

# Accuracy of Parallel Periapical Versus Bitewing Radiographs in Determining the Level of Alveolar Bone Crest at the Posterior Area of the Jaws

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**Objectives** Periodontal clinical parameters are highly sensitive for the assessment of bone resorption, while radiographic images are highly specific. Two-dimensional parallel periapical (PA) and bitewing (BW) intraoral radiographs are used as adjuvant methods to assess bone resorption in periodontal diseases. The present study aimed to compare the efficacy of PA and BW radiographs in assessing marginal bone level.

**Methods** This cross-sectional study was conducted on 77 (52 females and 25 males) subjects with a mean age of  $40.12 \pm 14.9$  years with chronic periodontitis. Parallel PA and BW radiographs of patients, who required periodontal flap surgery or crown lengthening, were acquired, and evaluated. The distance between the alveolar bone crest (ABC) and the cemento-enamel junction (CEJ) was determined during surgery using the Williams probe. The same distance was measured in proximal areas on intraoral radiographs using Romexis Version 11.4. To evaluate intra-observer agreement, three observers re-evaluated the radiographs after a minimum of 1 week. Intra-class correlation coefficient (ICC) was applied to evaluate the inter- and intra-observer agreement. Data were analyzed using the Shapiro-Wilk test and paired t-test.

**Results** According to the results, the mean distance between the CEJ and ABC was  $4.61 \pm 1.22$  mm, and the mean distance on the PA and BW radiographs was  $4.20 \pm 1.23$  ( $P < 0.001$ ) and  $4.02 \pm 1.06$  mm ( $P < 0.001$ ), respectively. PA radiography was more accurate than BW radiography, although the difference was insignificant ( $P = 0.182$ ). The mean ICC value of the inter-observer agreement was 0.88 for BW and 0.87 for PA radiographs. The mean intra-observer agreement was 0.97 and 0.95 for BW and PA radiographs, respectively.

**Conclusion** The accuracy of PA radiography was higher than BW radiography. However, there was no significant difference regarding the accuracy of these two techniques in determining the level of ABC in the posterior area of the jaws.

**Keywords** Radiography; Dental; Diagnosis; Chronic Periodontitis; Alveolar Bone Loss.

## Introduction

Clinical and radiographic examinations play an integral role in diagnosing periodontal diseases, treatment planning, and follow-up examinations.<sup>1</sup> Periodontitis, defined as an inflammatory disease of the supporting tissues of teeth caused by specific microorganisms, results in the progressive destruction of the periodontal ligament and alveolar bone. Since the prevalence of periodontal diseases is estimated at 40%, early diagnosis is vital. Diagnosis of periodontal diseases is based on clinical parameters, such as pocket probing depth (PPD), bleeding on probing (BOP), clinical attachment loss (CAL), and radiographic survey.<sup>2</sup> Clinical parameters with high sensitivity are used for diagnosis, while radiographic images are highly specific.<sup>3</sup>

Radiographs are especially helpful in the evaluation of factors, such as the amount of remaining bone support, the configuration of angular bone defects, bone loss in furcation areas, the width of periodontal ligament space, the relationship between the alveolar bone margin and the cemento-enamel junction (CEJ).<sup>4</sup> Dental radiographs play an integral role in the assessment of periodontal diseases. A periodontal examination is complete with accurate radiography, which is highly useful in periodontal

treatment planning.<sup>5</sup> Generally, radiographic views differ in accuracy, image quality, the structures they visualize, the diagnostic information they generate, and the effective radiation dose of assessments.<sup>6</sup>

Radiographs can provide key information for periodontal decision-making, which cannot be obtained via clinical examinations, such as measurement of the root length with the remaining bone support and the pattern of bone loss. They can also identify other periodontal features, such as overhanging restoration margins, calculus deposits, and furcation lesions.<sup>7,8</sup> Intraoral and extraoral radiographs can be used to examine hard bone tissues.<sup>9</sup> Intraoral radiographs show the least deviation from the bone resorption estimate relative to the actual amount.<sup>10</sup> In radiographic images, if the distance between the CEJ and the alveolar bone crest (ABC) is more than 1.9 mm, it is defined as bone loss.<sup>1,11,12</sup>

Various radiography techniques, such as panoramic, bitewing (BW), and periapical (PA) radiographs, are prescribed to diagnose periodontal diseases.<sup>13,14</sup> Superimposition, distortion of structures, blurring of anatomical landmarks, and loss of detail are the limitations of panoramic radiography, which diminish its value for bone loss assessment in periapical and periodontal diseases.<sup>15</sup> Simple two-dimensional intraoral radiography

techniques, such as parallel PA and BW radiography, help in diagnosis and treatment planning for periodontal diseases.<sup>3, 9</sup> These radiographs are easy to obtain, inexpensive, and high-resolution.

Vertical BW radiography is used when bone loss exceeds 4 mm.<sup>16</sup> One of the disadvantages of BW radiography is that it does not represent the apex of the tooth; therefore, the percentage of bone loss progressing to the apex cannot be calculated.<sup>17</sup> Also, a complete series of PA radiographs are used to detect bone loss, which is more useful for the posterior areas of the mandible rather than the maxilla.<sup>3, 18</sup> On the other hand, complete intraoral series takes a lot of time and require many films.<sup>19</sup> Evidence shows that PA radiography has more geometric errors than BW radiography.<sup>3, 14, 20</sup>

Diagnosis of periodontitis is based on a combination of clinical and radiographic examinations, and none of the available radiography techniques have all the features of an ideal radiograph.<sup>9, 21</sup> Therefore, the present study aimed to compare PA and BW radiographs in assessing marginal bone tissue and to compare them with the gold standard visual assessment during surgery.

## Methods and Materials

### Study design

This cross-sectional study was conducted on 77 subjects (52 females and 25 males) with a mean age of  $40.12 \pm 14.9$  years, referred to the Department of Periodontology, Faculty of Dentistry, Golestan University of Medical Sciences, Gorgan, Iran. This study was approved by the Ethics Committee of Golestan University of Medical Sciences (IR.GOUMS.REC.1398.015). All participants in this study signed a written informed consent form. Sites with proximal pockets deeper than 5 mm remaining three months after scaling and root planing were considered for periodontal surgery.

### Inclusion criteria

The inclusion criteria were as follows: (1) Chronic periodontitis with a pocket depth of more than 5 mm in the posterior area; (2) patients requiring crown lengthening in the posterior area; and (3) lack of teeth crowding in the surgical area.

### Exclusion criteria

The exclusion criteria were as follows: (1) patients with hopeless teeth; (2) CEJ decay or cervical abrasions; (3) individuals with an active gag reflex; (4) individuals unable to have an X-ray film in their mouth; and (5) pregnant and lactating women.

### Radiographic examination

After obtaining informed consent from the patients, parallel PA and BW radiographs were acquired at the radiology department of the faculty. All PA and BW radiographs were acquired by the same trained and experienced

radiologic technologist. All PA and BW radiographs were taken with a Planmeca system (Planmeca Inc.<sup>®</sup>, Helsinki, Finland) at 63 kV and 8 mA (exposure time, 0.4 sec). A film holder was used for PA and BW radiographs. All radiographs were processed in the same manner. An oral radiologist assessed the overall image quality of the radiographs, and images of poor quality in terms of film placement, projection, centering, density, contrast, or sharpness were re-acquired before the radiographic examination of each patient was considered complete. On radiographs, the bone level was defined as the most coronal location of the bone margin adjacent to the visible periodontal ligament space. The distance between the CEJ and the crest of the alveolar bone at the most coronal aspect of the tooth was measured by oral radiologists and dental students within an interval of two weeks, using Romexis Version 11.4.

### Surgical examination

Full thickness mucoperiosteal flaps were reflected under local anesthesia, and scaling and root planning were done for the surgical procedure. Direct surgical hard tissue measurements were made using a Williams probe. The distance between the CEJ and ABC in the distal and mesial aspects of the roots was measured before shaping and contouring the bone. Measurements were performed in patients whose bone loss was horizontal; if a patient showed vertical bone loss, they would be excluded from the study. An experienced periodontist performed all clinical measurements. Intra-examiner reliability was tested by examining three patients in an identical manner one hour apart and observing more than 98% of recordings being within 1 mm.

### Observers

Two different observers evaluated the BW and PA radiographs (a radiologist and a trained dental student) in a two-week interval. Agreement between the two observers was defined by the measurement of intraclass correlation coefficients (ICCs). To establish ICC between the observers, 10 BW and PA radiographs were selected. The distance between ABC-CEJ in the mesial tooth 27 and the distal tooth 46 was measured by two observers. To establish ICC intra-observer agreement, this measurement was repeated 2 weeks later.

### Statistical analysis

The data were processed using statistical software (SPSS 16.0, IBM, Chicago, IL). The Shapiro-Wilk test was used to confirm the normal distribution of the data. Paired t-test was used for pairwise comparison of the three methods. Data were considered significant at  $P < 0.05$ .

## Results

On the radiographs, the distance between the CEJ and ABC was measured on both the mesial and distal sides of the tooth

using Romexis software. The mean ICC value of the inter-observer agreement was 0.88 for BW and 0.87 for PA radiographs. The mean intra-observer agreement was 0.97 and 0.95 for BW and PA radiographs, respectively.

The mean measurement of the distance between the alveolar bone crest and CEJ was  $4.61 \pm 1.22$  mm in the visual assessment during surgery,  $4.20 \pm 1.23$  mm for PA, and  $4.02 \pm 1.06$  mm for BW. According to the results presented in the table, the difference from the actual amount was significant. The mean error calculated for the PA method was

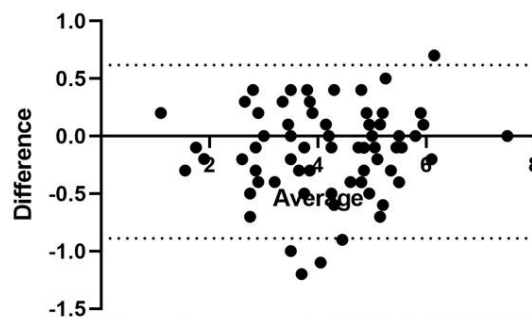
lower than that of the BW. Therefore, the accuracy of parallel PA was higher than that of BW radiography in estimating the alveolar bone level in periodontal diseases. Although the accuracy of parallel PA radiography was higher than that of the BW technique, the difference was insignificant ( $P=0.183$ ). Diagrams 1 and 2 show (Bland-Altman Plot) the difference between PA and BW radiographic measurement, respectively, with surgery. According to this diagram, there is a significant difference between the radiographic methods and visual assessment during surgery.

**Table 1:** Comparison of mean measurements of parallel periapical (PA), bitewing (BW) radiographs and visual assessment during surgery for measurement of the marginal bone level

Methods	Alveolar bone crest		Absolute error		Relative error		P-value*
	Mean	SD	Mean	SD	Mean	SD	
visual assessment during surgery	4.61	1.22	–	–	–	–	–
PA	4.20	1.23	0.52	0.42	0.11	0.10	<0.001
BW	4.02	1.06	0.69	0.59	0.14	0.10	<0.001

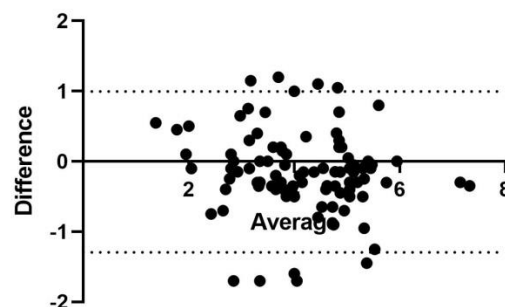
PA (Periapical), BW(Bitewing), SD (Standard deviation), \* Paired t-test

**Difference vs. average: Bland-Altman of Bland-Altman**



**Diagram 1:** Bland-Altman Plot, the difference between the mean measured bone loss with PA and visual assessment during surgery.

**Difference vs. average: Bland-Altman of Bland-Altman**



**Diagram 2:** Bland-Altman Plot, the difference between the mean measured bone loss with BW and visual assessment during surgery.

## Discussion

Various studies have been conducted to compare the accuracy of intraoral radiographs. These studies have reported inconsistent results, which can be due to various factors, such as the type of used technique, type of used device, device accuracy, operator's experience, oral areas

examined, age and sex of the participants, sample size, and dental status of the participants in the study.

The results of this study show a significant difference between parallel periapical and bitewing radiographs with reality. None of these radiographs showed preference over the other. Horizontal BW radiographs, useful for approximal caries detection, are not very helpful in

periodontal treatment or treatment planning if the bone loss is advanced. Vertical BW radiographs can be highly useful if no clinical information suggests a previous endodontic therapy or periapical periodontitis alone or combined with periodontal destruction. In vertical BW radiographs, not all root apices are evident, and some periapical bone is not visible. The long cone paralleling technique in periapical radiographs can most accurately represent the alveolar bone level.<sup>13, 22, 23</sup>

Many bone and tooth features are evident on conventional radiographs, along with features related to caries and endodontic, restorative, and prosthodontic conditions, which can influence periodontal treatment planning.<sup>24, 25</sup> One of the criteria for determining the disease's severity is measuring the amount of bone resorption on radiographs.<sup>26</sup> Many factors, such as X-ray angle, percentage of bone loss, type of film, and technician's skills, are important in the diagnostic accuracy of radiography.<sup>17, 27</sup> In this regard, Kelly<sup>28</sup> reported that PA radiography has the highest diagnostic accuracy among oral radiographs available to dentists, which is in line with the present findings. Soikkonen et al.<sup>29</sup> considered BW radiography reliable for determining the amount of bone loss; however, their results were contrary to the present findings. In their study, a paper tab was used to prepare the BW radiographs, and all samples were selected from the upper jaw, whereas in the current study, a film holder was used. The inconsistent results can be attributed to different angles of film placement in the mouth; our samples were also selected from both jaws.

Walsh and Fosam reported that PA and BW methods were similar in accuracy.<sup>30</sup> Conversely, Kipioti A and Bragger reported that the accuracy of parallel PA radiography for small lesions was lower than that of BW radiography,<sup>31</sup> which is inconsistent with the present study. This

discrepancy can be attributed to the larger number of participants and the greater bone resorption in the present study. In a study by Peplassi et al., which was conducted to measure the amount of alveolar bone destruction in parallel PA and BW radiography and to compare it with the measurements obtained via surgery, BW radiography showed small alveolar bone resorption more accurately than parallel PA radiography. However, in advanced periodontitis, the accuracy of parallel PA radiography was higher than that of BW radiography,<sup>32</sup> which is congruent with the present results.

In a study conducted by Rimondine et al.<sup>33</sup>, the degree of anatomic accuracy of radiographic images depended on the correct technical procedure, which includes exposure, angulation, object-film, and focal-film distance. This study showed that the parallel technique produced minimal dimensional changes. In the present study, all these conditions were standardized by preparing radiographs in a specific center by a specific operator, using the same devices and equipment (e.g., dental radiography devices, monitors, processing conditions, and holders).

## Conclusion

The accuracy of parallel PA radiography was higher than that of BW radiography. However, there was no significant difference in the accuracy of these two techniques in determining the level of ABC in the posterior area of the jaws.

## Conflict of Interest

No Conflict of Interest Declared ■

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