Original Article

The Ability of Panoramic Radiography in Determining the Relationship of Mandibular Third Molar Roots with the Inferior Alveolar Canal

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Abstract

Background and Aim: Panoramic radiography is the preoperative imaging technique of choice for impacted mandibular third molar surgery. However, controversy exists regarding the ability of panoramic radiography in determining the relationship of the mandibular third molar roots with the inferior alveolar canal. This study aimed to assess the ability of panoramic radiography in determining the relationship of mandibular third molar roots with the inferior alveolar nerve (IAN) canal.

Materials and Methods: This diagnostic accuracy study was conducted on 100 panoramic radiographs that were evaluated by 5 oral and maxillofacial surgery residents. They offered their expert opinion on the relationship of third molars with the IAN canal based on panoramic radiographs. These perspectives were compared with the actual post-surgical findings. Kappa and weighted Kappa reproducibility tests were used for data analysis.

Results: Among 100 understudy cases, physical contact between the mandibular third molar roots and the canal was not observed in 88 cases intra-operatively; while this relationship existed in 12 cases. The panoramic radiography had a diagnostic sensitivity of 83.3%, specificity of 83%, positive predictive value of 40% and negative predictive value of 97.3%. The overall accuracy was 85%. Kappa and weighted Kappa coefficients of reproducibility were 61% and 79%, respectively.

Conclusion: Panoramic radiography can be confidently used as the most reliable and commonly accessible imaging technique. Considering the obtained negative predictive value, panoramic radiography is capable of revealing the involvement of third molar roots with the IAN canal with 97.3% accuracy. Panoramic radiography had a low diagnostic value in determining the morphology of roots.

Key Words: Panoramic radiography , inferior alveolar nerve , third molar

Introduction

Appropriate radiographs should be obtained from the tooth that needs to be extracted. In the majority of cases, periapical radiographs adequately show the details.

Panoramic radiography offers a more precise image of the entire anatomy of the region and is the radiography of choice for surgical extraction of impacted third molars [1]. Before thesurgical extraction, the surgeon needs to assess the risk of damaging the IAN [2]. Several signs in conventional radiographs are indicative of the proximity of roots with the canal including the presence of darkness over the root area, tilted roots, presence of aninterruption in the external canal wall [3, 4] and deviation and narrowing of the canal [5].

At present, panoramic radiography is used as the leading imaging technique in third molar surgery [3]. Radiographic assessment of the tooth to be extracted is definitely the best way to find out about the potential problems that may be encountered during the surgical extraction. The first factor to be evaluated is the number of roots in the respective tooth in order to take sufficient care not to fracture the roots. Also, the length of roots, their curvature and degree of divergence must be estimated by the surgeon to pick the right strategy for the extraction of tooth or separation of roots [1].

A proper strategy along with anappropriate surgical technique reduces the risk of unexpected root fractures and the subsequent search for fractured apices [1]. Furthermore, by doing a pre-operative radiographic assessment, the surgeon can provide patients with necessary information regarding the surgical procedure, inform them about the possible risks and prepare them for potential complications. Additionally, the surgeon may alter the surgical approach to cause no or minimal damage to the IAN [1].

Considering the fact that the major drawback of panoramic radiography is its inability to show details, this study aimed to assess the diagnostic value of panoramic radiography in evaluating the position of mandibular third molars in relation to the mandibular canal. In order to do so, pre-operative radiographic interpretations of clinicians were compared to post-operative findings regarding the actual situation of teeth.

Materials and Methods

In this diagnostic accuracy study, the understudy population included all patients presenting to the Oral and Maxillofacial Surgery Department of Shahid Beheshti University for surgical extraction of impacted mandibular third molars. Sample size was 100 mandibular third molars.

Study equipment included a Planmeca 2002 CC Proline Panoramic x-ray and a Velopex Extra-X Automatic Dental X-Ray Film Processor for developing AGFA films (analog system).

Before surgery, the image of mandibular second and third molars was transferred from a panoramic radiograph to a tracing sheet and next to it, the position of IAN canal relative to the roots, based on the presence or absence of involvement, was rec-

orded according to the professional opinions of 5 surgical residents. The actual position of IAN canal relative to the third molar roots was determined based on direct observation. After the extraction of tooth, the surgeon cleaned and dried the socket and by direct observation of the area stated his/her personal opinion about the relationship of IAN and third molar roots as well as the morphology of the roots.

SPSS version 11 software was used for statistical analysis of data. Excel version 2003 software was applied to draw the charts for statistical indices and Kappa and weighted Kappa coefficients.

Results

Preoperative predictions regarding the presence of separate or fused roots were as follows: 26% fused, 72% separate and 2% single root. Post-operative observations revealed the actual rates to be 22% fused, 60% separate, 16% two fused roots and one separate root and 2% single root.

The "two fused roots and one separate root" was reported as a separate category due to its high frequency and was categorized as a subgroup of three-rooted teeth (Table 1).

Of 100 understudy samples, in 88 no contact with the IAN canal was observed during surgery; whereas, this relationship was noted in 12 cases. Panoramic radiography had a diagnostic sensitivity of 83.3%, specificity of 83%, positive predictive value of 40% and negative predictive value of 97.3%. Its overall accuracy was 85%. Kappa and weighted Kappa coefficients of reproducibility were 61% and 79%, respectively.

Discussion

It seems that most of the incorrect assumptions about the close spatial relationshipbetween the roots andIAN canalcome from a radiograph without sufficient resolution at the apex and nerve area. In this study, we tried to meet the standards in this regard as much as possible. For example, expert operators obtained the radiographs, an automated film processing machine was used, a final quality control was carried out by a senior radiologist and residents were allowed to use a standard negatoscope for interpretation of radiographs. Three methods can be used to precisely determine the relationship of tooth with the IAN canal:

Table 1: Morphology of roots before and after surgery

Surgery/Panoramic radiograph	Separate	Fused	Separate and fused	Single root	Total
Separate	48	8	16	0	72
Fused	12	14	0	0	26
Separate and fused	0	0	0	0	0
Single root	0	0	0	2	2
Total	60	22	16	2	-

1.CT scan

2.Autopsy

3.Direct observation

The first two methods were not applicable due to invasiveness, high costs, unavailability of devices and ethical considerations. Thus, the third method, which is a common technique, was used in this study.

Szalma et al, [6] evaluated the association of darkening of third molar roots on preoperative panoramic radiographs with perioperative IAN exposure. They studied 309 patients including 144 males and 165 females with a mean age of 26.7 ± 7.9 yrs. In 47 out of 309 cases (15.3%) IAN was visible. According to Pearson's chi square test, darkening of third molar roots was significantly associated with IAN exposure (P<0.001). Third molars with simultaneous darkening and other high-risk radiographic markers (interruption of the white line, diversion of the canal, and/or narrowing of the canal) had a significantly greater risk of IAN exposure than those with darkening of roots only (P <0.001). However, in our study, panoramic radiography had a high negative predictive value which means that most cases with no sign of involvement with the canal on panoramic radiograph, had no actual involvement in surgery. But, it should be noted that in our study no limitation was set for the landmarks of determining the association of third molar roots with the IAN canal or age of patients. Ezoddini et al, [7] in their study evaluated the diagnostic accuracy of panoramic radiography in determining the position of impacted third molars in relation to the IAN canal in comparison with surgery. They studied 59 patients (16 males and 43 females) referred for impacted third molar surgery who had panoramic radiographs. The position of impacted third molar in relation to the IAN canal was determined on the panoramic radiographs and 5 different subgroups were reported (A, B, C, D and E). Cases that were not allocated to any subgroup were assigned to F subgroup. The surgeon determined the position of tooth relative to the mandibular canal after surgery and reported it based on the mentioned classification. Sensitivity and specificity were calculated to be 91.2% and 95.2%, respectively. Kappa coefficient was calculated similar to our study and the inter-observer agreement was similar in both genders (P>0.99) assessment before impacted third molar surgery could reduce the risk of injuring the canal or traumatizing the nerve. In our study, the association between the third molar roots and IAN canal was determined based on surgeon's direct observation. Our sample size was larger than that of Ezoddini study and no gender limitation was set. Gupta et al, [8] evaluated and compared impacted mandibular third molars in terms of angulation, level of eruption, third molar space and relation of inferior alveolar canal with their roots on preoperative panoramic radiographs and after surgery. Of 988 understudy impacted mandibular third molars, 578 belonged to patients with 18 years of age and older. Patients were divided into different groupsbased on age, sex and side of impacted mandibular third molar (right or left). Of 578 patients, 307 (53.11%) were males and 271 (46.89%) were females. The gender distribution was similar to that of Hezza study; but in Linden, Yamaoka and Hattab studies, the majority of patients were females. In our study, no gender limitation was set. In Gupta et al, study, the maximum number of third molars were in 18-27 yrs. age group (398 patients or 68.89%). In our study, no age limitation was set. In the mentioned study, of 988 third molars, 39.93% were vertically placed, 61.84% were found at the level A and class II (79.65%) was found to be the most common relation for third

molar space. Notching (12.55%) was the most prevalent true IAN canal and root relation; while superimposition (41.80%) was the most frequent false relation between the IAN canal and third molar roots. They concluded that panoramic radiography had a high negative predictive value, which is similar to our finding. Therefore, panoramic radiography can be used as a safe and reliable technique for evaluation of impacted mandibular third molars.

Atieh [9] assessed the diagnostic accuracy of the markers of panoramic radiography for detection of the relationship between the IAN canal and third molar roots. The diagnostic accuracy of 3 panoramic radiographic markers including darkening of the root, interruption of the radiopaque borders and diversion of the mandibular canal was evaluated in 894 observations. The results were compared with surgical findings and the sensitivity and specificity for darkening of the root werefound to be 51.2% and 89%, respectively. These values were 53.5% and 80% for the interruption of radiopaque borders, respectively. The diversion of the canal criterion showed a sensitivity of 29.4% and a specificity of 94.7%. Considering the large sample size, panoramic radiography had a high negative predictive value; which is in accord with our study result. Nakagawa et al, [10] investigated the reliability of preoperative panoramic radiography in 73 patients that were mostly females. The results showed that panoramic radiography was capable of determining physical contact between the mandibular third molar and the mandibular canal; which is in contrast to our obtained results. In our study, gender limitation did not exist and we had a larger sample size.

Blaeser et al, [11] estimated the association of specific panoramic radiographic signs and IAN injury during the extraction of mandibular third molars. Their retrospective case-control study was conducted on patients who had undergoneextraction of impacted mandibular third molars. Cases were patients who had confirmed IAN injury after third molar extraction and controls were patients without nerve injury. There were 8 cases and 17 controls. Five surgeons blinded to the type of injury independently evaluated the preoperative panoramic radiographs of patients for presence of high-risk radiographic signs. Positive radiographic signs were found to be significantly associated with IAN

injury (P<0.0001). Presence of radiographic signs had positive predictive values in the range of 1.4% to 2.7%, indicating a 40% or greater increase in baseline likelihood of injury (1%) for patients. Absence of such radiographic findings had strong negative predictive values (>99%). Case-control studies have a higher reliability compared to other study designs.

Koong et al, [12] assessed the methods of determining the relationship of the mandibular canal with the mandibular third molars. They evaluated 9 radiographic criteria by surgeons in absence of radiologists. About 25% of surgeons believed that panoramic radiography was sufficiently accurate for determining the relationship of mandibular canal with the third molar roots; whereas, 61% considered CT scan as the ideal radiography for this purpose. Overall, they concluded that panoramic radiography has a high diagnostic value where no physical contact is present between the canal and the mandibular third molar but it is not sufficient in cases with an actual physical contact between the two. These findings are in agreement with our results.

Conclusion

Panoramic radiography is an affordable, commonly accessible tool for preoperative diagnosis in surgical extraction of mandibular third molars. Our obtained results revealed that panoramic radiography is capable of detecting cases with no physical contact between the mandibular third molar and IAN canal and has a high negative predictive value. However, it is not suitable for screening of cases with an actual physical contact between the two. Based on the obtained results, panoramic radiography is not capable of accurately determining the morphology of roots in terms of being fused or separate.

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