**Evaluation of Juxta-Apical radiolucency as risk factor to IAN injury in CBCT images**

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**Abstract**

Injuries to the third division of trigeminal nerve including inferior alveolar and lingual nerve through third molar surgery remain a typical and complicated clinical issue. In recent studies, Juxta-apical radiolucency on panoramic radiography has also been associated with paresthesia after mandibular third molar removal. The aim of this study is to assess the relation of juxta-apical radiolucency (JAR) to IAN and its effects on the cortical plate. In this cross sectional study, CBCT images of 20 cases with JAR selected as the sample were compared to 20 age-matched cases without JAR in axial, coronal and parasagittal planes. The relation of JAR’s and IAN as well as the relationship between 3rd molar apex and IAN in the control group were determined. Thinning and perforation of mandibular buccal or lingual cortical plates were also investigated. Statistical analysis was performed by Chi-square and McNemar test using SPSS version 23. The JAR was observed to be buccal to the IAN in 25% of cases, lingual in 40% of cases, and superior in 35% of cases. In the control group, the apex of the root was observed to be buccal to the IAN in 30% of cases, in 40% it was superior to the IAN, and in 30% it was in the lingual region. Cortical plates were perforated in 75% of the cases with JAR as opposed to the 45% of cases without JAR. The majority of the cases with JAR were in contact with IAN. The detection of JAR on panoramic images indicates a high risk of IAN injury. Hence, before surgical procedure, it is recommended that dentists resort to CBCT, as a valuable imaging modality.

Key words: juxta-apical radiolucency; IAN injury

**Introduction**

Injury to the inferior alveolar nerve (IAN) bundle is a serious dilemma following the extraction of impacted mandibular third molars.1 A preoperative evaluation of the exact relationship between the roots of the mandibular third molar and the IAN would help in predicting and possibly avoiding sensory impairment.1,2  It has been established that when a close relationship between the third molar and the mandibular canal is observed radiographically, there is a higher risk of IAN injury.3 The surgeon should be aware of this anatomical relation between the third molar roots and IAN in order to minimize postoperative sensory complications.

Panoramic radiography is the most widely used technique for this diagnosis besides the morphological evaluation of an impacted 3rd molar. Narrowing, diversion, loss of cortical lines of IAN and darkening of the roots are among the most important radiological markers which indicate a close relationship between the third molar and the mandibular canal.4-7

In recent studies, Juxta-apical radiolucency on panoramic radiography, which is diagnosed as a well-defined area lateral to the root, has also been associated with paresthesia after mandibular third molar removal .This has been shown to be more prognostic of nerve injuries than other signs.8-10

Due to the controversy which exists on the origin of this phenomenon in the literature and its association with increased risk of IAN injury,11 , 12 the purpose of this study is to investigate the location and relation of the JAR to the IAN and cortical plates through CBCT imaging in comparison with lower third molars without JAR. Further knowledge about these findings will hopefully help surgeons decrease the occurrence of paresthesia after the extraction of the third molar.

**Materials and Methods**

This is a descriptive cross-sectional study approved by the local Ethical Committee of Shiraz University of Medical Sciences. Panoramic images exhibiting a close relationship between 3rd molar and IAN canal were evaluated for the presence or absence of JAR. 20 panoramic radiographs of patients who demonstrated JAR and 20-aged match cases without JAR were extracted from the archives of a maxillofacial radiology center. Then, CBCTs of the same patients were extracted from the archives.

The CBCT images were obtained using the FDP-based CBCT (New Tom VGi, QRSrL, Italy). Each study was performed having adjusted the following parameters: 110Kvp, and exposure time of 3.6 using 8 cm\* 8cm field of view. The subjects were positioned with the Frankfort plane parallel to the floor.

The inclusion criterion was the presence of JAR or a close relationship between third molar and IAN. The exclusion criteria were the presence of carious lesion, other pathologies like cyst or tumor with third molars.

By applying slice thickness of 0.3 mm and interslice distance of 0.3 mm, the multiplanar reconstructed images were studied in the third molar region.

CBCT images of JAR group were evaluated in all planes to determine JAR's location (lingual, buccal, or superior) relative to IAN and the association of JAR with the IAN (separate, direct contact). Also, the relation of the apex of the root to IAN was assessed in these evaluations.

Having analyzed the effect of JAR in the case group and the apex of the roots or mandibular canal in the control group on cortical plates, we categorized the effect into 5 groups. For each case an MPR image with minimum thickness of the remaining cortex was selected to determine its status in the classification.

Then statistical analysis was performed using the SPSS software package (version 23, SPSS Inc, chicqo, IL, USA). The results obtained from the JAR group and control group were compared using Chi-square test and a paired comparison by McNemar test. The level of significance was set at p< 0.05.

Table 1 Classification for thinning of cortical plates

J0 the cortical plate was not thinned

J1 the remaining thickness of the cortical plate was two-

 thirds of the maximum thickness

J2 the remaining thickness of the cortical plate

 was on half of the maximum thickness

J3 When the remaining thickness of the cortical plate

 was one-quarter of the maximum thickness

Perforation when the cortical plate was perforated

**Results:**

CBCT of 40 patients-20 with JAR and 20 without JAR- were examined. The JAR group consisted of 16 females and 4 males, while the control group included 13 females and 7 males.

The location of JAR in relation to IAN was studied. The JAR was reported to be buccal to the IAN in 25% of cases, lingual to IAN in 40% of cases, and superior to the IAN in 35% of cases (table 2).

In the control group, the apex of the root was observed to be buccal to IAN in 30% of cases, 40% superior to IAN, and 30% in lingual region. In the case group, there was no significant relationship between the locations of JAR in relation to IAN (table2).

Lingual Cortical plate was perforated in 75% of the cases with JAR against 45% in the control group. An almost statistically increased perforation of cortical plates was seen in the JAR group compared with the control group (*p*=0.06). Considering the classifications given in table 1, we noticed that in the JAR group, 0 cases demonstrated J0, 2 cases J1, 1 case J2, 2 cases J3 and 15 cases showed perforation. As for the control group, 2 cases were observed to be in J0 category, 2 cases in J1, 4 cases in J2, 3 cases in J3 and 9 case were perforated (table 3).

The association of JAR with IAN was assessed and in the both groups, the majority of cases were in contact with IAN.



**Fig1** .relationship of JAR (black arrows) to mandibular canal (blue arrows) in the JAR group: (A) superior, (B) lingual and (C) buccal and inferior.

Table 2 Positional relationship of juxta-apical radiolucency (JAR)/ apex of root with mandibular canal (% of cases)

|  |  |  |
| --- | --- | --- |
| Positions | JAR group |  Control group |
|  |  |  |
| Buccal | 25 | 40 |
| Lingual | 45 | 20 |
| superior | 30 | 40 |
|  |  |  |

Table 3 Distribution of thinning of cortical plates according to the proposed classification (% of cases)

Classification Juxta-apical radiolucency group Control group

J0 0 10

J1 10 10

J2 5 20

J3 10 15

Perforation 75 45

**Discussion**

Trigeminal nerve is the largest peripheral sensory nerve in the body whose injury is the most problematic sequela of dental surgical operations.

Iatrogenic injuries to the third division of trigeminal nerve including inferior alveolar and lingual nerve through local anesthetic injection, third molar surgery, implants, endodontics, trauma and orthognathic surgery remain a typical and complicated clinical issue. Most reports have demonstrated injury with an incidence range from 0.5% to 8%.13 The extraction of impacted mandibular third molars may cause dysesthesia due to damage to the IAN.14 Temporary injuries in 0.4–5.5% and permanent nerve damage in 0.1–1.0% of cases of third molar extraction have been reported.15-17 However, these figures report the incidence of nerve damage when third molars of all degrees of difficulty are removed. When there is an intimate relationship between the tooth and the IAN, the incidence of nerve injuries has been reported to be as high as 23–35%.18 In these cases, the IAN may be injured during third molar removal, directly by surgical instruments, 19, 20 or indirectly by the manipulation of the IAN during unfavorable movements of the third molar roots.21

Therefore, an accurate pre-operative radiographic examination is considered indispensable before extraction of third molars.18 Panoramic radiographs are most commonly used for this purpose, and many researchers have reported imaging features suggestive of an intimate relationship between these two structures.14

The darkening of the root has been previously described as an increased radiolucency due to the impingement of the canal on the third molar.22, 23 It has also been pointed out that the darkening of the third molar root is one of the strongest signs of IAN exposure or paresthesia.24, 25On the other hand, it has been shown that the darkening of the root can even present as the evidence of thinning of the lingual cortical plate without root grooves.25

Recently, a new radiographic sign (periapical or paradontal radiolucent area) has also been associated with paresthesia after mandibular third molar removal. For the first time, Ronten et.al described JAR as well-circumscribed radiolucent area lateral to the root rather than at the apex.9 JAR has been seen on panoramic radiographs and has been shown to be more predictive of nerve injuries than that of other signs. In a randomized clinical trial, the presence of juxta-apical area was one of the radiographic signs that was associated with injury to the IAN.9

We evaluated the location of JAR in relation to IAN and its effect on cortical plates. Furthermore, we made a comparison between the two groups in terms of   the presence of these factors in patients with and without JAR.

The position of the root of third molar in relation to the mandibular canal was a significant risk factor in the incidence of IAN exposure.26 Patients are at a higher risk of IAN injury in cases where the mandibular canal was positioned lingual to the third molar root.12 The position of the roots and JAR was observed to be buccal to IAN in 30%, 25% of cases, respectively. These results were in accordance to other researches demonstrating the presence of JAR in 30% of cases in the buccal side.12

The effects of JAR and the apex of roots on cortical plates were evaluated. Cortical plates in JAR group were perforated in 75% of the cases and an almost statistically increased perforation of cortical plates was seen in the JAR group compared with the control group (*p*=0.06). Considering arranged classification, the results of the JAR group was dissimilar to the control group. Nevertheless, the overall grade of cortical plate thinning in JAR group was more in this study than that in Kapila et al study.12 None of the patients in their study showed perforation of the cortical plate on CBCT images. Knowledge about the cortical plate thickness is of crucial importance because thinning of cortical plates might be one of factors resulting in an increased incidence of paresthesia.27

Some studies have indicated that the JAR is likely to be a continuity of IAN lamella.9, 10, 12 This study observed JAR in contact with IAN canal in most of the cases. The results of this study were in accordance with the findings of other studies and confirmed the hypothesis that considers JAR as a sign of increased risk of injury to IAN. However; Umar et al stated that the origin of JAR was cancellous bone space.11

Based on the results yielded in this study, this study gives a new insight about the origin of JAR and its remarkable effects on cortical plates. Due to limitation of the present study in terms of gathering CBCT images and studies, we suggest further studies with a larger sample sizes to scrutinize our results.

**Acknowledgements**

The authors would like to acknowledge the vice-chancellery of Shiraz University of Medical Sciences, for supporting the research (Grant# 3295). The authors thank Dr. M. Vosughi from the Dental Research Development Center, for the statistical analysis. Dr. E. Amalsaleh for help with editing. This manuscript is based on the thesis of Dr Shabnam Rasti.

**Conflict of interest:** The authors declare that they have no conflict of interest.

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