

# Comparison of Radiographic Bone Height Assessments in Panoramic and Intraoral Radiographs of Implant Patients

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**Purpose:** To compare the ability of 2 radiographic methods, intraoral and panoramic radiography, commonly used in private practices following implant treatment to provide reliable information about the level of peri-implant marginal bone. An additional aim was to compare the inter- and intraobserver reliability. **Materials and Methods:** Patients with implants placed in the mandible in 10 private practices were studied retrospectively. Postoperative intraoral and panoramic radiographs were evaluated at a university oral radiology clinic. Two observers, a specialist in oral and maxillofacial radiology and a specialist in oral and maxillofacial surgery, assessed the bone level, and the thread at which the marginal bone seemed to be attached was registered for the distal and mesial surfaces of all implants at 2 assessments several weeks apart. Kappa statistics was used to compare the agreement between assessments, observers, and methods of radiography. **Results:** Intraobserver agreement was good or very good, while interobserver agreement was predominantly moderate. The agreement rate between the methods was also moderate. Seven percent of the sites were not possible to assess, with a small difference in favor for panoramic radiographs. In the assessment of the panoramic radiographs, the radiologist found more sites too difficult to assess than the surgeon did. **Conclusions:** In this study, panoramic radiographs were found to be as reliable as conventional intraoral radiographs when used to assess the point of bone attachment to implant threads. Intra- and interobserver agreement were reliable but not excellent. The radiologist was more successful in finding sites where the bone level was impossible to assess accurately. INT J ORAL MAXILLOFAC IMPLANTS 2007;22:96-100

**Key words:** bone height assessment, dental implants, intraoral radiographs, observer agreement, panoramic radiographs

Implant treatment is today a common prosthetic therapy in most countries. The quality and quantity of bone available at the anticipated implant site is of importance during planning and follow-up after implant insertion.<sup>1</sup> One radiographic success/failure

criterion for implant systems is the marginal bone level surrounding the implant.<sup>2</sup> During the first year, marginal bone resorption of a maximum of 1.5 mm has been accepted; during the following years, marginal bone loss of 0.2 mm annually is considered acceptable.<sup>2,3</sup> Panoramic radiographs or intraoral radiographs are commonly used to assess bone height,<sup>4,5</sup> and panoramic radiographs have also been used to get a general overview of the available bone during planning for implant placement.<sup>6</sup>

A panoramic radiograph includes both of the jaws and the teeth and is a simple examination; however, it gives a less detailed picture than an intraoral radiograph.<sup>7</sup> The operator must pay careful attention in patient positioning during the exposure in order to get a high-quality radiograph without too much distortion.<sup>4</sup> Most panoramic machines will also give a varied and unreliable magnification.<sup>7</sup> Intraoral radiographs have a higher resolution but are more time-consuming to obtain.<sup>4</sup>

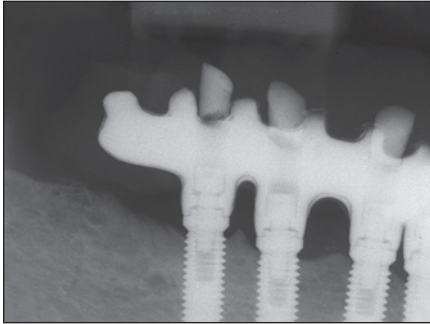
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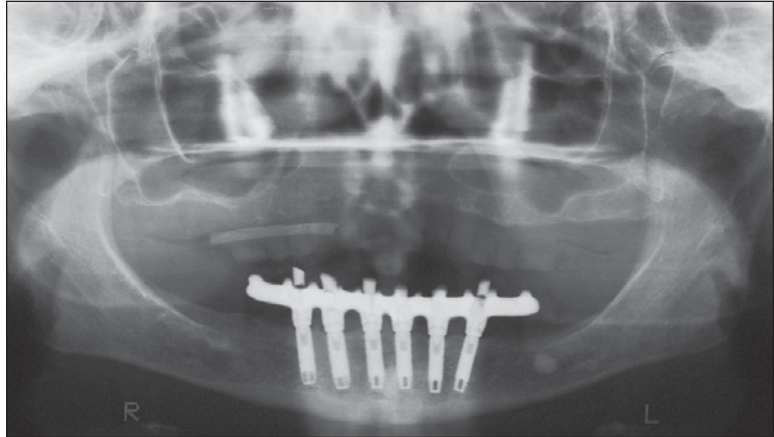
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**Fig 1** (Above) A typical intraoral radiograph.



**Fig 2** (Right) A panoramic radiograph of the same patient shown in Fig 1.

All radiographic methods have been shown to provide an underestimation of the marginal bone loss.<sup>7</sup> Several researchers have found that intraoral radiography is more accurate than panoramic radiographs in assessing bone height around roots and implants.<sup>7-10</sup>

Åkesson and associates<sup>7</sup> also reported that the image quality of panoramic radiographs from different clinics in Sweden was mostly unacceptable for assessment of the marginal bone, especially in the mandible; moreover, they found substantial interobserver variation. However, given that the radiographs were of a high quality, Åkesson<sup>11</sup> concluded that for the assessment of the marginal bone level around teeth the radiographic examination of choice should be the panoramic radiograph, which is in accordance with a recent study by Persson and associates.<sup>12</sup>

Molander and associates<sup>13</sup> studied the interobserver agreement in marginal bone assessment from intraoral and panoramic radiographs and found the same agreement rate methods. The conclusion was that panoramic radiographs can be used alone, supplemented when necessary by intraoral radiographs in cases where the panoramic radiograph is not of sufficient quality. Mörner-Svalling and colleagues, who used only intraoral digital and conventional radiographs,<sup>14</sup> recently found interobserver agreement around 85 percent when 10 observers evaluated the thread at which the marginal bone was attached to Brånemark implants. The observers were all working in the field of oral radiology; 5 were postgraduate specialists. Gröndahl and associates<sup>15</sup> recommended the use of several observers to read the same radiograph; their study found a small interobserver variation of 0.14 mm during repeated assessments around Brånemark implants. The largest component of this was the intraobserver variation. Earlier Kullman and colleagues<sup>16</sup> had also stressed the importance of having several observers in order to

avoid the bias of individual observers and recommended that each observer make repeated independent assessments in order to later average them.

The purpose of this investigation was to evaluate the difference in diagnostic outcome between panoramic and intraoral radiographs. The agreement between panoramic and periapical radiographs in assessment of marginal bone level was compared. An additional aim was to evaluate interobserver and intraobserver reliability during repeated assessments.

## MATERIALS AND METHODS

All patients who had implants (Implamed, Attleboro, MA) placed by the same oral surgeon (LZ) in 10 different private clinics in Sweden from 1995 to 1998 were included in this retrospective study. The implants supported fixed prostheses in all patients.

Intraoral and panoramic radiographs (Figs 1 and 2) were obtained at the same appointment for the patient during a follow-up visit after implantation. The technicians aimed at exposing stereoscopic pairs using a paralleling technique with the center of the x-ray beam perpendicular to the implant. This technique, described by Hollender and Rockler,<sup>17</sup> allows every implant to be viewed in at least 2 images. The radiograph in which the implant and surrounding bone subjectively looked most sharp was chosen and marked by the observers during the assessment, and the same one was used during repeated assessments.

The panoramic radiographs were exposed as a part of the daily routines of each private clinic. The radiographs were judged acceptable on the basis of the general subjective opinion of the technician or nurse. All the radiographs, intraoral and panoramic, were masked before the readings to shield the identity of the patient.

Table 1 Intraobserver Agreement				
	First observer (radiologist)		Second observer (surgeon)	
	Intraoral	Panoramic	Intraoral	Panoramic
Percentage	64	64	64	70
Kappa coefficient	0.54	0.54	0.56	0.63
Weighted kappa coefficient	0.75	0.72	0.77	0.82

Table 2 Interobserver Agreement				
	First reading		Second reading	
	Intraoral	Panoramic	Intraoral	Panoramic
Percentage	40	47	42	47
Kappa coefficient	0.29	0.35	0.31	0.36
Weighted kappa coefficient	0.58	0.59	0.60	0.62

Two observers at a university clinic in Kuwait (AA, LK), a specialist in oral and maxillofacial surgery and a specialist in oral and maxillofacial radiology, assessed the bone level in the radiographs using a light box and a Matsson magnifying viewer (X-produkter, Malmö, Sweden). The observers were not calibrated; they received only brief instruction on how to assess the bone level. The thread at which the marginal bone seemed to be attached was assessed by visual evaluation at the distal and mesial surfaces of all implants. The corresponding thread number for the bone attachment was recorded. All radiographs were read twice in a random order, with several weeks between the readings.

### Statistical Analysis

Agreement in assessing the implant thread at which the marginal bone attached was calculated for the 2 types of radiographs and between the 2 observers as well. The total proportion of agreement was calculated as a percentage and as a weighted kappa coefficient, which corrects for chance agreement. The kappa values were evaluated as follows: < 0.20 was considered poor; 0.21 to 0.40, fair; 0.41 to 0.60, moderate; 0.61 to 0.80, good; and 0.81 to 1.00, very good.<sup>18</sup>

The number of sites that could not be assessed because the attachment level was not clear was also calculated, and interobserver difference regarding this number was calculated as well.

## RESULTS

The bone levels at the mesial and distal sides were assessed in relation to the thread of the implant in 21 patients, 8 men and 13 women. The patients were an average of 72 years old. The intraoral and panoramic radiographs were exposed an average of 3.25 years after the implant placement. The agreement rates between and within observers can be seen in Tables 1 and 2. Intraobserver agreement was classified as good or very good in all cases, and while interobserver agreement was moderate or good. In Table 3 the agreement rates for the 2 imaging methods are presented for the 2 observers. The rates varied from 43% to 52% agreement.

The number of sites where the correct bone level could not be assessed is shown in Table 4. Of 1,840 available sites for both readings, mesial and distal, 133, or about 7%, could not be assessed. The radiologist classified significantly more sites as not possible to assess. Panoramic radiographs had fewer missing sites than intraoral radiographs. On further analysis, it was found that 86% of the difference was due to the observers' disagreement regarding 1 patient who had 6 implants with severe peri-implant bone loss. The surgeon considered only 1 site in the panoramic radiograph impossible to assess, while the radiologist registered all 24 sites for this patient as unassessable (all 12 sites on both readings). Consensus was later achieved when the observers checked this panoramic together. Two bone levels appeared on the radiograph around most of the implants, making assessment more difficult, and the surgeon later agreed that the radiograph could not be reliably assessed.

**Table 3 Comparison Between Intraoral and Panoramic Radiography**

	First observer		Second observer	
	First reading	Second reading	First reading	Second reading
Percentage	45	52	43	45
Mean difference between repeated measurements	0.1	0.1	0.2	0.1
Kappa coefficient	0.30	0.39	0.30	0.31
Weighted kappa coefficient	0.49	0.57	0.55	0.58

**Table 4 No. of Cases Considered Impossible to Assess**

	Intraoral	Panoramic	Total
First observer	35	45	80
Second observer	35	18	53
Total	70	63	133

The difference between the first and second observers was statistically significant (chi-square;  $P < .012$ ).

## DISCUSSION

This study found that panoramic radiographs are as reliable as intraoral radiographs for assessment of the thread at which the marginal bone level is attached, although neither radiographic method could be considered infallible.

The agreement rate was higher within observers (64% to 70%) compared with between observers (40% to 47%). The agreement rate was classified as good to very good (weighted kappa between 0.72 and 0.82) when the same observer repeated the assessment, while interobserver agreement was moderate to good. Panoramic radiographs had somewhat higher interobserver agreement than the intraoral radiographs. High interobserver variation, using different radiographic methods and 5 observers, was also found by Åkesson in 1992.<sup>19</sup> Lofthag and associates<sup>10</sup> found an interobserver kappa value of 0.33 for periapical radiography.

In another study using 2 trained radiologists as examiners, Molander and coworkers<sup>13</sup> demonstrated similar agreement within observers (66% to 68%) but greater agreement between observers (58% to 60%), using only radiologists as observers. The same researchers found also somewhat higher agreement rate when they compared bone height measurements in panoramic and intraoral radiographs, 55% and 49% respectively. Rohlin and associates<sup>20</sup> reported an agreement rate of 72% between panoramic and intraoral radiographs in the mandible. However, these researchers used a ruler with a larger line increment than did Molander and coworkers. Furthermore, only sites classified as read-

able in both sets of radiographs were included and measured.

When the methods of radiography were compared in the present study, the agreement between them ranged from 43% to 52%. The mean differences for repeated assessments were close to zero. This agreement rate was moderate according to weighted kappa statistics (0.41 to 0.60). However, it was not possible to make an assessment 7% of the time. Panoramic radiographs had fewer sites classified as unreadable. In the assessment of intraoral radiographs, both observers scored the same number of sites not assessable. However, the radiologist found more sites in the panoramic radiographs nonassessable than the surgeon did. It was found that this difference could mainly be explained by the surgeon's assessments of 1 patient who had severe alveolar bone resorption. The surgeon's assessment of this patient was later found to be unreliable. This finding is in accordance with findings reported by Rohlin and colleagues<sup>20</sup>; in their study, interobserver agreement in the assessment of marginal bone was lower in patients with severe bone loss.

In a study design such as the present one the quality of radiographs may be compromised, since images were made in a nonstandardized manner in private clinics rather than in radiology clinics. However, the majority of follow-ups after implant treatment are carried out in private clinics, and it is therefore of interest to know how reliable these radiographs are.

In most cases, a single clinician performs most long-term management, including evaluations of radiographs; this is common practice around the

world. This study supports this practice for typical patients, but consultation with a radiologist may be of value for more difficult cases.

## CONCLUSIONS

The results of this study, in which 21 patients were evaluated by 2 clinicians, demonstrate that panoramic radiographs show bone-to-thread contact as reliably as intraoral radiographs. However, neither method provided excellent inter- or intraexaminer reliability in radiographic assessment.

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