curved spatulas
f) Perforated metal tray

2. Materials, instruments and equipment for fabrication of radiographic stent

a. Separating Medium
b. Self-Cure Acrylic
c. Gutta Percha Points
d. Silicone mixing cup
e. Wax knife
f. Lecron carver
g. Straight micromotor handpiece
h. Acrylic trimming bur
i. No. 6 round bur

3. Equipment for radiographic evaluation

a. CBCT machine
b. CS 3D Imaging software
c. Laptop

4. Materials, instruments and equipment for measuring width of the bone

a. 2% Lignocaine HCl with 1:80000 Adrenaline
b. Sterile needle and syringe
c. Modified digital Vernier caliper

15 patients were selected from the OPD of Department of Prosthodontics according to the inclusion criteria for the study.

The inclusion criteria were as follows:

1. Patients who present with one or both missing mandibular first molars with the adjacent second premolar and second molar present.
2. Patients who present with a well healed edentulous span.
3. Patients who have opted for and have been approved clinically and medically to undergo a dental implant procedure to replace the same.
4. Patients who have given their informed consent to participate in the study.

A well extended impression was made using an irreversible hydrocolloid recording the edentulous area and its adjoining buccal and lingual sulci. The impression was immediately poured in Type IV dental stone. The model was then retrieved and a stent was made with clear acrylic covering the edentulous ridge and extending to the deepest part of the sulcus as well as the occlusal and middle thirds of one adjacent tooth on each side. The stent was retrieved carefully and finished. One hole was made on the buccal and lingual aspect respectively with a no. 6 round bur corresponding to the centre of the mesio-distal width of the edentulous space and the deepest portion of the sulcus that had been recorded. These holes were then sealed with warm gutta percha points.

The customized stent was tried in the patient's mouth. It was ensured that the stent fits smoothly and seats firmly on the teeth adjacent to the edentulous area. A CBCT was performed with the customized stent to record the area of interest according to the manufacturer recommended standardized procedure. The patient is positioned such that the Frankfurt Horizontal plane is parallel to the floor and the Mid-Sagittal plane is perpendicular to the floor. The area of interest is positioned within the focal trough and the facial planes coinciding with the laser beams for ideal patient head positioning and orientation.

The bucco-lingual dimension was measured in the resultant scan report from the outer limits of the bony cortices as a straight line between the two gutta percha points and not from the inner border of the radiopaque markers due to the intervening soft tissue thickness. The values obtained were noted and tabulated.

At the time of surgery, the gutta percha points were removed from the stent using a heated instrument. The patient was anaesthetised by infiltration technique using 2% Lignocaine HCl with 1:80000 Adrenaline and the stent was placed back in the mouth. A modified, digital Vernier caliper was used to measure the bucco-lingual dimension of the ridge by placing the two probes of the caliper into the holes that were previously occupied by the gutta percha, until contact was made with bone. The values obtained were then tabulated and analysed statistically.

RESULTS:

Table 1: Showing the readings obtained through CBCT and RM.
Table 2: Showing paired sample statistics
Table 3: Showing paired sample correlations

Table 1: Readings Obtained Through Cbct And Rm In Millimetres

CBCT	RM
8.1	7.9
6.4	6.3
7.5	7.2
7.2	6.9
6.9	6.8
6.3	6.1
5.7	5.7
7.8	7.6
5.1	5.0
6.6	6.6
5.4	5.3
6.8	6.6
7.0	6.9
5.5	5.4
6.2	6.1

TABLE 2: Descriptive Statistics

	Mean	N	Standard Deviation	Standard Error Mean
CBCT	6.57	15	0.89	0.23
RM	6.43	15	0.84	0.22

TABLE 3: Paired Sample Correlations

	N	Correlation	p-value
CBCT & RM	15	0.99	0.000

The results showed a statistically significant difference between CBCT and ridge mapping with a mean difference of 0.14mm ±0.05mm

DISCUSSION:

Meticulous planning is an indispensable component of long term clinical success for dental implant treatments. Even before an incision is made, the clinician must have comprehensive knowledge of the surgical field, surrounding anatomy and volume of bone at the recipient site. The use of CBCT scans provides the clinician with the required information which is unparalleled by other methods of measuring the ridge width. But for any new technology or method to be accepted, it must be evaluated against the ones that are already established.

Upon examining the results, it was found that 87% of the readings showed CBCT measurements were more than RM measurements and 13% of the readings showed CBCT measurements equal to RM measurements. The mean CBCT readings were 6.57mm ± 0.89mm. The mean RM readings were 6.43mm ± 0.84mm. A mean difference of 0.14mm ± 0.05mm was found between CBCT and RM readings. The 'p' value was found to be less than 0.005 thus indicating a statistical difference between the readings obtained via these methods.

imension in only 2 of 15 cases (13%).
Chen et al[10] observed deviations within 1 mm for 70% and 55% for examiner 1 and 2, respectively. Teresa et al[14] found that in cases with adequate ridge height, CBCT readings were favourable in 12 of 15 cases (92%) whereas in cases where ridge height was inadequate, the CBCT readings were favourable in only 1 of 46 cases (2%). The results put forth by Chugh et al[13] show that the alveolar ridge dimensions measured by direct surgical exposure and CBCT were same at point 1(3mm from the crest of the ridge) and point 2 (6mm from the crest of the ridge).

Thus CBCT can be recognized as an important adjunct in implant planning but clinicians should be aware of the margin of error of 0.14mm ± 0.05mm, according to this study, and therefore account for the same to ensure long term clinical success.

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