Australian Dental Journal 1997;42:(3):149-52

Inferior alveolar nerve damage following removal of mandibular third molar teeth. A prospective study using panoramic radiography

Andrew C. Smith, BDS, FDSRCS, FDSRCPS, FRACDS(OMS)*
Susan E. Barry, BDSc†
Allan Y. Chiong, BDSc†
Despina Hadzakis, BDSc†
Sung-Lac Kha, BDSc†
Steven C. Mok, BDSc†
Daniel L. Sable, BDSc†

Abstract

Permanent alteration of sensation in the lip after the removal of mandibular third molar teeth is an unusual but important complication. Studies have been performed to assess the risk of nerve damage but most of these have been retrospective and poorly controlled.

This prospective trial predicted the outcome of altered sensation prior to surgery based on assessment of a panoramic radiograph and correlated this with the result postoperatively in the consecutive removal of 479 third molar teeth.

Results indicated that 5.2 per cent had transient alteration in sensation but only one patient (0.2 per cent) had prolonged anaesthesia. As 94.8 per cent of teeth extracted had no neurological sequelae the figures for prediction were skewed and a kappa statistical analysis of 0.27 illustrated a fair level of agreement between prediction and outcome.

This study supports previously reported levels of neurological damage and confirms that panoramic radiography is the optimum method for radiological assessment for mandibular third molar teeth prior to their removal.

Key words: Inferior alveolar nerve, injury, incidence, recovery, prognosis.

(Received for publication January 1996. Accepted February 1996.)

Introduction

Many complications can occur from the removal of mandibular third molar teeth. Damage to the inferior alveolar nerve (IAN) is an unusual but important one. The IAN runs in a bony canal within the mandible in close proximity to the root tips of mandibular molar teeth. Damage to the nerve manifests itself as a sensory disturbance of the lower lip and chin up to the midline.

Studies of the relationship of the IAN to third molar teeth have been reported.[1-3] Rood and Nooraldeen Sheehab[4] 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.

A panoramic radiograph is frequently used as the radiological investigation of choice prior to third molar surgery. The criteria previously mentioned are identifiable on this projection, but like other conventional radiographs it is unable to give complete information in three dimensions. The most accurate method of prediction with precision of the position

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	

*Oral and Maxillofacial Surgery, School of Dental Science, The University of Melbourne.
†Final Year Student Research Group, 1995, School of Dental Science, The University of Melbourne.

Table 2. Classification of nerve injury

Injury	Type of damage	Prognosis
Neuropraxia	No axonal degeneration	Excellent
Axonotmesis	Axonal degeneration and regeneration	Fair
Neurotmesis	Neural separation, healing with cicatrisation	Poor

of the IAN pre-operatively is the use of computerized tomography; however, unnecessary radiation dosage and cost/benefit analysis need to be considered.

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. Merrill[5] outlined the classification defined by Sneddon and this is the standard used for neurological assessment (Table 2). Prognosis also depends on other factors including the age of the patient and adequacy of the local vascular supply.

The subjective and objective assessment of nerve damage is problematic. It is possible to classify patterns of sensory loss[6] (Table 3).

The exact aetiology of IAN injury is also imprecise and multi-factorial. Kipp, Goldstein and Weiss[7] considered that mechanical injury from chisels, burs or elevators was most likely. Howe and Poyton[2] 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 (Fig. 1). Crushing of the roof of the IAN canal onto the IAN has also been implicated.[8]

Howe and Poyton[2] 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.[9] Studies vary in size from less than 100 to over 1400 teeth, but most have been performed retrospectively, possibly resulting in data collection inaccuracy.

The aims of this study were to identify the incidence of IAN damage following the removal of mandibular third molar teeth and to assess whether the panoramic radiograph is valuable in predicting outcome.

Table 3. Patterns of sensory loss

Hypoaesthesia	Decreased sensitivity to stimulation
Hyperaesthesia	Increased sensitivity to stimulation
Paraesthesia	Abnormal sensation, spontaneous or evoked
Dysaesthesia	Unpleasant abnormal sensation, spontaneous or evoked
Anaesthesia	Total loss of sensation

Table 4. Predictions of alteration in sensation

1	No anticipated change
2	Hypoaesthesia
3	Hyperaesthesia
4	Dysaesthesia or paraesthesia
5	Anaesthesia

Materials and methods

Male and female patients aged 17 to 35 years, undergoing general anaesthesia for the removal of mandibular third molar teeth, were recruited for the trial. Exclusion occurred if they did not meet these criteria or if they required the removal of other mandibular teeth, had other associated mandibular pathosis, or any neurological disorder that might unfairly influence the outcome. Patients who failed to attend for follow-up appointments or were otherwise lost to the study were also excluded. After consultation with a statistician, a sample size of 500 third molars was selected.

Prior to surgery, the surgeon was asked to predict from a panoramic radiograph any change in sensation to the lower lip that might be present post-operatively. The prediction categories are displayed (Table 4). At the postoperative check, two weeks later, the patient was questioned by another surgeon and any altered sensation scored on the same scheme (Table 4).

To allow for comparison of accuracy and consistency of prediction, a sample of thirty radiographs from the study population were selected for 15 sites assessed pre-operatively as no change (Category 1, Table 4) and 15 within the predicted categories of altered sensation (Category 2-5, Table 4). These radiographs were presented to postgraduate trainee oral and maxillofacial surgeons who were asked to predict alteration in IAN sensation after removal of mandibular third molar teeth. This procedure was repeated twice with a one-month time gap.

Data collection and statistical analysis were performed. It was felt inappropriate to apply conventional correlation coefficient and chi-squared analyses on the data, as these tests are not designed to assess agreement. After advice a kappa analysis was chosen. This does have inherent problems in that the prevalence of the outcome in each category is important and if there is a large proportion of one outcome then this can skew the kappa result. Advice from a statistician was that this analysis was still the most appropriate for this study.

Table 5. Data and statistical analysis (2)

Prevalence of abnormality

		Outcome		Total
		Normal	Abnormal	
Prediction	Normal	411	7	418
	Abnormal	43	18	61
	Total	454	25	479

Table 6. Data and statistical analysis

Predictions	Correct %
Sensitivity	72
Specificity	90.5

Results

Five-hundred sites were entered into the study. Twelve patients with 21 sites failed to attend for follow-up.

Prevalence

From a total of 479 third molar removals, 25 patients (5.2 per cent) reported having transient alteration in IAN sensation. Within two weeks of surgery only one patient (0.2 per cent) had a residual neurological deficit. This patient's hypoaesthesia has persisted (Table 5).

Predictability

Of the 454 normal outcomes (94.8 per cent) 411 were predicted from the radiographs to be normal. This shows a 90.5 per cent specificity. Of the 25 outcomes with altered sensation, 18 were predicted from the radiograph showing a 72.0 per cent sensitivity (Table 6).

Kappa value

Table 7 shows the distribution of pre-operative prediction compared with the actual outcome. The last row and column of the chart show the incidence of IAN damage predicted compared with the incidence of IAN damage that resulted. The diagonals on the table represent the agreement between the prediction and the actual outcome. The kappa value tests the strength of agreement along this diagonal and was 0.27 with a 95 per cent upper and lower confidence interval of 0.45 and 0.10 respectively (Table 8). This shows a statistically fair level of agreement between prediction and actual outcome.

To confirm accuracy and consistency of prediction, the results of repetitive testing of postgraduate oral and maxillofacial surgery trainees show a statistically good level of agreement (-0.06) between the tests conducted with a time interval (Table 8).

Discussion

Information obtained from the Defence Committee of the Australian Dental Association

Fig. 1. – Mandibular third molar with root perforated by IAN. The tooth was sectioned during surgery to preserve the contents of the neurovascular bundle and the tooth has been repaired with acrylic for this illustration.

Victorian Branch reveals that from 1990-1994 third molar removal was responsible for 18.1 per cent of all litigation and that 43.7 per cent of this was due to neurological damage.

It is therefore important to be able to predict and assess the risk of nerve damage. Previous studies have reported a large variability in outcome which may be due to operative technique dependent on or influenced by the design of the investigation. This study is prospective and overcomes these problems. There are difficulties in statistical analysis, however, and it would be inaccurate to derive any further statistical significance than those figures presented in the results section. As there was a large number of normal outcomes, the data are skewed; however, the results do show that panoramic radiography is useful in predicting a normal outcome from surgery.

Operating surgeons would be aware of the low incidence of neurological damage and so their

Table 7. Data distribution comparing prediction with actual outcome

	No change	Hypoaesthesia	Hyperaesthesia	Para/Dysaesthesia	Anaesthesia	Total
No change	411	6		1		418
Hypoaesthesia	31	9	1	5		46
Hypaesthesia	1					1
Para/Dysaesthesia	7	2			1	10
Anaesthesia	4					4
Total	454	17	1	6	1	479

Table 8. Data and statistical analysis (3)

Kappa value	A	B
Kappa	0.27	-0.06
Upper confidence interval	0.45	0.10
Lower confidence interval	0.10	-0.17

A=Agreement between prediction and postoperative assessment including confidence intervals.
B=Agreement between first trial and second trial on panoramic radiographs including confidence intervals.

estimations might be biased towards a prediction of normal outcome. Patients who failed to attend for follow-up might be assumed to have a normal outcome, but it was felt that in terms of accuracy these patients should be excluded from the study.

It is clear that panoramic radiography, being readily available and relatively low in radiation dose, provides the optimum method of predicting neurological damage. At present coronal computerized tomographic scans are the only way to image, with precision, the relationship of the tooth root to the IAN. Radiation dosage and cost to the community preclude this investigation as a routine, particularly as the outcome of neurological deficit does not just necessarily depend on direct contact of IAN with tooth root. Surgical techniques of bone crushing or the use of neurotoxic materials during surgery may cause damage to the IAN even if it is distant from tooth root. This enhances the unpredictable nature of the certainty of outcome in mandibular third molar surgery.

Conclusion

Despite many studies and reports in the literature there is still debate about the aetiology, incidence and outcome of neurological damage during third molar surgery. This study confirms the previously reported prevalence rates.

In order to ensure adequate informed consent prior to the removal of mandibular third molar teeth the patient should be educated in the risks and benefits of surgery. It has been shown by this study that the panoramic radiograph is a valuable but by no means infallible guide to the prediction of a successful outcome with no neurological deficit in sensation to the lower lip.

Acknowledgements

Thanks are due to the Statistics Department of the University of Melbourne and the Commonwealth Scientific and Industrial Research Organization for valuable advice in the design of this study.

References

1. Main J. Further roentgenographic study of mandibular third molars. J Am Dent Assoc 1938;25:1993.
2. Howe GL, Poyton HG. Prevention of damage to the inferior dental nerve during the extraction of mandibular third molars. Br Dent J 1960;109:355-63.
3. Merrill RG. Prevention, treatment and prognosis for nerve injury related to the difficult impaction. Dent Clin North Am 1979;23:471-3.
4. Rood JP, Nooraldeen Shehab BAA. The radiological prediction of inferior alveolar nerve injury during third molar surgery. Br J Oral Maxillofac Surg 1990;28:20-5.
5. Merrill RG. Decompression for inferior alveolar nerve injury. J Oral Surg 1964;22:291-30.
6. Klineberg I. Craniomandibular disorders and orofacial pain: Diagnosis and management. London: Wright, 1991:144-9.
7. Kipp DP, Goldstein BH, Weiss WW Jr. Dysesthesia after mandibular third molar surgery: a retrospective study and analysis of 1377 surgical procedures. J Am Dent Assoc 1980;100:185-90.
8. Rud J. Third molar surgery: relationship of root to mandibular canal and injuries to inferior dental nerve. Danish Dent J 1983;87:619-31.
9. Carmichael FA, McGowan DA. Incidence of nerve damage following third molar removal: a West Scotland oral surgery research group study. Br J Oral Surg 1992-30:78-82.

Address for correspondence/reprints:
A. C. Smith,
School of Dental Science,
The University of Melbourne,
711 Elizabeth Street,
Melbourne, Victoria 3000.