Dental Research Journal

Original Article

Accuracy of linear vertical measurements in posterior mandible on panoramic view

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Received: February 2012
Accepted: January 2013

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ABSTRACT

Background: One of the most frequent concerns encountered in dental implant treatments is inadequate pre-operative planning. Panoramic radiographs are readily accessible and cost efficient. The aim of this study is to assess the accuracy of vertical measurements in mandibular molar and premolar region on panoramic radiography.

Materials and Methods: Panoramic radiographs were made of a partially edentulous sheep mandible mounted in acryl. Measurements collected from the computer-generated images were compared to measurements made directly on the cross-sectioned hemi-mandibles using *t*-test. $P < 0.05$ was considered significant.

Results: The results show that panoramic image is overestimated in predicting the linear measurements in posterior mandible. By applying the magnification factor of 1.29 the difference became insignificant.

Conclusion: It seems rational to use panoramic radiography for pre-surgical implant assessment of posterior mandible if a true magnification factor is applied.

Key Words: Implant, mandible, panoramic, vertical measurements

INTRODUCTION

Implant surgery in posterior mandible is a challenging operation, which can cause serious complication of inferior alveolar nerve injury, resulting in sensory disturbance in lower lip area.[1] The complication is ranging from 8.5% to 43.5% of cases in different studies.[2,3]

A through radiographic assessment is paramount for evaluating bone volume and bone quality, detecting the precise location of the anatomical structures to guarantee success rate and to avoid damage during surgery.[1,4,5] This is achieved best by sectional imaging; however, these sophisticated imaging modalities have their own limitations. High-radiation dose, metallic artefacts, high-cost, limited availability and need of trained operators are major limitations of multi-detector Computed Tomography (MDCT) scan, the most exact and reliable technique, used for several years.[6] Recently cone beam CT scan, especially dedicated to maxillofacial region, is widely replacing MDCT.[4,5,7,8] However, it is not accessible everywhere and still suffers from increased scatter radiation and consequently, low-contrast resolution.[9]

In compliance with that, some investigators reported that panoramic views could support surgeons when implants are to be placed in posterior mandibular area.[1,5,10-12]

Panoramic radiography is a widely used technique with the advantage of providing a satisfactory coverage of both jaws, with a relatively low-radiation dose, in a short-period of time, and at lower cost if compared to more sophisticated techniques.[5,13] In implantology, this technique provides information about the localization of anatomic structures and vertical bony dimensions. However, without

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knowing the magnification degree and the image distortion, errors in measurements may occur. In addition, panoramic radiography does not provide the cross-sectional view of the bone.[4,5,13]

Not many reports are available, which had used direct measurement on dry specimen as gold standard.[5,14] The aim of this study, is to evaluate the reliability of vertical measurements in posterior mandible, on panoramic views comparing the obtained values in dry animal specimens.

MATERIALS AND METHODS

In this pilot *in vitro* study, nine sheep mandibular bones were disinfected and all remained teeth were extracted. To facilitate the positioning of samples in panoramic unit, all samples were mounted in an acrylic human-dentiform, which was cut in the left posterior mandible, from canine to third molar [Figure 1]. Obviously, samples were chosen from the left side of mandible to compensate the slight curvature of arch in an acrylic model.

Radiographs were taken by Proline XC unit (Planmeca, Finland) and a pre-set exposure factors (64 Kvp, 6 mA) on 15 × 30 PSP receptor (Regius 110, Konica Minolta, Japan) [Figure 2]. Panoramic views of low detectable septal crests were excluded from study, and a total of 42 septal crest remained.

The distance was measured by drawing a perpendicular line from the highest point of septal crest to the inferior border of mandible [Figure 3]. Collected data were compared with direct measurements on dissected bone by three blinded observers, (two maxillofacial radiologists and one dentist). Radiographic measuring accomplished digitally using Medecom software (Daoulas, France) capable of true size measurements.

The samples then sectioned mesio-distally in a right angle to their base and the measurements were made directly on the specimens, using the same reference points encountered for the radiographs, by a caliper (Rohsnorm/95/EC) at accuracy of 0.01 mm [Figure 4].

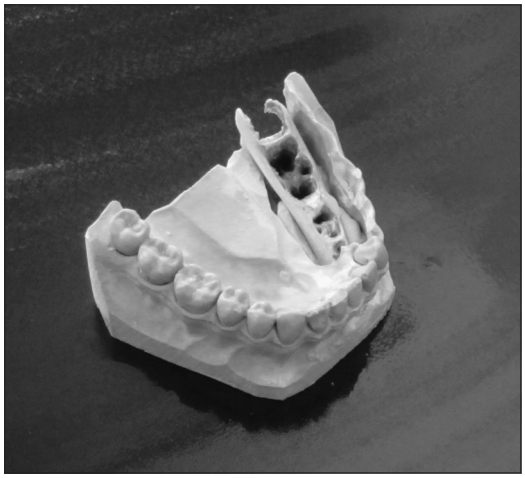

Figure 1: Mounted mandibular bone

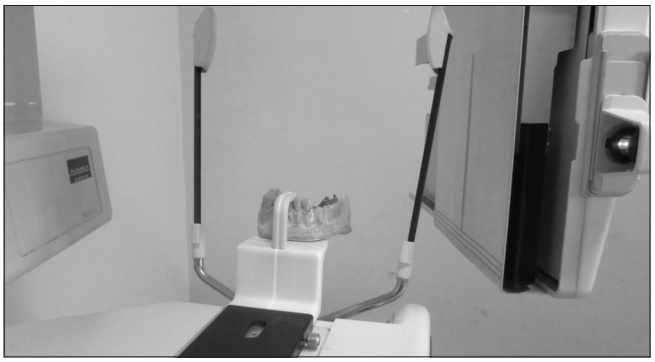

Figure 2: Positioning of the acrylic model in panoramic unit

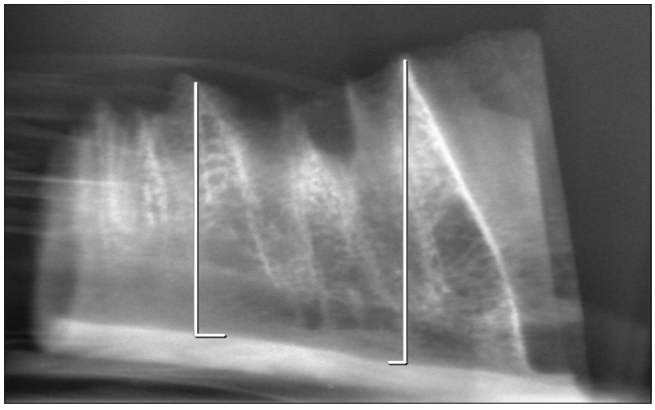

Figure 3: Vertical measurements on panoramic view using Medecom software

Figure 4: Direct measurements on specimen

The mean amount of radiographic measurements was calculated and compared with the average amount of real values from direct measurements.

By analyzing the differences between real and radiographic values, a second magnifying factor calculated, and the comparison was repeated regarding the new corrected values.

T-test was employed to compare the radiographic and real values; meanwhile, Dannet test was used to estimate the agreement coefficient between observers.

RESULTS

In this study, vertical measurements on panoramic radiography alone were overestimated significantly compared with the measurements determined directly on specimen [Table 1]. By applying the magnification factor of 1.29, calculated by advanced statistical analysis, the differences decreased to become insignificant (P = 0.31) [Table 2].

Dennet test showed no significant difference between observers [Table 3].

DISCUSSION

This study showed that there was a tendency for panoramic image to overestimate in predicting the values of posterior mandible. This result was in perfect agreement with Rockenbach, *et al*.[5] They stated that implant length planned with panoramic radiography was overestimated. However, considering the new magnification factor in this study made the measurements more reliable. There are some concerns about reliability of panoramic views in predicting the available bony structures before implant placements. The need is more highlighted when the general practitioners ask radiologists to report the available length considering adjacent anatomic landmarks based on a single panoramic radiograph. This issue seems to be still the matter of debate by other researchers.[12,14,15]

Table 1: Mean value of direct measurements compared with panoramic view

Measurements	Mean	SD	*T*	*P* value
Panoramic	15.39	4.11	7.07	<0.001
Direct	14.46	4.34		

Table 2: Mean value of direct measurements compared with panoramic view by magnification of 1.29

Measurements	Mean	SD	*T*	*P* value
Panoramic	14.38	3.8	1.04	0.31
Direct	14.47	4.33		

Table 3: Inter-examiner agreement

	Observer	Observer	Mean	*P* value
Dannet test	1st radiologist	Dentist	1.85	0.17
	2nd radiologist	Dentist	1.61	0.26

The prospective clinical study using the panoramic radiographs to evaluate the preoperative planning of posterior mandibular implants showed that panoramic radiographs appeared to be sufficient to evaluate available bone height before insertion of posterior mandibular implants when a safety margin of at least 2 mm above the mandibular canal is respected.[1]

In addition, Tal and Moses in 1991, confirmed that application of panoramic views to be accurate for routine clinical purposes in the planning of implant surgery.[16]

In contrast, Klinge found that only 17% of measurements made from the crest of the alveolar ridge to the most superior border of the mandibular canal were accurate within 1 mm.[17]

In the study by Laster, *et al*., it was shown that horizontal measurements in panoramic radiography were greater than vertical. Use of a magnification factor underestimated the actual dimensions.[18]

These controversial reports may be attributed to ignoring real magnification of panoramic views.

It is usually expected that an average magnification of 125% is seen in panoramic images.[10] Several studies have considered positioning errors as a crucial factor that could influence radiographic magnification.[19,20] However, mandibular molars are reported to be less affected by positioning errors and are usually better seen than other teeth on a panoramic radiography. Using bite block supports in panoramic unit and the calibration procedure of vertical beam may have reduced the positional errors.[15]

However, since correct positioning of the patient in panoramic machine is requisite; measurements of posterior mandible can be believed to be reliable.[21,22]

Results of this study, shows that the magnification factor of panoramic unit (used in this study) is 1.29.

If direct or digital measurements on panoramic views are accomplished considering this genuine factor of magnification, the obtained values can be applied to implant surgeries safely.

Considering the high-rate of agreement between observers in this study, it seems there is little problem in diagnosing the crest and alveolar canal borders in digital views. This confirms the reliability of measurements on panoramic views even when a general practitioner is to choose the proper implant length. With regard to this point that panoramic views do not support for buccolingual values and manual evaluation in oral cavity may be helpful.

In economically developing countries, application of sophisticated imaging techniques are restricted due to their limited access. So, in cases of few or single implant placements it seems rational to use panoramic radiography for pre-surgical assessment of bone in posterior region of mandible.

CONCLUSION

If true magnification factor is incorporated in measurements, values extracted from panoramic views can be safely be used for posterior mandibular implants. Clinical examination and traditional radiographs may be adequate for patients with wide residual ridges that grant sufficient bone, however, we emphasis the use of sophisticated imaging modalities in complicated cases.

ACKNOWLEDGMENT

This article has been derived from the undergraduate thesis No. 1257, Shiraz University of Medical Sciences, Faculty of Dentistry.

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How to cite this article: Haghnegahdar A, Bronoosh P. Accuracy of linear vertical measurements in posterior mandible on panoramic view. Dent Res J 2013;10:220-4.

Source of Support: Nil. **Conflict of Interest:** None declared.