10.5005/jp-journals-10024-1961

ORIGINAL RESEARCH


# Evaluation of Osseointegration in Implants using Digital Orthopantomogram and Cone Beam Computed Tomography

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## ABSTRACT

**Introduction:** Accurate assessment of osseointegration in dental implants requires precise radiographic visualization of pathologic conditions as well as anatomical structures. The present study aimed to evaluate the formation of bony tissue (osseointegration) using digital orthopantomogram (OPG) and cone beam computed tomography (CBCT) immediately after implant insertion (within 7 days) and 3 months postinsertion.

**Materials and methods:** Twenty single-implant sites on mandibular posterior regions were selected on patients irrespective of their gender. Both digital OPG and CBCT were done within a week and again after 3 months of implant insertion surgery, using the same exposure parameters.

**Results:** Three of the 20 implants were submerged and were excluded as the crestal bone height could not be measured. The participants were recalled for radiographic measurements after 3 months of implant placement. On an average, there was 0.03 mm of osseointegration at the apical portion after 3 months of implant insertion on digital OPG; 0.04 mm of osseointegration at the crestal bone height after 3 months on digital OPG; and 0.01 mm of osseointegration at the apical portion after 3 months on CBCT. No change or ≤0.02 mm of osseointegration at crestal bone height after 3 months on CBCT.

**Conclusion:** Both digital OPG and CBCT are significant for the assessment of osseointegration in implants, and hence, endow definite benefit for accurate assessment in terms of the success of the implant placement.

**Clinical significance:** However, CBCT is a better mode of evaluating dental implants but one should keep in mind that radiographic examination must be conducted to the benefit of the patient by application of the lowest achievable dose.

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**Keywords:** Cone beam computed tomography, Digital orthopantomogram, Implants, Osseointegration.

**How to cite this article:** Chopra A, Mhapuskar AA, Marathe S, Nisa SU, Thopte S, Saddiwal R. Evaluation of Osseointegration in Implants using Digital Orthopantomogram and Cone Beam Computed Tomography. J Contemp Dent Pract 2016;17(11):953-957.

**Source of support:** Nil

**Conflict of interest:** None

## INTRODUCTION

Evidence from ancient civilizations shows that attempts were made to replace missing teeth by banding artificial tooth replacements to remaining teeth with metal, many centuries ago.[1] Implants should be anchored in bone by surrounding connective tissue sheath, but generally, it does not show the degree of organization and specialization to the extent that it substitutes for the periodontal ligament.[2-4]

Several cases have revealed that loading may lead to widening of fibrous tissue layer and loosening of implant, subsequently resulting in implant failure. A fibrous tissue sheath in contrast to periodontal ligament is a poorly differentiated scar tissue.[4,5]

In Dorland's Dictionary (31st edition, 2007) osseointegration is defined as "direct anchorage of an implant by formation of bony tissue around the implant without the growth of fibrous tissue at the bone-implant interface." Later it is modified "as a direct structural and functional association between, living, ordered bone and the surface of a load carrying implant"[6] (1977).

The primary function of the interface between bone and the implant is to provide an effective and safe transfer of the occlusal load through the implant to the bone tissue. Some evidence supports the hypothesis that the interface is strongly influenced by biomechanical factors, which have more influence on bone regeneration than the biomaterial properties.[7,8]

It has to be kept in mind that the purpose of the radiographic examination is not solely to diagnose loss of osseointegration. Radiography is also used to assess the status of the alveolar bone and to monitor whether the bone support has been changed since the last radiographic examination.[9] Potentially, both two-dimensional (2D) and three-dimensional (3D) imaging modalities can be used for implant site assessment, but they are inaccurate and less reliable.[10]

Medical computed tomography (CT) has become an essential diagnostic tool and considered the gold standard in implant dentistry, for it allows 3D views of the region of interest and relevant jaw anatomy, such as the maxillary sinus and mandibular nerve.[11] However, one limitation of conventional medical CT is a relatively large radiation dose; the scanning of one jaw can be equivalent to 10 panoramic X-rays. Cone beam computed tomography (CBCT) allows the clinician to have an accurate 3D picture of the position of teeth/areas of interest which facilitates planning for both the orthodontist and surgeon.[12]

## MATERIALS AND METHODS

Ethical permission was taken from Institutional Ethical Committee before the commencement of the study. Partially edentulous patients reporting to the Department of Oral Medicine for replacement of their missing tooth were selected.

### Inclusion Criteria

- Patients requiring replacement of tooth in mandibular posterior region
- Patients age – 16 to 60 years
- Patients who are cooperative and motivated about their oral health give a written consent for participating in the study.

### Exclusion Criteria

- Patients with chronic or acute systemic diseases that may hamper successful implant placement
- Patients with poor oral hygiene practice
- Patients with tissue abuse habit.

### Method of Data Collection

After extraction of the nonrestorable tooth that would be replaced by dental implant, the extraction socket was prepared for the insertion of the implant and it was screwed to its final position in the prepared socket. Digital orthopantomogram (OPG) was performed within 1 week of implant insertion using Kodak 8000C Digital Panoramic Unit. Cone beam computed tomography was also performed on the same day using "Sirona-Orthopos XG 3D" at 75Kvp, exposure time 12 seconds with the field of view 8 × 8 cm. Both digital OPG and CBCT were done again after 3 months of implant insertion surgery, using the same exposure parameters.

### Evaluation Parameters

On the digital OPG, the following measurements were done within 1 week 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 implant's mesial and distal portion.

On CBCT, special software called "Galileos, 3D reconstruction" was used for measurement of the same within 1 week of implant insertion.

Measurements were done again on digital OPG and CBCT 3 months postimplant insertion. With the help of the special software of CBCT, the following observations were also done[12]:

*Zone 1*: Located adjacent to the implant and represented osseointegration zone (bone-implant interface)

*Zone 2*: Located just around the first one and represented the bone surrounding implant.

## RESULTS

The sample analyzed in the present study consisted of 20 implant sites on mandibular posterior region. However, three of the 20 implants were submerged and were excluded as the crestal bone height could not be measured.

The participants were recalled for radiographic measurements after 3 months of implant placement. The height of the crestal bone was measured along the edges of the implant's mesial and distal portion. So the apical distance measurements were done on 20 implants using digital OPG and CBCT, and 17 crestal bone height measurements were done using the same radiographs after 1 week of implant placement.

The apical distance which is measured is the distance between the apical portion of the implant and the layer of bone surrounding the implant (mm). These were radiographically measured and recorded on a master chart and then statistically analyzed. Paired t test was used to evaluate the recorded readings done after 1 week to that after 3 months postimplant insertion on digital OPG.

On an average, there was 0.03 mm of osseointegration at the apical portion after 3 months of implant insertion on digital OPG; 0.04 mm of osseointegration at the crestal bone height after 3 months on digital OPG; 0.01 mm of osseointegration at the apical portion after 3 months on CBCT. No change or ≤0.02 mm of osseointegration at crestal bone height after 3 months on CBCT.

**Table 1:** Comparison of mean apical portion after 1 week and 3 months by using digital OPG

| *Apical portion (AD)* | *Number of cases (n)* | *Apical portion* | | |
|---|---|---|---|---|
| | | *Mean* | *SD* | *p-value* |
| 1 week | 20 | 0.619 | 0.174 | <0.001 |
| 3 months | 20 | 0.607 | 0.169 | |

**Table 2:** Comparison of mean CHM after 1 week and 3 months by using digital OPG

| *Crestal bone height (mesial) (CHM)* | *Number of cases (n)* | *CHM* | | |
|---|---|---|---|---|
| | | *Mean* | *SD* | *p-value* |
| 1 week (CHM1) | 17 | 2.469 | 0.644 | 0.005 |
| 3 months (CHM2) | 17 | 2.409 | 0.648 | |

**Table 3:** Comparison of mean CHD after 1 week and 3 months by using digital OPG

| *Crestal bone height (distal) CHD* | *Number of cases (n)* | *CHD* | | |
|---|---|---|---|---|
| | | *Mean* | *SD* | *p-value* |
| Day 1 | 17 | 2.495 | 0.668 | 0.009 |
| 3rd month | 17 | 2.419 | 0.654 | |

**Table 4:** Comparison of mean apical portion after 1 week and 3 months by using CBCT

| *Apical portion (AD)* | *Number of cases (n)* | *Apical portion* | | |
|---|---|---|---|---|
| | | *Mean* | *SD* | *p-value* |
| 1 week | 20 | 0.267 | 0.065 | <0.001 |
| 3 months | 20 | 0.250 | 0.063 | |

**Table 5:** Comparison of mean CHM after 1 week and 3 months by using CBCT

| *Crestal bone height (mesial) (CHM)* | *Number of cases (n)* | *CHM* | | |
|---|---|---|---|---|
| | | *Mean* | *SD* | *p-value* |
| 1 week (CHM1) | 17 | 1.716 | 0.503 | 0.148 |
| 3 months (CHM2) | 17 | 1.645 | 0.514 | |

**Table 6:** Comparison of mean CHD after 1 week and 3 months by using CBCT

| *Crestal bone height (distal) (CHD)* | *Number of cases (N)* | *CHD* | | |
|---|---|---|---|---|
| | | *Mean* | *SD* | *p-value* |
| Day 1 | 20 | 1.743 | 0.473 | 0.163 |
| 3rd month | 20 | 1.675 | 0.486 | |

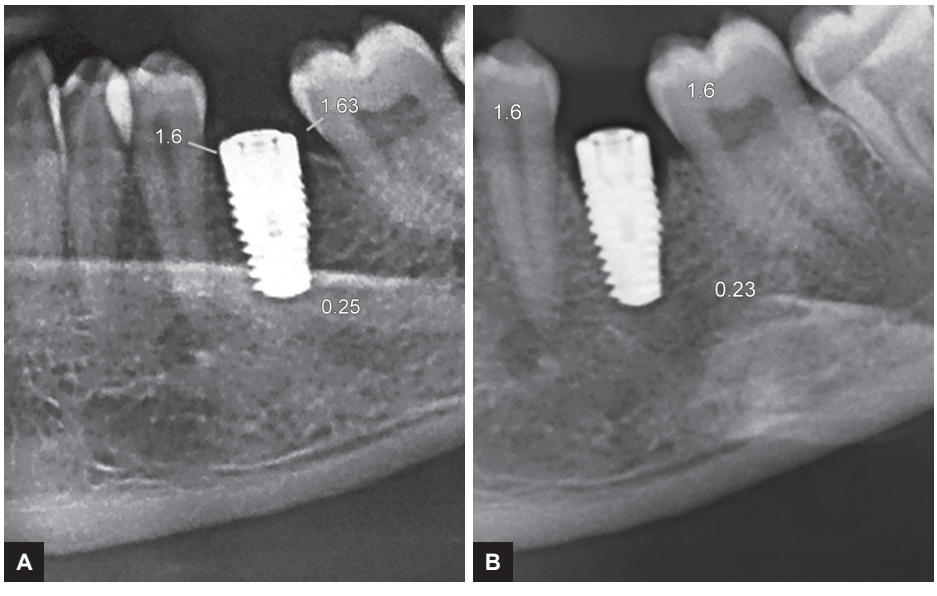
Abbreviations used: Implants (I): 1 to 20 implant sites; AD = apical distance; AD1 = apical distance within 1 week of implant insertion; AD2 = apical distance 3 months postimplant insertion; CH = crestal bone height; CHM1 = crestal bone height on mesial aspect within 1 week of implant placement; CHM2 = crestal bone height on mesial aspect after 3 months of implant insertion; CHD1 = crestal bone height on distal aspect within 1 week of implant insertion; CHD2 = crestal bone height on distal aspect after 3 months of implant insertion; SI = Submerged implants

Tables 1 to 3 showed statistically significant difference between mean apical portion, mean Crestal height of bone on mesial side (CHM), mean Crestal height of bone on distal side (CHD) after 1 week and 3 months by using digital OPG respectively (Figs 1A and B).

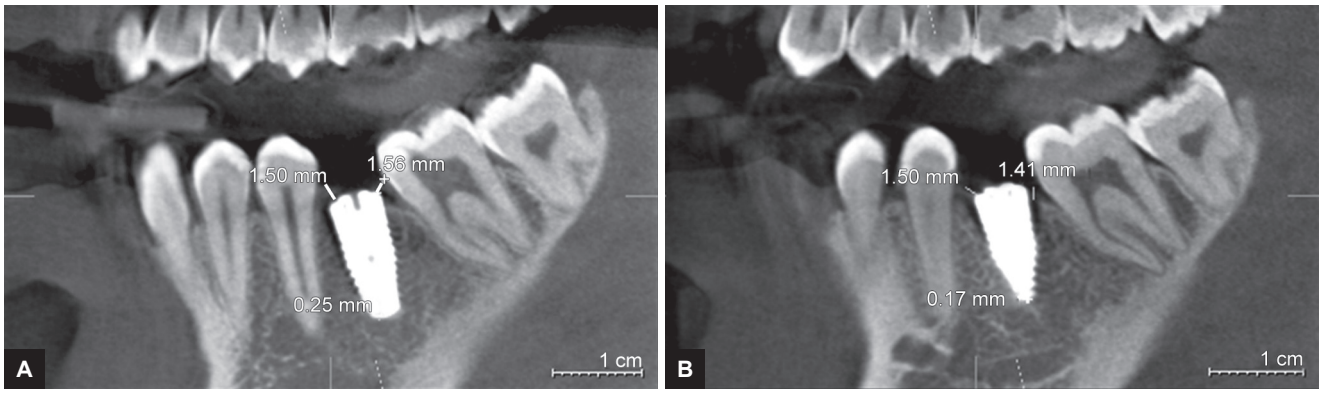
Tables 4 to 6 showed comparison of mean apical portion, mean CHM, and mean CHD after 1 week and 3 months by using CBCT (Figs 2A and B). Results showed that there is statistically nonsignificant difference these parameters after 1 week and 3 months.

## DISCUSSION

After the introduction of osseointegration, dental implants are becoming popular in the oral rehabilitation and are considered a successful treatment modality for replacement of teeth. Our primary objective for doing this study was to determine the amount of osseointegration in implant within 3 months of time of placement; by measuring it on digital OPG and CBCT. The results obtained in our study are somewhat similar to those reported in other studies.




**Figs 1A and B:** Measurement on digital OPG: (A) 1 week of implant placement; and (B) after 3 months of implant placement




**Figs 2A and B:** Measurement on CBCT: (A) 1 week of implant placement; and (B) after 3 months of implant placement

In case of panoramic radiographs, there is a degree of magnification up to 1.2 to 1.5% in the horizontal and vertical planes.[10] Digital panoramic radiography is a simple, effective method for pre and periimplant evaluation and the vertical assessment can provide accurate information.

In our study when we assessed the measurements of the same patient on digital OPG and CBCT, we observed that the readings were larger on OPG, e.g., in one case, the crestal bone height on mesial and distal aspect was 3 mm on OPG and on CBCT it was 2 mm.

But because of this magnification, the changes after 3 months postinsertion were more significant on OPG.

Two of the 20 cases were followed up after 6 months to check for the status and it was seen that the measurement went from 0.25 to 0.2 mm on the apical portion and from 2.12 to 2 mm on the crestal bone in CBCT. According to Cochran et al,[11] periimplant bone remodeling after implant placement is more accentuated in the first 6 months after surgery. Since the time span in our study was 3 months, hence, significant changes were not seen.

Radiography is one of the most important methods to assess success or failure of osseointegrated implants. Postoperative radiographs to monitor the reactions around implants are usually taken at intervals from the day of delivery of the prosthesis and continuing as long as felt necessary from a clinical point of view.[12]

Our results were in accordance with study carried out by Dreiseidler et al[13] who suggested superior radiographic visualization for all important high-contrast structures in osseointegrated implants assessment for CBCT in contrast to OPG and a CT-like degree of information for high-contrast structures in CB data sets. Clinically, however, the high radiation dosages transmitted by CBCT must also be taken into account.

Only one study by Bedi et al[14] has been done by far which had measured the distance from the most apical part of the implant and the first point of bone-implant contact and on the cervical region mesially and distally (crestal bone) to measure the bone level. The result of this study on CBCT for mesial and distal cervical region (Crestal bone) was mean of 1.201 mm on 1st day and 1.173 mm after 3 months. So, the result of our study for crestal bone was mean of 1.716 mm on 1st week and 1.645 mm after 3 months.

The drawback of the present study was the limited sample size. Additional parameters, such as the implant length and the number of threads on implant-abutment interface, can also be included in such studies.

## CONCLUSION

The results obtained were more apparent on the digital OPG, in spite of the magnification. Within the parameters of this study, both digital OPG and CBCT[15,16] are significant for the assessment of osseointegration in implants and hence, endow definite benefit for accurate assessment in terms of the success of the implant placement.[17]

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