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Nerve Injuries Following Third Molar Surgery at an Australian University: A 4-Year Review

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Abstract

Introduction: Nerve injury during the removal of third molars in oral surgery is a rare complication; however, it could lead to severe and long-term complications. For this study, data regarding third molar extractions were collected to identify predictive risk factors for inferior alveolar nerve and lingual nerve injuries.

Methods: Clinical and radiographic data from Griffith University electronic records were obtained from January 2015 to December 2018. Out of 2826 extractions realised during that period, only fifteen nerve injuries were identified.

Results: The incidence of nerve injury encountered was 0.35% for the inferior alveolar nerve and 0.18% related to the lingual nerve, both lower than incidences shown in previous studies. Moreover, no permanent nerve injuries were identified. The mean resolution time for the injuries was eight weeks. This study also identified several risk factors associated with inferior alveolar and lingual nerve injuries, such as the gender and age of the patients, the type of impaction and angulation of the tooth, the type of surgical technique and incision performed, and the proximity to the inferior alveolar canal.

Conclusion: Overall, inferior alveolar nerve and lingual nerve injury incidences at Griffith University dental school were lower than the current literature, and no permanent nerve injury was encountered.

Keywords: Mandibular nerve; Alveolar nerve; Inferior; Lingual nerve; Lingual nerve injuries; Mandibular nerve injuries; Surgery; Oral; Molar.

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Introduction

The removal of lower third molars is a standard procedure in oral surgery. The procedure can be undertaken by dental students, qualified dentists, or specialist surgeons. Injury to branches of the trigeminal nerve, including the inferior alveolar nerve (IAN) and the lingual nerve (LN), is one of the most problematic concerns of dental surgical procedures [1]. Nerve damage after lower wisdom tooth removal affects a small number of patients and can sometimes produce permanent sensory loss or impairment [2]. The inferior alveolar nerve is the largest branch of the mandibular nerve (CN V3). It descends through the infratemporal fossa with the lingual nerve and enters the mandibular canal. The IAN travels within the mandibular canal close to the apex of the molars and is closest to the lower third molars. The lingual nerve consists of fibres from the trigeminal (CN V3) and facial nerves (CN VII). It travels anteriorly and medially to the IAN in the infratemporal fossa and then reaches the medial face of the mandible above the mylohyoid ridge and muscle. In this area, it is very close to the lower third molar, and in up to 17.6% of cases, it can be found at the level of the alveolar crest or higher [3]. Nerve injury can occur due to the proximity of the lower third molar to the IAN (within the mandibular canal) or to the LN, resulting in direct damage to the nerve. It can also occur due to placing the incision in the wrong direction or position (e.g., too lingually towards the LN), instrument slippage (e.g., elevator), cutting too deeply with a bur (e.g., sectioning the nerves while removing bone or sectioning the tooth), over forceful retraction (e.g., lingual flap), pushing root tips into the mandibular canal or due to compression of the nerve as a result of post-surgery oedema and inflammation [2]. These disturbances can be distressing for the patients involved due to unfavourable effects on sensation, gustation (LN), speech, mastication, swallowing, and social interactions. Fortunately, most injuries are short-lived, and patients recover in time. Nevertheless, sometimes these injuries can be permanent [4]. There are few published studies on nerve injuries post third molar surgery in dental schools, only one from another Australian dental school [5] and another from a Scottish dental school [6]. This study aims to determine the incidences and risk factors of nerve injuries post third molar surgery performed at Griffith University dental school (GU).

Methods

Ethics approval for this study was granted by the Griffith University Human Research Ethics Committee (GU: 2019/119). The initial data collected from Griffith University's electronic patient management system included information from January 2010 to December 2018. The data collected encompassed extractions of all lower third molars removed via simple extraction, sectional extraction, surgical extraction not requiring bone removal or tooth division, surgical extraction requiring bone removal only, and surgical extraction requiring bone removal and tooth division. However, the data from January 2010 to December 2014 was excluded due to poor quality of written clinical records and often missing panoramic x-rays. Therefore, only data from January 2015 to December 2018 were included in this study. During these four years, 2826 lower third molar extractions were performed at Griffith University Dental Clinic (GUDC). The simple and sectional extractions were grouped as simple extractions for this study, while the remaining were classified as surgical extractions. All clinical notes for the 2826 lower molar extractions were reviewed, and incidences of nerve disturbances were identified. Of the confirmed nerve injuries, preoperative, clinical and radiographic data were also collected to identify predictive risk factors for IAN and LN injuries. The data collected included gender, type of operator, age of the patient, smoking status, service code, local anaesthetic used, type of procedure, angulation (Winter) and depth of impaction (Pell and Gregory), surgical technique used, radiologic proximity to the mandibular canal and if a cone-beam computed tomography (CBCT) was available. These factors are defined in (Table 1).

Table 1: Preoperative clinical and radiographic data collected to identify predictive risk factors for inferior alveolar nerve (IAN) and lingual nerve (LN) injuries.

Variable (Definition)	Classification
Gender	Male Female
Type of operator	Undergraduate student Postgraduate student Professional dentist Oral Surgery Specialist
Age of patient	Below 25 At or above 25
Smoking status	Yes No Not noted
Type of procedure	Simple or sectional Surgical
Local Anaesthetic used	Lignocaine Articaine Mepivacaine
Type of impaction	Unerupted Partially erupted Fully erupted
Angulation of impaction (Winter)	Mesial impaction Horizontal impaction Vertical impaction Distal impaction
Depth of impaction (Pell and Gregory)	Depth according to occlusal plane (Class A, B or C) Depth according to relationship to the ramus (Class I, II, III)
Surgical technique	Triangular flap (Buccal flap with mesial relieving incision) Envelope flap (Buccal flap with no mesial relieving incision) No flap Buccal bone removal Distal bone removal Crown of the tooth removed Roots sectioned
Radiologic proximity to the mandibular canal	Distant Touching or crossing

All extractions were undertaken at Griffith University Dental Clinic, School of Medicine and Dentistry, Queensland, Australia. Clinical notes were thoroughly analysed to see if the patient had any altered sensation or complained of paraesthesia in the tongue, lower lip, or chin following the lower third molar tooth removal. Additionally, information about the type of injury (temporary/permanent) and time for complete resolution, if temporary, were determined. Patient factors such as gender, age and smoking status were tallied. Operators were classified as undergraduate

and postgraduate students, professional dentists, and oral surgery academic specialists. Clinical factors such as eruption status and surgical aspects were also considered. Furthermore, the operational technique was scrutinised to see what type of an incision and mucoperiosteal flap was implemented, bone removal, crown sectioning (decoronation) and if the roots were divided. All the surgeries were performed under local anaesthesia.

Results

From January 2015 to December 2018, a total of 2826 lower third molars on 2065 patients were removed at Griffith University dental school, encompassing 1087 simple extractions and 1739 surgical extractions. In total, fifteen incidences of nerve injury post lower third molar extraction in fifteen distinct patients were identified and included in this study. Ten nerve injuries were linked to the inferior alveolar nerve, while five were related to the lingual nerve. After removing lower third molars, the overall incidence of acquiring any nerve injury was 0.53%. The incidence of the IAN injury was 0.35%, and the incidence of LN injury was 0.18%. During the four years of this study, all nerve injuries were temporary, with no patient sustaining permanent IAN or LN injury. The mean time for total recovery was eight weeks (6.1 weeks for IAN and 11.4 weeks for LN). When looking at the procedure type, only 7% (1/15) of the nerve injuries occurred during simple extractions, and 93% (14/15) occurred during surgical extractions. The incidence of nerve injury was calculated as 0.09% for simple extractions and 0.8% for surgical extractions. In this study, collectively, most of the nerve injuries occurred when the third molar tooth was either mesioangular (33%), vertical (33%) or horizontally (27%) impacted. However, there was a noticeable difference when looking at the nerves individually. With IAN injuries, 90% occurred with mesial (5/10) and horizontal (4/10) impacted teeth. The risk factors associated with IAN nerve injury post lower third molar extraction are identified in (Table 2). The risk factors that impacted the IAN injury include being male, patients older than 25 years, the tooth being unerupted with deep and horizontal impaction, and the mandibular canal's proximity. (Table 3) shows the risk factors related to LN nerve injury post lower third molar extraction. The risk factors that increased lingual nerve injuries were male patients, patients older than 25 years, the use of a triangular flap with relieving incision, the removal of buccal bone and the tooth being partially impacted and presenting vertical impaction.

Table 2: Factors affecting inferior alveolar nerve injury following removal of lower third molars (n=10 cases out of 2826 extractions).

Variable (Definition)	Classification	Nerve Injury		
		Number	Percentage	
Gender	Male	6	60%	
	Female	4	40%	
Age of patient	Below 25	3	30%	
	At or above 25	7	70%	
Smoking status	Yes	2	20%	
	No	2	20%	
	Not noted	6	60%	
Type of operator	Undergraduate student	2	20%	
	Postgraduate student	0	0%	
	Professional dentist	1	10%	
	Oral Surgery Specialist	7	70%	
Service code	Simple or sectional	0	0%	
	Surgical	10	100%	
Anaesthesia used	Lignocaine	3	30%	
	Articaine + Lignocaine	7	70%	
	Mepivacaine + Articaine	0	0%	
Type of impaction	Unerupted	8	80%	
	Partially erupted	2	20%	
	Fully erupted	0	0%	
Angulation of impaction (Winters classification)	Mesial impaction Horizontal impaction Vertical impaction	5 4 1	50% 40% 10%	
	Distal impaction	0	0%	
Depth of impaction (Pell and Gregory classification)	Depth according to occlusal plane (Class A, B or C)	A= 1 B=1 C=8	10% 10% 80%	

	Depth according to relationship to the ramus (Class I, II, III)	I =1 II=1 III=8	10% 10% 80%	
Surgical technique	Triangular flap	Y = 10 N = 0	100%	0%
	Envelope flap No flap	Y = 0 N = 10 Y = 0 N = 10	0% 100% 0% 100%	
	Buccal bone removal	Y = 10 N = 0	100%	0%
	Distal bone removal	Y = 2 N = 8	20%	80%
	Crown of the tooth removed	Y = 9 N = 1	90%	10%
	Roots sectioned	Y = 7 N = 3	70%	30%
Radiologic proximity to the mandibular canal	Distant Touching or crossing	1 9	10% 90%	

Table 3: Factors affecting lingual nerve injury following removal of lower third molars (n= 5 cases out of 2826 extractions).

Variable (Definition)	Classification	Nerve Injury	
		Number	Percentage
Gender	Male	3	60%
	Female	2	40%
Age of patient	Below 25	2	40%
	At or above 25	3	60%
Smoking status	Yes	0	0%
	No	0	0%
	None noted	5	0%
Type of operator	Undergraduate student	0	0%
	Postgraduate student	1	20%
	Professional dentist	1	20%
	Oral Surgery Specialist	3	60%
Service code	Simple or sectional	1	20%
	Surgical	4	80%
Anaesthesia used	Lignocaine	3	60%
	Articaine + Lignocaine	1	20%
	Mepivacaine + Articaine	1	20%
Type of impaction	Unerupted	1	20%
	Partially erupted	3	60%
	Fully erupted	1	20%
Angulation of impaction (Winters classification)	Mesial impaction Horizontal impaction	0 0	0% 0%
	Vertical impaction	4	80%
	Distal impaction	1	20%
Depth of impaction (Pell and Gregory classification)	Depth according to occlusal plane (Class A, B or C)	A= 1 B=3 C=1	20% 60% 20%
	Depth according to relationship to the ramus (Class I, II, III)	I =1 II=4 III=0	20% 80% 0%
Surgical technique	Triangular flap	Y = 2 N = 3	40% 60%
	Envelope flap No flap	Y = 2 N = 3 Y = 1 N = 4	40% 60% 20%. 80%

	Buccal bone removal	Y = 4 N= 1	80% 20%
	Distal bone removal	Y = 2 N = 3	40% 60%
	Crown of the tooth removed	Y = 3 N = 2	60% 40%
	Roots sectioned	Y = 1 N = 4	20% 80%
Radiologic proximity to the inferior alveolar canal	Distant Touching or crossing	4 1	80% 20%

Looking at the different types of operators, the highest incidence was amongst the oral surgery specialists, accounting for two-thirds of the total nerve injuries. This was expected as they usually manage only the more complex cases. Two injuries were related to undergraduate students as operators, and only one of the nerve injuries was obtained under the care of postgraduate students.

Discussion

Accurate and meticulous preoperative assessment and preparation are essential in minimising nerve injury risk in third molar surgery. Nerve injury can affect the patient in many unique ways, including their speech, eating, and drinking, and negatively impact their quality of life [7]. Fifteen nerve injuries were identified in this study out of 2826 extractions of lower third molars. The overall incidence of acquiring any nerve injury at Griffith University dental school was calculated at 0.53%. The incidence of the IAN injury was 0.35%, while the incidence of LN injury was 0.18%. No patient sustained permanent IAN or LN injury. This incidence rate of nerve injuries at Griffith University dental school is considerably lower than current literature. Moosa and Malden [6] completed a study at Edinburgh Dental Institution which revealed the incidence rate for IAN injury was 4.7%, while the LN injury incidence rate was 0.9%. Likewise, Queral-Godoy et al. [8] carried out a study to calculate the incidence of IAN injury following lower third molar removal. In their study, 4995 extractions were completed with 55 patients showing IAN alterations with an incidence rate of 1.1%. Moreover, Sarikov and Juodzbalys [9] conducted a systematic review of 14 studies which found IAN injury rates ranged from 0.35% to 8.4%. Additionally, Pogrel et al. [10] reported that injury to the lingual nerve after third molar extraction ranged from 0.6% to 2.0%. The low incidence of nerve injury at Griffith University Dental Clinic could be attributed to many factors, including the correct and thorough pre-extraction assessment protocol where the more complex extractions are assigned to the oral surgery specialists—likewise, having appropriate surgical equipment, including rotary surgical motors with saline irrigation, and access to on-site OPG and CBCT radiographic equipment.

All fifteen nerve injuries in this study self-resolved between one week to 20 weeks post-surgical procedure, with the average time around eight weeks (6.1 weeks for IAN and 11.4 weeks for LN). This recovery time is lower than the one shown in the Nguyen et al. [5] study, which demonstrated the mean-time for complete resolution as 4.3 months, but agreed with Sarikov and Juodzbalys [9] systematic review findings that most IAN injuries recovered within eight weeks. In general, it is noted that most temporary paraesthesia resolves within six months of injury occurring; however, it can take up to 24 months for this to transpire in some rare and unusual circumstances. The risk factors that predicted a higher risk of nerve injury were identified in this study, including patients over the age of 25. In this research, the mean age of the patients was 33 years, while the median age was 29. The consensus of the literature, including Shahana [11], Leung and Cheung [12], Nguyen et al.[5] and Jerjes et al.[13] support the conclusion that the risk of nerve complications increases with age. This can be attributed to the increased operative difficulty associated with age-related changes such as increased bone density, reduced bone elasticity, decreased vascularisation impairing the nerve regeneration process and a higher incidence of hypercementosis requiring surgical intervention. Therefore, having third molar surgery after 25 years of age can be considered a positive predictor of permanent neurological injury, which is in keeping with other studies in the literature [5]. Regarding gender, nine of the fifteen incidences reported in this study occurred in male patients, with the results showing that out of the five LN injuries, three occurred in males while two occurred in females. Jerjes et al. [13] stated that being male was a risk factor in LN injuries. However, no other tangible evidence of any gender bias regarding nerve injuries was found in the other studies reviewed in the literature. Smoking has been suggested as a positive predictor of alveolar osteitis [14]. It can also affect wound healing; however, there is no literature evidence to suggest it can be a risk factor for nerve injury. Within the fifteen cases reported, the smoking status was only known for four of the patients due to incomplete clinical and medical records. Out of the four known cases, 50% were smokers at that time. While looking at the different types of operators, the highest incidence was amongst the oral surgery specialists, accounting for two-thirds of the total nerve injuries. This bias can be explained by the fact that during an assessment, anything deemed too difficult or likely to cause significant complications gets automatically allocated to the oral surgery specialists. Two injuries were related to undergraduate students as operators, and only one of the nerve injuries was obtained under the care of postgraduate students. However, this can be explained as the postgraduate oral surgery program was only started in 2018.

All procedures were performed under local anaesthesia as GUDC does not have the facility for general anaesthesia. Brann et al. [15] concluded that IAN and LN damage was five times more likely to occur when lower third molars were removed under general anaesthesia than when performed under local anaesthesia. In this study, the three main local anaesthetic solutions utilised in the surgical procedures were Lignocaine Hydrochloride 2% with 1: 80,000 adrenaline, Articaine Hydrochloride 4% with 1: 100,000 adrenaline and Mepivacaine Hydrochloride 3% plain. It was found that Lignocaine was used in six of the procedures, the combination of Articaine and Lignocaine was used in eight of the procedures, and the combination of Mepivacaine and Articaine was used in only one of the procedures involved in the injuries. In Australia, Articaine is not recommended for blocks, according to the Therapeutic Guidelines. Haas and Lennon[1] [16] reported a higher incidence of nerve paraesthesia when using Articaine Hydrochloride 4% when injecting for IAN block. Hillerup et al [17] found a

positive association between Articaine 4% and neurosensory disturbances following IAN block, especially on the lingual nerve.

However, other studies have claimed this is incorrect, and reports stating a greater risk of paraesthesia are based solely on anecdotal evidence with no scientific justification. Pogrel [18] indicated that the association between Articaine and nerve damage occur in proportion to its usage. Meanwhile, Malamed et al. [19] concluded that Articaine provides adequate anaesthesia with a low risk of toxicity that appears comparable to other local anaesthetics. Over the years, many proposed assessment methods have been used to determine the difficulty of the third molar tooth extracted. In this study, radiological studies in orthopantomograms (OPG) were evaluated to determine if the depth and inclination of the tooth impaction had any effects on nerve injury, and the findings are supported by similar reports by Nguyen et al.[5] and Jerjes et al. [13]. Based on Winter classification, four out of the five LN injuries presented vertical impactions in this study. One presented a distal impaction; however, some literature suggests that distoangular impactions are more likely to lead to LN injury [13].

Regarding the depth of the impacted tooth, and based on Pell and Gregory's classification, results from this study show that most of the IAN injuries occurred when the impacted tooth was below the cervical margin of the second molar (class C), and the impacted tooth crown positioned posterior to the anterior aspect of the ascending ramus (class III). This agrees with Leung and Cheung [12] report, which stated that deep impactions are a risk factor for IAN injuries. Orthopantomograms were also evaluated to see if any relation was obtained when looking at the proximity of the apex of the impacted tooth to the mandibular canal. Out of the fifteen nerve injuries, ten (67%) occurred when the apex of the impacted tooth was either touching or crossing over the mandibular canal. Individually, out of the ten IAN injuries, nine of the impacted teeth were in proximity to the mandibular canal. This is consistent with the article by Rood and Shebab [20], which outlined the radiological diagnostic signs to assess the likelihood of IAN nerve injury during third molar extraction. The information gained from the radiologic examination is vital to making an informed decision on surgical difficulty and thus operator suitability [5]. Out of the five LN injuries, only one of the removed molars was close to the mandibular canal, while the other four were away from the mandibular canal. The LN runs on the lingual aspect of the mandible; hence the proximity to the mandibular canal is usually of no relevance. In this study, 38% of the lower molar extractions were classified as simple, while 62% were surgical. The incidence of nerve injuries was 0.09% for simple extractions and 0.8% for surgical extractions. Most nerve injuries occurred during surgical removal of the impacted lower third molar tooth, which required raising a buccal mucoperiosteal flap (fourteen out of the fifteen cases). Injuries of the IAN and LN materialised more frequently with the use of a triangular flap, the need to remove buccal bone and the need to remove the crown. Two out of the fifteen cases involved an envelope flap technique, and one of the procedures which led to LN injury was a simple extraction. The limitations recognised in this study included the lack of uniform and consistent clinical records and radiographs. The original objective of this study was to identify incidences over a 9-year period (January 2010 to December 2018); however, due to poor record-keeping, this was not feasible. Unfortunately, due to the small sample size, inferential statistics could not be carried out and dissected; however, descriptive data analysis was undertaken. Additionally, it was evident from the clinical data that there was no consistent management plan followed when incidences of nerve injury did occur. On most occasions, no additional measures were undertaken, with no set timeframe follow up protocols or a referral to oral surgery specialists. Corticosteroids (Prednisone) were prescribed occasionally; however, the dosage and frequency were inconsistent. For each time an incidence of nerve injury occurred, the management of the patient and follow-up time frame was different. Therefore, to help facilitate a more favourable outcome for the patients involved, it is recommended that a standardised strategy for managing nerve injury following third molar surgery is implemented. This may include a standardised review follow-up process every two weeks for two months, every six weeks for six months, every six months for two years, followed by an indefinite annual review.

Moreover, corticosteroid therapy with consistent dosage and frequency could be considered and referral to an oral surgery specialist when these complications arise. It is also recommended to repeat the study, particularly as record-keeping has improved.

Conclusion

This study concluded that the overall incidences of IAN (0.35%) and LN (0.18%) injuries at Griffith University dental school were lower than reported in current literature. All nerve injuries were temporary, with no permanent IAN or LN injuries. Some important risk factors were identified for IAN injuries, including increasing age of the patient (25-year-old plus), mesioangular, horizontally and deeply impacted teeth which needed to be removed surgically. Another risk factor for IAN injuries was the proximity of the tooth to the mandibular canal on the OPG. Risk factors for LN injuries included older patients and vertically impacted teeth. There were limitations to this study mainly due to poor record-keeping and lack of radiographs. It is recommended that a standardised management plan should be implemented to help facilitate a more favourable outcome for the patients involved in these unfortunate injuries. Further investigations should be conducted to record the efficiency of the management plan.

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