The Effect of Bite Registration on the Reproducibility of Parallel Periapical Radiographs Obtained with Two Month Intervals

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Abstract:
Statement of Problem: Digital Subtraction Radiography (DSR) needs reproducible alignment between the x-ray source, the object, and the film for obtaining identical projections of the same anatomic region.

Purpose: The aim of this study was to evaluate the effect of bite registrations (placed on individual bite blocks) on the reproducibility of parallel periapical radiographs, obtained every 2 months, in patients undergoing periodontal surgery for furcation involvement.

Materials and Methods: Ninety eight parallel periapical radiographs were used in this study. The radiographs were taken with individual bite-blocks attached to the beam-guiding device. In order to individualize the bite blocks, bite registrations were fabricated using silicon impression material, and were placed on the individual bite blocks. All radiographs in each series were processed under similar conditions and were digitized with the flatbed scanner fitted with a transparency adaptor (hp Scanjet 7400) at 300 dpi resolution. Reproducibility of this method for obtaining similar parallel periapical radiographs was assessed by measuring the horizontal and vertical distances between two selected unchanged reference points on each radiograph and comparing them in each series. Reliability of measurements was analyzed using the one way random model intraclass correlation coefficient for average of raters.

Results: For both measurements (Horizontal and Vertical) statistically significant reliability was found between three repeated radiographs with two month intervals in 16 patients, as well as 5 repeated radiographs with two month intervals in 10 patients (P<0.001).

Conclusion: The result of this study shows that bite registration on individual bite blocks is enough for obtaining identical parallel periapical radiographs.

Key Words: Geometric standardization; Standard intraoral radiography; Reproducibility

INTRODUCTION
Two methods are frequently used to evaluate the presence and the severity of periodontal disease, namely, radiographic assessment of alveolar bone height and clinical detection of attachment loss as measured by probing attachment levels [1]. Radiographic examination is limited by the fact that the radiograph provides a restricted two dimensional representation of the 3-
dimensional anatomy. As a result, many features of the anatomy are not apparent to the examiner during visual inspection of the radiograph. This is due to the limitation imposed by the physics and geometry of radiography, as well as the examiner’s perception of the radiographic image [2]. Early diagnosis of periodontal disease and monitoring the efficacy of therapy requires detection of early osseous changes from longitudinally obtained radiographs over months or years. Visual interpretation of intraoral radiographs, however, has been reported to be of limited diagnostic value for the early detection of subtle bone changes. According to previous studies [2,3] between 30-60% of bone mineral content must be lost in order to visualize a change on a conventional radiographic image. However, digital subtraction radiography (DSR) is a powerful technique for revealing subtle changes in radiographic density on serial radiographs of the same anatomic region. When properly applied, it has been shown to be a sensitive tool that can improve the detection of hard tissue changes such as those associated with periodontal diseases, caries and other lesions. In addition it can improve the detection of bone regeneration following therapy. In spite of the evidence that supports DSR as a superior tool for a number of diagnostic tasks, the technique has been slow to make inroad into everyday clinical practice. The greatest obstacle to widespread clinical use of DSR to detect and measure subtle changes in dental tissues has been standardization of projection geometry. DSR requires that the images to be subtracted, to be identical projections of the same anatomic region. Subtraction of anatomical regions that do not properly overlap will produce undesirable artifacts that can mimic or obfuscate true changes [4]; therefore, there must be reproducible alignment between the x-ray source, the object and the film [5-7].

Several methods, mostly as a result of in vitro studies, have been described for obtaining a reproducible alignment between the x-ray source, the object and the film [5-7]. Bite registration with or without the use of other techniques is the most preferred method for obtaining standardized periapical radiographs. Considering the importance of obtaining radiographs with standardized techniques, it seems necessary that further clinical investigations to be conducted on this subject. Hence, this study was designed to evaluate the effect of individualized bite blocks by use of bite registrations, on the reproducibility of parallel periapical radiographs, obtained every 2 months, in patients undergoing periodontal surgery for furcation involvement.

MATERIALS AND METHODS

Ninety eight parallel periapical radiographs were obtained from patients undergoing periodontal surgery for furcation defects. All radiographs were taken using the paralleling technique on the same radiographic unit (CASTELINI 70 kv 8 mA, Italy). Ten patients had x-ray series consisting 5 parallel periapical radiographs (pre-operative, 2 months post-op, 4 months post-up, 6 months post-up, 8 months post-up). The radiographs were taken with individual bite-blocks attached to the beam guiding device (XCP, Rinn, USA). In order to individualize the bite blocks, bite registrations were fabricated using silicon impression material (Polyvinylsiloxane, Kerr, Germany), and were placed on the individual bite blocks. After disinfection with Deconex (Switzerland), the individualized bite blocks were kept in a refrigerator between appointments. All radiographs in each series were processed under similar conditions and were digitized with the flatbed scanner fitted with a transparency adaptor (hp Scanjet 7400, China) at 300 dpi resolution and stored on the hard disk of a personal computer with bmp format. Reproducibility of this method for obtaining
similar parallel periapical radiographs was determined by measuring the horizontal and vertical distances between two selected unchanged reference points on each radiograph (for example cementoenamel junction and forcation). The Adobe Photoshop 7 software was used for measurements. These measurements were compared in each series in order to detect all differences. Reliability of the measurements was analyzed using the one way random model intraclass correlation coefficient for average of raters.

RESULTS
The horizontal and vertical measurements between selected unchanged reference points in each radiograph as well as the mean and standard deviation (SD) for each series were calculated. Then, the ability of this method for obtaining unchanged radiographs with two month intervals (geometric standardization) was calculated by comparison of three Horizontal (H₀-H₂) and Vertical (W₀-W₂) measurements in repeated radiographs of 16 patients, which revealed a high reliability relation between H₀-H₂ (standardized coefficient item=0.919) and W₀-W₂ (standardized coefficient item=0.999). In addition five Horizontal (H₀-H₄) and Vertical (W₀-W₄) measurements in repeated radiographs of 10 patients were compared, showing high reliability relations between H₀-H₄ (standardized coefficient item=0.944) and W₀-W₄ (standardized coefficient item=0.999). For both measurements (Horizontal and Vertical) statistically significant reliability was found between three repeated radiographs with two month intervals in 16 patients, as well as 5 repeated radiographs with two month intervals in 10 patients (P<0.001).

DISCUSSION
The present study demonstrates the potential of bite registrations placed on individual bite blocks attached to the beam guiding device (XCP), for obtaining standard periapical radiographs. The results of this study are comparable with that of an investigation conducted by Ludlow et al [8]. They compare

Table I: Mean and extreme value of errors of vertical distance measurements (cm) between reference points in radiographs of patients

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Minimum error</th>
</tr>
</thead>
<tbody>
<tr>
<td>W₁ difference</td>
<td>0.005</td>
<td>0.035</td>
<td>-0.04</td>
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<tr>
<td>W₂ difference</td>
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<td>-0.05</td>
<td>0.06</td>
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<tr>
<td>W₃ difference</td>
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<td>W₄ difference</td>
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<tr>
<td>Mean difference</td>
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<td>0.025</td>
<td>0.05</td>
<td>0.05</td>
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Table II: Mean and extreme value of errors of Horizontal distance measurements (cm) between reference points in radiographs of patients

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
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<th>Minimum</th>
<th>Maximum</th>
<th>Minimum error</th>
</tr>
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<td>0.089</td>
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<td>H₃ difference</td>
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<td>0.50</td>
<td>0</td>
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<tr>
<td>Mean difference</td>
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<td>0.119</td>
<td>-0.10</td>
<td>0.33</td>
<td>0</td>
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</table>
a method that used a film positioning instrument, laser aligned beams and a cephalostat with a previously validated method that used film petitioners and elastic impression material. In their study, two series of periapical radiographs were obtained from six different anatomic areas of six phantoms using both techniques. Film pairs were digitally subtracted twice, and analyzed. The method used in the present study was comparable with the technique used by Trope et al [9], who performed a study to evaluate radiographic healing of teeth with apical periodontitis.

Woo et al [10] used a custom made acrylic bite block attached to a Rinn XCP film holder, and a rigid attachment between the bite block and the cone, in order to obtain standardized periapical radiographs for subtraction. Devices which have been used for Geometric standardization by means of occlusal registration are two types; those mechanically coupled to the source, and those uncoupled from the source. Devices which are rigidly coupled to the source require laboratory fabrication and are also uncomfortable. Their advantage is rigid coupling between the source and the film so that the angular error should be less than that introduced by uncoupled devices; however, in practice this advantage is often offset by patient discomfort and operator inconvenience [11]. Alternatively, an extraoral geometric standardization method using a cephalostat head holder and a long film to object distance [6] was developed. A real time video feedback has also been established in order to standardize image geometry for intra-oral radiography [12]. This system stabilizes films by utilizing a stored image of the face, taken at the time of the first radiograph. According to the results of this study it seems that there is no need to use rigid connections between the X-ray source and bite registration or cephalostat to achieve standardized parallel periapical radiographs.

Recently Danesh et al [13] in a digital subtraction radiographic analysis of GTR in human intrabony defects used a Rinn film holder and E speed film and obtained periapical radiographs without standardized projection geometry. They concluded that digital subtraction radiography appeared to be a sensitive measure of changes in crestal alveolar bone mass following GTR therapy in clinical practice, despite small differences in angulation between non standardized pre-surgical and post-surgical radiographs.

CONCLUSION
Considering the limitations of this study, it can be concluded that bite registration on individual bite blocks is enough for obtaining identical parallel periapical radiographs.

ACKNOWLEDMENT
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REFERENCES
6- Jeffcoat MK, Reddy MS, Webber RL, Williams