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Digital OPG vs CBCT in Implant Placement in Edentulous Patients

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Abstract

The process by which implant attach to the bone is called osseointegration. The term osseointegrtion was defined by Branemark as a direct contact of living bone with the surface of an implant at the light microscopic level of magnification. The placement of implant is defined by the three dimention mesiodistallly, coronapically and buccolingually in which it is divided into two zones; the comfort zone and the danger zone. The comfort zone is the ideal position for an implant placement in which the ideal mesiodistal of space between the nature tooth and the shoulder of implant should be 1-1.5mm. The zone up to or less than 1-1.5mm from the adjacent teeth to the shoulder of implant is called the danger zone. In buccolingual dimensions the facial bone thickness should be at least 2mm and the lingual bone thickness should be at least 1.5mm. If the implant is placed in the danger zone can cause bone loss and black triangles of the papilla which can lead to the implant failure.

A radiographic examination can help us to determine the status and anatomy of the implant which can be done by radiovisiography, orthopantomography and cone beam computered tomography. In this study our aim is to evaluate the accuracy of panoramic radiography (OPG) and cone beam computed tomography (CBCT) to precisely portray vital structure and osseointegration in conventional implant placement.

Material and method: This retrospective, randomized study was conducted in the department of Oral and Maxillofacial Surgery, Indira Gandhi Govt Dental College, Jammu after attaining the ethical clearance. A total of 32 implants were involved in this study in which all the patients undergo both the group A(OPG) and group B(CBCT).In which evaluation of osseointegration and vital structure were made after 1 week and 3 month after conventional implant placement.

Result: In this retrospective study, the mean age distribution of group A was 25.23 years, while group B has a mean age of 26.37 years. Out of all the patients 50% was male and 50% was also female with equally distributed among the group. The comparison of crestal bone measurements (mesial) using OPG and CBCT showed significant differences. OPG measurements were 1.05 ± 0.14 mm at 1 week and 1.06 ± 0.13 mm at 3 months, with a mean difference of 0.12 mm while in the distal site OPG group, the mean measurements were 0.99 ± 0.15 mm at 1 week and 0.98 ± 0.13 mm at 3 months, with a mean difference of 1.21 mm. The comparison of distance from vital structures between OPG and CBCT revealed significant differences.

Conclusion: As differences between CBCT and panoramic radiographs were statistically significant, CBCT is more accurate and reliable. CBCT is recommended to be used as an assessment tool to minimise injury and assessment of osseointegration of implant for implant placement. As CBCT gives us a 3 dimensional view in all the saggital, axial and coronal plane for implant placement.

Keywords: CBCT, Danger Zone, Injury, Osseointegrtion, Radiovisiography

Introduction

Implant has been an emerging and a routinely dental procedure in the world of dentistry. When the teeth are lost or being extracted there is alveolar atrophy in which reduction in bone occur at buccolingual as well as apicocoronal dimension at the edentulous site, this may lead to the functional and aesthetically problem for the patients [1]

The process by which implant attach to the bone is called osseointegration. The term osseointegrtion was defined by Branemark as a direct contact of living bone with the surface of an implant at the light microscopic level of magnification [2]. An implant is said to be osseointegrated when an implant is in direct contact with the bone with no relative movement between the implant and the bone [3]. Implant placement is a very technique sensitive which required a proper pre-surgical and prosthetic planning for the success of implant placement and to prevent injury to the vital structures. The placement of implant is defined by the three dimention mesiodistallly, coronapically and buccolingually in which it is divided into two zones; the comfort zone and the danger zone

The comfort zone is the ideal position for an implant placement in which the ideal mesiodistal of space between the nature tooth and the shoulder of implant should be 1-1.5mm. The zone up to or less than 1-1.5mm from the adjacent teeth to the shoulder of implant is called the danger zone [4] (figure 1). The mesiodistal distance between both the implants should be at least 3 mm. In the apicocoronal direction the apex of the

implant should be at least 1-2 mm away from the any anatomical structure such as nerve, sinus. The shoulder of the implant should be al least 1mm apical to the cementoenamel junction of the adjacent teeth or crest of the bone (figure 2) [5] In buccolingual dimensions the facial bone thickness should be at least 2mm and the lingual bone thickness should be at least 1.5mm [5]. If the implant is placed in the danger zone can cause bone loss and black triangles of the papilla which can lead to the implant failure. After implant placement marginal loss around the implant occur and it should be less than 0.2 mm of bone loss per annually for the success of osseointegration which can be measure by radiograph [6]

A radiographic examination can help us to determine the status and anatomy of the implant which can be done by radiovisiography, orthopantomography and cone beam computered tomography. In this study our aim is to evaluate the accuracy of panoramic radiography (OPG) and cone beam computed tomography (CBCT) to precisely portray vital structure and osseointegration in conventional implant placement

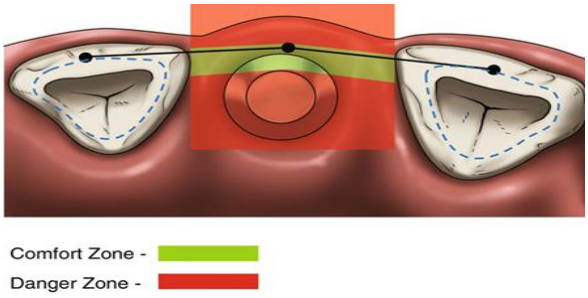


Figure 1: green- comfort zone and red- danger zone

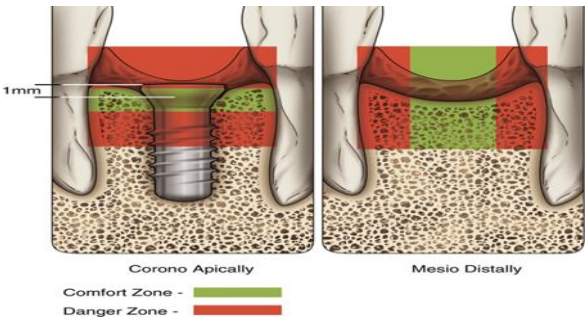


Figure 2: 1mm from the crest of alveolar bone

Aim and Objectives

1. To evaluate the accuracy of panoramic radiograph (OPG) and cone beam computed tomography (CBCT) to precisely portray the distance of vital structure (inferio alveolar nerve) in conventional implant placement
2. To evaluate the accuracy of panoramic radiograph (OPG) and cone beam computed tomography (CBCT) in accessing the osseointegration in conventional implant placement

Material and Method

1. This retrospective, randomized study was conducted in the department of Oral and Maxillofacial Surgery, Indira Gandhi Govt Dental College, Jammu after attaining the ethical clearance. A total of 32 implants were involved in this study in which all the patients undergo both the group A and group B so t no bias study will be there
2. Group A – measurement was taken under OPG after conventional implant placement
3. Group B – measurement was taken under CBCT after conventional implant placement

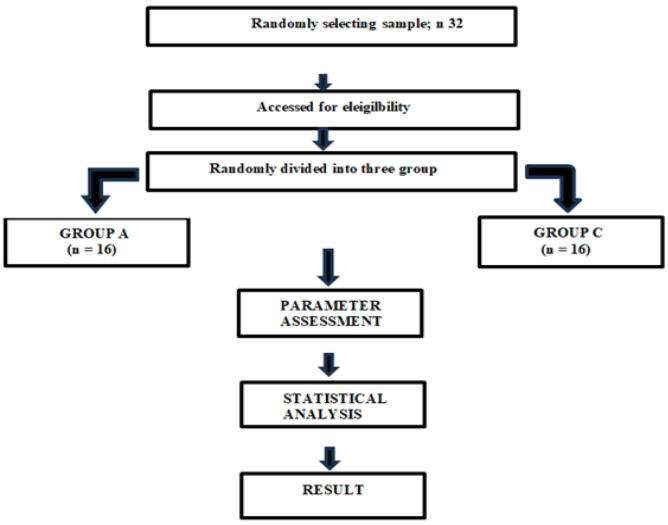
Inclusion Criteria

1. Patients requiring replacement of tooth with partially edentulous denture
2. Patients age – 16 to 60 years
3. Patients who were cooperative and motivated about their oral health give a written consent for participating in the study.

Exlusion Criteria

1. Patients with chronic or acute systemic diseases that may hamper successful implant placement
2. Patients with poor oral hygiene practice

Study Design



Parameter

1. Evaluation of Osseointegration

On the digital OPG and CBCT the following measurements were done within 1 week and 3 months of implant insertion:

- Distance between the apical portion of the implant and the layer of bone surrounding the implant (in mm)
- Height of the crestal bone (in mm). The height of the crestal bone was measured along the edges of the implants at the first thread of implant at mesial and distal portion.

2. Evaluation of vital structure

Evaluating the distance between the implant and vital structure (sinus, nerve and blood vessels) in OPG that is coronal cut and CBCT in sagittal and coronal views, measuring the closest points between the implant and vital structure in which it is divided into four zone:-

1. Safety zones ≥2 mm
2. Risky zone 1-2 mm
3. Error and high risk >0-1 mm
4. Traumatized ≤0 mm

This parameter was measured within 1 week of implant placement and after 3 months of implant placement

Statistical Analysis

Data was analyzed using the statistical package SPSS 26.0 (SPSS Inc., Chicago, IL) and level of significance was set at $P<0.05$. Descriptive statistics was performed to assess the mean and standard deviation of the respective groups. Inferential statistics to find out the difference Between the group was done by Independent T test. Within group analysis was done using Paired T test.

Results

In this retrospective study, the mean age distribution of group A was 25.23 years, while group B has a mean age of 26.37 years with the p value exceeds the conventional threshold of 0.05 showing that there was no statistically difference in age group(table1). Out of all the patients 50% was male and 50% was also female with equally distributed among the group (table 2)

The sample analysis in this presents study consists of 32 implants on the posterior edentulous region in which all the 32 implants were submerged and the implant load was done after 3 months of implant placement.

The height of the crestal bone was measured along the edge of implant in both the mesial and distal side and distance between the apical portion of implant and the layer around the bone surrounding the implants for measuring the osseointegration in both the group A (fig 1) and group B (fig 2)

The vital structure distance were measured from the the apex of the implant to the vital tissue (inferior alveolar nerve) and the measurement were taken at after 1 week and 3 months of implant placement in both the group A (fig1) and group B (fig 2), (fig 3)

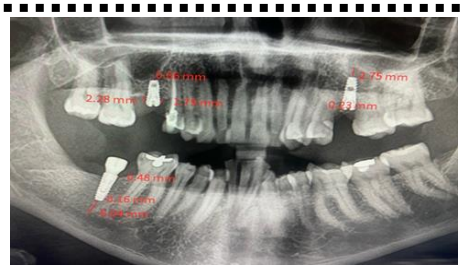


Figure 1: Group A (OPG)

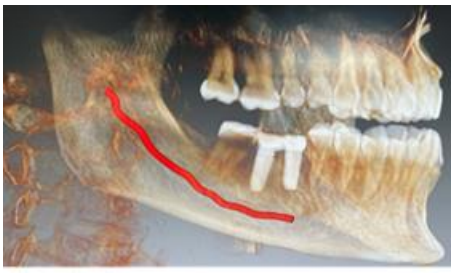


Figure: 2 CBCT vital structure

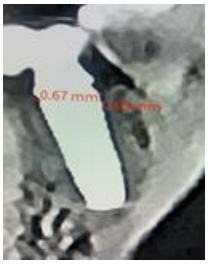


Figure: 3 CBCT crestal bone measure

Ossteointergration

The comparison of crestal bone measurements (mesial) using OPG and CBCT showed significant differences. OPG measurements were 1.05 ± 0.14 mm at 1 week and 1.06 ± 0.13 mm at 3 months, with a mean difference of 0.12 mm (P = 0.96). In the CBCT group, measurements were 0.55 ± 0.21 mm at 1 week and 0.58 ± 0.19 mm at 3 months, resulting in a mean difference of 0.18 mm (P = 0.89) (table 3).

The comparison of crestal bone measurements (distal) between OPG and CBCT showed distinct results. In the OPG group, the mean measurements were 0.99 ± 0.15 mm at 1 week and 0.98 ± 0.13 mm at 3 months, with a mean difference of 1.21 mm and a P value of 0.23. Conversely, the CBCT group recorded mean measurements of 0.56 ± 0.26 mm at 1 week and 0.59 ± 0.26 mm at 3 months, resulting in a mean difference of 0.34 mm and a P value of 0.74. Both techniques exhibited significant T values of 4.81 and 5.22, along with P values of 0.0001, underscoring the statistical significance of the changes in crestal bone measurements over time. (table 4)

The comparison of apical bone measurements between OPG and CBCT indicated negligible differences. For the OPG group, the mean measurements were 0.17 ± 0.11 mm at 1 week and 0.16 ± 0.11 mm at 3 months, yielding a mean difference of 0.08 mm with a P value of 0.92. In the CBCT group, measurements remained constant at 0.18 ± 0.15 mm at both time points, resulting in no mean difference and a P value of 0.99. The T values were low, at 0.14 and 0.43, suggesting that the observed changes in apical bone measurements were not statistically significant. (Table 5)

Vital structure

The comparison of distance from vital structures between OPG and CBCT revealed significant differences. In the OPG group, mean distances were recorded at 3.72 ± 1.16 mm at 1 week and 3.42 ± 0.88 mm at 3 months, resulting in a mean difference of 0.30 mm and a P value of 0.92. In contrast, the CBCT group consistently measured a mean distance of 5.00 ± 1.70 mm at both time points, with no mean difference noted. The T values were significant, at 3.51 and 4.67, with P values of 0.0001, indicating strong statistical significance. (table 6)

Table 1: Mean Age

	N	Mean	SD
Age	32	25.23	3.26

Table 2: Gender

	N	Male	Female
GENDER	32	16(50%)	16(50%)

Table 3: Comparison -CRESTAL BONE (Mesial)- OPG vs CBCT

	N	1 WEEK	3 MONTHS	T Value	Mean Difference	P Value Paired T Test
OPG	32	1.05±0.14	1.06±0.13	0.12	0.01±0.12	0.96
CBCT	32	0.55±0.21	0.58±0.19	0.18	0.03±0.20	0.89
T Value		7.92	7.65			

Table 4: Comparison -CRESTAL BONE (Distal)- OPG vs CBCT

	N	1 WEEK	3 MONTHS	T Value	Mean Difference	P Value Paired T Test
OPG	32	0.99±0.15	0.98±0.13	1.21	0.06±0.14	0.23
CBCT	32	0.56±0.26	0.59±0.26	0.34	0.03±0.25	0.74
T Value		4.81	5.22			
P Value (T test)		0.0001*	0.0001*			

Table 5: Comparison -Apical bone OPG vs CBCT

	N	1 WEEK	3 MONTHS	T Value	Mean Difference	P Value Paired T Test
OPG	32	0.17±0.11	0.16±0.11	0.08	0.01±0.11	0.92
CBCT	32	0.18±0.15	0.18±0.15	0	0.18±0.15	0.99
T Value		0.14	0.43			
P Value (T test)		0.88	0.67			

Table 6: Comparison -Distance from vital structure OPG vs CBCT

	N	1 WEEK	3 MONTHS	T Value	Mean Difference	P Value Paired T Test
OPG	32	3.72±1.16	3.42±0.88	0.08	0.30±0.76	0.92
CBCT	32	5±1.70	5±1.70	0	0.0±0.01	-
T Test		3.51	4.67			

Discussion

After introducing dental implant, it has become the primary oral rehabilitation and considered as the most successful treatment modality for replacement of teeth. Dental implant stability defined as the capacity of the implant to withstand loading in the axial, lateral, and rotational directions [1]. The primary stability of dental implants depends on contact between the bone and implant during the surgical placement of the implant, and this mechanical contact can be obtained through the fixation of a press-fit structure into a bony cavity [2].

The degree of primary stability after implant placement is also dependent on bone quality, implant design, patient characteristics, bone density, implant diameter, implant site, and surgical technique[3]. The cortical/cancellous ratio of local bone is extremely important for implant stability at the time of implant placement and for determining the quality of local bone conditions, and optimal bone conditions are critical for implant success [4]

After 6 week of implant placement the bone remodelling occur in which the implant again achieved secondary implant stability [1]

So precise radiographic assessments for ossteointegration and bone morphology plays important role in the success of the dental implant. The distance of anatomical structures, such as mental foramen, the floor of the nasal cavity, floor of the maxillary sinus, inferior alveolar canal, nerves, and vessels can significantly affect the morbidity of the surgical procedure and influence the outcome [5]

In our present study, the mean ossteointegration at crestal height (mesial) using OPG measurements were 1.05 ± 0.14 mm at 1 week and 1.06 ± 0.13 mm at 3 months, In the CBCT group, measurements were 0.55 ± 0.21 mm at 1 week and 0.58 ± 0.19 mm at 3 months, resulting in a mean difference of 0.18 mm (P = 0.89) and the mean ossteointegration at crestal height (distal) were 0.99 ± 0.15 mm at 1 week and 0.98 ± 0.13 mm at 3 months. Conversely, the CBCT group recorded mean measurements of 0.56 ± 0.26 mm at 1 week and 0.59 ± 0.26 mm at 3month resulting a statistically different at the crestal height

The comparison of apical bone measurements for the OPG group, the mean measurements were 0.17 ± 0.11 mm at 1 week and 0.16 ± 0.11 mm at 3 months.In the CBCT group, measurements remained constant at 0.18 ± 0.15 mm at both time points, resulting in no mean difference and a P value of 0.99. In accordance to our study Aastha Chopra et al [6] have concluded that there was a significant difference in crestal bone height but no difference in the apical ossteointegration in both the group.

In contrast to this study, Oznur Ozalp et al [7] suggested CBCT for determing the ossteointegration in both the crestal and apical ossteointegration of dental implant but paranomic radiograph can provide sufficient information if there was no CBCT available

The mean vital distance for OPG was 3.72 ± 1.16 mm at 1 week and 3.42 ± 0.88 mm at 3 months and for CBCT was 5.00 ± 1.70 mm at both 1 week and 3 month indicating strong statistical difference showing CBCT more accurate in which there was 3 mm difference giving CBCT a superior result with the same relevant study did by Anand Choudary et al [8] that the measurements made by CBCT images were more precise, in addition CBCT images were also helpful in accurate three dimensional in locazation of vital structures.

Gintaras et al [9] suggest that at least 2 mm distance between the apex of implant and vital structure to avoid neurosensory and bleeding complications Cone-beam

computed tomography (CBCT) has revolutionized diagnostic imaging in dentistry. CBCT imaging provides three-dimensional volumetric data construction of dental and associated maxillofacial structures with isotropic resolution and high dimensional accuracy. Unlike conventional panoramic radiographs, which provide 2-D images, CBCT provides volumetric imaging with the ability to visualize the imaged region in virtually any plane at a relatively low radiation dose to the patient [10]

In our study, we assessed the measurements of the same patient on digital OPG and CBCT, we observed that the readings were larger on OPG for ossteointegration measurement due to the magnification and only 2 dimensional radiograph while for measuring the vital structure CBCT gives larger measurement due to the more accuracy and 3 dimensional scan.

Conclusion

Dental implant ossteointegration is one of the most important procedure in the success of dental implant and determining the vital structures also depend on the success of dental implant so radiographic evaluation and proper treatment planning become a necessary procedure before and after implant placement. CBCT has proven to be an excellent guiding tool for planning because of the various tools in the software provides a three-dimensional idea to the dental surgeon about the characteristics of the dental implant site but due to the availability, cost and superior technique, OPG can be use for the accurate assessment of for the success of dental implant

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