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Neuropraxia and Other Iatrogenic Nerve Injuries in Mandibular Third Molar Surgery and Endodontic Treatment: A Narrative Review

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Abstract

Objective: Injury to branches of the trigeminal nerve, particularly the inferior alveolar and lingual nerves, is a recognised complication of both mandibular third molar surgery and endodontic treatment. The purpose of this narrative review is to summarise current evidence on the classification, incidence, risk factors, diagnosis, and management of nerve injury — with particular emphasis on neuropraxia, the mildest and most common form — arising from these two common dental procedures.

Methods: A narrative review of the English-language literature was conducted using PubMed/MEDLINE and the Cochrane Library, employing combinations of the keywords "neuropraxia", "inferior alveolar nerve injury", "lingual nerve injury", "third molar surgery", "endodontic nerve injury", and "sodium hypochlorite accident". Systematic reviews, meta-analyses and cohort studies were prioritised and supplemented with relevant case reports and case series where higher-level evidence was unavailable.

Results: Reported incidence of inferior alveolar nerve injury after third molar surgery ranges from 0.35% to 8.4% for transient deficits and is generally below 2% for permanent deficits. Lingual nerve injury is closely linked to surgical technique, with lingual flap retraction and the lingual split technique associated with a several-fold increase in temporary injury compared with a buccal-only approach. The great majority of these injuries represent neuropraxia and resolve spontaneously within weeks to a few months. Endodontic-related nerve injury is less common but can follow chemical (sodium hypochlorite, calcium hydroxide, sealer extrusion) or mechanical (overinstrumentation, overfilling) insult, and its course is more variable, at times accompanied by neuropathic pain. Cone-beam computed tomography improves preoperative risk stratification in radiographically high-risk cases. Management ranges from observation and pharmacological neuropathic pain control to surgical removal of extruded material and microsurgical nerve repair, with the best outcomes generally reported when repair is undertaken within approximately twelve months of injury.

Conclusion: Neuropraxia accounts for the majority of nerve injuries encountered in third molar surgery and endodontics and carries a favourable prognosis. Careful preoperative risk assessment, judicious technique selection, prompt recognition of injury, objective neurosensory testing, and timely referral for specialist or microsurgical intervention when indicated together optimise clinical outcomes and reduce medicolegal exposure.

Keywords

Neuropraxia; Inferior Alveolar Nerve; Lingual Nerve; Third Molar Surgery; Endodontics; Nerve Injury

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1. Introduction

The surgical removal of impacted or symptomatic mandibular third molars is among the most frequently performed procedures in oral and maxillofacial and general dental practice, accounting for a substantial proportion of all oral surgical procedures undertaken worldwide [1]. While the majority of extractions proceed uneventfully, the mandibular third molar occupies an anatomical position in close proximity to two structures of major clinical concern: the inferior alveolar nerve (IAN), travelling within the mandibular canal, and the lingual nerve, which courses along the lingual aspect of the mandible in a highly variable and sometimes superficial position. Injury to either nerve, although uncommon, is consistently identified as the complication of greatest concern to both surgeon and patient, and is a leading cause of dento-legal dispute [1].

Peripheral nerve injury exists along a spectrum of severity, classically described by Seddon in 1943 as neuropraxia, axonotmesis, or neurotmesis, and later refined by Sunderland into five degrees of increasing structural disruption [1]. Neuropraxia — a transient conduction block arising from focal demyelination, compression, or ischaemia without loss of axonal continuity — is the mildest form of nerve injury and, fortunately, accounts for the great majority of nerve injuries sustained during dentoalveolar surgery. Its hallmark is a good prognosis, with spontaneous resolution expected as the affected segment of nerve remyelinates.

Although third molar surgery is the procedure most classically associated with trigeminal nerve injury in dentistry, endodontic treatment of mandibular posterior teeth — particularly the second molar, whose root apices frequently lie in close proximity to the mandibular canal — can also result in injury to the IAN. Such injury may arise mechanically, through overinstrumentation or overfilling of the root canal system, or chemically, through the extrusion of irrigants, intracanal medicaments, or obturation materials into the mandibular canal. Reports of endodontic-related nerve injury, while still infrequent relative to surgical cases, appear with increasing regularity in the literature, and their clinical presentation and management differ in important respects from those of surgically induced injury.

The purpose of this review is to consolidate current evidence on the classification, incidence, risk factors, diagnosis, and management of neuropraxia and related nerve injuries arising specifically from mandibular third molar removal and from endodontic treatment, with a view to informing clinical decision-making, patient counselling, and risk mitigation in everyday dental practice.

2. Materials and Methods

This is a narrative literature review rather than a systematic review or original clinical study. A literature search was performed using the PubMed/MEDLINE database and the Cochrane Library, employing combinations of the following keywords: “neuropraxia”, “inferior alveolar nerve injury”, “lingual nerve injury”, “third molar surgery”, “coronectomy”, “endodontic nerve injury”, “sodium hypochlorite accident”, “calcium hydroxide extrusion”, and “microsurgical nerve repair”. The search was restricted to English-language, peer-reviewed publications. No date restriction was applied, given that several foundational papers on nerve injury classification and third molar-related neurosensory outcomes remain the primary reference standard in the field.

Systematic reviews, meta-analyses, and prospective or retrospective cohort studies were prioritised for inclusion, and were supplemented with relevant case reports and case series in areas where higher-level evidence is not available, in particular the endodontic nerve injury literature, which remains dominated by individual case reports. No formal PRISMA protocol was followed, and no quantitative synthesis (meta-analysis) was undertaken; the review instead aims to provide a clinically oriented narrative synthesis of the available evidence.

As this is a review of previously published, de-identified data and did not involve the recruitment, examination, or treatment of human or animal subjects by the author, formal institutional ethical approval and individual patient informed consent were not required for the preparation of this manuscript.

3. Results and Discussion

3.1 Applied Anatomy

The inferior alveolar nerve is a branch of the posterior division of the mandibular nerve (the third division of the trigeminal nerve). It enters the mandibular foramen on the medial surface of the ramus and travels within the bony mandibular canal, giving off branches to the mandibular teeth before

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exiting as the mental nerve to supply sensation to the lower lip and chin. Its relationship to the roots of the mandibular third molar is highly variable: the canal may lie buccal, lingual, inferior to, or directly between the roots, and this anatomical relationship is the single most important determinant of surgical risk [1].

The lingual nerve, by contrast, is not enclosed within bone in the third molar region. It runs on the medial aspect of the mandibular ramus and, in a proportion of individuals, lies at or above the level of the lingual crest of the alveolar bone, occasionally in direct contact with the lingual periosteum. This superficial and variable course renders the lingual nerve particularly vulnerable to injury during flap reflection, lingual retraction, or bone removal on the lingual aspect of the third molar socket.

3.2 Classification of Peripheral Nerve Injury and the Concept of Neuropraxia

Seddon's original 1943 classification divides peripheral nerve injury into three categories of increasing severity: neuropraxia, axonotmesis, and neurotmesis [3]. Sunderland subsequently expanded this scheme into five degrees, with his first degree corresponding to Seddon's neuropraxia and his second to fifth degrees subdividing axonotmesis and neurotmesis according to the extent of connective tissue (endoneurial, perineurial, and epineurial) disruption [4].

Neuropraxia represents a purely physiological conduction block, most commonly caused by focal demyelination secondary to compression, traction, or ischaemia. Critically, axonal continuity and all supporting connective tissue layers remain intact; there is no Wallerian degeneration distal to the site of injury. Clinically, neuropraxia presents with variable degrees of sensory (and occasionally motor) impairment, but the prognosis is excellent, with recovery typically occurring within days to a few months as the affected segment of nerve remyelinates [5]. This contrasts with axonotmesis, in which the axon itself is disrupted while the connective tissue framework is preserved, permitting axonal regeneration at a rate of approximately 1 mm per day but with a less certain and often incomplete functional recovery, and with neurotmesis, the most severe injury, involving complete disruption of the nerve trunk and its connective tissue coverings, for which spontaneous recovery cannot be expected and surgical repair is generally required [4,5].

The great majority of nerve injuries encountered in dentoalveolar surgery and in endodontic practice fall into the neuropraxia category, which accounts for the generally favourable prognosis reported across the third molar and endodontic literature. Nonetheless, a minority of cases — particularly those involving direct nerve transection, compression by displaced bony fragments or extruded endodontic material, or chemical injury from potent irrigants — may represent axonotmesis or neurotmesis and require a different management pathway, as discussed further below.

3.3 Nerve Injury in Mandibular Third Molar Surgery

Injury to the inferior alveolar nerve following mandibular third molar removal has been reported with an incidence of approximately 0.35% to 8.4% for transient deficits, with permanent injury generally reported at well under 2%, and frequently below 1%, of cases [1]. Large prospective series illustrate this range: Valmaseda-Castellón and colleagues, in a prospective study of 1117 surgical extractions, and Jerjes and colleagues, in a series of 3236 patients undergoing third molar removal, both documented similar patterns of early postoperative paraesthesia followed by substantial, though not universal, spontaneous recovery over the following months [15,16].

Risk factors consistently identified across the literature include increasing patient age (particularly beyond the mid-twenties), horizontal or deep bony impaction, close or intimate radiographic proximity between the tooth roots and the mandibular canal, direct contact between the roots and the canal, and reduced surgeon experience [1,16,17]. Intraoperative visualisation or exposure of the inferior alveolar neurovascular bundle within the extraction socket is itself an important predictor of postoperative injury: in a case-control study of 288 extractions, On and colleagues reported a significantly higher incidence of IAN injury in cases where the nerve was intraoperatively exposed compared with those where it was not (4.3% versus 0%) [7].

Preoperative imaging plays a central role in risk assessment. Panoramic (orthopantomographic) radiography remains the standard initial investigation, with recognised high-risk signs including darkening or deflection of the tooth root, narrowing of the root or canal, interruption of the radiopaque lines bordering the canal, and diversion of the canal itself [1,17,19]. When such signs are present, cone-beam computed tomography (CBCT) offers three-dimensional visualisation of the true spatial

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relationship between the roots and the canal, including whether the canal is positioned buccally, lingually, or interradicularly. While CBCT undoubtedly improves the surgeon's anatomical understanding and may inform the choice of surgical approach in selected high-risk cases, the evidence that its routine use reduces the overall incidence of nerve injury compared with panoramic radiography alone remains mixed, and its use is generally reserved for cases in which panoramic signs already indicate a close anatomical relationship [1].

The lingual nerve merits separate consideration, as its risk profile is determined less by root anatomy and more by surgical technique. Systematic review and meta-analysis evidence indicates that lingual flap retraction, whether performed as an adjunct to a standard buccal approach or as part of the lingual split technique, is associated with a substantially increased risk of temporary lingual nerve injury compared with a buccal-only approach without lingual retraction. Lee and colleagues, in a 2023 systematic review and meta-analysis, calculated a combined relative risk of 4.80 for temporary lingual nerve injury with lingual flap retraction compared with a buccal-only approach without retraction [8]. This corroborates earlier work by Pichler and Beirne, whose systematic review found lingual nerve injury rates of 9.6%, 6.4%, and 0.6% for the lingual split, buccal-with-retraction, and buccal-only techniques respectively, with no clear protective effect of retraction against permanent injury [9]. Taken together, this body of evidence supports minimising unnecessary lingual flap elevation and retraction wherever the surgical field permits.

For third molars judged, on the basis of radiographic proximity, to carry a particularly high risk of IAN injury with conventional total removal, coronectomy — the deliberate removal of the tooth crown with intentional retention of the root(s) in situ, allowing the roots to remain undisturbed adjacent to the nerve — has emerged as a recognised risk-reduction strategy. Systematic reviews of the coronectomy literature report inferior alveolar nerve injury rates generally below 1% following the procedure, considerably lower than rates typically quoted for conventional extraction of comparable high-risk teeth, though at the cost of a measurable rate of subsequent infection, need for reoperation, and post-operative pain in some series [2,6,18].

3.4 Nerve Injury in Endodontic Treatment

Nerve injury as a complication of endodontic treatment is considerably less common than that associated with third molar surgery, but is well documented, particularly in relation to the mandibular second molar and, less frequently, the first molar and premolars, whose root apices may lie in close proximity to the mandibular canal or mental foramen [20]. Two broad mechanisms of injury are described. The first is mechanical: overinstrumentation beyond the apical foramen, or iatrogenic perforation of the canal wall or apex, can create a pathway through which gutta-percha, carrier-based obturation material, or endodontic sealer is inadvertently extruded into the mandibular canal, where it may exert direct compressive or space-occupying pressure on the nerve. The second mechanism is chemical: many endodontic materials, including calcium hydroxide dressings, resin- and calcium silicate-based sealers, and particularly sodium hypochlorite irrigant, are cytotoxic and neurotoxic when they come into direct contact with neural tissue, and can provoke an intense local inflammatory reaction or frank chemical burn of the nerve and surrounding tissue.

The clinical presentation of endodontic-related nerve injury typically involves the sudden onset of severe pain during or immediately after the procedure, followed within minutes to hours by paraesthesia, hypoaesthesia, or complete anaesthesia of the lower lip and chin. Where sodium hypochlorite has been extruded beyond the apex or has escaped into the soft tissues, the presentation is often more dramatic, with rapid-onset swelling, ecchymosis, and occasionally transient facial nerve weakness in addition to sensory disturbance, reflecting the tissue-destructive nature of hypochlorite on contact with periapical and perineural tissue [22,23]. Case reports of calcium hydroxide extrusion into the mandibular canal similarly describe acute pain and paraesthesia at the time of the procedure, with the clinical course thereafter often determined by the rate of resorption of the extruded material; several published cases describe gradual, near-complete resolution of paraesthesia over a period of months as calcium hydroxide is progressively resorbed from the canal, corroborated by serial CBCT imaging [21].

CBCT has become an important adjunct not only in confirming the diagnosis of material extrusion into the mandibular canal, but in guiding subsequent management, including decisions around observation versus surgical removal, and, in selected cases, in planning digitally guided surgical

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decompression of the canal [21]. Where endodontic-related nerve injury is dominated by neuropathic pain rather than pure sensory loss, a non-surgical pharmacological approach combining a short course of systemic corticosteroid with a GABA-analogue such as pregabalin has been reported to achieve complete resolution of pain and paraesthesia within several weeks in individual cases, and represents a reasonable first-line strategy in the absence of a mechanically compressive lesion requiring removal [20].

3.5 Diagnosis and Neurosensory Evaluation

Accurate diagnosis and monitoring of trigeminal nerve injury, whatever its cause, depends on objective neurosensory testing rather than reliance on the patient's subjective report alone. Standard clinical tests include light-touch detection, two-point discrimination, pin-prick (sharp-blunt) discrimination, and thermal testing, each performed over the affected distribution and compared against the corresponding contralateral, uninjured side as an internal control [1]. Findings should be carefully mapped and, where possible, photographically or diagrammatically recorded at baseline and at subsequent review intervals, both to guide management and to provide a clear contemporaneous record should the case later become the subject of a complaint or claim. In the microsurgical literature, the Medical Research Council Scale is commonly used to grade the degree of sensory impairment and to define “functional sensory recovery” as an outcome measure following nerve repair [12].

3.6 Management Principles

Because neuropraxia accounts for the majority of nerve injuries in both third molar surgery and endodontics, a period of observation with serial objective neurosensory testing is the appropriate initial management for most patients, particularly where sensory loss is partial rather than complete and there is no radiographic evidence of a displaced foreign body, bony fragment, or extruded endodontic material compressing the nerve. Most neuropraxic injuries show measurable improvement within the first six to eight weeks and substantial or complete resolution within six months [1].

Where pain, rather than pure numbness, dominates the clinical picture — as is relatively common in endodontic-related injury — early pharmacological management of neuropathic pain, for example with a GABA-analogue such as pregabalin, with or without a short tapering course of systemic corticosteroid, may hasten symptomatic resolution and should be considered alongside referral where appropriate [20]. Where a space-occupying or directly compressive cause is identified radiographically — displaced root fragments, bony spicules, or extruded root canal filling material within the canal — timely surgical removal or decompression of the causative material is indicated and has been associated with good outcomes in case reports and small case series [21].

For injuries that fail to show meaningful improvement on serial testing, that present with complete anaesthesia from the outset, or in which nerve transection is suspected or confirmed, referral for specialist microsurgical exploration and repair should be considered. Outcome data, though derived predominantly from mixed cohorts of implant-, third molar-, and orthognathic-related IAN injury, are informative: in a retrospective cohort of 186 microsurgical IAN repairs, Bagheri and colleagues reported functional sensory recovery in 81.7% of cases overall, with the likelihood of a successful outcome declining significantly once the interval between injury and repair exceeded approximately twelve months, and similarly declining with increasing patient age beyond the early fifties [12]. Comparable principles apply to lingual nerve repair, where a retrospective review of 222 microsurgically repaired lingual nerve injuries again demonstrated that earlier intervention and younger patient age were associated with more favourable sensory outcomes [10]. These findings support prompt referral once a decision for surgical exploration has been made, rather than prolonged observation beyond the point at which spontaneous recovery has plateaued.

It is important to acknowledge, however, that the overall quality of evidence guiding intervention and timing decisions in iatrogenic inferior alveolar and lingual nerve injury remains limited. A Cochrane systematic review addressing interventions for iatrogenic inferior alveolar and lingual nerve injury found insufficient randomised controlled trial evidence to draw firm conclusions regarding the optimal type or timing of intervention, underscoring a persistent gap between the volume of observational outcome data and the availability of high-quality comparative evidence [11]. Management decisions in individual cases therefore continue to rely substantially on clinical

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judgement, informed by the pattern and severity of sensory loss, the presence or absence of a mechanically correctable cause, and the balance of risks and benefits of further intervention versus continued observation.

3.7 Prevention

In third molar surgery, risk reduction begins with careful preoperative clinical and radiographic assessment, appropriate use of CBCT in radiographically high-risk cases, and thoughtful selection of surgical technique, including minimising unnecessary lingual flap elevation and retraction, considering coronectomy for teeth at particularly high risk of direct IAN contact, and ensuring the involvement of an appropriately experienced operator for complex cases [1,2,6,8,9]. Comprehensive, documented informed consent discussing the specific risk of temporary and permanent nerve injury, tailored to the individual patient's radiographic risk profile, remains an essential component of preoperative care.

In endodontics, prevention of nerve injury centres on accurate preoperative assessment of root apex proximity to the mandibular canal and mental foramen — particularly for mandibular second molars — supplemented by CBCT where periapical or panoramic imaging suggests a close relationship; strict control of working length to avoid instrumentation beyond the apical constriction; use of controlled, low-pressure irrigation techniques with side-vented rather than open-ended needles to reduce the risk of hydraulic extrusion of irrigant; and caution in the volume and technique of calcium hydroxide or sealer placement in teeth identified as high-risk. Prompt recognition of the clinical signs of an intraoperative accident — sudden pain, swelling, or altered sensation — and immediate cessation of the causative step, together with early imaging and referral where indicated, are essential to limiting the extent of injury when an accident does occur [21,22,23].

3.8 Medicolegal Considerations

Nerve injury following both third molar surgery and endodontic treatment remains one of the most frequent grounds for dento-legal complaint and claim in restorative and surgical dental practice. Thorough, contemporaneously documented informed consent that specifically addresses the risk of temporary and permanent altered sensation, careful preoperative radiographic risk assessment, objective and well-documented neurosensory testing when injury does occur, and timely referral for specialist opinion where indicated together constitute the recognised standard of care and represent the clinician's best protection in the event of an adverse outcome [1].

4. Conclusion

Neuropraxia is the most frequently encountered and most favourable form of nerve injury associated with both mandibular third molar removal and endodontic treatment, and the great majority of affected patients can expect spontaneous, near-complete recovery within weeks to a few months. Inferior alveolar nerve injury in third molar surgery is closely linked to radiographically demonstrable proximity between the tooth roots and the mandibular canal, while lingual nerve injury is more strongly determined by surgical technique, particularly the use of lingual flap retraction. Endodontic-related nerve injury, though less common, can arise from either mechanical or chemical insult during root canal treatment of posterior mandibular teeth and often follows a more variable and occasionally more painful clinical course. Across both settings, careful preoperative risk assessment supplemented by cone-beam computed tomography where indicated, judicious selection of technique, objective neurosensory monitoring, and timely referral for pharmacological or microsurgical intervention when spontaneous recovery fails to occur together represent the cornerstones of good clinical practice, optimal patient outcomes, and appropriate medicolegal risk management.

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Conflict of Interest

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