Risk assessment of endodontic-related nerve injuries: part 2

In the final part of two articles, Dr. Tara Renton explores risk assessment, diagnosis, and management of endodontic-related nerve injuries.

Minimizing risk

Risk assessment of the patient and dental factors are very important. Patients over the age of 50 are less likely to recover from nerve injury. Certain medical conditions may predispose your patient to developing chronic post-traumatic neuropathy and/or pain (existing fibromyalgia, migraines, Raynaud’s disease, IBS, and psychological morbidity). Pre-screening of dental neuropathic pain is advised before undertaking repeated endodontics or further interventional surgery.

A key factor in these cases appears to be proximity of the tooth apex to the inferior dental canal (IDC). The mandibular premolars located close to the mental foramina are considered high risk in endodontics for potential nerve damage (Knowles, Jergenson, Howard, 2003; Baxmann, 2006; Scarano, et al., 2007).

An important factor often overlooked in endodontics is the “safety zone,” often referred to during estimation of drilling depths for implant preparation surgery. A single paper addresses the notion that endodontists should consider the distance between the tooth apex and the inferior dental canal (IDC) estimated on a plain film not necessarily by a cone beam computed tomography (CBCT) to ensure that accidental apical leakage or over-instrumentation will more likely cause nerve injury if the apex is adjacent to the IDC (Ngeow, 2010).

Assessment of other dental factors, including root fractures and periapical lesions (Table 1) must also be assessed. Assessing the actual position of the IDC, mental loop, and accessory canals can be complex, and the clinician involved in treatment planning must be able to analyze and risk-assess radiological investigations and not leave the risk assessment to another clinician. There continues to be considerable debate as to whether CBCT is superior in assessing these risk factors.

Minimizing technical causes

Apical extrusion of products may be increased by ultrasonics and minimized by using EndoVac. Postoperative root canal treatment views must be arranged on the day...
of completion of the treatment, and identifi-
cation of any root canal treatment product in
the inferior alveolar nerve (IAN) canal should
be reviewed carefully and removed within 48
hours (Helvacıog˘lu Kivanç, 2015). A system-
atic review made a specific recommendation
in care when preventing extrusion of endo-
materials into the IDC (Olsen, et al., 2014).

CBCT guidance
All radiographic examinations must be
justified on an individual needs basis whereby
the benefits to the patient of each exposure
must outweigh the risks. In no case may the
exposure of patients to X-rays be consid-
ered “routine,” and certainly CBCT exami-
inations should not be done without initially
obtaining a thorough medical history and
clinical examination. CBCT should only be
considered an adjunct to two-dimensional
imaging in dentistry (American Association
of Endodontists, American Academy of Oral
and Maxillofacial Radiology, 2011).

Risk assessment — location of the inferior
dental canal
• A classic study of the relationship
between mandibular premolar apices
and the mental foramen has reported
close proximity with the first premolar
apex in 15.4% of patients and with
the second premolar apex in 13.9% of
patients (Fishel, et al., 1976).
• In their morphometric study, Phillips
and colleagues reported that each
mental foramen was located an
average distance of 2.18 mm mesially
and 2.4 mm inferiorly from the radi-
ographic apex of the second premolar
• More precisely, each mental foramen
was found to be located, on average,
anywhere between 3.8 mm mesial,
2.7 mm distal, 3.4 mm above, or 3.5
mm below the apex of the respec-
tive second premolar (Phillips, Weller,
Kulild, 1992).
• In contrast, the apex of each second
premolar was between 0 mm and
4.7 mm from the respective mental
foramen in various cadaveric studies
(Denio, Torabinejad, Bakland, 1992).

Is CBCT better than long cone periapical
radiographs (LCPA) for risk assessment?
Periapical pathology diagnosis using
CBCT revealed a significantly lower number
of favorable outcomes than periapicals in
root canal retreatment. This significantly
affected the future management of cases
attending for a review (Davies, et al., 2015).
In a study by Chavda and colleagues
(2014), 21 unsalvageable teeth from 20
patients that had been radiographed and
scanned with CBCT imaging were included
to look at root fractures. The teeth were atrau-
matically extracted and visually inspected
under a microscope to confirm the presence/ab
sence of fracture. Both digital radiography
and CBCT imaging have significant limita-
tions when detecting vertical root fractures.

Is dose reduction possible in CBCT?
Limited field-of-view CBCT systems can
provide images of several teeth from approxi-
mately the same radiation dose as two peri-
apical radiographs, and they may provide a
dose savings over multiple traditional images
in complex cases.
Both 360° and 180° CBCT scans yielded
similar accuracy in the detection of artificial
bone lesions. The use of 180° scans might
be advisable to reduce the radiation dose
to the patient in line with the International
Commission on Radiological Protection
(ICRP) guidance to use as low a dosage as
reasonably achievable (Lennon, et al., 2011).

Diagnosis and assessment
A previous literature review of paraes-
thesia in endodontics recommended that
the clinician must carry out a complete
medical history, panoramic and periapical
radiography, and (in some cases) computed
tomography, as well as mechanoreceptive
and nociceptive tests.

It is important to recognize that inferior
alveolar nerve injuries (IANI) can occur due
to local anesthetic block injections, and the
clinician can often discriminate between
endodontic and local anesthesia-caused
erve injuries by careful questioning and
clinical neurological assessment.

Chemical nerve injury may not be obvious
radiographically:
• If the patient is suffering from
neuropathy after the local anes-
thetic has worn off and the post-
operative radiographs confirm that
there is no radiopaque material in
the canal, chemical nerve injury may be
presumed.
• Mapping of the neuropathic area will
discriminate between inferior dental
block (IDB) and endodontic nerve
injury.
• This may be an irreversible injury
to the nerve and subsequent, even
swift, removal of the root canal fill-
ning or tooth is unlikely to resolve the
nerve injury.
• If there is material recognized within
the canal, this would suggest injury,
but if there is no material in the canal,
is the same presumption made?
The patients must be assessed holis-
tically, including their history of the event, and
if it is related to the initiation of pain. Ensure
that the pain history excludes pre-existing
neuropathic pain, including:
• Severe pain during procedure (funny-
bone pain)
• High level post-surgical pain (indica-
tive of nerve injury)
Ongoing pain, altered sensation and/or numbness
Functional problems
Psychological issues

Important questions about the mechanism and duration of the neuropathy will drive the timing and type of management (Renton, et al., 2006). Necessary investigations include:

- Radiological: LCPA; CBCT necessary post-trauma.
- Neurosensory to confirm that the presence of a neuropathy and distribution correlates with potential nerve injury.
- Diagnostic local anesthesia blocks may be useful in evaluating the potential of some peripheral pain management strategies when medical management is unsuccessful.

Management is that of the patient with the nerve injury not the neuropathy itself (Renton, Yilmaz, 2012). Grötz and colleagues (1998) reported on 11 patients with endodontic-associated neuropathy and their management. They similarly reported that the neurosensory findings were dominated by hypoesthesia and dysesthesia, with 50% of patients reporting pain. Initial X-rays showed root filling material in the area of the mandibular canal. Nine cases were treated with apicoectomy and decompression of the nerve. In two cases, extraction of the tooth was necessary; only one patient reported persistent pain after surgery. Primarily, all patients should have an apology and explanation (duty of candor) by the treating clinician.

Management tools may include counseling for all patients with nerve injuries, which is very effective (there is limited evidence for success of this treatment for endodontic-related IANs, but evidence does support psychological therapies for chronic pain and IANs) (Renton, Yilmaz, 2011) for:

- Local anesthesia, orthognathic fracture
- Endodontic or implant injuries greater than 30 hours
- TMS injuries older than 6 months

Counseling includes reaffirming nerve injury is permanent and reassurance and explanation. Other management tools include medical symptomatic therapy (pain or discomfort) through topical and systemic agents for pain.

Lastly, surgical exploration is significant:

- Explore IAN injuries through socket in less than 4 weeks.
- Explore LN injuries before 12 weeks.

### Surgical management

- Repeat endodontic treatment with removal of the overfill or over-instrumentation. There are many reports of repeated endodontic treatment for IANIs related to endodontics; however, the outcomes remain poor (Nayak, et al., 2011; Yatsuhashi, et al., 2003).
- Surgical excision of the overfill of chemicals and endodontic root fillers: Pogrel (2007) reported 11 cases of acute surgical intervention with five patients reporting improvement, and two none. On this basis, Pogrel recommends urgent (under 24 hours) surgical exploration with aggressive irrigation and removal of overfill. Several report cases successfully treated using urgent surgical treatment (Scala, et al., 2014; Scolozzi, Lombardi, Jacques, 2004; Brkic’, Gürkan-Köseoglu, Olgac, 2009). A similar protocol is recommended for sodium hydroxide neuropathies (Byun, et al., 2015).
- Medical management to minimize acute surgical neural inflammation by using NSAIDs and prednisolone-mimic protocols undertaken for other acute sensory nerve injuries (Gatot, Tovi, 1986; Grötz, et al., 1998).
- Medical management of chronic pain associated with endodontic treatment: Oshima (2009) reported that 16 out of 271 patients presenting with chronic orofacial pain were diagnosed with chronic neurosensory tooth pain subsequent to endodontic retreatment. Most of these patients were treated for maxillary teeth. Seventy percent of the patients responded to tricyclic antidepressant therapy, which highlights the importance of establishing whether the patient has neuropathic pain.

In Renton and Yilmaz’s (2012) study, all the patients presented too late for surgical decompression, or it was not indicated. Thus, two patients were managed with oxcarbazepine for neuralgic pain elicited with touch or cold and with topical clonazepam intraorally to manage the severe gingival discomfort. Two patients were prescribed topical 5% lidocaine patches (12 hours on nocte and 12 hours off daily) for debilitating mechanical allodynia in the extracranial dermatome of the IAN, causing pain and functional problems. This is a treatment used successfully for patients with chronic orofacial pain, particularly those with mechanical or cold allodynia of the face.


### Timing of treatment

Nerve tissue is incredibly sensitive to pH changes; thus, chemical nerve injuries are commonly permanent and often cause severe neuropathic pain. These chemical nerve injuries often cause severe neuropathic pain.

If the patient is suffering from neuropathy after the local anesthesia has worn off, and the postoperative radiographs (not CBCT) confirm that there is no radiopaque material in the canal, chemical nerve injury may be presumed. This may be an irreversible injury to the nerve, and subsequent “swift” removal of the root canal treatment or tooth extraction is unlikely to result in resolution of the nerve injury (Pogrel, 2007).

### Management and timing

**Acute management (greater than 30 hours)**

Confirm overfill/neuropathy. In some reports, 20% of the nerve injuries are delayed in presentation, and the endodontist may need to warn the patient that onset of altered sensation, pain, and/or numbness up to 3 to 4 days post-endodontic treatment must immediately be reported.

Treatment should be considered within 30 hours of neuropathy presentation to minimize permanency of nerve injury while maximizing resolution.

- Consider endodontic retreatment (Yatsuhashi, et al., 2003)
- If there is extensive overfill in IDC, refer urgently for extraction, apicoectomy or IAN decompression.

### Later management

If minimal or no symptoms are present, reassure and review (duty of candor).

For mild symptoms, such as small neuropathic area, low discomfort:

- Reassurance/topical Versatis patches (5% lidocaine patches).
- Some authors recommend steroid therapy for early postoperative neuritis (Gatot, Tovi, 1986).

For moderate symptoms, such as a larger neuropathic area, functional and
psychological implications, discomfort/pain:
- Systemic medical management (nortriptyline, pregabalin)
- Referral for psychological support
- Review

For severe symptoms:
- Systemic medical management (nortriptyline, pregabalin)
- Referral for psychological support
- Review
- Pain management referral (possible interventional procedures) (Kim, et al., 2013); and Botox (Ngeow, 2010)

**Recommendations**

Based on current evidence, dental practitioners undertaking endodontic treatment should:
- **Not** attempt root canal treatment (RCT) in teeth close to the IDC; instead, they should refer for specialist care.
- **Screen** out neuropathic pain pre-RCT.
- **Risk-assess**, including identifying dental risk factors (+/- CBCT case dependent), such as teeth in close proximity to the inferior alveolar nerve, and take special care to prevent over-instrumentation and the extrusion of irrigants and materials into the periapical tissues; root fractures; resorption; apical pathology.
- To **prevent** offultr or extrusion, consider: creating an apical stop or dentin apical plug; make sure the preparation has taper and hence resistance form; obturating shorter; using cold lateral condensation to gain apical control; do not use resin-based sealers such as AH Plus® sealer.
- Avoid over-instrumentation; care with instrumentation and patency filing may have to work shorter; care using intracanal medication (for example, calcium hydroxide) — do not synge down to full working length; deliver more coronally; use a file to deliver the calcium hydroxide toward the apical part of the canal.
- Record any events that may indicate operative nerve injury, including severe pain during LA IDB, canal instrumentation, irrigation, medication, or filling; and sudden and profound hemorrage arising from the apex of the tooth.
- Take appropriate postoperative periapical radiographs to check for any extrusion of dressing or filling materials into the inferior dental canal or around the mental foramen.
- **Home check**, and if signs of persistent or new neuropathy; remove overfill urgently (30 hours); no antibiotics; recommend vitamin B, NSAIDs, steroids, predisnolone (step down 15 mg for 5 days, 10 mg for 5 days, and 5 mg 5 days), and high dose NSAIDs, 600 mg ibuprofen and make a timely referral to an appropriately trained neurosurgeon, if necessary; long-term therapeutic management.

**Conclusion**

In this article, the author aims to have highlighted many areas of poor evidence base for prevention, assessment, and management of IanRs related to endodontic treatment; but in addition, focus attention on some areas where improved risk assessment and avoidance of these nerve injuries is possible.

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**REFERENCES**

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