An In Office, Cost Effective Technique For Measuring Width Of Bone Using Intra Oral Periapical Radiographs In Occlusal Projection

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Abstract

Aim:
The aim of this invitro & radiographic study was to determine the dimensions of ridge / width of bone & deviation of center of ridge using IOPA (Intra Oral Periapical) radiographs in occlusal projection.Materials and methods: Mandibles with edentulous space were procured and cold cure acrylic stents were fabricated. Then mandibles were tied to menaquine model which was fitted to a dental chair. IOPA radiographs in occlusal projection were taken. Radiographs were scanned to obtain a digital image which was analysed using a computerised software. Direct measurements were taken and compared. The position of center of ridge compared invitro and radiographically using student unpaired t test and width of bone compared using karl pearson’s coefficient test. Results: Comparisons of bucco-lingual ridge width using radiographical measurement versus invitro method showed a mean value of 4.1930 with deviation of 0.5934 and the proposed position of centre of ridge for both the methods gave a mean value of 0.2738 with deviation of 0.1164.Conclusion: The findings in this study suggest that IOPA radiographs in occlusal projection can be used to assess the width of the alveolar bone and future placement of flapless implant.

INTRODUCTION

Dental implant therapy has been used increasingly frequently for the rehabilitation of missing dentition, replacing conventional therapies in the areas of complete and partial edentulism as well as single tooth anodontia1-5. Two stage submerged implant placement technique was routinely done to allow 3-4 months of undisturbed healing & load free environment for successful osseointegration.6 In implant dentistry, surgical flap reflection may lead to soft & hard tissue loss.7,8 With the rapid advancement of dental implant therapeutics, the current trend is more geared toward enhancing esthetics and patient comfort and satisfaction. One stage surgical protocol using non-sub-merged implants has been proven successful comparable to the two stage surgical approach.9,10 The acceleration of treatment time and less surgical intervention with one-stage surgical approach can significantly enhance patient comfort, satisfaction, and acceptance.

The recent advancement in implant dentistry is flapless implant placement because of patient preference for non invasive procedure. Minimally invasive implant surgery allows clinicians to place implants in less time, without extensive flaps, and with less bleeding and postoperative discomfort.11-15 The flapless placement of dental implants requires precise planning that considers the vital anatomic structures and restorative goals. Sufficient width of the alveolar ridge must be available for implant placement using a flapless technique11-13. Evaluation of the dimensions of the available alveolar bone is an important prerequisite.16

Assessment of the bucco-lingual dimension of the osseous ridge also is needed for proper treatment planning.17-19 The bucco-lingual ridge width can be evaluated by computerized tomography (CT),20,21 Ridge mapping22,23, Trans tomography26, Ultrasonography and Direct Caliper Measurements following surgical exposure of the bone.16

The above methods require expensive instrumentation, surgical exposure of bone, more radiation exposure to patient and technique sensitive lab procedures. Although panaromic & IOPA radiographs produce two-dimensional image, advantages are they provide information about length of bone, visualization of nerves & vessels, but do not provide information regarding width of bone about implant.
sites.\textsuperscript{6}

Occlusal radiographs are used to determine position of impacted teeth, cysts or tumors, evaluation of fracture, locate salivary stones in the submandibular duct. They provide the maximum width of bone at the base of the mandible & do not give information about crestal width\textsuperscript{27}. That is why occlusal radiographs are not used for evaluation of width of bone for implant placement. Till today, there is no data or report of any method using the intra oral periapical radiography in occlusal projection for assessment of ridge dimension.

So, the purpose of this Invitro & radiographic study was to determine the dimensions of ridge / width & deviation of center of ridge using IOPA radiographs in occlusal projection.

**MATERIALS AND METHODS**

This study was carried out in the department of Periodontology & Implantology.

**PROSTHETIC STENT FABRICATION**

A total of 2 Mandibles with 20 edentulous spaces were procured. Along the edentulous space modeling wax of 2mm was adapted (figure 1).

**Figure 1**

Figure 1. Modelling wax adapted.

An impression was made using alginate and cast was poured with dental stone. A prosthetic stent was fabricated along edentulous space pertaining to the missing teeth with acrylic. With the help of micro motor, a hole was drilled along the long axis of the tooth till the bur meets the cast, then the area was marked. This was marked as prosthetically driven centre (figure 2).

**Figure 2**

Figure 2. Prosthetic stent with probe denoting prosthetic center.

**OCCLUSAL STENT FABRICATION**

Along the wax adapted mandible, an occlusal stent was fabricated with three holes drilled in occlusal, lingual and buccal areas (figure 3). The occlusal hole was drilled by placing the occlusal stent on marked prosthetically driven centre on the cast then it was transferred to the mandible with the help of reamer. With respect to buccal and lingual surfaces, a linear trough was drilled and a reamer or file was probed first along the buccal side to check the resistance of bone, if no resistance was felt and then it was probed at a distance of 1 mm from previous one. Once when the resistance was felt, the area was marked with gutta percha. The same procedure was carried out along the lingual side and area where resistance felt was marked with gutta percha.
RADIOGRAPHIC PROCEDURE

The marked occlusal stent with mandible was tied to a menaquine, then it was fitted to dental chair. An intra oral periapical film was placed occlusally on the occlusal stent. The occlusally projected beam was directed and radiograph was taken. Now radiograph shows 3 gutta percha markings (buccal, lingual and occlusal) (figure 4).

The occlusal marking showed the prosthetic centre. Using Dental Eye® (Sundbyberg Sweden) software, the radiographic analysis was done to calculate the width of bone and centre of ridge (figure 5).
thickness. To deduct tissue thickness, an endodontic reamer was probed through the wax on both buccal and lingual side and depth to which it penetrated was measured using measuring scale. Now the exact width of the bone was measured by deducting tissue thickness from the distance between 2 GP points. Dividing the width of the bone by 2 gave the radiographic centre. So, 2 dots obtained were one the prosthetic centre and the other the radiographic centre. (figure 6).

**Figure 6**
Figure 6. Prosthetic & Radiographic center.

**STATISTICAL ANALYSIS**

The clinical and radiographic method was compared using student unpaired t test and karl pearson’s correlation coefficient test was used to correlate the 2 methods.

**RESULTS**

The clinical and radiographic methods were compared on two aspects;

- Width of the bone and
- Centre of ridge.

The summary statistics of width of bone in two methods is shown in table 1. The mean values of clinical and radiographical method when compared by student’s unpaired t-test were 4.2525 & 4.1335 respectively and the deviation of these 2 methods was 0.5934. The values were plotted in a graph which is shown in the fig 7.

**Figure 7**
Figure 7. Comparison of Prosthetic & Radiographic center with respect to width of bone.

The deviation of the 2 methods with respect to Proposed Position of Centre of Ridge and width of the bone was found to be 0.1164 & 0.5934 respectively.

The sensitivity for the width of bone was 87% and
specificity was 100% . The kappa measure of agreement was 0.89 (Table 3). The sensitivity of the proposed position of centre of ridge was found to be 100% and specificity was 80%. The kappa measure of agreement was 0.80 (Table 4). Kappa measures of agreement in both methods were statistically significant. (P < 0.001).

Figure 9
Table 1: Comparison of Radiographic and Invitro procedures with respect to Width of bone (mm) by student’s unpaired t-test

<table>
<thead>
<tr>
<th>Method</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiographic</td>
<td>20</td>
<td>4.1335</td>
<td>0.6081</td>
<td>-0.0292</td>
<td>0.9530</td>
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<tr>
<td>Invitro</td>
<td>20</td>
<td>4.2525</td>
<td>0.5787</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>4.1930</td>
<td>0.5934</td>
<td></td>
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</tbody>
</table>

Figure 10
Table 2: Comparison of Radiographic and Prosthetically driven centre with respect to Proposed position of center of ridge by student’s unpaired t-test

<table>
<thead>
<tr>
<th>Method</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiographic</td>
<td>20</td>
<td>0.2258</td>
<td>0.1212</td>
<td>-0.6690</td>
<td>0.5126</td>
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<td>Prosthetically driven centre</td>
<td>20</td>
<td>0.2860</td>
<td>0.1331</td>
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<tr>
<td>Total</td>
<td>40</td>
<td>0.2708</td>
<td>0.1164</td>
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</table>

Figure 11
Table 3: Diagnostic value of Invitro Vs Radiographic (Width of Bone)

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<tbody>
<tr>
<td>Sensitivity</td>
<td>87%</td>
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<tr>
<td>Specificity</td>
<td>100%</td>
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<td>PPV</td>
<td>100%</td>
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<tr>
<td>NPV</td>
<td>92%</td>
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<tr>
<td>Overall Accuracy</td>
<td>95%</td>
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<tr>
<td>Kappa Measure of Agreement</td>
<td>0.89</td>
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<td></td>
<td>P &lt; 0.001</td>
<td></td>
</tr>
</tbody>
</table>

DISCUSSION
The present Invitro & radiographic study was done to assess the width of bone/ dimensions of alveolar ridge using IOPA radiographs in occlusal projection and also to locate the centre of ridge.

There are techniques for assessing ridge dimension like ridge mapping, CBCT, transtomography and direct caliper measurement following surgical exposure of the bone. Ridge mapping is a procedure that allows the implant surgeon to determine the thickness or width of the alveolar bone before a mucoperiosteal flap is reflected during surgery. The ridge-mapping technique involves a series of measurements with a specially designed caliper. The sharp points of the caliper penetrate the anesthetized mucosa until the surface of the bone is reached. A millimeter scale near the handle end of the caliper will give an accurate reading of ridge thickness. However; it must be kept in mind that ridge mapping may give erroneous readings.

Conventional tomography is the method of choice for obtaining cross-sectional information of small regions of interest for implant planning. Tomograms before dental implant placement will help determine the height, width, inclination and undercut of the alveolar bone, as well as the location of anatomical structures such as the mandibular canal, the submandibular gland fossa, the maxillary sinus and the nasal fossa. Computer-assisted implant planning on 3D models allows the optimal assessment and investigation for implant placement, which is often difficult to predict prior to the initiation of care. The use of stereolithographic guides for the placement of dental implants is designed to provide greater control and eliminate the risks that are involved in standard implant surgery.
However, the risk for deviation (transfer error from the software-planning stage to the surgical field) remains substantial.  

Radiographs play an adjunctive role in clinical diagnosis. In dentistry, the routinely prescribed are periapical and orthopantograms. Occlusal radiographs are used when patient unable to open wide for IOPA or other reasons cannot accept periapical. The uses are for determining fractures, pathologies and in trismus conditions. Occlusal radiography shows widest width of bone (symphysis) versus the width at crest where diagnostic information is needed most. So it is not indicated for diagnostic preprosthetic phase in implant dentistry.  

To avoid the more radiation of bone, surgical exposure, expensive instrumentation, sensitive lab techniques, IOPA radiographs in occlusal projection were chosen to measure the width of bone as well as center of ridge. Using the CT data of various studies, the difference between preplanned drill starting point in reference model & actual drill starting point was in the range of 0.95 – 1.6mm. But comparatively the data obtained from our study has deviation for the 2 methods to be very minimal for the proposed position of centre of ridge which was 0.1164. Also the data for the width of the bone based on two methods were reliable with kappa measure of agreement giving the similar data. The radiographic and Invitro measurement were almost similar making the professional to opt for either of the methods. This in office technique gives quicker, reliable and convincing results to assess the ridge dimension.  

The advantages of this method are  

- A routine quick chair side method.  
- Cost effective.  
- Also in compromised knife edge ridges.  

The limitations of this study , as it was carried out only in mandible because maxilla precludes itself with complex anatomical structures for assessment and radiographs are two dimensional images whereas CT gives three dimensional image.  

**SUMMARY & CONCLUSION**  
The study was designed to overcome various limitations of the radiographs and proves that the neglected occlusal projection can be well utilized. This procedure has increased the affordability for the patients and an easy approach for the dental professional and for the patient,  

1. IOPA radiographs in occlusal projection can be used as preprosthetic diagnostic to assess the width of the alveolar bone.  
2. Difference between the preprosthetic position of GP point on the template & the proposed radiographic centre of the ridge was 0.1164 only and widths of the bone measurement using two methods were also reliable.  
3. This method gives an accurate measurement of the width of the bone so it can be used for the future placement of flapless implant.  

Authentication of this method by conduction of human randomized controlled clinical trials with a large sample size and comparison of groups is required for the routine usage for flapless implant surgical procedures.  

**References**  
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