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RADIOGRAPHIC RISK PREDICTOR SIGNS ASSOCIATED WITH IMPACTED THIRD MOLARS AND INFERIOR ALVEOLAR NERVE DAMAGE – A PANORAMIC RADIOGRAPHIC STUDY

Dental Science

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ABSTRACT

Introduction : Mandibular third molars are the most frequently impacted teeth and are associated with various pathoses ranging from infection, inflammatory to cystic lesions necessitating their removal. Neurosensory disturbances related to the inferior alveolar nerve due to the close anatomic relationship between the roots of mandibular third molars and the inferior alveolar canal is one of the most grave complications of such a procedure. This study aimed to assess the radiographic proximity (distance) and the reliable radiographic risk predictor signs that indicate close proximity of impacted mandibular third molars to the inferior alveolar canal on panoramic radiographs to guide the dental surgeon in pre-surgical treatment planning.

Methods: This study comprised of 60 subjects with symptomatic impacted mandibular third molars. They were clinically examined and panoramic radiographs were made. The radiographs were interpreted for type of impaction, proximity (distance) from impacted mandibular third molars to inferior alveolar canal and presence of radiographic risk predictor signs. Further, these teeth were surgically removed and the proximity was assessed based on the exposure of inferior alveolar canal/nerve which was considered as Gold standard.

Results: The overall mean distance from the impacted mandibular third molars to inferior alveolar canal was -0.792 mm most of the (59%) samples extended beyond the superior border of the inferior alveolar canal. Vertical impactions were found to be in the close proximity (-2.00 mm) to inferior alveolar canal. Interruption of the white line was the most frequently observed sign on panoramic radiographs. No statistical significant association was found between the radiographic signs on surgical evaluation.

Conclusion: There is no any positive correlation between presence of radiographic signs of third molar proximity with Inferior alveolar nerve on surgical evaluation..

KEYWORDS:

Panoramic radiographs; Inferior alveolar canal/nerve; Impacted mandibular third molars; Radiographic risk predictor sign.

INTRODUCTION

Mandibular third molars exhibit great variation in size, shape and path of eruption and are also the most commonly impacted teeth. Impacted teeth could give rise to various complications like pericoronitis, dental caries, resorption, abscess formation and cellulitis necessitating their surgical removal. [1,2,3].

Determining the position of impacted third molars and their proximity with the inferior alveolar canal (IAC) is of utmost importance before attempting their surgical removal to prevent complications like injury to inferior alveolar nerves and vessels. The prevalence of inferior alveolar nerve paraesthesia ranges approximately from 0.4% to 8.4% according to different studies [4]. Therefore pre-operative radiographic assessment of the proximity of these two structures becomes an essential measure before surgical removal of impacted mandibular third molars.[4]

The preoperative radiographic evaluation has been considered as having a potential capacity to predict possible Inferior alveolar nerve (IAN) injuries during a surgical procedure. Panoramic radiography is a commonly complementary exam used in the treatment plan for impacted teeth removal, being useful in the evaluation of surgical difficulty degree, third molars morphology and position, operative risks and proximity to adjacent vital structures, such as IAN[4]. Certain radiographic signs often associated with damage to IAN can be observed in panoramic radiographs[5]

Studies addressing both these parameters have been far and few in between. Also, such studies have been sparsely conducted on panoramic radiographs alone. Consequently, this study was designed with an aim to assess the proximity (distance) of impacted mandibular third molars to the inferior alveolar canal and determine the reliable radiographic risk predictor signs that indicate proximity between the two on panoramic radiographs.

MATERIALS AND METHODS

Ethical clearance was obtained from the Institutional Ethical Committee prior to conducting the study. Sixty subjects of either gender in the age range of 20 years to 40 years, were selected by simple random sampling The inclusion criteria were 1) Individuals presenting with symptomatic unilateral or bilateral impacted mandibular third molars with presence of ipsilateral second molars. The exclusion criteria were individuals with 1) history of trauma/surgery to the mandible. 2) developmental anomalies affecting the jaws and 3) clinical and/or radiographic evidence of pathologies of the impacted mandibular third molar teeth or mandible which could obscure the visualization of the periapical region or inferior alveolar canal.

A written informed consent was obtained from the subjects so selected. Following a detailed history and a thorough clinical examination, panoramic radiographs were made using Planmeca ProMax (Helsinki, Finland) under similar conditions (80 Kvp,12 mA,18 s). for each study subject.

Interpretation of all the 60 panoramic radiographs was done using 17" LCD monitor with Romexis software 3.1R. The type of impaction of mandibular third molars was identified by the method adapted by Winter et al [6,7]. Subsequently, they were categorized as Vertical, Horizontal, Mesioangular or Distoangular. Radiographs were then interpreted cautiously for the following:

a) Proximity (distance) of impacted mandibular third molar to inferior alveolar canal

The distance between the inferior most part of the tooth and the superior border of the inferior alveolar canal was measured using a vernier caliper. The distance had a 'positive numerical' value when the inferior most part of the tooth was above the superior border of inferior alveolar canal. Similarly the distance had a 'negative numerical' value when the inferior most part of the tooth was below the superior border of inferior alveolar canal. The values obtained were corrected for the magnification factor of 20% (as mentioned by the manufacturer)

b) Radiographic risk predictor signs

The consensus of three oral radiologists was considered in evaluating the presence of each of the following sign.

1. Darkening of the root – Loss of root density in a tooth that is impinged upon by the canal.
2. Interruption of the white line – Discontinuity of the superior radio-opaque line that constitutes the superior border of the inferior alveolar canal.
3. Diversion of the canal – A change in the direction of the canal while crossing the mandibular third molar.
4. Deflection of the root – An abrupt deviation of roots near the canal.
5. Narrowing of the root – Narrowing of the tooth roots where the canal crosses.
6. Narrowing of the canal – An abrupt decrease in the width of the canal while it crosses the root apices.
7. Dark and bifid root apex - A loss of root density in a tooth that is impinged upon by the canal with bifid apex of the root.

Presence of radiographic risk predictor signs, either single or multiple (combination) on panoramic radiographs was considered as close to IAC radiographically

A single experienced oral surgeon subsequently performed the surgical extraction of all the impacted mandibular third molars according to his discretion. The surgeon was blinded regarding the proximity parameters (distance and signs) assessed in the study but had pre-operative access to the radiograph. The proximity of the impacted mandibular third molars to the inferior alveolar canal was assessed after copious irrigation of the socket and direct visualization of the inferior alveolar canal as follows:

1. **Close :** inferior alveolar canal /nerve visible after extraction
2. **Not Close :** inferior alveolar canal /nerve not visible after extraction

The recordings at/after surgery were considered as 'Gold standard' for radiographic registrations with respect to measurements and radiographic signs.

Statistical methods

The data tabulated was subjected to Chi-square/Crosstabs test, Independent-Samples T Test and One-Way ANOVA to obtain the results. Sensitivity, Specificity, Positive predictive value (PPV), Negative predictive value (NPV) and Odd's ratio were calculated for each risk predictor sign.

RESULTS

The total study sample constituted 60 impacted mandibular third molars. There were 18 (30%) males and 42 (70%) females and the male to female ratio was 3:7. The overall mean age of the study group was 25.72 years (Standard Deviation (SD) 6.5). The mean age of the male subjects was 28.39 years (SD 5.9) and of female subjects was 24.57 years (SD 6.5).

Among the 60 impacted mandibular third molars, 4 (6.7%) were vertical impactions, 20 (33.3%) horizontal impactions, 29 (42.6%) mesioangular impactions and 3 (4.4%) were distoangular impactions. (Table 1)

Proximity (distance) of impacted mandibular third molars to inferior alveolar canal

The overall mean distance from the impacted mandibular third molars to inferior alveolar canal was -0.7925 mm (SD 2.00).

Radiographic risk signs and correlation with surgical findings (gold standard)

Seven radiographic risk predictor signs were assessed on the panoramic radiographs. Radiographic risk predictor signs either single or multiple (combination) were seen in 40 (66.7%) [Positive samples] and no signs were observed in 20 (33.3%) [Negative samples] of the 60 total samples. On surgical extraction, 15 (25%) samples were found to be *close* and 45 (75%) were found to be *not close* to the inferior alveolar canal among the 60 samples.

Type of impaction and proximity to inferior alveolar canal

Upon radiographic evaluation, the mean distance of the 4 vertically impacted teeth from inferior alveolar canal was -2.000 mm (SD 1.22) and none of them were surgically found to be close to inferior alveolar canal. The 20 horizontally impacted teeth had a mean distance of 0.4600 mm (SD 2.10) and 2 (10.0%) among them were surgically close, 33 mesioangularly impacted teeth had a mean distance of -.8591 mm (SD 2.07) and 13 (39.4%) of them were surgically *close* and 3 distoangularly impacted teeth had a mean distance of 0.6667 mm (SD 0.57) none of them being surgically close. (Table 2)

Correlation of individual signs with the surgical findings

All the seven radiographic signs were evaluated individually and their association with the surgical findings was studied. *Interruption of the white line* was the most frequently observed sign with a p value of 0.12 (> 0.05) and odds ratio of 2.531. Narrowing of canal showed an odds ratio of 1.231 (Table 3)

DISCUSSION

Third molars position is very important for surgical planning and assessment of the procedure difficulty degree[8]. For the present study, panoramic radiographs were used for topographic evaluation of the third molars (3Ms), considering the effectiveness of this commonly used imaging exam as a tool in assessing risks and possible complications during the surgical removal of 3Ms, especially injury to IAN[9]. It allows general practitioners and maxillofacial surgeons to obtain an evaluation of the elementary preoperative conditions, such as teeth position and angulation (Pell-Gregory and Winter classif ications), proximity of the 3Ms with the mandibular canal and assessment about root shape and number and bone quality[8,9]. Patients with deficits related to IAN often suffer from paresthesia, anesthesia or dysesthesia of the lip, chin or vestibular gum in the affected side. Prevalence of IAN injury has been reported between 0.5% and 5% according to some studies[9]. Inferior alveolar nerve paraesthesia following third molar surgery may be the result of direct trauma to the nerve or the pressure excreted over the nerve due to vessel rupture leading to hematoma formation[10].

Panoramic radiographs are by far the most commonly employed for this purpose and form the basic screening radiographs which dictate the need for advanced imaging. They have the advantage of a wider area of coverage with low radiation exposure thus facilitate the assessment of the distance from the root tip to the inferior alveolar canal which may not be possible on intra oral periapical radiographs.

In the present study, subjects with symptomatic impacted third molars in the age group of 20 – 40 years were included. The mean age of the study samples was [25.72] years. This is comparable to the mean age reported by Knutson et al and Nordenram[11,12]. Females constituted most (70%) of the total study sample which was in accordance with Jerjes W et al, Knutson et al and Szalma et al [5,11,13]. In contrast, studies by Gupta et al 14 observed a male preponderance. This could be attributed to the variations in sample sizes involved and demography.

In our study the mesioangular impactions (55%) were most frequently noted and this was in agreement with Mwanki et al, Knutson et al, Sedaghatfar et al, Gomes et al and Reddy et al [15-17]. This could be attributed to the fact that the normal development and path of eruption of mandibular third molars is antero-superior[18].

Most of the impacted mandibular third molars (66.76%) extended beyond the superior border of the inferior alveolar nerve with mean distance of –0.7925 mm, after correction of the magnification factor. This is in accordance with the study conducted by Miloro et al[19]. They further noted that unerupted mandibular third molars were closer to the canal than erupted ones but did not consider the magnification factor while drawing the results of their study. The results of the present study and Miloro et al suggest that impacted mandibular third molars lie in close proximity to the canal [19].

Horizontal impactions were closer to the inferior alveolar canal with mean distance of -.4600 mm, in contrast to Miloro et al 18 who found mesioangular impactions to be closest to IAC.

Certain radiographic signs have been suggested as risk factors predicting the close proximity of the impacted mandibular third molars to the inferior alveolar nerve [19,20,21].

The association of radiographic risk predictor signs with the type of impaction was analysed in the present study. Vertical and Horizontal impactions (100%) were most commonly found to be associated with radiographic risk predictor signs followed by mesioangular (63.6%). To the best of our knowledge this is the first study correlating these two parameters and hence comparisons are not feasible.

In this study mesioangular impactions were associated with surgical exposure of the inferior alveolar canal in higher number followed by the horizontal impactions. However, they were statistically insignificant (p>0.05). Blaeser et al also found no significant relationship between the type of impaction and inferior alveolar nerve involvement [20]. On the contrary, Jerjes et al found that horizontally impacted teeth were at high risk of developing paraesthesia following inferior alveolar nerve involvement [22].

Amongst the 60 samples, 40 (66.7%) showed one or more radiographic risk predictor signs of which 15 (25%) samples positively correlated with surgical findings. This finding was statistically insignificant (p>0.05) and indicates that presence of radiographic risk predictor signs on panoramic radiographs is not significantly associated with involvement of inferior alveolar canal. Sensitivity is the probability that a test will be positive given a patient with the condition. When applied to our study it signifies that panoramic radiographs predicted 11 out of 15 cases that were actually close to inferior alveolar nerve and had a sensitivity of 74%.

This indicates that the reliability of the panoramic radiographs in predicting the proximity of impacted mandibular third molars to the inferior alveolar nerve is low when the proximity is assessed with respect to radiographic risk predictor signs. The presence/absence of risk factors observed in panoramic radiographs is not always accurate, since it is a bidimensional-imaging feature. For better observation of these signs is necessary to obtain an image in three dimensions, such as computed tomography, and thus enable a better and more accurate visualization of anatomical structures related to the third molar.

On correlation of individual radiographic risk predictor signs with surgical findings, (gold standard) *interruption of the white line* was found to be highly correlated but not statistically significant (p>.05), with an odds ratio of 2.531 and was in accordance with Blaeser et al [20], Rood and Shehab [19], Sedaghatfar et al [15], and Ghaeminia et al23 but in contrast with Gomes et al [16]. In the present study, a sensitivity of 53.3% and specificity of 69% was obtained for this sign. This is within the range of values for sensitivities and specificities obtained by Bell (34%,63%), Sedaghatfar (75%, 66%) [15] and Szalma et al (51%, 80%)[13]. The positive predictive value of 36.4% and negative predictive value of 82% in our study too lie within the range of values obtained by various other researchers [21,20,16,19].

The other signs evaluated in the study were not statistically significant but were found reliable in various other studies. 'Darkening of the roots' was found to be more reliable in a number of others studies followed by 'diversion of the canal' contrasting with our study. A meta analysis stated that three signs namely 'darkening of the roots', 'interruption of the white line' and 'diversion of the canal' were associated with higher risk of nerve injury [24]. These inconsistencies observed between studies could be due to the differences in the sample sizes, radiographic technique standardizations, subjective assessment of inferior alveolar nerve involvement and most importantly, the radiographic acumen and surgical expertise of the investigators.

All the radiographic risk predictor signs have higher negative predictive values which assert that the absence of any of the risk predictor signs is a strong indication of decreased risk of nerve injury.

To conclude, this study demonstrated that conventional panoramic radiographs should be asserted with 3Dimaging in determining the relationship of the impacted mandibular third molars to the inferior alveolar canal When specific radiographic predictors are seen (eg. Interruption of white lines). It was observed that mesioangular impactions were the most common, and were in the most intimate relationship with the inferior alveolar canal in terms of distance and radiographic risk predictor signs when compared with surgical findings which was considered as gold standard. The presence of radiographic risk predictor signs specifically interruption of the white line on panoramic radiographs as observed in our study should caution the dental surgeon regarding close proximity of the impacted mandibular third molars to the inferior alveolar canal so as to minimize complications associated with inferior alveolar canal involvement. Alternative modes of treating symptomatic impacted mandibular third molars such as pericoronal ostectomy, coronectomy or orthodontic extractions could be employed in such situations.

Nevertheless, additional studies incorporating larger samples and advanced imaging modalities will be indispensable in justifying the findings of the present study.

Table 1 Descriptive statistics summary

Number of subjects		60
Gender distribution	Males	18 (30%)
	Females	42 (70%)
Mean age	Study group	25.72 (SD 6.5)
	Males	28.39 (SD 5.9)
	Females	24.57 (SD 6.5)
Type of impactions	MA	33 (55%)
	DA	3 (5%)
	Horizontal	20 (33.3%)
	Vertical	4 (6.7%)

Table 2 Type of impaction with their mean distance, radiographic and surgical findings

Type of impaction	Number of samples	Mean distance	Number of samples showing radiographic risk predictor signs	Number of samples found to be close on surgical evaluation
Vertical	4	-2.0000 mm (SD 1.22)	4 (100%)	0 (0%)
Horizontal	20	-.4600 mm (SD 2.10)	12 (60%)	2 (10%)
Mesioangular	33	-.8591 mm (SD 2.07)	21 (63.6%)	13 (39.4%)
Distoangular	3	-.6667 mm (SD 0.57)	3 (100%)	0 (0%)
Total	60	-.7925 (SD 2.00)	40 (66.7%)	15 (25%)

Table 3 Individual Radiographic risk signs

Sign	Radiographic Findings	Surgical Findings	p value	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	OR (CI%)
Darkening of the roots	0	0	0	0	0	0	0	0
Interruption of the white line	22 (36.7%)	8 (53.3%)	0.12	53.3%	68.9%	36.4%	81.6%	2.531 (0.76 - 8.35)
Diversion of the canal	5 (8.3%)	0 (0%)	0.17	0.0%	88.9%	0.0%	72.7	0
Deflection of the roots	0	0	0	0	0	0	0	0
Narrowing of the roots	5 (8.3%)	1 (6.7%)	0.78	6.7%	91.1%	20%	74.5%	0.732 (0.075 – 7.113
Narrowing of the canal	7 (11.7%)	2 (13.3%)	0.81	13.3%	88.9%	28..6%	75.5%	1.231 (0.213 – 7.119)
Dark and bifid root apex	1 (1.7%)	0 (0%)	0.56	0%	97.8%	0%	74.6%	0

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