COMPARISON OF DIFFERENT IMAGING TECHNIQUES FOR THE EVALUATION OF PROXIMITY BETWEEN MOLARS AND THE MANDIBULAR CANAL

ABSTRACT

Background and Aim: To compare the radiographic distance from the inferior part of mandibular second and third molars to the superior border of mandibular canal on radiographs obtained by conventional periapical radiographs, intraoral photostimulable phosphor plate (Intraoral PSP) and panoramic photostimulable phosphor plate (Panoramic PSP).

Subjects and Methods: The study was carried out on 25 patients. Periapical radiographs and photostimulable phosphor plate images were obtained with the paralleling technique. The radiographic distance from the most inferior part of mandibular molar teeth to the nearest superior border of mandibular canal were measured using image analysis software (ImageJ). All measurements were performed by an oral radiologist. Comparisons of the measurements were evaluated by Intraclass Correlation Coefficients.

Results: Periapical radiographs and intraoral PSP, periapical radiographs and panoramic PSP, and intraoral PSP and panoramic PSP showed agreement levels of 99%, 91%, and 91%, respectively. Repeated measures of ANOVA showed no statistical significant difference among periapical radiograph, intraoral PSP and panoramic PSP (F=1.409, p=0.234).

Conclusion: Periapical radiographs, images obtained by intraoral PSP and panoramic PSP can be used interchangeably for the evaluation of the proximity of molar teeth and the mandibular canal.

Key words: Conventional Film, Digital Imaging, Mandibular Canal, Photostimulable Phosphor Plate, Proximity
**INTRODUCTION**

Dental surgical procedures carry the risk of causing serious complications to adjacent anatomic structures. As such, damage to the inferior alveolar nerve is a common postoperative complication of lower third molar removal. Consequently, determination of the exact relationship between the mandibular canal and lower third molar is mandatory. Another noteworthy oral surgical procedure is the placement dental implants. Osseointegrated implants are often placed in the posterior region of the mandible, mostly for the aim of supporting fixed dentures. In many cases the bone is resorbed, jeopardizing placement of sufficiently long implants without encroaching on the mandibular canal, particularly if the position of the canal is not determined preoperatively. The inferior alveolar nerve may also be vulnerable during orthodontic and endodontic treatment. Accidental overfilling and overinstrumentation of mandibular premolar and molar teeth during endodontic treatment may cause neural injury. Orthodontic tooth movement can cause pressure on the inferior alveolar nerve, and this may lead to nerve paraesthesia.

To optimize surgical planning and avoid complications, precise identification of the mandibular canal is important. Intraoral and extraoral radiographs (film based or digital) and cone beam computerized tomography (CBCT) images have been utilized to assess the proximity of the mandibular canal and mandibular molar teeth and remaining bone height. The aim of the present study was to compare the radiographic distance from the inferior part of mandibular second and third molar teeth to the superior border of mandibular canal on radiographs obtained by conventional intraoral radiographic film, intraoral photostimulable phosphor plate (intraoral PSP) and panoramic photostimulable phosphor plate (panoramic PSP). This study also aimed to evaluate the possible use of panoramic PS instead of periapical radiography for radiographic distance measurements.

**SUBJECTS AND METHODS**

This study was carried out on a total of 25 healthy patients (15 females, 10 males) who admitted to the Department of Oral Diagnosis and Radiology. The study protocol was performed upon approval by the Institutional Human Subject Review Committee of Hacettepe University (Approval number: DPT 06/3-7) and informed consent obtained from the patients. The inclusion criterion stipulated selection of patients who needed periapical and panoramic radiographic examination of the mandibular molar region for the purpose of routine dental diagnosis and treatment planning. Emergency patients and those who had systemic disorders that could affect bone density were not included. Periapical radiographs and intraoral photostimulable phosphor plate (PSP) images were standardized and taken perpendicularly to the long axis of the teeth with the paralleling technique by the same radiologist. Periapical radiographic examination was carried out using Kodak Insight film (Eastman Kodak Company, Rochester, NY) and a VistaScan phosphor plate (Dürr Dental, Bietigheim-Bissingen, Germany) employing a RINN film holder (XCP Instruments, Elgin, IL). Exposures were made using a KaVoIn Exam dental X-ray unit operating at 70 kVp, 7 mA and 0.115 s exposure time for both the periapical film and the phosphor plate. While obtaining periapical radiographs, intraoral PSPs and panoramic radiographs an orthodontic wire was used as a reference with a known length for calibration and measurements. Radiographs were converted to digital images using a flatbed scanner at 2400 dpi (EPSON EXPRESSION 10000 XL, Seiko Epson Co., Nagano, Japan). All the images were stored as TIFF file (Tagged Image File Format) on a personal computer and no data compression was used. Panoramic radiographs were obtained by an OP100 Orthopantomograph (Instrumentarium Corp., Tuusula, Finland) with amagnification value of 1.3. In accordance with the manufacturer’s instructions; the patients placed their upper and lower incisors into the bite block, their midsagittal plane were centered within the image layer, and the occlusal plane was aligned so that it was lower anteriorly to form a line from the tragus of the ear to the outer canthus of the eye being parallel to the floor. Finally, in order to eliminate air space, the patients swallowed and held their tongue on the roof of their mouth. This standardized head positioning was used during to reduce magnifications. Magnification correction was also undertaken during evaluation of measurements on panoramic radiographs. An open-source image analysis software (ImageJ 1.42m, National Institutes of Health, MD, USA), running on a windows workstation was used at X600 magnification for the measurements. All measurements were performed by the same radiologist. During measurements, histogram equalization was performed when needed. From a total of 25 patients, 86 measurements were made from the mesial and distal roots of the most inferior part of mandibular second and third molar teeth to the nearest superior border of the mandibular canal. Accordingly, a line was drawn to connect the mesial
and distal cementoenamel junctions. Thereafter, the line was moved apically, and the last contact point of the line at the root apex was set as the most inferior part of the tooth (Figures 1-3).

The measurements were compared statistically using Intraclass Correlation Coefficients (ICC). Repeated measures of ANOVA was used to evaluate differences among periapical radiograph, intraoral PSP and panoramic PSP. All data were analyzed using Statistical Package for the Social Sciences (SPSS) edition 11.5. For ICC the power of this study is 99%.

RESULTS

The measurements obtained using the tested radiographic techniques are presented in Table 1 as mean±standard deviation. After two weeks from the first measurements, all images were re-measured by the same operator. Intra-observer agreement with reliability analysis test was determined as 97%.

Measurements obtained by periapical radiographs and intraoral PSP showed an agreement level of 99%, while that of periapical radiographs and panoramic PSP was 91%. Intraoral PSP and panoramic PSP showed an agreement level of 91%. Repeated measures of ANOVA showed no statistical significant difference among periapical radiograph, intraoral PSP and panoramic PSP (F=1.409, p=0.234).

DISCUSSION

To avoid surgical complications, proper radiographic assessment is essential to determine the exact topographic relationship between the mandibular canal and the lower molars.1 To serve this aim, intraoral and extraoral radiographs have been used frequently. Paralleling technique is the preferred method for obtaining periapical radiographs, as it minimizes geometric distortion and presents the teeth and supporting bone in their true anatomic relationships.1, 10 Kazzi et al.11 reported that the paralleling technique is effective in accurately imaging teeth. The paralleling method works equally well for conventional film, charge coupled device (CCD), complementary metal oxide semiconductor (CMOS) sensors, or PSP.12 Since the size, corners and shape of PSP are similar to that of conventional radiographic films, PSP systems have been recommended for intraoral radiographic examination of the mandibular molars.12, 13

Comparing direct digital radiographs and conventional intraoral radiographs in detecting alveolar bone loss, Khocht et al.14 observed that intraoral direct digital radiographs are...
not an equivalent substitute for conventional radiographs. Indeed, the size and magnification of digital images are much different from those of conventional film images, and may vary among different sensor types. Presumably, the sensor type could have affected the results of Khocht et al. Shearer et al. compared three phosphor plate systems and conventional film for imaging root canals, and found that a greater length of root canal was visible on conventional film than on the tested PSP systems. In the latter study, the spatial resolution was reported as 20 lp/mm for intraoral film and 7 lp/mm for PSP, which might be responsible for their results. On the other hand, Versteeg et al. reported that estimations of distance on digital images (CCD) are comparable with or even better than those of conventional radiographs. Brito-Junior et al. have also reported that linear measurements obtained on either conventional or digital radiographs (PSP) were similar. Jorgenson et al. compared F-speed film and digital images (PSP) for the detection of vertical bone defects, and found that digital images were diagnostically comparable to conventional radiographs. Recent PSP systems have a spatial resolution that is similar to conventional films, which may be the reason of similar or even better results. The present results demonstrate a high level of agreement between periapical radiographs and intraoral and panoramic PSP. Our results demonstrate a high level of agreement between periapical radiographs and intraoral PSP, and also between intraoral PSP and panoramic PSP.

Radiographic bone measurements on conventional radiographs can be influenced by several factors including image quality and observer interpretation. On the other hand, a single examiner should be used to avoid interexaminer disagreement, especially during radiographic measurements of the bone. In this study, a single examiner performed all the measurements to avoid interexaminer disagreement. Lazzerini et al. compared the conventional and digital techniques for the measurement parameters in dental radiography and pointed out that digital techniques must be used carefully whenever a reliable measurement is required. Furthermore, Peker et al. compared the subjective image quality in conventional and digital panoramic radiography and found both to be similar. However, regardless of being film-based or digital, intraoral radiography has many inherent limitations. A fundamental one is that, the three dimensional anatomy is collapsed into a two-dimensional surface, which causes image features representing different anatomical structures to be superimposed. Features of diagnostic interest may, therefore, be obscured and diagnostic accuracy is decreased. Dental CBCT has been accepted for its high sensitivity, as well as its superiority to panoramic radiographs in predicting the mandibular canal, and for

### Table 1. Mean and standard deviations of the study group

<table>
<thead>
<tr>
<th>TEETH</th>
<th>Conventional Periapical</th>
<th>Intraoral PSP</th>
<th>Panoramic PSP</th>
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<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>37, 38, 47, 48 (N= 86)</td>
<td>5.07</td>
<td>2.83</td>
<td>5.08</td>
</tr>
</tbody>
</table>

(N=Number, SD=Standart Deviation)
implant planning in the posterior mandible. However, owing to its high cost, limited availability and high radiation dose compared to periapical and panoramic radiographs, dental CBCT is not the first choice radiographic technique for identifying the proximity of the mandibular molar roots and the mandibular canal. The digital imaging offers many advantages over conventional radiography. It eliminates the need for film and film developing. Hazardous wastes in the form of processing chemicals, lead foil and time involved in processing conventional radiographic film are eliminated with digital systems. Images can be electronically transferred to other clinicians without any alteration of the original image quality. The most significant advantages of digital imaging are computer-aided image interpretation and image enhancement, in addition to the obvious options of standardized image archiving and image retrieval. However, enhancements used in digital radiographic imaging systems should be used cautiously as a diagnostic adjunct, and only in conjunction with unenhanced images to attain accurate radiographic diagnosis. Many studies have found the diagnostic accuracy of conventional film and PSP systems to be quite similar. The present study has various limitations that need to be taken into account. Firstly, in order to investigate the proximity of two structures three dimensional assessments are necessary. Horizontal distances also need to be evaluated. Three dimensional data can only be obtained with the use of CBCT in dentistry. However, in some circumstances, CBCT data cannot be obtained. Therefore, in these conditions, panoramic radiography can be the technique to evaluate the proximity of teeth and anatomic structures. Although buccolingual measurements cannot be done, vertical measurements can be important to avoid the complications during surgery. Finally, due to the limited sample size, the results of the study cannot be generalized. However, despite these limitations, the present study provides valuable information.

**CONCLUSION**

In conclusion, periapical radiographs, images obtained by intraoral PSP and panoramic PSP can be used interchangeably for the evaluation of the proximity of teeth and mandibular canal. To determine the relationship between mandibular molars and the mandibular canal, the first choice of intraoral imaging technique can be periapical radiography or PSP image obtained with the paralleling technique. However, because of the need of a film-holding instrument and trained personnel, it may difficult to routinely perform the paralleling technique. Whenever these limitations are present, the panoramic PSP can also be used to evaluate the proximity of teeth and mandibular canal.

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