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RADIOLOGICAL PREDICTION OF INFERIOR ALVEOLAR NERVE INJURY FOLLOWING SURGICAL REMOVAL OF IMPACTED MANDIBULAR THIRD MOLAR- A COMPARATIVE STUDY BETWEEN PANORAMIC RADIOGRAPH AND CONE BEAM COMPUTED TOMOGRAPH

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ABSTRACT

The chances of neurological complications following surgical removal of impacted mandibular third molar increase when there is close contact between the inferior alveolar nerve and the tooth root. Thus, it is important to evaluate the topographic relationship between them preoperatively. ***AIMS AND OBJECTIVES***- To assess the possible nerve injury following extraction of impacted mandibular third molar by comparing the relevant panoramic features with cone beam computed tomography (CBCT) findings and evaluate the diagnostic accuracy of OPG. ***MATERIAL AND METHODS*** –A total number of 30 patients requiring surgical removal of impacted mandibular third molar under local anesthesia and having a close relationship between impacted mandibular third molar and inferior alveolar canal in panoramic radiograph were included in the study and were advised for CBCT evaluation. ***RESULTS*** - Statistically significant association was found between darkening of the root in OPG and absence of narrowing of the canal in CBCT with P value 0.008 ($P<0.05$) while distribution of darkening of the root (OPG) according to presence or absence of corticalisation (CBCT) was not statistically significant . ***CONCLUSION*** - The panoramic radiographs may be useful to assess the close relationship between mandibular canal and third molar root tip but it cannot appraise the type of intimate relationship present between them for which CBCT is the reliable tool.

KEYWORDS

Inferior Alveolar Nerve (IAN) Injury, Third Molar Position , Impacted Mandibular Third Molar Surgery, Panoramic Radiography (OPG), Cone Beam Computed Tomography (CBCT).

INTRODUCTION

Removal of an impacted mandibular third molar is one of the most common oral and maxillofacial surgical procedure and can be associated with a number of neurological complications. Several factors are considered to be associated with nerve injury. It is known that the risk dramatically increases when there is direct contact between the nerve and the tooth root. Thus, it is important to evaluate the topographic relationship between the mandibular canal and impacted third molars preoperatively.

Nerves consist of fasciculi held together by a protective areolar connective tissue that coalesces to form the nerve sheath. This sheath is strengthened by linear collagen bands. The outcome of damage to a nerve depends on the nature of the injury. Prognosis also depends on other factors including the age of the patient and adequacy of the local vascular supply. The exact aetiology of IAN injury is also imprecise and multi-factorial. Kipp, Goldstein and Weiss[4] considered that mechanical injury from chisels, burs or elevators was most likely. Howe and Poyton[3] concluded that crushing or tearing of the nerve from movements of the teeth was more likely, particularly if the IAN grooved or perforated the third molar tooth . Crushing of the roof of the IAN canal onto the IAN has also been implicated. Howe and Poyton[3] also suggested that there was an increased risk of IAN damage with advancing age and difficulty of extraction. There is no substantiation of these factors in the literature. The incidence of transient IAN damage ranges from 0.41 per cent to 8.4 per cent and permanent damage is reported to occur in 0.014 per cent to 1.5 per cent of cases.[13]

Studies of the relationship of the IAN to third molar teeth have been reported. Rood and Sheehab(1990)[11] defined seven radiological markers that suggest an intimate relationship between mandibular third molar teeth and the IAN (Table 1). At present these markers are the standards used for the assessment of the likelihood of risk of damage to the IAN and the basis for gaining informed consent from the patient.

Table -1 Radiological markers of proximity of tooth roots to IAN

Root related	Canal related
Darkening	Diversion
Narrowing	Narrowing
Deflection	Loss of lamina dura
Bifid apex	

When the panoramic image is suggestive of an intimate relationship between the impacted tooth and the mandibular canal, medical CT is recommended to demonstrate three-dimentional relationship between two structures. However, drawback of medical CT is the higher radiation dose. Due to introduction of maxillofacial CT, 3D images are more readily available for use of dental application. The major advantage of cone beam computed tomography (CBCT) high spatial resolution and low radiation dose. Our study is to assess the reliability of panoramic features suggestive of an intimate relationship between the impacted tooth and the mandibular canal, to compare the panoramic features with cone beam computed tomography (CBCT) findings and to predict possible post-surgical inferior alveolar nerve injury.

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Study Design

Image-1 Comparison of (a) panoramic (OPG) features like darkening of the root and interruption of white line with (b) presence or absence of corticalisation of inferior alveolar canal (IAC) along with thinning of lingual cortical plate in CBCT

The study population was selected from the patients attending the outpatient department of our institute. A total number of 30 patients, aged 18 years and above , were included in the study, who underwent CBCT evaluation after radiological detection (in an OPG) of a possible close contact between the apex of the impacted tooth root and IAN prior to surgical extraction. Indication of a close relationship between impacted mandibular third molar and inferior alveolar canal (IAC) in panoramic radiograph *(*darkening of the root, interruption of the white line, divergence of the canal, narrowing of the canal, dark and bifid root apex, deflection of the root, narrowing of the root) was a selective criteria for cone beam computed tomography (CBCT) evaluation.

Patients with comorbidities (such as uncontrolled diabetes or hypertension), impacted teeth associated with any pathologic lesion, pregnant women and lactating mothers, cases with pre-existing sensory disturbance in the lip and chin region on the side of impacted mandibular third molar were excluded from the study. No further predilection was made for sex, caste, creed or religion.

All the patients underwent surgical removal of impacted mandibular third molar tooth under local anaesthesia by the same surgeon following standard protocols and methods.

Post Operative Neuro-sensory Testing

Post-operative neurological symptom namely paraesthesia was Evaluated for all cases on postoperative 1st day ,7th day, 1st month, 3rd month by two-point discrimination, contact detection, sharp blunt discrimination, thermal test method of nerve testing. Testing was performed over a 1-cm span on the labio-mental fold on the side of the surgical extraction. The contralateral side of the labio-mental fold was taken as control site. Any abnormality noted in the sensation was recorded.

Level A Test

Two-Point Discrimination Test -

The two pointed, but not sharp, tips of the calliper touched the skin simultaneously with light pressure while the patient's eyes were closed. The separation of the two points was gradually reduced from 20 mm at the chin and 10 mm at the lip at 2 mm interval to the moment where the patient could feel one point only. This was repeated three times for each test area. The minimum separation at which two points could be detected was recorded. Distances 2 mm greater than the normal values were considered abnormal. They are considered diminished at 15-20 mm and absent above 20 mm.

Level B Test

Contact Detection (Light touch)-

This test was done by wisp of cotton wool. The patient's perception of touch is evaluated on contact in the region of the operated and unoperated site (control).It is done for detection of the integrity of the Merkel cell and Ruffini ending, which are innervated by myelinated A beta afferent axons. These receptors are slow to adapt and their putative sensory modality is pressure.

Level C Tests

These tests assess the small myelinated A-delta and c fibres.

Sharp Blunt Discrimination-

This was done by touching the test area with a sharp or a blunt head of the mechanical probe. A rubber stopper is centred at the end of the dental probe so that when the tip is pressed to the skin, a constant degree of skin indentation was caused. The patient has to decide whether the stimulus was sharp or blunt. This assesses the free nerve ending and small A delta and C fibre that innervate the free nerve ending responsible for nociception.

Thermal Test-

Perception of warmth is attributed to the integrity of A delta fibre and cold to C fibre. Two small glass tube containing water at 50^0 c(warm) and 15^0 c(cold) were used. The report of each stimulus i.e. cold versus hot recorded.

Statistical Analysis

The data from the Case Record Form (CRF) was transcribed onto an excel database and analysed using R version 3.3.3 and R Studio version 1.0.136 (R foundation) statistical software (Language). Categorical variables were analysed using Chi-Square Test. Difference between two groups for numerical variables were analysed using t-test for parametric distribution and Kruskal-Wallis Test for non-parametric distribution. The level of significance was set at 5% for all comparisons.

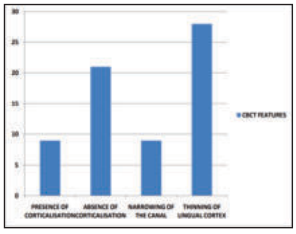

Image 2- Distribution of CBCT features

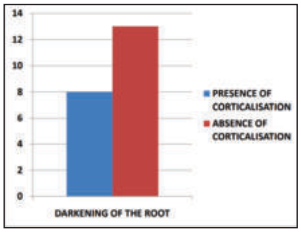

Image 3- Comparison of darkening of the root in OPG with presence or absence of corticalisation in CBCT

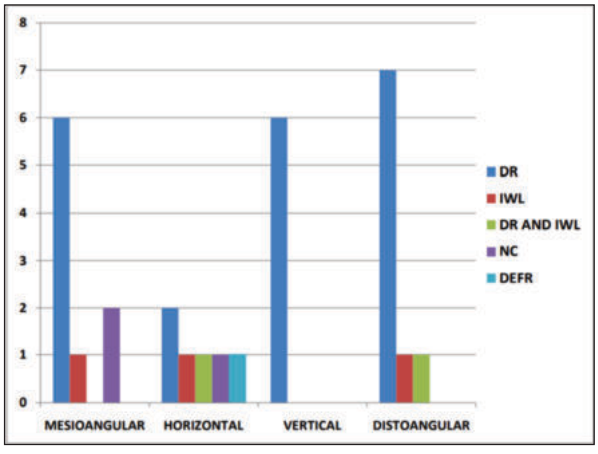

Image 4- Distributions of the panoramic features according to angulation of impaction *dr=darkening of the root; iwl= interruption of white line; defr=deflection of the root; nc=narrowing of the canal

RESULT

On radiological assessment, darkening of the root (70%) was the most common panoramic finding among the distribution irrespective of the angulation of the impacted tooth compared to other features like interruption of the white line (10%), darkening and interruption (6.67%), deflection of root (3.33%), narrowing of the mandibular canal (10%). The result of Single sample proportion test was statistically significant with a P-value < 0.05. Absence of corticalisation (70%) along with thinning of the inferior alveolar canal at the closest proximity of the root surface was the most common CBCT finding among the distribution. The result of single sample proportion test was statistically significant with a P-value of 0.044.

Out of thirty patients, only one patient, whose pre-operative radiology revealed interruption of white line in OPG and absence of corticalisation along with narrowing of the inferiorly positioned canal, presented with post-operative inferior alveolar nerve paraesthesia for a transient period .

DISCUSSION

In our study, amongst several radiographic (OPG) signs reflecting

close relation between tooth root and IAN canal, we took the following into consideration- darkening of the root, interruption of the white line, combined darkening and interruption, narrowing of the canal and deflection of the root.

Monaco et al. (2004)[7] and Tantanapornkul et al. (2007)[14] in their respective articles concluded that panoramic signs of the darkening of the roots and the interruption of the radiopaque border of the canal were the most frequent, while panoramic signs of the diversion of the canal and narrowing of the canal were the least frequent respectively. The study performed by Neves et al. (2012)[8] also revealed that the most common panoramic radiographic findings were interruption of the white line (20.4%) and darkening of the roots (17.4%) in case of close association between impacted mandibular third molar and inferior alveolar canal. The clinical observation by Peker et al. (2014)[10] also concluded verbatim with the previous studies that darkening of root (39.9%) was the most frequent radiographic finding followed by interruption of the radiopaque border (37.2%), narrowing of the canal (10.7%), and deflection of the canal (8.4%) .

In our study we get similar finding with the study done by the previous authors. Among the distribution of the panoramic features, we got darkening of the root is significantly higher compared to other findings seen in OPG with P value 0.004.

CBCT has overcome the evident limitations of panoramic radiograph such as the buccolingual relationship between the mandibular canal and the mandibular third molars, cortication of the mandibular canal which is a very important tool to predict the postoperative IAN paraesthesia. We evaluated the CBCT images to identify features described below based on terms defined by Ohman et al[9] : (a) Presence of corticalisation (b) Absence of corticalisation (c) Narrowing of the canal (d) Position of the canal in respect to third molar (buccal/lingual/interradicular/inferior).

Dalili et al.(2011)[1] in his study showed that the incidence of absence of corticalisation in a CBCT was found in 76.6% of the third molars studies. This frequency is lower than those reported by Ghaeminia et al.[2] (85%) and Ohman et al.[9] (94%) and is higher than that reported by Tantanapornkul et al.[14] (36%). The differences observed in these studies may be due to the different case selection criteria used for CBCT examination.

In our study, the incidence of absence of corticalisation was is lower than reported by various authors may be due to small sample size and different ethnic group of the study.

Miller et al. (1990)[6] in his study on twenty-two patients with 31 impacted mandibular third molars examined with a new, precise, cross-sectional tomographic technique and concluded that the buccal positioning of the canal in relation to the roots of the third molar was the most common finding. Maegawa et al. (2003)[5] in his study observed the same findings, although their results were not significant. It was also found in this study that in cases in which the mandibular canal was interrupted on panoramic radiographs, lingually positioned canals were more frequent, increasing risk of IAN exposure. This was in agreement with results of Sekerci et al.[12] On the contrary, Monaco et al. (2004)[7] in his study with sample of 73 third molars, concluded that the inferior positioning of the canal in relation to the roots of the third molar was a common finding. Tantanapornkul et al.[14] inferred that inferior positioning of the canal in relation to the roots of the third molar was commonly found. This is in agreement with other studies which demonstrated the incidence of inferior positioning of the canal to be around 45–51%. Ghaeminia et al.[2] in their study came to the conclusion that the inferior alveolar nerve (IAN) was more commonly exposed during third molar removal when the mandibular canal was positioned lingually or inter-radicular to the third molar root rather than buccally.

In the present study we got the similar result with the study done by Monaco et al (2004)[7] and Tantanapornkul et al. (2007)[14]. Our study shows inferiorly positioned (60%) canal is significantly higher among the distribution of different positions of canal seen in CBCT.

CONCLUSION

The panoramic radiographs though lacking in demonstrating the three-dimensional information they may be useful in predicting the anatomic relationship and risk factor preoperatively. Most common panoramic finding in the present study is the darkening of the root followed by interruption of white line hence these patients should be advised for a CBCT investigation. Considering CBCT observation, absence of corticalisation is significantly higher among the other features. In case of narrowing of the canal there is significant difference in diameter from its mesial and distal portion of the canal at an interval of 2mm. Last but not the least, the patients whose pre-operative radiographs reveal the above discussed features should be thoroughly explained about probable post-operative complication whilst utmost care and precautionary measures should be executed to avoid that complication to arise.

Limitations Of Our Study

Less sample size and not taking into consideration the position of the impacted tooth were the main limitations of our study.

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