

Research Paper: Evaluation of Panoramic Radiography Accuracy in Estimating the Crestal Width of Dental Implant in Different Jaw Regions



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ABSTRACT

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Keywords:

Panoramic radiography, dental implants, crestal width

Introduction: The aim of this study was to determine the accuracy of digital panoramic radiography in estimating the crestal width of implant fixtures after surgery.

Materials and Methods: We selected 241 digital panoramic images after implant insertion which had documented information of their actual size. The crestal width was measured on radiographs. We compared two measuring methods in different jaw regions (total, maxilla, mandible, whole right, whole left, all sextants) in order to find their accordance.

Results: There was a significant difference between the two methods by using inter-observer ecoefficiency (ICC) in all regions ($p < 0.05$). There was also a significant difference between the two by using the bland-altnan plot ($p < 0.05$) except in mandibular anterior right and left sextants.

Conclusion: Digital panoramic radiography is not accurate enough for exact measurements such as inserted implant dimensions because of image distortion and magnification. It had better use more accurate methods like CBCT in implant treatments.

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Introduction

Nowadays, dental implants, especially intraosseous root-formed types, are one of the best treatments for restoring edentulous areas of jaws. It is needed to monitor them by radiologic images pre-operatively, during the insertion procedure, and post-operatively.

Panoramic radiographs are an accepted standard radiographic examination tool when planning an implant treatment because of accessibility, rapid acquisition, low cost and low radiation dose¹⁻⁵. Furthermore, they have been reported to be sufficiently reliable to evaluate the available bone height before inserting posterior mandibular implants⁴⁻⁶; and vertical and horizontal dimensions of inserted implants⁷.

However, image distortion due to variation in the degree of magnification in the horizontal and vertical planes in both conventional film-based and digital panoramic machines is mentioned as disadvantage⁸⁻¹². Consequently, the use of three-dimensional (3D) imaging systems such as CBCT has been promulgated.

It is a prerequisite to assess the height and crestal width of residual bone and the implant itself in radiographs not only for correct placement, but also not harming anatomical sites of skull^{12,13}. So qualified imaging systems with meticulous measuring are essential to meet the above needs. On the other hand, horizontal values especially pericoronal ones have been shown to be the most anticipated parts prone to distortion and enlargement¹⁴. We chose the crestal width of the implant fixture to compare its real size with its measures in a digital panoramic view.

The aim of this study was to determine the accuracy of digital panoramic radiography in estimating the crestal width of implant fixtures in different jaw regions after implant surgery.

Methods and Materials:

Sample Criteria

This study was conducted on 241 implant panoramic images taken in private clinics dependent on Guilan University of Medical Sciences (GUMS) from Jan 2017 to Jan 2018.

The demographic data of patients was concealed due to ethical issues. The radiographs which had recorded data of abutment width size have been included. The ones without 1) complete size records, 2) sufficient quality and 3) exact positioning were excluded.

Data collection:

The digital panoramic radiographic equipment used was CRANEX D PAN/Ceph (Soredex, Helsinki, Finland). All radiographs were confirmed by one maxillofacial radiologist according to general and manufacturer standards in the same conditions (dimmed room, light screen and digital collis). The true dimensions of respective implants were obtained and recorded from previous patients' information.

Statistical Analysis:

Descriptive statistic values such as frequency, mean and standard deviation (SD) were gathered. Two-way analysis of variance (ANOVA) post hoc (Tukey HSD) was used to test the differences between the two measuring methods. The level of significance value was considered 0.05. Moreover, the bland-altman plot and the inter-observer coefficient (ICC) was measured for analyzing the data. A reliability analysis scale (alpha) was used for ICC, for which a minimum of 0.7 was considered acceptable. Statistical analysis was performed by using Statistical Package for the Social Sciences (version 24 for Windows; SPSS, Chicago, IL, USA) and MedCalc software (version 18.9).

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Table1. Descriptive data of two measuring methods in different jaw regions

variant	Mean difference	Upper limit	Lower limit	significance	ICC
Total	-0.39(-0.46, -0.32)	0.67(0.55,0.79)	-1.44(-1.57,-1.32)	<0.001	0.47
Mandible	-0.34(-0.45,-0.23)	0.76(0.56,0.95)	-1.44(-1.63,-1.24)	<0.001	0.27
Maxilla	-0.43(-0.52,-0.33)	0.59(0.44,0.75)	-1.45(-1.6,-1.29)	<0.001	0.55
Whole Right	-0.26(-0.35,-0.16)	0.72(0.55,0.88)	-1.23(-1.4,-1.07)	<0.001	0.62
Whole Left	-0.51(-0.61,-0.41)	0.57(0.4,0.74)	-1.58(-1.75,-1.41)	<0.001	0.35
Maxillary anterior left	0.69(0.43,0.95)	1.75(1.3,2.21)	-0.37(-0.83,0.08)	<0.001	0.31
Maxillary anterior right	0.33(0.09,0.57)	1.45(1.03,1.87)	-0.79(-1.2,-0.37)	0.008	0.65
Maxillary posterior left	0.49(0.34,0.64)	1.41(1.15,1.67)	-0.43(-0.69,-0.17)	<0.001	0.50
Maxillary posterior right	0.27(0.11,0.44)	1.27(0.98,1.55)	-0.43(-1,-0.43)	0.002	0.61
Mandibular anterior left	0.27(-0.19,0.62)	1.52(0.81,2.22)	-1.09(-1.8,-0.38)	0.269	0.44
Mandibular anterior right	0.07(-0.23,0.37)	0.84(0.3,1.38)	-0.7(-1.23,-0.16)	0.602	0.63
Mandibular posterior left	0.52(0.35,0.7)	1.65(1.35,1.94)	-0.6(-0.9,-0.3)	<0.001	0.08
Mandibular posterior right	0.25(0.09,0.41)	1.15(0.88,1.42)	-0.65(-0.92,-0.38)	0.002	0.45

Results :

After data collection, Bland-Altman plot and ICC were used for analysis. The mean measurements of two methods (the real size and the width in digital panoramic radiography) have been investigated by the bland-altman plot. If the mean was not significant (more than 0.05), panoramic measures could be adopted instead of finding the real dimensions. Whether not, we could not rely on panoramic views for measuring.

The inter-observer coefficient (ICC) was also used. If the reliability analysis scale (alpha) was more than 0.7, two methods would be assumed to correspond. The analytic measurements are shown in Table 1.

As shown, two methods in both jaws generally and in all sextants except mandibular anterior left and right sextants had a significant difference in the bland-altman plot. The method of real measurement had higher amounts. The amount of ICC in all cases was less than 0.7, so the two cannot replace each other and the panoramic view did not meet the exact measurement of implant dimensions.

Discussion:

Panoramic radiography is often used as the first choice method for implant therapy because of its extensive field of view, lower cost and dose. Besides, in order to imaging conditions and two-dimensional (2D) view, it shows distortion and uneven magnification. The aim of the present study was to determine the accuracy of digital panoramic radiographs in measuring the exact amount of crestal width of implant fixture after surgery. It was shown that it is not accurate enough by using ICC and the bland-altman plot –except mandibular anterior left and right sextants in Bland-Altman plot. This means we can not use panoramic measures instead of real ones for treatment planning or follow-up.

This issue has been investigated in some other previous studies. The findings of the study of Esmaeli et al were quite similar to the present one¹⁵. They evaluated the accuracy of dimensional measurement of markers inserted in mandibular bone on panoramic radiographs in standard and improved magnification mode. Horizontal and vertical dimensions had significant differ-

ences in the real size of markers in both modes.

However, some studies showed different findings. Vazquez et al investigated the reliability of magnification factor in panoramic images in posterior parts of mandible⁵. They found panoramic magnification is acceptable in these areas. In another study, Al Hage et al investigated the impact of digital panoramic radiography magnification on vertical measurement accuracy¹⁶. They placed six dental implants in posterior segments in an animal model. Radiographs in low, moderate and high magnification were obtained and the width of implants was compared with their real size. They concluded that low magnification should not be used, although other modes are reasonable. Kim et al explored the accuracy and effectiveness of digital panoramic radiography for pre-operative assessment of dental implants⁷. First, they found out that there was no significant difference between the planned implant length and the actual inserted implant ($p > 0.05$) but the difference of width measurements was significant. Secondly, the magnification rate of the implant width was largest in the mandibular anterior part. The first theory is approved by the present study, but not the second one. The difference between all of these studies with the present study may originate in different imaging systems, different jaw areas included and different statistical tools used.

Conclusion:

All over, according to the present study, digital panoramic measurements are not completely reliable to predict the exact size of crestal width of implants because of image distortion. These measurement differences are smaller in some parts of jaws such as mandibular anterior ones. It is suggested to document manufacturers' measures before surgery or use more accurate and modern imaging modalities such as 3D systems like CBCT to achieve the best results.

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Implant in Different Jaw Regions in Patients Who Referred to Private Offices in Rasht City, 2017-2018" by Elmira Bahari performed at Gilan University of medical sciences (GUMS), Dentistry Faculty (register number: 1745).

Conflict of Interest:

The authors declared no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

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