Predicting the Risk of Inferior Alveolar Nerve Injury in Impacted Lower Third Molars Using Panoramic Radiography and Cone Beam Computed Tomography

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ABSTRACT

BACKGROUND

A serious complication of surgical removal of impacted lower third molars is inferior alveolar nerve (IAN) injury. Evaluation of radiographic factors to predict IAN injury using CT and panoramic radiography includes root morphology assessment, follicular sac size, mandibular bone density, inferior alveolar nerve and vessels, condition of the overlying tissues, relation of the impacted tooth with the body and ramus of the mandible and the adjacent teeth. This study was done to evaluate the radiological features of the impacted lower mandibular teeth and their relationship with IAN through panoramic radiography and CT and to assess the most predictable radiological criteria for inferior alveolar nerve injury in impacted third molar surgery.

METHODS

All the patients indicated for lower third molar extraction were included in the study and pre-operative conventional panoramic radiographs (Planmeca Proline PM 2002 CC, Helsinki, Finland) and CBCT (Kodak CBCT) were taken. Any post-operative nerve injuries detected were followed up after 15 days or 1 month. Fisher's exact test was done to find the association between the outcome variable and explanatory variables.

RESULTS

Only 11.4 % (N = 4) of all participants had IAN injury following surgical disimpaction. All the participants with IAN injury showed narrowing of the canal on their pre-operative panoramic radiographs and presence of nerve approximation with the tooth in cone beam computed tomography (CBCT) reports (P < 0.05).

CONCLUSIONS

A statistically significant association exists between IAN injury and nerve exposure, radiographic signs of nerve involvement for panoramic radiograph, level of third molar impaction, and nerve approximation in CBCT.

KEY WORDS

Inferior Alveolar Nerve Injury, Lower Third Molar Impaction, Panoramic Radiography, CBCT

BACKGROUND

Among the many procedures conducted in oral and maxillofacial surgery, third molar surgery is most common.[1] Different classifications exist for dental impactions, the most commonly employed being soft tissue, partially bony and full bony impactions. As compared to other teeth, the impaction rate is higher for third molars. Their surgical removal is done to correct or intercept associated pathology.[2] However, post-surgical complications are common following the procedure. The most common complications of a lower third molar surgery are soft tissue inflammation, pain, alveolar osteitis, trismus, nerve damage (inferior alveolar and lingual nerves), and infections.[3] The rate of these complications vary from 2.6 % to 30.9 % and depend upon factors, such as age, sex, overall health condition, level of tooth impaction, experience of the surgeon, smoking and alcohol consumption status, oral hygiene status, presence of comorbid medical conditions, intake of contraceptive medicines among others.[3] A serious complication of surgical removal of an impacted lower third molar is inferior alveolar nerve (IAN) injury. Low incidence but a large number of lower third molar extractions make the absolute number of IAN injuries significant.[4] Many studies have been conducted in the past to evaluate radiographic factors to predict IAN injury using CT and panoramic radiography. These evaluations include root morphology assessment, follicular sac size, mandibular bone density, inferior alveolar nerve and vessels, condition of the overlying tissues, impacted tooth and its relation with the body and ramus of the mandible and the adjacent teeth.[2]

The purpose of this study was to use panoramic radiography and CT to assess radiological features of the impacted lower mandibular teeth and their relationship with IAN. It also intended to determine the most predictable radiological criteria for inferior alveolar nerve injury in impacted third molar surgery. To the best of our knowledge, no such study has been previously conducted in a tertiary care hospital in our region.

METHODS

This was a pilot study conducted between October 2012 and December 2014. Due approval was taken from institutional ethics committee before conducting the study. The study participants included patients who visited the Department of Oral and Maxillofacial Surgery in a tertiary care hospital in Greater Noida, Uttar Pradesh with deep impacted mandibular third molars. All the patients indicated for lower third molar extraction were included in the study and pre-operative conventional panoramic radiographs ("Planmeca Proline PM 2002 CC, Helsinki, Finland") and CBCT ("Kodak CBCT") were taken. The primary predictive criterion were the presence or absence of either one or multiple findings on the preoperative panoramic radiographs, such as interrupted superior cortical line of the inferior alveolar canal wall, canal diversion or narrowing, and darkening of the root. The outcome variable was the presence or absence of inferior alveolar nerve paraesthesia after third molar surgery.

All patients, both males and females, in the age group of 24 - 45 years with recurrent pericoronitis, and with panoramic radiograph demonstrating dark bands on the third molar root or deviation of inferior alveolar root canal or root morphology with a groove or hook were selected. Patients who were medically compromised, had mandibular third molar with associated pathology (such as fracture, cyst, tumour, etc.) and with teeth not in proximity of the inferior alveolar nerve were not selected. Out of all the patients, 35 patients met the inclusion criteria and were included in the study. All the patients were informed in detail about the study and the effects of drugs used. After taking due consent, case history, physical examination and local examination of the impacted tooth to be removed, pre-operative investigations were conducted and findings were recorded using a pre-structured proforma. All the information and data collected during this study were kept confidential.

All the impacted mandibular molars were classified for the type of impaction based on radiographic findings of their relationship with the inferior alveolar canal. Radiographic assessment was done for 7 signs of mandibular nerve proximity with mandibular third molar on OPG. The radiographic features used for classification were darkening, root deflection or narrowing, bifid and dark root apex, interrupted white line of the IAN canal, and canal diversion and narrowing. The surgical procedure was carried out by an oral surgeon with four to five years of experience using standard impaction surgical kit, 3.0 silk suture material, scale, and panoramic radiograph and CBCT.

Surgical Procedure

Before surgery, all the patients were informed about the potential complications following surgical disimpaction of the impacted mandibular third molar including the risk of damaging the nerve while performing the procedure. The procedure was carried out after locally anaesthetising the area. For superficial impactions, envelope (sulcular) mucoperiosteal flaps and for deeper impactions triangular flaps were raised, which was followed by removal of the vestibular and distal bone. In cases with a higher risk of nerve damage, the impacted tooth was removed sectionally. For sectioning and removal of the bone, tungsten carbide burs (round and fissure) were used (speed of the air - rotor - 35000 - 40,000 rpm). Following the disimpaction, irrigation of the sockets was done with sterile saline solution (20 mL), which was previously stored at room temperature, and sockets were checked for inferior alveolar nerve exposure both during and after performing focused suction. After manual compression of the socket, single interrupted sutures were placed to close the flaps. A normal saline soaked cotton swab was put on the surgical site under pressure. Post-surgical instructions for wound care were given to each patient. Sutures were removed after one week and patients were examined for signs and symptoms indicating postoperative IAN functional problems. Subjective complaints including but not limited to "numbness in teeth and / or chin", "pins and needles" sensation and objective complaints, for example "light touch", "direction sense", "two - point discrimination" and "pinprick" using the Zuniga (1998) method were recorded.

All patients were asked about altered labial sensation. Any nerve injury detected was followed up after 15 days or 1 month. The affected areas were assessed again using 2 - point discrimination test, pinprick test and light touch test. The

outcome variable was IAN injury and the selected explanatory variables include age group, sex, and site of impaction, level of impaction, panoramic radiographic signs, CBCT nerve approximation, and nerve exposure. Fisher's exact test was applied to ascertain the association between the outcome variable and explanatory variables.

Statistical Analysis

Descriptive and inferential statistical analyses were conducted. Categorical variables were presented in number or percentages. A 5 % level of significance was taken to assess the significance of findings. Proportions were compared using the Fisher's exact test with P value < 0.05 considered to be statistically significant. SPSS software (version 20.0, IBM Corp. Armonk, New York, United States) was used to analyse data.

RESULTS

A total of 35 patients participated in the study who underwent pre and post-operative panoramic radiography and CBCT of the impacted lower third molar. Out of these, 80 % (N = 28) of the patients were males and 20 % (N = 7) were females. The maximum number of participants (60 %, n = 21) belonged to the age group of 20 - 25 years followed by 31 - 35 years (20 %, N = 7), 26 - 30 years (14.3 %, N = 5), 36 - 40 years (2.9 %. N = 1) and 41 - 45 years (2.9 %, N = 1). Most of the impactions of the lower mandibular third molars were of the right quadrant (54.3 %, N = 19) and the rest were of the left quadrant (45.6 %, N = 16). Among all the participants, only 11.4 % (N = 4) had IAN injury following surgical disimpaction. Out of these, 50 % (N = 2) belonged to the age group of 20 - 25 years and the other 50 % (N = 2) to 31 - 35 years' age group. Among the participants, 42.9 % (N = 15) had bony impactions while 57.1 % (N = 20) had soft tissue impactions. It was seen that all the participants with post-operative complication of IAN injury had bony impactions whereas no neurological symptoms were reported by those with soft tissue impactions. All the participants with IAN injury showed narrowing of the canal on

their pre-operative panoramic radiographs and presence of nerve approximation with the tooth in CBCT reports.

The results of Fisher's exact test revealed no significant association (P > 0.05) between IAN injury and age group (Pearson's χ^2 = 3.011, p = 0.556), sex (Pearson's χ^2 = 1.129, p = 0.288), and the site (left or right sided) of impaction (Pearson's χ^2 = 0.033, p = 0.855). However, the results showed a statistically significant association (p < 0.05) between IAN injury and nerve exposure (Table 1), radiographic signs of nerve involvement for panoramic radiograph (Table 4), level of third molar impaction (Table 3), and nerve approximation in CBCT (Table 2).

| | | | Exposure of Nerve | | Total |
			No	Yes	
Nerve injury	No	Count	31	0	31
		% within Nerve injury	100.0 %	.0 %	100.0 %
	Yes	Count	3	1	4
		% within Nerve injury	75.0 %	25.0 %	100.0 %
Total		Count	34	1	35
		% within Nerve injury	97.1 %	2.9 %	100.0 %

Table 1. Frequency Distribution of Nerve Injury and Nerve Exposure in Patients

| | | | CBCT Nerve Approximation | | Total |
			No	Yes	
Nerve injury	No	Count	29	2	31
		% within Nerve injury	93.5 %	6.5 %	100.0 %
	Yes	Count	0	4	4
		% within Nerve injury	.0 %	100.0 %	100.0 %
Total		Count	29	6	35
		% within Nerve injury	82.9 %	17.1 %	100.0 %

Table 2. Frequency Distribution of Nerve Injury in Patients by Their CBCT Nerve Approximation
(Chi - square value = 21.828; *p* - value = 0.0001; df = 1)

| | | | Impaction | | Total |
			Bony	Soft	
Nerve injury	No	Count	11	20	31
		% within Nerve injury	35.5 %	64.5 %	100.0 %
	Yes	Count	4	0	4
		% within Nerve injury	100.0 %	.0 %	100.0 %
Total		Count	15	20	35
		% within Nerve injury	42.9 %	57.1 %	100.0 %

Table 3. Frequency Distribution of Nerve Injury in Patients by Their Type of Impaction

| | | | Radiographic Signs | | | | | | | |
			Darkening of Root	Narrowing of Root	Dark and Bifid Apex of Root	Deflection of Root	Interruption of White Lines of Canal	Narrowing of Canal	Diversion of Canal	Total
Nerve injury	No	Count	3	1	1	1	18	5	2	31
		% within Nerve injury	9.7	3.2	3.2	3.2	58.1	16.1	6.5	100.0
	Yes	Count	0	0	0	0	0	4	0	4
		% within Nerve injury	0.0	0.0	0.0	0.0 %	0.0	100.0	0.0	100.0
Total		Count	3	1	1	1	18	9	2	35
		% within Nerve injury	8.6	2.9	2.9	2.9	51.4	25.7	5.7	100.0

Table 4. Frequency Distribution of IAN Injury and Radiographic Signs of Nerve Involvement on the Panoramic Radiograph
(Chi - Square value = 13.047; *p* - value = 0.042; df = 6)

DISCUSSION

A tooth is called impacted when it is partially or completely unerupted.[2] Among the most common reasons of impaction are abnormal anatomical position, lack of arch space, and physical barriers, such as soft tissue or bone. Though they are considered vestigial, their removal or retainment has been a

subject of discussion among doctors for decades.[5] Multiple factors have to be considered before deciding and planning the disimpaction of an impacted mandibular third molar. [6] The mandibular third molar is in close approximation with some important anatomical structures, such as IAN, lingual nerve and the mandibular second molar. The deeper the impacted tooth into the bone, more difficult is its extraction and higher are the chances of post-operative complications.[7] Among the

various complications, temporary or permanent IAN injury is of most concern to the surgeons, which has an overall incidence of 0.4 - 13.4 %.[8] To assess the risk of IAN injury, a pre-operative clinical and radiologic assessment using panoramic, computed tomography or CBCT as routine procedures may help in examining the association of the third molar roots and inferior alveolar canal.[8] On a panoramic radiograph, the radiologic risk predictor signs of close approximation of IAN to third molar include darkening of the root, interruption of the white line, narrowing of the root, narrowing of the canal and dark and bifid root apex.[9] Although conventional radiography provides good level of nerve injury risk, advancements in medical engineering have provided better alternatives (CT and CBCT) with much clearer images of the prospective surgical areas, which may be considered for routine preoperative assessments for mandibular tooth impactions.[10]

Many studies have been previously conducted to study the role of radiography in pre-operative risk assessment of IAN injury.[7-12] This study included 35 participants with 80 % (N = 28) males and 20 % (N = 7) females. The gender distribution is in line with another study conducted by Deshpande et al. and other studies that show male predominance.[14,15] Most impactions were reported in the age group of 20 - 25 years. Other studies have reported maximum cases from 15 - 30 years' age group. This is because the eruption time of mandibular third molars is 17 - 21 years.[13-16] In this study, the association of age group with mandibular third molar impaction was not significant. These findings are in line with the study done by K. Venu Gopal Reddy.[13] The association of gender was found to be insignificant in this study, which was also reported by Nagaraj et al.[17]

Radiographic assessment of the relationship between IAN and lower third molar helps in assessing the risk of IAN injury.[10] In our study, narrowing of root canal was found to be the most predictable sign of high risk of IAN injury, which was also confirmed in previously published studies.[11,18] In this study, CBCT was found to be better than conventional radiography in assessing the risk of IAN nerve injury in third molar impactions. Similar results were reported by Wang et al.[8] while Pathak et al. found no significant difference.[19] Wang et al. also reported a significant association of bony impactions and intraoperative nerve exposure with IAN injury, which was also found in the current study.[8]

The current study showed significant association between IAN injury and level of impaction, radiographic signs, nerve approximation in CBCT reports, and intraoperative nerve exposure, however, the findings need to be confirmed by large sample studies to assess other correlates.

CONCLUSIONS

Pre-operative panoramic radiography and CBCT assessment can predict the risk of IAN injury in lower third molar impactions, the most predictable features being narrowing of the inferior alveolar canal and proximity of IAN with the impacted tooth. Therefore, a true relationship can be assessed using CBCT technique, which is usually lacking in conventional panoramic radiography. Hence, a CBCT investigation of all the patients indicating high risk of IAN injury on panoramic radiographs should be carefully done to prevent IAN injury following surgical removal of impacted lower third molars.

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