Reliability of Orthopantomography and Cone-beam Computed Tomography in Presurgical Implant Planning: A Clinical Study

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ABSTRACT

Background: Preoperative diagnosis and treatment planning are fundamental requirements to ensure success rate of implant. Cone-beam computed tomography (CBCT) provides all three dimensions and has been proved as a tool for radiology, especially in the success of implant. This study was conducted to evaluate the reliability of orthopantomography (OPG) and CBCT in presurgical implant planning.

Materials and methods: The study was conducted on 110 partially or completely edentulous adult patients (male 50 and female 60). Patient information regarding name, age, gender, and so forth was recorded. Thorough clinical examination was done to locate the edentulous site for the placement of implant. All patients were subjected to OPG and CBCT.

The OPG was taken with digital panoramic unit (Planmeca) operating at 120 kVp, 2 mA, and exposure time of 17 seconds. The CBCT was taken using NewTom machine with field of view 11 × 8 cm and resolution of 0.3 × 0.3 × 0.3 mm operating at 120 kVp at 5 mA. NNT software with slice thickness of 0.1 mm was used in this study.

Measurement of bone height and distance from anatomical structures was done on OPG, whereas bone height and bone width were measured on CBCT scan in all three planes, such

as coronal plane, sagittal plane, and axial plane. The measurement was done by two experienced observers.

Results: The present study comprised 110 patients (male 50 and female 60). About 102 (16.7%) implants were placed in anterior region, and 508 (83.3%) implants were placed in posterior region. Implant site was incisor region (55), canine (30), premolar (250), and molar (275). The difference was significant ($p < 0.01$). Variations are usually observed in presurgical planning with CBCT and OPG. The length and width of implant remained unchanged in 90 and 85% of the cases respectively. In 8% of cases, OPG revealed more length of implant than CBCT, whereas only in 2% cases CBCT revealed more length of implant than OPG. The difference was significant ($p < 0.05$). When we compared the diameter, OPG revealed more diameter in 10% of cases, whereas CBCT only revealed 5% of cases. The difference was significant ($p < 0.05$). Observer found CBCT as effective in 95% of cases and ineffective in only 5% of cases, whereas OPG was effective in 78% of cases and ineffective in 22% of cases. The difference was significant ($p < 0.05$).

Conclusion: The CBCT being three-dimensional provides detailed information that two-dimensional radiographs cannot offer, which aids in precision to further improve the entire implant process.

Clinical significance: In recent times, implant has become the treatment of choice for edentulous patients. The CBCT has increased the success rate of implant due to its high resolution, ability to demonstrate anatomical structures more effectively than other radiographic diagnostic tools.

Keywords: Bone height, Cone-beam computed tomography, Orthopantomography.

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INTRODUCTION

Implants have emerged as new treatment modalities for partially or completely edentulous ridges. The placement of implant provides benefit to patient as it requires good

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esthetic results and no crown preparation as is done in case of fixed partial denture. Preoperative diagnosis and treatment planning are fundamental requirements to ensure success rate. Precise radiographic assessment of available alveolar bone and identification of characteristic bone morphology are of prime importance for dental implant placement.¹ The distance of anatomical structures, such as mental foramen, floor of nasal cavity, floor of maxillary sinus, inferior alveolar canal, nerves, and vessels can significantly affect the morbidity of the surgical procedure and influence the outcome.² Earlier, the implant site was assessed with the help of two-dimensional (2D) imaging modality, such as intraoral periapical radiograph and panoramic radiographs. Since these imaging modalities are 2D, there are restrictions of implant planning leading to implant failures. With the advent of cone-beam computed tomography (CBCT), this limitation has been overcome.³ The CBCT provides all three dimensions (3D) and has been proved as a tool to radiology, especially in the success of implant. It provides high spatial resolution and offers less patient exposure as compared with full mouth radiographs and computer tomography. The CBCT images become essential when there is proximity of area to vital structures. Clinical method for assessing edentulous ridges transversely is ridge mapping, in which sharp-beaked calipers are used to measure the faciolingual width of the residual bony ridge at the proposed implant site.⁴

This study was conducted to evaluate the reliability of orthopantomography (OPG) and CBCT in presurgical implant planning.

MATERIALS AND METHODS

This study was conducted in the year 2010. It was conducted on 110 partially or completely edentulous adult patients (male 50 and female 60). Patient information regarding name, age, gender, and so forth was recorded.

Fig. 1: Implant planning on OPG

Thorough clinical examination was done to locate the edentulous site for the placement of implant. All patients were subjected to OPG and CBCT.

The OPG was taken with digital panoramic unit (Planmeca) operating at 120 kVp, 2 mA, and exposure time of 17 seconds. The CBCT was taken using NewTom machine with field of view 11 × 8 cm and resolution of 0.3 × 0.3 × 0.3 mm operating at 120 kVp at 5 mA. NNT software with slice thickness of 0.1 mm was used in this study. Measurement of bone height and distance from anatomical structures was done on OPG (Fig. 1), whereas bone height and bone width were measured on CBCT scan in all three planes, such as coronal plane, sagittal plane, and axial plane (Figs 2–5).

Since OPG is 2D, buccolingual assessment is not possible. In CBCT (3D) apart from measuring the height, diameter of implant was done in all three planes.

The measurement was done by two experienced observers. Results thus obtained were subjected to statistical analysis; $p < 0.05$ was considered statistically significant.

RESULTS

Table 1 shows that the present study comprised 110 patients (male 50 and female 60). Graph 1 shows that 102

Figs 2A and B: Implant planning on CBCT

Figs 3A and B: Assessment of available bone height and width on CBCT

Fig. 4: Measurement of height of bone and implant

Fig. 5: Measurement of width of bone and implant

(16.7%) implants were placed in anterior region and 508 (83.3%) implants were placed in posterior region. Graph 2 shows that implant site was incisor region (55), canine (30), premolar (250), and molar (275). The difference was significant ($p < 0.01$). Table 2 showed presurgical planning variations with CBCT and OPG. The length and width of implant remained unchanged in 90 and 85% of the cases respectively. In 8% of cases, OPG revealed more length of implant than CBCT, whereas only in 2% cases CBCT revealed more length of implant than OPG. The difference was significant ($p < 0.05$). When we compared the diameter, OPG revealed more diameter mesiodistally in 10% of cases, whereas CBCT only revealed increased diameter in 5% of cases measured both from mesiodistal

and buccolingual aspect. The difference was significant ($p < 0.05$). Graph 3 shows that the observer found CBCT effective in 95% of cases and ineffective in only 5% of

Table 1: Distribution of patients

Total – 110 patients		
Gender	Male	Female
Number	50	60

Graph 1: Distribution of implant site **Graph 3:** Image quality of OPG and CBCT as observed by observer

cases, whereas OPG was effective in 78% of cases and effective in 22% of cases. The difference was significant ($p < 0.05$).

DISCUSSION

With the advent of CBCT, the implant planning has become easy. Suitable treatment planning is a basic step of implant therapy for the selection of an implant with the appropriate size, dimensions, and location. With 2D imaging modality, such as OPG, one cannot evaluate the complexity of the bone volume because of superimposition of the different structures. There is limitation of assessment of bone volume and orientation with OPG.⁵ This study was conducted to evaluate the reliability of OPG and CBCT in presurgical implant planning.

Table 2: Variation on presurgical planning with panoramic radiography (OPG) and CBCT (n = 610)

Length of implant	Number (%)	Diameter of implant	
		OPG = CBCT	Number (%)
OPG = CBCT	549 (90)	OPG = CBCT	519 (85)
OPG > CBCT	48 (8)	OPG > CBCT	61 (10)
OPG < CBCT	13 (2)	OPG < CBCT	30 (5)

Graph 2: Position of implant

The present study comprised 110 patients (male 50 and female 60). In 16.7%, implants were placed in anterior region and in 83.3% implants were placed in posterior region. In their study, Loubele et al⁶ compared OPG with CBCT in implant planning. Implant planning was done in 35% of anterior region and 65% of posterior region.

Implant site was incisor region (55), canine (30), premolar (250), and molar (275).

We also compared presurgical implant planning variations with CBCT and OPG. The length and width of implant remained unchanged in 90 and 85% of the cases respectively. In 8% of cases, OPG revealed more length of implant than CBCT, whereas only in 2% cases CBCT revealed more length of implant than OPG. Our results are in agreement with the results of Correa et al⁷ who studied implant size (width and length) planned with digital panoramic radiographs, CBCT in 71 patients with a total of 103 implant sites in the upper premolar and/or lower molar regions. They observed that the implant-to-be was significantly narrower and shorter when recorded in CBCT-cross than in digital panoramic radiography (D-PAN). For premolar sites, the width also differed significantly between D-PAN and CBCT-pan modalities. The implant-to-be was also significantly shorter when recorded in CBCT-cross than in D-PAN. In premolar sites, there were no significant differences in implant length among the three image modalities.⁷

A study conducted by Chen et al⁸ found that the length and width of implant remained unchanged in 60 and 75% of the cases.

When we compared the diameter, OPG revealed more diameter in 10% of cases, whereas CBCT only revealed 5% of cases.

Baba et al⁹ in their study also found similar results. However, Peker et al¹⁰ in their study found that in 24% of cases OPG revealed more diameter of implant, whereas only 4% of cases CBCT showed more diameter.

Observer found CBCT as better in 95% of cases and poor in only 5% of cases, whereas OPG was better in 78% of cases and poor in 22% of cases. Kullman et al¹¹ in their study found CBCT as good in 81% of cases in demonstrating anatomical structures more effectively.

Miles and Danforth¹² showed that conventional tomography had little effect on the treatment planning of implant dimensions in posterior mandible cases. In their study, treatment plans with and without tomograms were identical in 91% implant sites. In only 9% of these cases, implant diameters had changed, while no changes occurred in the implant length after the use of tomograms.

Naitoh et al¹³ reported that CBCT images were significantly better than OPG with respect to the visualization and delineation of the lamina dura and the periodontal ligament space.

CONCLUSION

Successful implant placement can be ensured by taking into account the patient's prosthetic needs, functional requirements, and anatomical constraints. During the assessments, CBCT being 3D contributes to a greater success rate due to its ability to visualize previously undetectable anatomic variability and pathology. The CBCT-generated images provide detailed information that 2D radiographs cannot offer, which aids in precision, to further improve the entire implant process.

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