Assessment of proximity of impacted mandibular third molar roots to the mandibular canal using intra oral periapical radiography and cone-beam computerized tomography: A comparative study

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Abstract

Objective: To assess the reliability of five intra oral periapical radiography (IOPAR) radiographic signs, and to compare the reliability of IOPAR with that of cone-beam computerized tomography (CBCT) for determining the proximity of impacted mandibular third molar and mandibular canal.

Methods: The present study consisted of 50 subjects, in age group of 18-30 years with impacted mandibular third molar visiting the department, Oxford Dental College and Hospital, Bengaluru. Relationship of impacted mandibular third molar with the mandibular canal was assessed using IOPAR signs and CBCT findings. The 5 radiographic signs i.e. darkening of roots, diversion of canal, narrowing of canal, presence of cortication, and interruption of white line seen on IOPAR, were correlated for the proximity and involvement with CBCT findings for the same.

Results: In this study only 4% (2) subjects showed absence of corticalization on CBCT compared to different radiographic (IOPAR) signs in all subjects. Among these two subjects diagnosed with an absence of corticalization, 50% (1) presented with a radiographic sign of darkening of roots and both i.e. 100% (2) presented interruption of white line seen on IOPAR, were correlated for the proximity and involvement with CBCT findings for the same.

Conclusion: This study showed the poor reliability of radiographic signs of IOPAR predicting the proximity of mandibular third molar root with mandibular canal related to CBCT finding. This creates the controversy and questions regarding the radiographic signs of IOPAR reliability with CBCT findings that was found far more precise and accurate as per for future prospects.

Introduction

Extraction of third molar is a routine procedure in maxillofacial surgery, whether for prophylactic or for orthodontic reasons.[1] Damage to the inferior alveolar nerve (IAN) during mandibular third molar extraction surgery is a significant and common complication, which can result in post-operative paresthesia in patients.[2] IAN paresthesia is characterized by prolonged sensory deficit and/or abnormal sensation in the lower jaw, mental region and lower lip of the affected side, and may be transient or permanent in nature.[3] The incidence of IAN paresthesia following surgery is reported to be between 0.4% and 8%.[4] Permanent paresthesia may lead to functional deficits, and a decreased quality of life. To optimize surgical planning and avoid complications, such as paresthesia, precise identification of the mandibular canal is important.[5]

An imaging exam is an essential tool for diagnosis and surgical management. So accurate preoperative radiographic examination is therefore considered indispensable before extraction of mandibular third molar.[6,7]

Studies suggest that five specific signs observed on an intra oral periapical radiography (IOPAR) which are darkening of root, diversion of canal, narrowing of canal, presence of cortication, interruption in white line are reliable ways to assess proximity of the impacted mandibular third molar and mandibular canal.[8]
Cone-beam computerized tomography (CBCT) scanners have recently been developed for dentomaxillofacial imaging. CBCT reduces the radiation dose as compared with conventional CT and offers high spatial resolution.[9,10]

In the present study, IOPAR and CBCT images have been utilized to assess the proximity of mandibular canal and mandibular third molar root and evaluate the reliability of five IOPAR signs and compare it with CBCT in predicting the proximity of impacted third molar root with mandibular canal.

Materials and Methods

Source of data

The study group consisted of 50 patients of either sex in the age group of 18-30 years and above with impacted mandibular third molar. The study subjects were selected from out patients attending the department of oral medicine and radiology oxford dental college and hospital, Bangalore. Inclusion criteria include - Individuals with impacted mandibular third molar, Unerupted mandibular third molars with mandibular second molar present. Good quality radiograph.

Whereas Inability to identify inferior alveolar canal on radiograph, displacement of the root due to pathology, such as cyst or tumor, patient with systemic diseases, Pregnancy were the exclusion criteria.

Methodology

Preliminary clinical and radiographic examination

Any patient with impacted mandibular third molar was subjected for IOPAR and was taken into the study. The procedure was explained to the patients, and an informed written consent was obtained from them to be a part of the study. Ethical clearance was obtained.

For IOPAR exposure

The patient was made to wear a lead apron and seated comfortably in a conventional dental chair with the sagittal plane perpendicular and occlusal plane parallel to the floor.

For paralleling technique, intraoral periapical Kodak ekta speed film was used; the procedure was explained to the patient and was asked to remain stable during the exposure.

The film was placed in Rinn XCP holder with all the exposure parameter set (70 kvp, 10 ma and 0.7 s). The film was placed in the floor of the mouth, centered over the impacted mandibular third molar. The X-ray tube was aligned over the position indicating ring of the Rinn XCP holder, and the exposure was made. The film was processed using a standardized technique in well-equipped darkroom.

Interpretation of IOPAR

The radiograph was checked for the following 5 signs that are - darkening of the root, diversion of the canal, narrowing of canal, presence of cortication, interruption in white line. If any of the above-mentioned five sign were present, patient is subjected for CBCT Figures 1 and 2.

CBCT procedure

The working of the CBCT machine was demonstrated to the patients, and the subject was explained the need to be still during the procedure. After the patient positioning is done, the machine is adjusted such that the mandibular view comes. The exposure parameters were selected from the machine with automatic exposure control, and the exposure is made (90 voxel size, 85 kvp, 20 s, 8 ma).

Interpretation of CBCT

The canal was traced, and the image formed was seen in three dimensional view. i.e. sagittal, coronal, and axial planes. The obtained images were evaluated for the presence of corticalization and were measured for the distance i.e., between the root tip from the mandibular canal on (21 inch LCD monitor with 128061024 resolution). Under dim lighting conditions, images were evaluated with the use of the “zoom” tool and manipulation of brightness and contrast (Figures 3 and 4).

Figure 1: Intra oral periapical - Interruption canal

Figure 2: Intra oral periapical - Darkening of root
The above-mentioned criteria were determined and were recorded in the Performa specially designed for the study.

**Statistical analysis**

The data were analyzed with SPSS software.

**Results**

In the present study, darkening of the root was present in maximum no of subject narrowing, and diversion of the canal were present in the least number of patient.

Patient presented with darkening of root and interruption of white lines on IOPAR showed the absence of corticalization on CBCT findings in 4.17% (1) and 12.50% (2) patients respectively. On Chi-square test, P value for darkening of root and interruption of the white line was measured as 0.5064 and 0.1834 respectively. On contrary, patients presented with the diversion and narrowing of the canal on IOPAR, showed the presence of corticalization on CBCT. On Chi-square test, P value for diversion of canal and narrowing of the canal was found to be 0.9168 and 0.6473 respectively.

Also, in this study, we have found that out of 50 subjects, only 4% (2) were diagnosed with absence of corticalization on CBCT (Mean and SD value for distance of mandibular third molar root to canal was measured as 2.25± 1.48. for the same patients). Among these 2 patients with absence of corticalization, (1) presented with darkening of roots whereas the other patient showed both darkening of roots and interruption of white line (Tables 1 and 2, Graphs 1 and 2).

**Discussion**

The incidence of IAN injury from surgical removal of mandibular third molar varies from 0.4% to 8.4%.[11] Injury of the IAN is a worrisome consequence following mandibular third molar removal, since the symptoms associated with the nerve injury may persist for several months or in serious case the patient may end up with a permanent paresthesia.[12,13] In most cases, the presence of numbness from a nerve injury will resolve within or less than 6 months. In cases of permanent paresthesia, the incidence is commonly reported to be <1% (Gulicher and Gerlach 2001, Sedaghatfar et al. 2005, Susarla and Dodson 2007).[14]

Studies showed the diagnostic accuracy of CBCT in predicting neurovascular bundle exposure prior to impacted mandibular third molar removal (Tantanapornkul et al. 2007, Ghaeminia et al. 2011).[12,13] However, due to the higher dose and cost of this imaging modality, many dental settings only rely on conventional radiographs such as intraoral periapical radiograph in the assessment of impacted mandibular third molar. 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. Understanding the limitation of conventional radiograph in the assessment of impacted mandibular third molar is paramount in determining the need of CBCT in selected cases and avoids unnecessary radiation exposure to the patient.

This study showed that out of 50 subjects, only 4% were diagnosed with absence of corticalization on CBCT. Among these 2 patients with absence of corticalization, (1) presented with darkening of roots whereas the other patient showed both darkening of roots and interruption of the white line in IOPAR.

In literature, no studies are reported on comparison of radiographic signs on IOPAR and CBCT, to assess the proximity of the root of the mandibular third molar with mandibular canal.

**Table 1:** Percentage of presence of various criteria in male, female and total samples

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Male</th>
<th>%</th>
<th>Female</th>
<th>%</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Darkening of roots</td>
<td>15</td>
<td>50.00</td>
<td>9</td>
<td>45.00</td>
<td>24</td>
<td>48.00</td>
</tr>
<tr>
<td>Diversion of canal</td>
<td>7</td>
<td>23.33</td>
<td>4</td>
<td>20.00</td>
<td>11</td>
<td>22.00</td>
</tr>
<tr>
<td>Narrowing of the canal</td>
<td>3</td>
<td>10.00</td>
<td>4</td>
<td>20.00</td>
<td>7</td>
<td>14.00</td>
</tr>
<tr>
<td>Presence of cortication</td>
<td>3</td>
<td>10.00</td>
<td>2</td>
<td>10.00</td>
<td>5</td>
<td>10.00</td>
</tr>
<tr>
<td>Interruption of the white line</td>
<td>11</td>
<td>36.67</td>
<td>5</td>
<td>25.00</td>
<td>16</td>
<td>32.00</td>
</tr>
</tbody>
</table>
Table 2: Association between absence of corticalization of canal on CBCT with presence of various criteria on IOPAR

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Absent</th>
<th>%</th>
<th>Present</th>
<th>%</th>
<th>Total</th>
<th>%</th>
<th>Chi-square</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Darkening of roots</td>
<td>1</td>
<td>4.17</td>
<td>23</td>
<td>95.83</td>
<td>24</td>
<td>48.00</td>
<td>0.4415</td>
<td>0.5064</td>
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<tr>
<td>Diversion of canal</td>
<td>0</td>
<td>0.00</td>
<td>11</td>
<td>100.00</td>
<td>11</td>
<td>22.00</td>
<td>0.0109</td>
<td>0.9168</td>
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<tr>
<td>Narrowing of the canal</td>
<td>0</td>
<td>0.00</td>
<td>7</td>
<td>100.00</td>
<td>7</td>
<td>14.00</td>
<td>0.2094</td>
<td>0.6473</td>
</tr>
<tr>
<td>Presence of cortication</td>
<td>0</td>
<td>0.00</td>
<td>5</td>
<td>100.00</td>
<td>5</td>
<td>10.00</td>
<td>0.5208</td>
<td>0.4705</td>
</tr>
<tr>
<td>Interruption of the white line</td>
<td>2</td>
<td>12.50</td>
<td>14</td>
<td>87.50</td>
<td>16</td>
<td>32.00</td>
<td>1.7703</td>
<td>0.1834</td>
</tr>
</tbody>
</table>

CBCT: Cone-beam computerized tomography, IOPAR: Intra oral periapical radiography

Graph 1: Percentage of various criteria in male, female and total samples

Graph 2: Association between absence of corticalization of canal on cone-beam computerized tomography with presence of various criteria on intra oral periapical radiography
Numerous studies are done on osteoprotegerin (OPG) and CBCT to evaluate the same.

Various studies have been done using OPG and CBCT or CT, which have shown a positive correlation of darkening of root and interruption of the white line indicating the increased risk of IAN injury.[12,13] which is in accordance with our study.

Tantanapornkul et al. (2007) [13] showed that CBCT was superior to OPG in predicting neurovascular bundle exposure following assessment of the relationship of the mandibular third molar root tip to the mandibular canal. They studied 161 impacted teeth and reported that the relative sensitivity and specificity of CBCT and OPG in predicting the nerve exposure was 93%, 77% and 70%, 63% respectively.

Ghamenia et al.[12] in his study observed that three signs that are darkening of root, interruption of the white line and diversion of the mandibular canal were significantly associated with IAN exposure. Salzama et al.[14] confirmed the finding of Ghamenia et al.[12] in her study.

This study showed the poor reliability of radiographic signs of IOPAR on predicting the proximity of mandibular third molar root with mandibular canal. Two patients were diagnosed with the absence of corticalization in CBCT findings among 50 patients. This creates the controversy and questions regarding the reliability of IOPAR signs with CBCT findings that was found far more precise and accurate. However, the two radiographic signs that are darkening of roots and interruption of the white line in IOPAR have shown a positive correlation indicating the increased risk of IAN injury. And also owing to its easy availability and less radiation exposure to the patient it can be taken as primary diagnostic tool for evaluating the proximity of the mandibular canal and mandibular third molar root.

Conclusion

The present study therefore gave adequate insight to maxillofacial surgeons who need to decide whether CBCT is required in addition to pre-operative intraoral periapical radiography in mandibular third molar extractions. Further studies requiring the larger sample size using both IOPAR and CBCT or by surgical exposure will prove constructive.

References
