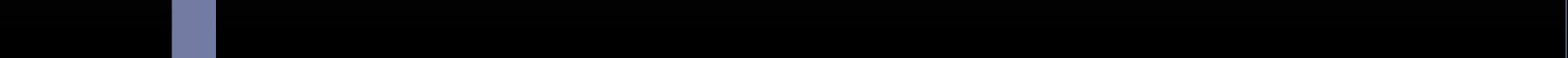


A collage of 12 images showcasing various attractions in Colorado. The images include: a 'Welcome to Colorful Colorado' sign; a roller coaster; a large white sculpture; a person on a bull; a large blue bear statue; a person on a horse; a large red bull statue; a person on a horse; a large red bull statue; a person on a horse; a large red bull statue; and a person on a horse.



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BA British Association of Oral Surgeons
OS

Declaration COI

- ▶ Conflict of interest include;
 - ▶ Consultant for M3M in tuition relating to Dental Local Anaesthesia

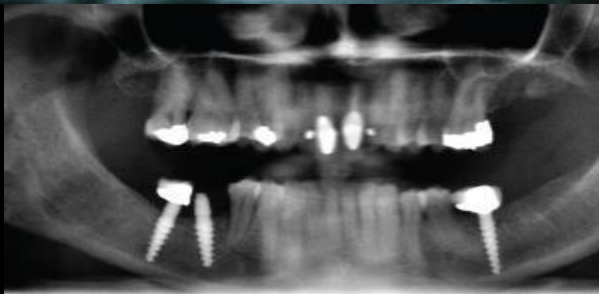
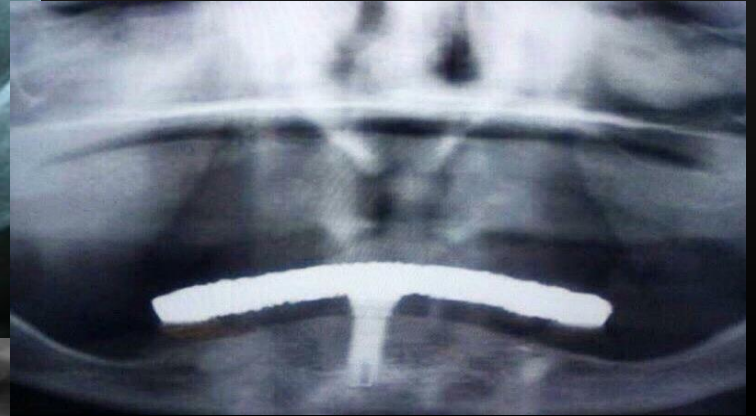
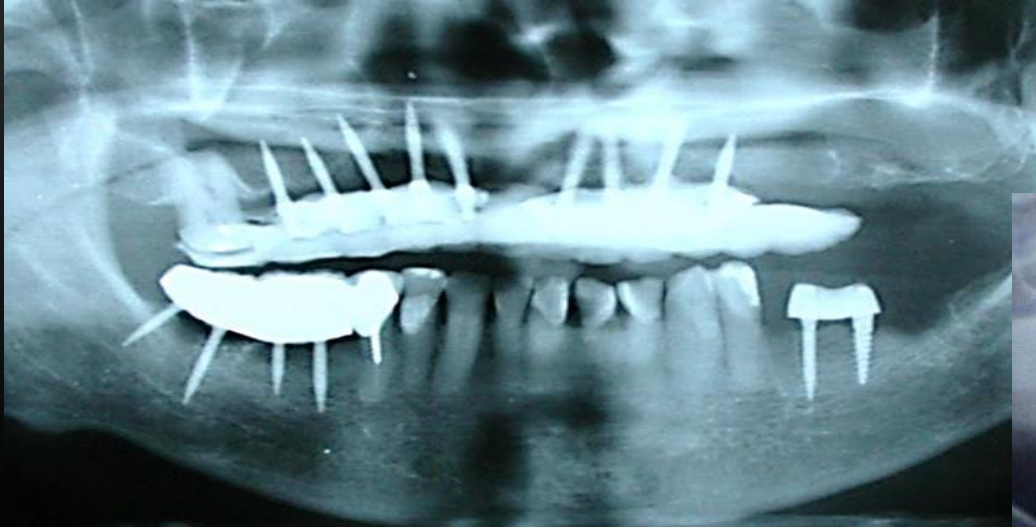
Learning objectives

- ▶ Describe risk assessment, prevention and management of nerve injuries related to local anesthesia and endodontics.
- ▶ Apply simple strategies to identify patients at higher risk of potential nerve injury and to mitigate those risks.
- ▶ Recognize how to prevent, identify and manage trigeminal nerve injuries in relation to local anesthesia or endodontics.

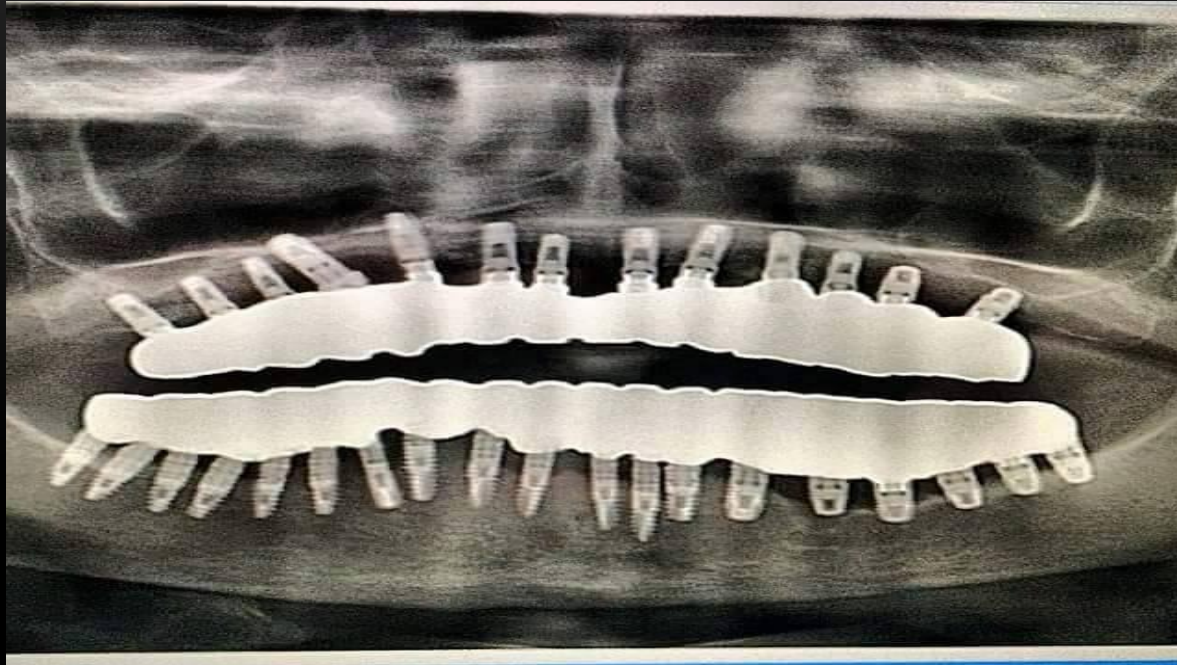
► There are three kinds of dental surgeons.....



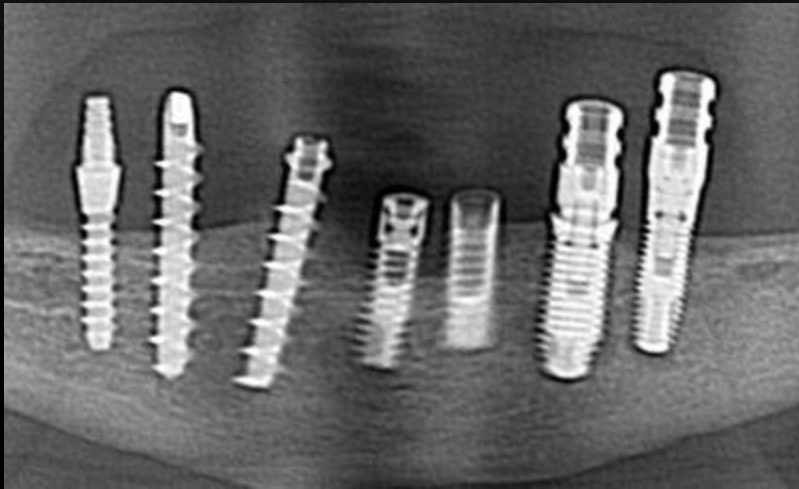
The Optimists



The Pessimists



And the undecided.....

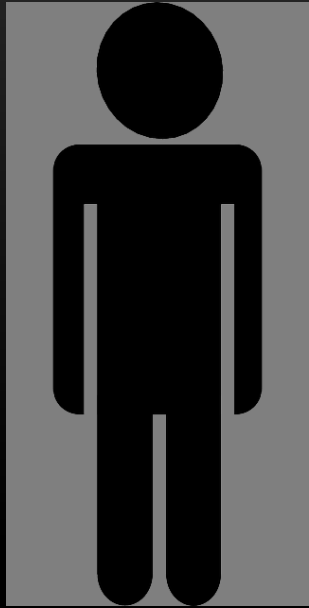


However.....

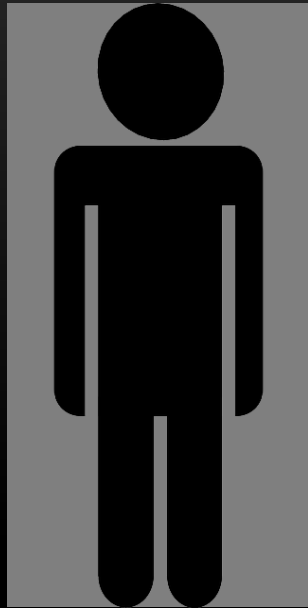
- ▶ All dentists are optimists when considering the outcome of nerve injuries in their own patients!



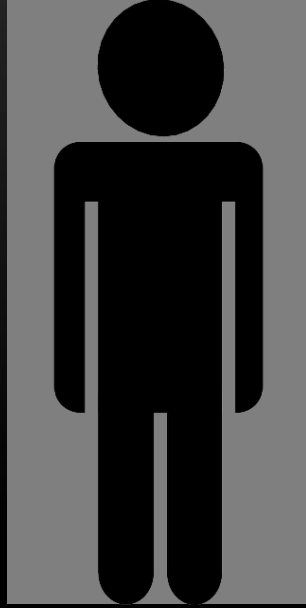
Overview



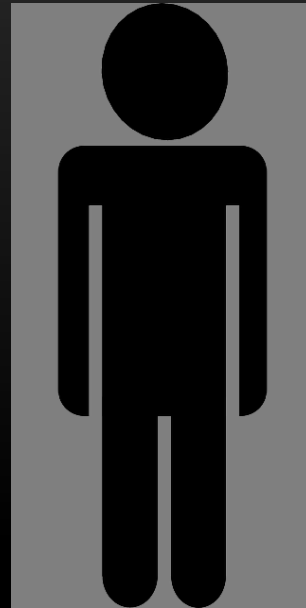
Why prevent these
nerve injuries?



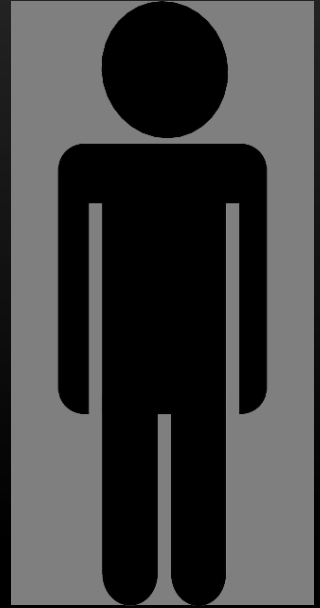
How to prevent
LA nerve injuries?



How to prevent
Endo nerve injuries?



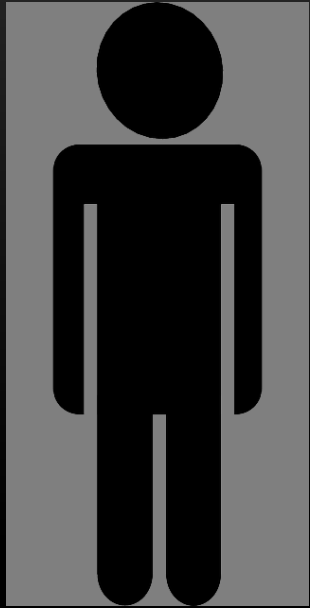
How to manage
nerve injuries?



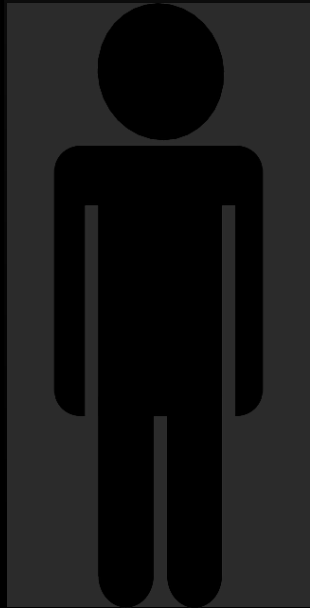
Summary and
work to do



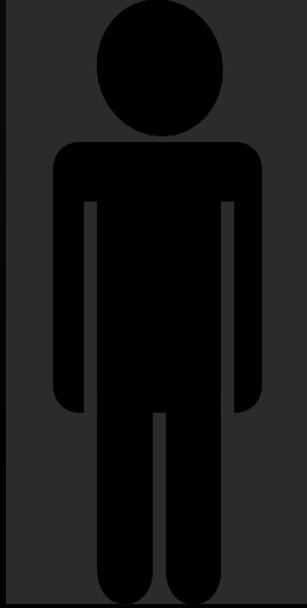
Overview



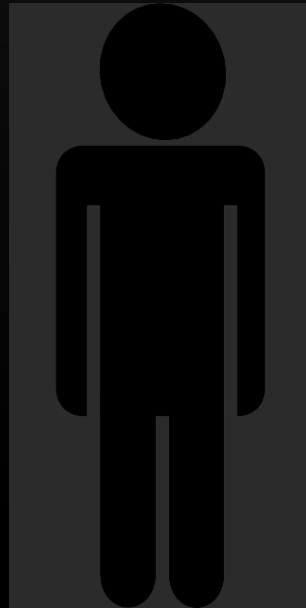
Why prevent these
nerve injuries?



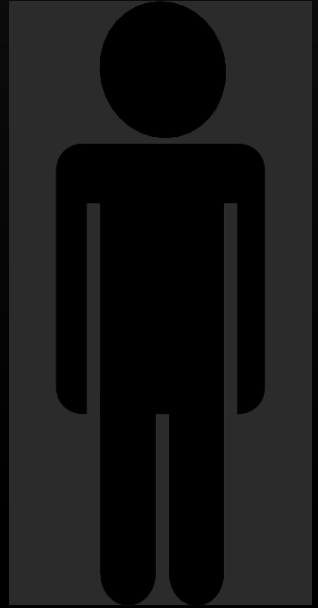
How to prevent
LA nerve injuries?



How to prevent
Endo nerve injuries?



How to manage
nerve injuries?



Summary and
work to do



Why are nerve injuries such a big deal ?



They are rare but very impactful on the patient and clinician

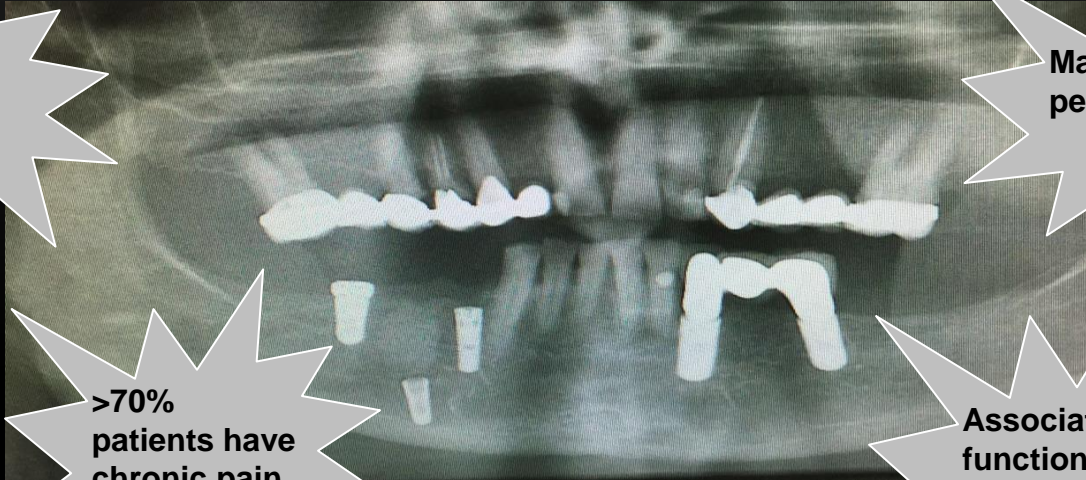
Why are nerve injuries such a big deal ?

**Avoidable /
negligent**

**>70%
patients have
chronic pain**

**Mainly
permanent**

**Associated
functional and
psychological
impact**



And.....

When pain is poorly managed, diagnosed, or persistent, it is the most common cause for complaints and litigation

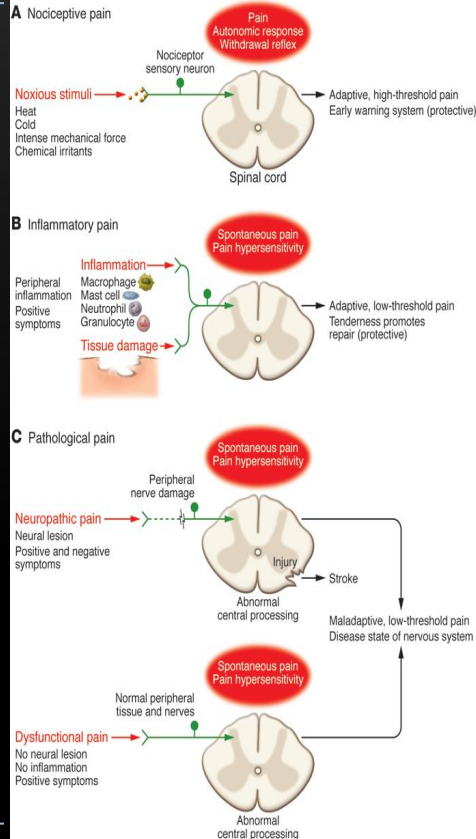


The consequences of trigeminal nerve injury include;

- ▶ Constant pain, numbness and altered sensation
 - ▶ (>70% of patients, 95% implant /endo related nerve injuries)
- ▶ Permanent nerve injury after endo and implants
 - ▶ (Implant 92%, 95% endo , LA 25% and M3M 0.2-2%)
- ▶ Functional problems with speech, socialising and coping with pain (all patients)
- ▶ Psychological impact
 - ▶ (68% of patients have Post traumatic stress disorder)
- ▶ Medicolegal issues
- ▶ **Nerve trauma caused by dental procedures is associated with altered sensation and chronic pain.** Complete or partial loss of sensation is often reported by patients who have experienced nerve trauma during implant surgery. Some patients report persistent pain and neurosurgery disturbance long after the normal healing time has passed. In addition, neuropathic pain is reported after implant surgery.
- ▶ **Practitioners who undertake high risk dental procedures must be familiar with the differential diagnosis, prevention, and management of neuropathic pain.**

Al-Sabbagh M^{et} al Persistent pain and neurosensory disturbance after dental implant surgery: prevention and treatment. Dent Clin North Am. 2015 Jan;59(1):143-56

What type of pain?



Healthy acute pain

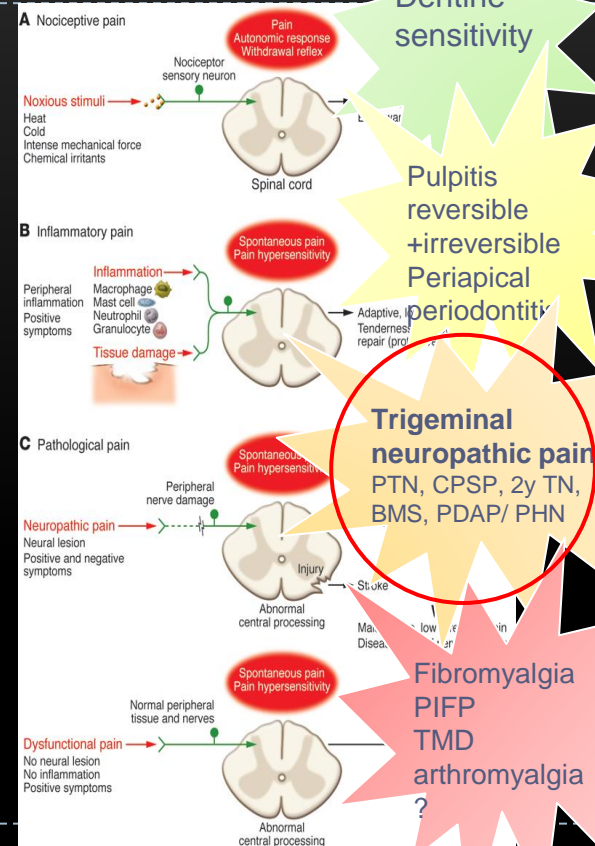
Nociceptive
healthy feeling pain 'pain'

Inflammatory pain
healthy short lived after insult

Chronic pain =
disease of neuromatrix

Neuropathic pain
Associated with nerve lesion

Dysfunctional or centralised pain
Unknown cause



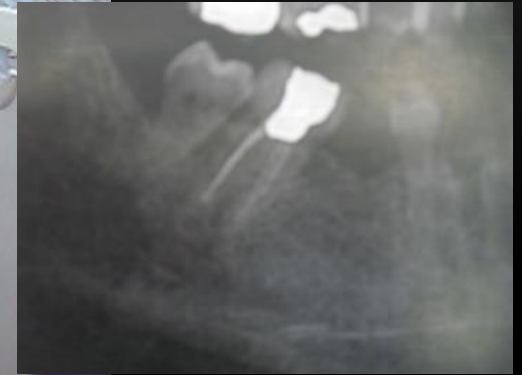
Dentine sensitivity

Pulpitis reversible
+irreversible
Periapical periodontitis

Trigeminal neuropathic pain
PTN, CPSP, 2y TN, BMS, PDAP/ PHN

Fibromyalgia
PIFP
TMD
arthromyalgia
?

Painful sensory neuropathy (PPTTN)



Chronic post surgical neuropathic pain

	Estimated incidence of chronic pain	Estimated chronic severe (disabling) pain (>5 out of score of 10)	US surgical volumes (1000s)†
Amputation ²	30–50%	5–10%	159 (lower limb only)
Breast surgery (lumpectomy and mastectomy) ³	20–30%	5–10%	479
Thoracotomy ⁴⁻⁷	30–40%	10%	Unknown
Inguinal hernia repair ⁸⁻¹⁰	10%	2–4%	609
Coronary artery bypass surgery ¹¹⁻¹³	30–50%	5–10%	598
Caesarean section ¹⁴	10%	4%	220

Kehlet H *et al*, 2006 Lancet

*Gall bladder surgery not included, since preoperative diagnosis of pain specifically from gall bladder is difficult and persistent postoperative pain could therefore be related to other intra-abdominal disorders. †National Center For Health Statistics, Ambulatory and Inpatients Procedures, USA, 1996.

Table 1: Estimated incidence of chronic postoperative pain and disability after selected surgical procedures*

General surgery 30% get persistent pain 10% are severely affected
 Very few related to dentistry (< 1-0.2%) However **1-7 % Endo cases**

Patient risk factors for chronic post surgical (Ne) pain

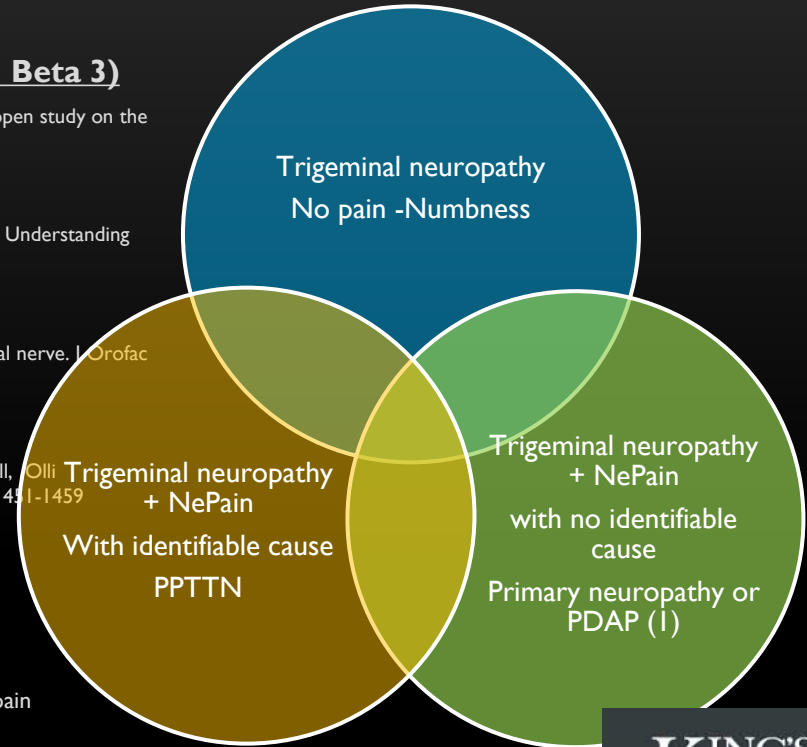
- ▶ Age -Higher risk of persistent neuropathy over 50 years
- ▶ Pre-existing NePain conditions Migraine, Fibro Myalgia
- ▶ Pre-existing nerve pathology
- ▶ Psychological diagnoses (cognitive fear pain and or surgery, personality disorder poor coping, hypervigilance, catastrophising, introversion)
- ▶ Prior abuse and neglect or institutionalisation or significant life event
- ▶ Minimising CPSP
 - ▶ Minimal access surgery
 - ▶ Local anaesthesia
 - ▶ Good perioperative pain management
 - ▶ Preoperative identification of neuropathic pain



Nomenclature for V neuropathic pain

Its confusing!

- ▶ **Painful post traumatic trigeminal neuropathy PPTTN (ICHD Beta 3)**
 - ▶ J Oral Facial Pain Headache. 2014 Winter; 28(1):52-60. Painful traumatic trigeminal neuropathy: an open study on the pharmacotherapeutic response to stepped treatment. Haviv Y, Zadik Y, Sharav Y Benoliel R
- ▶ **Persistent dento alveolar pain PDAP**
 - ▶ Rev Pain. 2011 Dec; 5(4): 18–27. Dento-Alveolar Pain Disorder (PDAP): Working towards a Better Understanding Donald Nixdorf and Estephan Moana-Filho,
- ▶ **Trigeminal neuropathy post intervention PTN**
 - ▶ Renton T, Yilmaz Z. Profiling of patients presenting with posttraumatic neuropathy of the trigeminal nerve. J Orofac Pain. 2011 Fall; 25(4):333-44.
- ▶ **Trigeminal Neuropathic pain TNP**
 - ▶ Differences and similarities between atypical facial pain and trigeminal neuropathic pain Heli Forssell, Olli Tenovuuo, Pekka Silvoniemi, and Satu K. Jääskeläinen Neurology October 2, 2007 vol. 69 no. 14 1451-1459
- ▶ **Chronic post surgical pain**
- ▶ **Trigeminal neuralgia TN**
- ▶ **Other redundant terms**
 - ▶ Non-odontogenic tooth pain, Chronic tooth pain, Atypical odontalgia Phantom tooth pain
- ▶ **What about neuropathic dental pain preceding surgery?**



Post Endo pain

► Prevalence

- Nixdorf et al. 10.0% 651 patients meeting criteria for pain 6 months following RCT. On average, these patients reported their pain as mild to moderate in intensity, present for about 10 days in the preceding month
- Vena et al. 3.5% persistent odontogenic pain @ 3-5 years

► Impact

- Post Endo pain minimally interfered with daily activities.
- RCT significantly increased the risk of developing persistent pain (odds ratio [OR]=1.19 per 1 day increase in pain duration, 95% confidence interval [CI]: 1.07–1.33), whereas optimism about the procedure reduced the risk (OR=0.39, 95% CI: 0.22–0.67).



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Author manuscript

Pain. Author manuscript; available in PMC 2017 January 01.

Published in final edited form as:

Pain. 2016 January ; 157(1): 159–165. doi:10.1097/j.pain.0000000000000343.

Frequency, Impact, and Predictors of Persistent Pain Following Root Canal Treatment: A National Dental PBRN Study

Donald R. Nixdorf^{1,2,3,*}, Alan S. Law^{4,5}, Kimberly Lindquist⁶, Gregory J. Reams⁷, Emery Cole⁸, Keith Kanter⁹, Ruby H.N. Nguyen¹⁰, D. Robert Harris¹¹, and National Dental PBRN Collaborative Group¹²

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³HealthPartners Institute for Education and Research, Bloomington, MN

⁴Private Practice, The Dental Specialists, Lake Elmo, MN

J Endod. 2014 Dec;40(12):1917-21. doi: 10.1016/j.joen.2014.07.026. Epub 2014 Sep 12.

Prevalence of persistent pain 3 to 5 years post primary root canal therapy and its impact on oral health-related quality of life: PEARL Network findings.

Vena DA¹, Collie D², Wu H², Gibbs JL³, Broder HL⁴, Curro FA⁵, Thompson VP⁶, Craig RG⁷; PEARL Network Group.

Author information

Abstract

INTRODUCTION: The frequency of persistent pain 3-5 years after primary root canal therapy and its impact on the patient's perceived oral health-related quality of life was determined in a practice-based research network.

METHODS: All patients presenting to participating network practices who received primary root canal therapy and restoration for a permanent tooth 3-5 years previously were invited to enroll. Persistent pain was defined as pain occurring spontaneously or elicited by percussion, palpation, or biting. The patient also completed an oral health-related quality of life questionnaire (Oral Health Impact Profile-14).

RESULTS: Sixty-four network practices enrolled 1323 patients; 13 were ineligible, 12 did not receive a final restoration, and 41 were extracted, leaving 1257 for analysis. The average time to follow-up was 3.9 ± 0.6 years. Five percent (63/1257) of the patients reported persistent pain, whereas 24 of 63 (38%) exhibited periapical pathosis and/or root fracture (odontogenic pain). No obvious odontogenic cause for persistent pain was found for 39 of 63 (62%). Teeth treated by specialists had a greater frequency of persistent pain than teeth treated by generalists (9.3% vs 3.0%, respectively; $P < .0001$). Sex, age, tooth type, type of dentist, and arch were not found to be associated with nonodontogenic persistent pain; however, ethnicity and a preoperative diagnosis of pulpitis without periapical pathosis were. Patients reporting pain with percussion tended to experience pain with other stimuli that negatively impacted quality of life including oral function and psychological discomfort and disability.

CONCLUSIONS: These results suggest that a small percentage (3.1%) of patients experience persistent pain not attributable to odontogenic causes 3-5 years after primary root canal therapy that may adversely impact their quality of life.

Post Endo

Persistent pain

- ▶ 19 patients with persistent pain
- ▶ 7 patients (37%) were given odontogenic diagnoses (4 involving the RCT tooth, 3 involving an adjacent tooth).
- ▶ 8 patients (42%) were given non-odontogenic pain diagnoses
 - ▶ 7 from referred temporomandibular disorder [TMD] pain
 - ▶ 1 from persistent dentoalveolar pain disorder [PDAP]).= neuropathic pain ? Nerve injury
- ▶ 2 patients (11%) had both odontogenic and non-odontogenic diagnoses



HHS Public Access

Author manuscript

J Endod. Author manuscript; available in PMC 2016 April 01.

Published in final edited form as:

J Endod. 2015 April ; 41(4): 457–463. doi:10.1016/j.joen.2014.12.012.

Differential Diagnoses for Persistent Pain Following Root Canal Treatment: A Study in the National Dental PBRN

Donald R. Nixdorf^{1,2,3,*}, Alan S. Law^{4,5}, Mike T. John^{1,6}, Radwa M. Sobieh⁷, Richie Kohli⁸, Ruby H.N. Nguyen⁶, and National Dental PBRN Collaborative Group⁹

¹Division of TMD and Orofacial Pain, School of Dentistry, University of Minnesota, Minneapolis, MN

²Department of Neurology, Medical School, University of Minnesota, Minneapolis, MN

³HealthPartners Institute for Education and Research, Bloomington, MN

⁴Private Practice, The Dental Specialists, Lake Elmo, MN

⁵Division of Endodontics, School of Dentistry, University of Minnesota, Minneapolis, MN

⁶Division of Epidemiology & Community Health, School of Public Health, University of Minnesota, Minneapolis, MN

⁷Private Practice, Norfolk, VA

⁸Dental Public Health, Portland, OR

Abstract

Introduction—Pain present 6 months following root canal treatment (RCT) may be either of odontogenic or nonodontogenic origin. This is important because treatments and prognoses are different; therefore the aim of this study was to provide specific diagnoses of patients reporting pain 6 months after receiving initial orthograde RCT.

Methods—We enrolled patients from the Midwest region of an existing prospective observational study of pain after RCT. Pain at 6 months was defined as ≥ 1 day of pain and average pain intensity of at least 1/10 over the preceding month. An Endodontist and an Orofacial Pain practitioner independently performed clinical evaluations, which included periapical and cone-beam CT radiographs, to determine diagnoses.

Results—Thirty-eight out of the 354 eligible patients in the geographic area (11%) met the pain criteria, with 19 (50%) consenting to be clinically evaluated. As the sole reason for pain, 7 patients

Differential diagnosis of persistent post endo pain

- ▶ Odontogenic pain
 - ▶ Dentine sensitivity
 - ▶ Inflammatory
 - ▶ Periapical periodontitis
 - ▶ Pulpitis
- ▶ TMD
- ▶ PPTTN Painful Post Traumatic Trigeminal Neuropathy
 - ▶ Unilateral facial or oral pain following trauma to the trigeminal nerve, with other symptoms and/or clinical signs of trigeminal nerve dysfunction. ICHD-3 Beta-2016 Part 3 (13.1.2.3)
- ▶ PDAP Persistent dentoalveolar pain
 - ▶ Dysesthesia episodes, otherwise referred to as 'pain' which: Located in the dento-alveolar region (anatomically innervated by the trigeminal nerve. Demonstrating continuous or near continuous temporal course and present more often. Cannot be explained by another disease or disorder presence (AAOP classification)

[Oral Surg Oral Med Oral Pathol Oral Radiol](#), 2018 Jan 5. pii: S2212-4403(18)30004-X. doi: 10.1016/j.oooo.2017.12.020. [Epub ahead of print]

Identifying criteria for diagnosis of post-traumatic pain and altered sensation of the maxillary and mandibular branches of the trigeminal nerve: a systematic review.

Devine M¹, Hirani M², Durham J³, Nixdorf DR⁴, Renton T².

[Author information](#)

[Abstract](#)

OBJECTIVE:

The aim of the study was to system trigeminal nerve injury.

STUDY DESIGN:

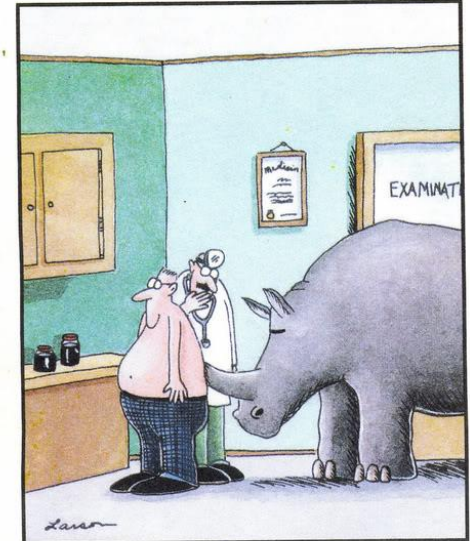
A systematic review of the literature were patients diagnosed with nerve branches of the trigeminal nerve, w persistent pain or unpleasant sens:

RESULTS:

In total, 28 articles were included. I thermal quantitative sensory testing (14%). Neuropathic pain was asses neuropathic medication (7%); ques Functional impact was assessed in in performing clinical neurosensory of nerve injury was found to be incc comparison of results difficult.

CONCLUSIONS:

Recommendations for assessment based on the best available eviden consensus in diagnostic criteria, cri stakeholder organizations to impro



"Wait a minute here, Mr. ADAMS ... Maybe it isn't kidney stones after all."

Post endo persistent pain

- ▶ Non predictors
 - ▶ Specialty training
 - ▶ Patient demographics

- ▶ Predictors

- ▶ Patient >57 years (Klasser et al)
 - ▶ Severe pre operative pain-symptomatic periapical periodontitis

(Seltzer et al. 1961; Genet et al. 1987; Walton and Fouad 1992; Torabinejad et al. 1994; Imura and Zuolo 1995; Glennon et al. 2004).

- ▶ High level pain post surgery
 - ▶ Pain worsened with stress (is this neuropathic pain)

No Axis 2 assessed

CLINICAL INVESTIGATIONS

Predicting Severe Pain after Root Canal Therapy in the National Dental PBRN

A.S. Law^{1,2}, D.R. Nixdorf^{1,4,5*}, A.M. Aguirre⁶, G.J. Reamer⁷, A.J. Tortomas⁸, B.D. Manne⁹, D.R. Harris¹⁰, and National Dental PBRN Collaborative Group¹¹

Abstract: Some patients experience severe pain following root canal therapy (RCT) despite advancements in care. We sought to identify factors, which can be measured preoperatively, that predict this negative outcome so that future research may focus on preemptive steps to reduce postoperative pain intensity. Sixty-two practitioners (46 general dentists and 16 endodontists) who are members of the National Dental Practice-Based Research Network enrolled patients receiving RCT for this prospective observational study. Baseline data collected from patients and dentists were obtained before treatment. Severe postoperative pain was defined based on a rating of ≥ 7 on a scale from 0 (no pain) to 10 (pain as bad as can be) for the worst pain intensity experienced during the preceding week, and this was collected 1 wk after treatment. Multiple logistic regression analyses were used to develop and validate the model. A total of 708 patients were enrolled during a 6-m period. Pain intensity data were collected 1 wk postoperatively from 652 patients (92.1%), with 19.5% ($n = 127$) reporting severe pain. In multivariable modeling, baseline

factors predicting severe postoperative pain included current pain intensity (odds ratio [OR], 1.15; 95% confidence interval [CI], 1.07 to 1.25; $P = 0.0003$), number of days in the past week that the subject was kept from their usual activities due to pain (OR, 1.32; 95% CI, 1.13 to 1.55; $P = 0.0005$), pain made worse by stress (OR, 2.55; 95% CI, 1.22 to 5.35; $P = 0.0130$), and a diagnosis of symptomatic apical periodontitis (OR, 1.63; 95% CI, 1.01 to 2.64; $P = 0.0452$). Among the factors that did not contribute to predicting severe postoperative pain were the dentist's specialty training, the patient's age and sex, the type of tooth, the presence of swelling, or other pulpal and apical endodontic diagnoses. Factors measured preoperatively were found to predict severe postoperative pain following RCT. Practitioners could use this information to better inform patients about RCT outcomes and possibly use different treatment strategies to manage their patients (Clin Oral Implants Res 2016;17:1681).

Key Words: predictors, endodontics, evidence-based dentistry/health care, clinical outcomes, clinical studies/trials, patient outcomes.

Introduction

Initial orthograde root canal therapy (RCT) is a common treatment in the United States (American Dental Association Survey Center 2007). Severe postoperative pain following RCT, a negative outcome of treatment (Pak and White 2011; Law et al. 2014), continues to occur despite improvements in care. If risk factors for severe postoperative pain could be identified that are measurable before initiation of treatment, dentists could use this information to prospectively identify patients at increased risk and implement preemptive steps to minimize the pain and reduce patient suffering.

Predictors of severe pain following RCT have been explored in several studies that were succinctly reviewed in Hargreaves and Cohen's *Pathways of the Pulp* (2011; see Keiser and Byrne 2011). They listed 12 predictors from 38 studies, including presenting factors (i.e., patient specific, tooth specific, and diagnosis) and procedural factors (i.e., retreatment, intracanal medicament, apical patency, and 1-step procedures versus multiple appointments). This body of literature, however, is subject to the following major limitations: 1) retrospective

DOI: 10.1177/0022034516655144. *Private Practice, The Dental Specialists, Lake Elmo, MN; ²Division of Endodontics, School of Dentistry, University of Minnesota, Minneapolis, MN; ³Division of Endodontics, School of Dentistry, University of Minnesota, Minneapolis, MN; ⁴Department of Neurology, Medical School, University of Minnesota, Minneapolis, MN; ⁵HealthPartners Institute for Education and Research, Bloomington, MN; ⁶Private Practice, Endodontic Associates, Coon Rapids, MN; ⁷IDA Permanent Dental Associates, Tigard, OR; ⁸Private Practice, Sunbelt Dental, Sunbelt, AL; ⁹Private Practice, Ormond Beach, FL; ¹⁰Westat, Rockville, MD; and ¹¹The National Dental PBRN Collaborative Group includes practitioners, faculty, and staff investigators who contributed to this activity (a complete list is at <http://nationaldentalspbrn.org>).

*Corresponding author: nixdorf@umn.edu

A supplemental appendix to this article is published electronically only at <http://jib.sagepub.com/supplemental>.

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Endo related chronic neuropathic pain

- ▶ *1-7% of single endo treatment results in chronic neuropathic pain*
- ▶ *How many patients have Neuropathic pain before endo RX?*
- ▶ *Survey of 2338 patients undergoing non surgical endo using A modified version of the Self-Administered Leeds Assessment of Neuropathic*
- ▶ *The prevalence of persistent pain of neuropathic origin among respondents after receiving single-tooth nonsurgical root canal treatment was 7% with the average pain reported as 7.2 on a visual analogue scale (where 0 is no pain and 10 is pain as severe as it could be).*
- ▶ *Neuropathic pain was more common in middle-aged (mean 50.6 years of age) individuals with no sex predilection and occurred more frequently in the mandibular arch without any differences attributable to the number of canals treated.*
- ▶ *Also, the majority of subjects most frequently endorsed their pain experiences as abnormal sensitivity to touch and pain when the area is pressed or rubbed*

Consequences Endo related PPTN– NePain, numbness + altered sensation

- ▶ Whilst surgical endodontics resulted in chronic **neuropathic pain in 5% of patients**

Campbell RL, Parks KW, Dodds RN Chronic facial pain associated with endodontic therapy. Oral Surg Oral Med Oral Pathol. 1990 Mar;69(3):287-90

- ▶ In a previous study of 135 patients with inferior alveolar nerve injuries caused by dental treatment or malignancy, **22% presented with dysaesthesia which was significantly associated with the female gender and previous chronic pain**

Oshima K, Ishii T, Ogura Y, Aoyama Y, Katsuumi I. Clinical investigation of patients who develop neuropathic tooth pain after endodontics procedures. J of Endodontics 35;7:958-961

- ▶ Groltze et al reported on 11 patients with endodontic associated neuropathy and their management. They similarly reported that the neurological findings were dominated by hypaesthesia and dysaesthesia with **50% of patients reporting pain.**

11 of 61 patients with Endo NI presented with significant pain only 40% responded to surgery Pogrel 2007

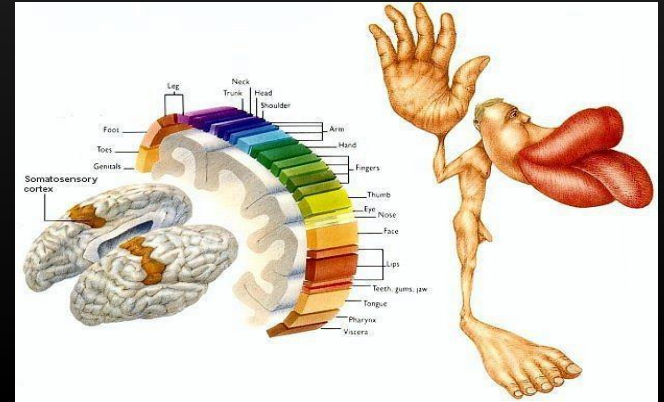
- ▶ In our cohort of 28 patients **80% had ongoing pain for more than 3 months** (definition of chronic pain) prior to the most recent endo treatment. Renton et al in press

Devine M, Modgill O, Renton T Mandibular division trigeminal nerve injuries following primary endodontic treatment. A case series. Aust Endod J. 2017 Aug;43(2):56-65. doi: 10.1111/aej.12209. Epub 2017 Jul 7.



Particular issues with Trigeminal pain?

- ▶ Big part of our lives
- ▶ Underpins the primordial survival instincts
- ▶ Constant unavoidable activity
- ▶ Underpins daily pleasure in health
 - ▶ Eating
 - ▶ Drinking
 - ▶ Speaking
 - ▶ Smiling
 - ▶ Sexual interaction
- ▶ **Underpins our identity!**



Most nerve injuries are permanent and cannot be fixed



Consequences of nerve injury

Pathophysiological

The IAN is contained within a bony canal which predisposes it to compression and possible ischaemic type injury.

- ▶ **Compression of peripheral sensory nerves over 6 hours can evoke nerve fibre atrophy** Shimpo T, Gilliatt RW, Kennett RP, Allen PJ. Susceptibility to pressure neuropathy distal to a constricting ligature in the guinea-pig. J Neurol Neurosurg Psychiatry. 1987 Dec;50(12):1625-32
- ▶ **Ischaemia alone without direct nerve damage will cause sufficient neural inflammation and damage to cause permanent nerve injury.** Park YT, Kim SG, Moon SY. Indirect compressive injury to the inferior alveolar nerve caused by dental implant placement. J Oral Maxillofac Surg. 2012 Apr;70(4):e258-9.
- ▶ **Three months after the IAN injury, permanent central and peripheral changes** occur within the nervous system subsequent to injury, that are unlikely to respond to surgical treatment intervention Yekta SS, Smeets R, Stein JM, Ellrich J. Assessment of trigeminal nerve functions by quantitative sensory testing in patients and healthy volunteers. J Oral Maxillofac Surg. 2010 Oct;68(10):2437-51.

Consequences

Presentation Features of neuropathic pain

Pain

Allodynia pain with non noxious stimulus

pain on touch/cold/hot

- 70% mechanical allodynia
- Cold allodynia a particular feature of extra oral dermatome in patients with IANIs
- Some LNI patients report tastent and warm allodynia

Hyperpathia

pain continues when stimulus removed 54% patients

Hyperalgesia

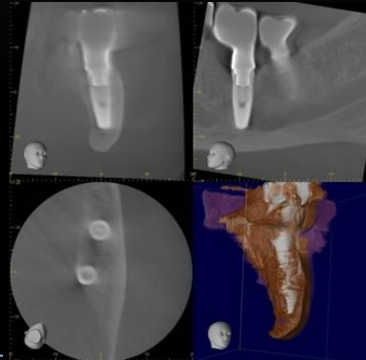
increased pain to painful stimulus 48% of patients

Altered sensation -Hyperaesthesia

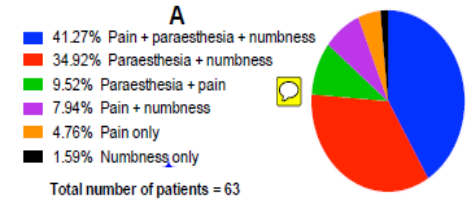
- Paraesthesia –pins and needles, formication, many descriptions
- Dysaesthesia – uncomfortable sensations often burning

Anaesthesia -Numbness- hypo aesthesia

Wheal and flare



Neuropathic pain in 60 patients post implant nerve injury



Neuropathic pain in;
95% of implant patients
92% of endodontic nerve injuries
57% of wisdom tooth surgery
IANI> LNI

Clinical presentation

Trigeminal Post Traumatic Neuropathy (n=525)

- ▶ **Onset of neuropathy +/- pain correlates with intervention surgery or local anaesthetic**
 - ▶ LNI patients (mean age 38.4 years [range 20-64]
Male:Female ratio 37:63%
 - ▶ IANI patients (mean age 43.2 years [range 22-85];
Male:Female ratio 27:70%
- Referral from:
 - ▶ General dental practitioner LNI = 40%/IANI = 51%
 - ▶ Specialist LNI = 50% IANI = 32%
- ▶ **Reported extreme pain during surgery 48%**
- ▶ **Reported high level pain post surgically 56%**
- ▶ IANI related to;

▶ Third molar surgery	60%
▶ Implant	14%
▶ LA	16%
▶ Endo	8%
- ▶ Periapical infections 1%
- ▶ Facial electrolysis 1%



Pain descriptors

Presenting with neuropathic pain 70%

Functionality

Significantly daily functional impact 65%

Increased with associated pain

Psychologically (PTSD in 68% of patients)

Significant impact especially with pain 62%

Neuropathy 100%

Dermatome: The neuropathic area varied between 5-100% of the affected dermatome (intra- and/or extra-orally).

Hypoeasthetic or Hyperaesthetic?

Mechanical allodynia 70%

Mechanical Hyperalgesia 48%

CBT			
		Subjective Function	
	Neuropathic Area (%)	Min	Max
Extraorally	70 (2-100)	3.1 (0-10)	8.8 (1-30)
Intraorally	66 (0-100)	2.3 (0-5)	10.5 (6-12)
Versatis			
		Subjective Function	
	Neuropathic Area (%)	Min	Max
Extraorally	68 (8-100)	1.75 (1-2)	9.6 (4-12)
Intraorally	69 (0-100)	4.0 (4)	10.0 (6-12)

Consequences Permanency of nerve injuries

Nerve damage related to dental procedures are mainly permanent
(except LNIs related to LA or lingual access M3M surgery)

Permanency of NIs

- ▶ TMS IANI 0.01-2%
- ▶ TMS lingual access LNI 10-12%
- ▶ LA IDB 25%
- ▶ Implant 60-87%
- ▶ Endo 86-87%



chronic pain.....10 years on

PROCEDURE	RECOVERY RATE	REFERENCE
Third molar surgery	Buccal access TMS	(Cheung et al., 2010)
	Permanent and temporary IANI – 67%; LNI – 72%	
	Permanent IANI 98% Overall High risk 98% Low risk 99.8%	(Rud 1983, Renton et al 2005)
	LNI – lingual access TMS 90% & 88%	(Mason, 1988) (Blackburn, 1990)
Mandibular fractures	IANI 91%	(Bede, Ismael, Al-Assaf, & Omer, 2012)
Orthognathic surgery	IANI 97% BSSO IANI (patients are quoted 8-20%)	(Iannetti, Fadda, Riccardi, Mitro, & Filiaci, 2013)
Local anaesthesia Inferior dental block (Lidocaine)	75%	(T. Renton & Devine, 2013)
Implant-related IANI	Complete recovery 50% Partial recovery 44% No change 6%	(Juodzbaly, et al Galindo-Moreno, 2013)
	Complete 3% Partial lot 13% some 23% None 61%	(Renton et al 2016 in press)
Endodontics	Survey 2338 patients 7% sustained chronic NePain	(Klasser et al 2011)
	61 patients post endo overfill recovery 13% 8 asymptomatic, 42 only mild symptoms (<3 months injuries) 10 partial resolution 11 symptomatic + surgical exploration	(Pogrel et al 2007)
	14% (24/28 of patients experienced no)	(Renton et al 2016 in press)

Consequences of nerve injury

Lack of consent

Poor consent practice re nerve injury (N=585 patients)

- 90% of M3M patients
- Only 10% of M3M patients were advised of high risk
- < 24% of implant patients
- 0% LA or endo nerve injury patients

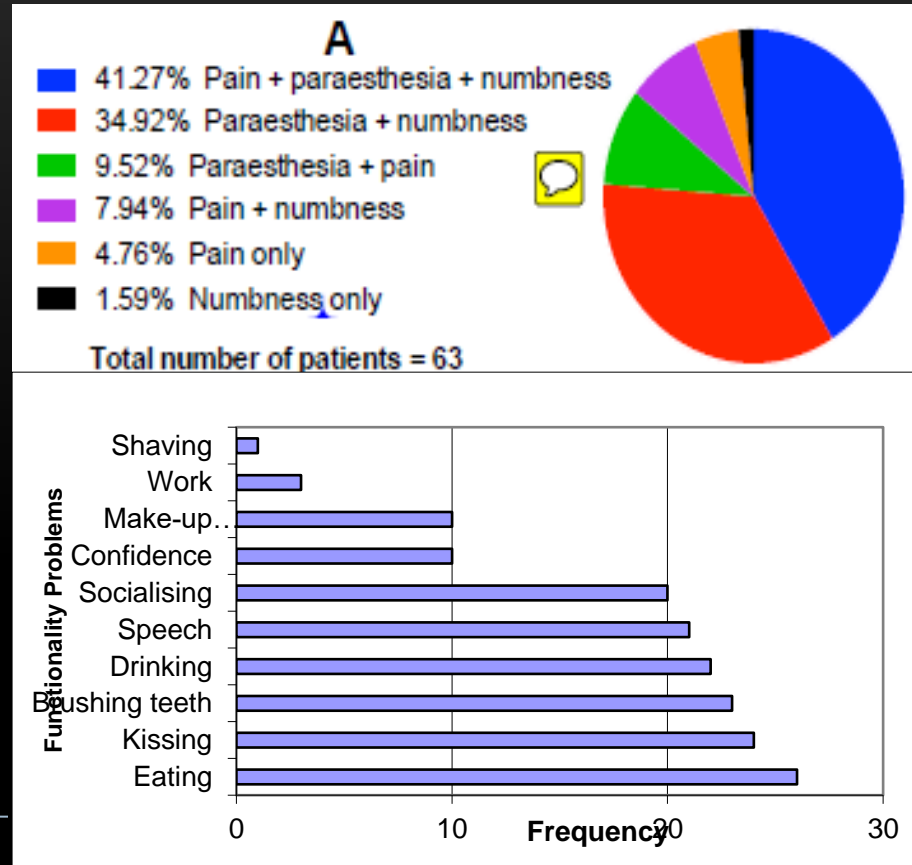
Renton T, Dawood A, Shah A, Searson L, Yilmaz Z. Post-implant neuropathy of the trigeminal nerve. A case series. Br Dent J. 2012 Jun 8;212(11):E17. doi: 10.1038/sj.bdj.2012.497, Ucer C, **Yilmaz Z**, Scher E, Suzuki J, **Renton T**. A Survey of the Opinion and Experience of UK Dentists Part 3: An Evidence-Based Protocol of Surgical Risk Management Strategies in the Mandible. Implant Dent. 2017 May 10. doi: 10.1097/ID.0000000000000602. [Epub ahead of print] **Yilmaz Z**, Ucer C, Scher E, Suzuki J, **Renton T**. A Survey of the Opinion and Experience of UK Dentists: Part 2: Risk Assessment Strategies and the Management of Iatrogenic Trigeminal Nerve Injuries Related to Dental Implant Surgery. Implant Dent. 2017 Apr;26(2):256-262. **Yilmaz Z**, Ucer C, Scher E, Suzuki J, **Renton T**. A Survey of the Opinion and Experience of UK Dentists: Part 2: Risk Assessment Strategies and the Management of Iatrogenic Trigeminal Nerve Injuries Related to Dental Implant Surgery. Implant Dent. 2016 Oct;25(5):638-45

Consequences

Neuropathy causing functional problems

Recent study @ KCL on 585 nerve injury patients
Usually related to ongoing persistent pain and or elicited pain
Reported functional impact on;

Eating
Kissing
Brushing teeth
Drinking
Speech
Socialising
Sleeping
Outdoor activities

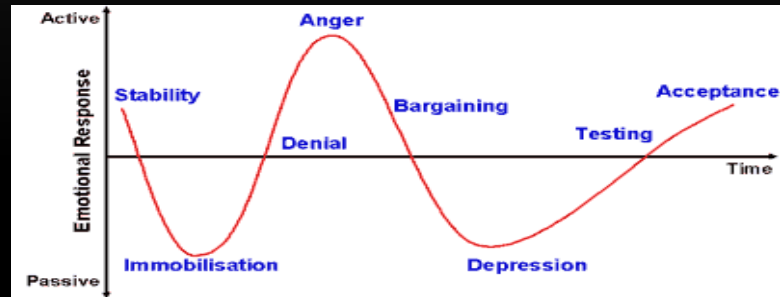


Psychological consequences

- ▶ Depression
- ▶ Anger
- ▶ Post traumatic stress disorder 68%
- ▶ Victim of abuse
- ▶ Loss of ability to trust



Kubler Ross



The psychosocial and affective burden of posttraumatic neuropathy following injuries to the trigeminal nerve. **Smith JG, Elias LA, Yilmaz Z, Barker S, Shah K, Shah S, Renton T.** J Orofac Pain. 2013 Fall;27(4):293-303. doi: 10.11607/jop.105 Sullivan MJ et al. Catastrophizing and perceived injustice: risk factors for the transition to chronicity after whiplash injury. Spine (Phila Pa 1976). 2011 Dec 1;36(25-Suppl):S244-9 Dec;92(12):2041-56. Review

Consequences Medicolegal.....

Vol. 112 No. 1 July 2011



Oral Surgery, Oral Medicine,
Oral Pathology, Oral Radiology, and
Endodontology

ENDODONTOLOGY

Editor: Larz S.W. Spångberg

Medico-legal aspects of altered sensation following endodontic treatment: a retrospective case series

Navot Givol, DMD,^a Eyal Rosen, DMD,^b Lars Bjørndal, DDS, PhD,^c
Silvio Taschieri, MD, DDS,^d Ronen Ofec, DMD,^e and Igor Tsesis, DMD,^f Tel Hashomer and
Tel Aviv, Israel, Copenhagen, Denmark, and Milan, Italy
THE CHAIM SEBA MEDICAL CENTER, TEL AVIV UNIVERSITY, UNIVERSITY OF COPENHAGEN, AND
UNIVERSITY OF MILAN

Objective. The objective of this study was to analyze cases of liability claims related to persistent altered sensation following endodontic treatments so as to characterize the medico-legal aspects of this complication.

Study design. A comprehensive search of an Israeli professional liability insurance database was conducted to retrospectively identify and analyze cases of persistent altered sensation following endodontic treatment.

Results. Sixteen claims of persistent altered sensation following endodontic treatments were identified and analyzed. The typical profile of a claim was a female patient who underwent an endodontic treatment at a second mandibular molar, which was associated with overfilling. A significant correlation between the tooth location and the suggested cause of nerve injury was found. None of the claims were reported by the practitioners, and all cases were identified as a result of the patient's demand for financial compensation, either directly or by legal actions.

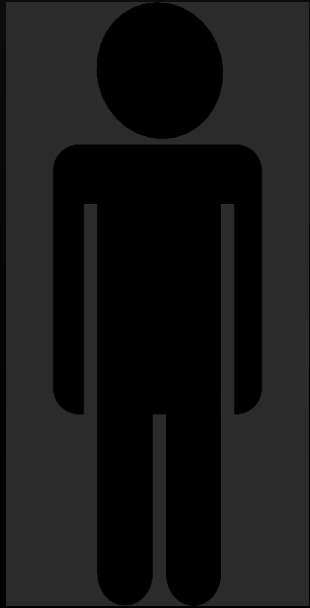
Patient's perspective

When the damage is done

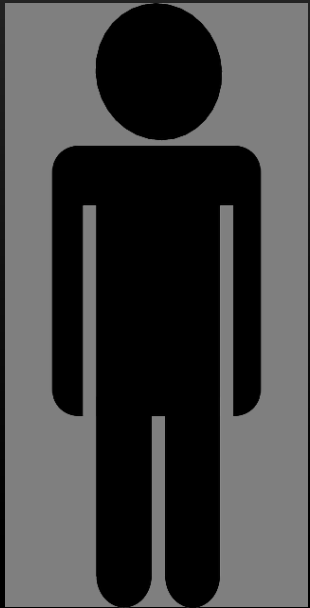


Its too late!

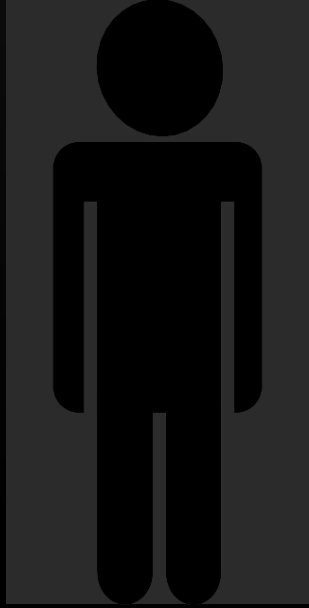
Overview



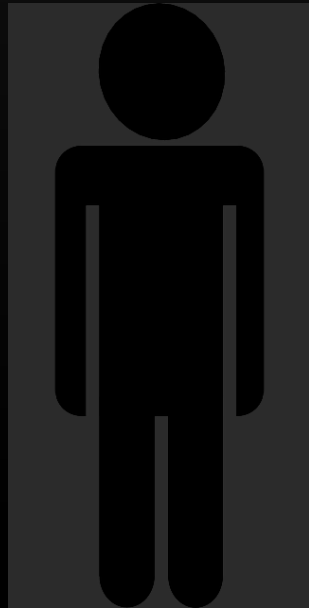
Why prevent these
nerve injuries?



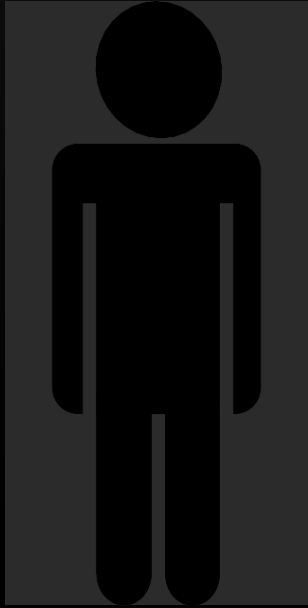
How to prevent
LA nerve injuries?



How to prevent
Endo nerve injuries?



How to manage
nerve injuries?



Summary and
work to do



Why prevent Local anaesthetic nerve injury? (LANI)

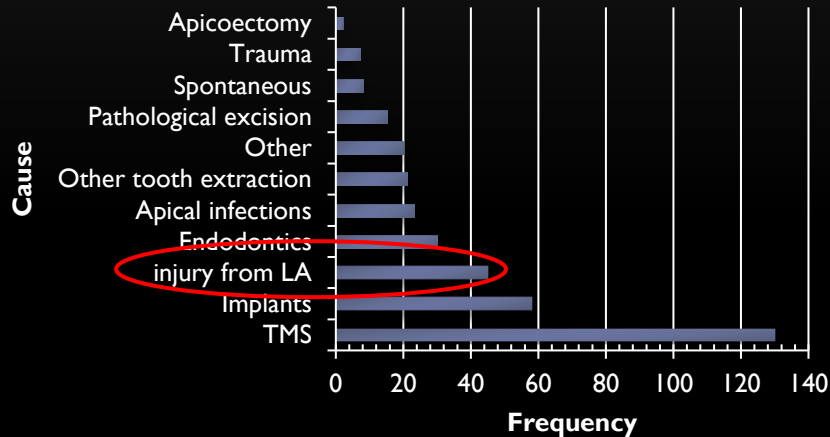
Most importantly prevention of nerve injuries is possible. The long term significant problems seen in patients with these nerve injuries is exemplified in that the;

- ▶ **nerve injuries cannot be 'fixed'.** We have to wait for resolution whilst managing the patient therapeutically using medical and psychological interventions. Thus there is no 'fix' for IA related nerve injuries only prevention.
- ▶ **25% of the LA nerve injuries are permanent**
- ▶ The injury is **related to high levels of dysaesthesia** and pain mainly affecting the tongue with attendant social and psychological impact
- ▶ **No warning** and patient has ever heard of them and the **resultant isolation for the patient is severe.** At least with consent patients are aware of these rare but possible injuries.
- ▶ **There is significant stress to both dentist and patient.**

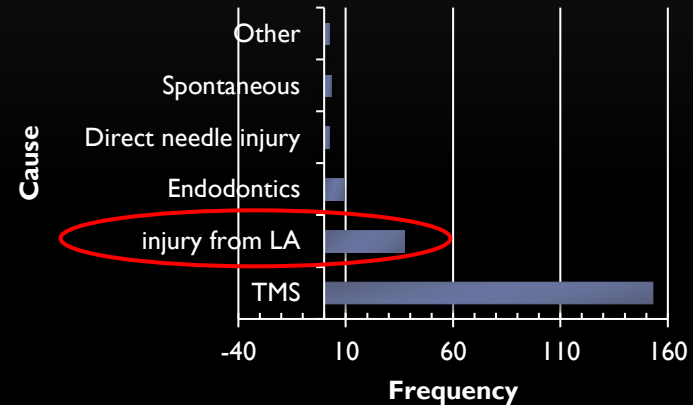
LA nerve injuries related to dentistry

- ▶ Summary of nerve injury patients March 2008 –2016
- ▶ 400 IANI patients (73% F: 26.8% M; mean age = 46.5 years [range 18 – 85])
- ▶ 214 LNI patients (64.5% F: 34.6% M; mean age = 38.6 years [range 20 -73])

Causes of IANI's



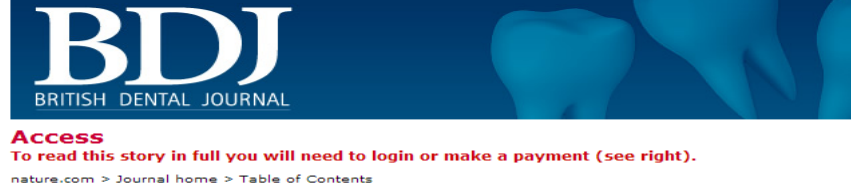
Causes of LNI



Operative risk

Preventing Local anaesthetic nerve injuries (LANIs)

Block
injections
cause nerve
injuries



Research

British Dental Journal **214**, 633 - 642 (2013)
Published online: 21 June 2013 | doi:10.1038/sj.bdj.2013.583
Subject terms: [Anaesthesia and sedation](#) | [Oral surgery](#) | [Medical m](#)

UK dentists' experience of iatrogenic trigeminal nerve injuries in relation to routine dental procedures: why, when and how often?

T. Renton¹, H. Janjua², J. E. Gallagher², M. Dalgleish⁴ & Z. Yilmaz²

The use of the mandibular infiltration anesthetic technique in adults

John G. Meechan, BSc, BDS, PhD, FDSRCS, FDSRCPs

Local anesthesia in the mandible traditionally has been provided by means of one of the inferior alveolar nerve block (IANB) techniques such as the Halsted, Gow-Gates or Akinosi-Vazirani methods. The regional block anesthetic technique may be more difficult technically to perform.

ABSTRACT

Background: This article describes the use of the infiltration anesthetic technique to anesthetize mandibular teeth in adults and explores

European Journal of Oral Implantology

QUINTESSENCE PUBLISHING

All journals Latest issues SignIn Con

Eur J Oral Implantol 9 (2016), No. 1 23. Mar. 2016

Eur J Oral Implantol 9 (2016), No. 1 (23.03.2016)

Page 59-66, PubMed:27022637

A low dose of subperiosteal anaesthesia injection versus a high dose of infiltration anaesthesia to minimise the risk of nerve damage at implant placement: A randomised controlled trial

Sánchez-Elipe, Marina / Camacho-Alonso, Fabio / Salazar-Sánchez, Noemi / Aguinaga-Ontoso, Enrique / Muñoz, Javier Guardia / Calvo-

Whether a low-dose subperiosteal anaesthesia is effective in minimising risks of inferior alveolar nerve damage at implant placement compared to high-dose infiltration anaesthesia.

One hundred and twenty patients requiring the placement of a single implant in order to replace a missing first molar were allocated to two groups: group A (awake hemilip) subperiosteal crestal injection equal to 0.9 ml of articaine with 1:200,000 adrenaline; group B (numb hemilip) infiltration equal to 7.2 ml of articaine with 0.5% epinephrine in the vestibular sulcus. Sensory control using sensory tests was carried out in all patients. Outcome measures were neurological symptoms and postoperative visual analogue scale (VAS) scores for pain and swelling, and a questionnaire evaluating patient satisfaction.

Patients were followed for 1 week postoperatively. At 7 days postoperatively the postoperative VAS score for pain and swelling was lower in group A in a significant manner (difference = -3.41%; 95% CI: -5.57, -1.26; P = 0.002 and difference = -3.33%; 95% CI: -5.57, -1.26; P = 0.002).

Nerve damage occurred using either anaesthesia types, therefore the choice of type of anaesthesia is a subjective decision. It may be preferable to use a low dose (0.9 ml) of subperiosteal anaesthesia, since it is unnecessary to deliver a high dose to anaesthetise a single mandibular molar implant site.

Conclusion: For inferior alveolar nerve, local anaesthesia

order article as PDF-file (20.00 €)

Dentistry is the **ONLY** healthcare
profession taught to aim for nerves
blindly during block injections!

Possible mechanisms

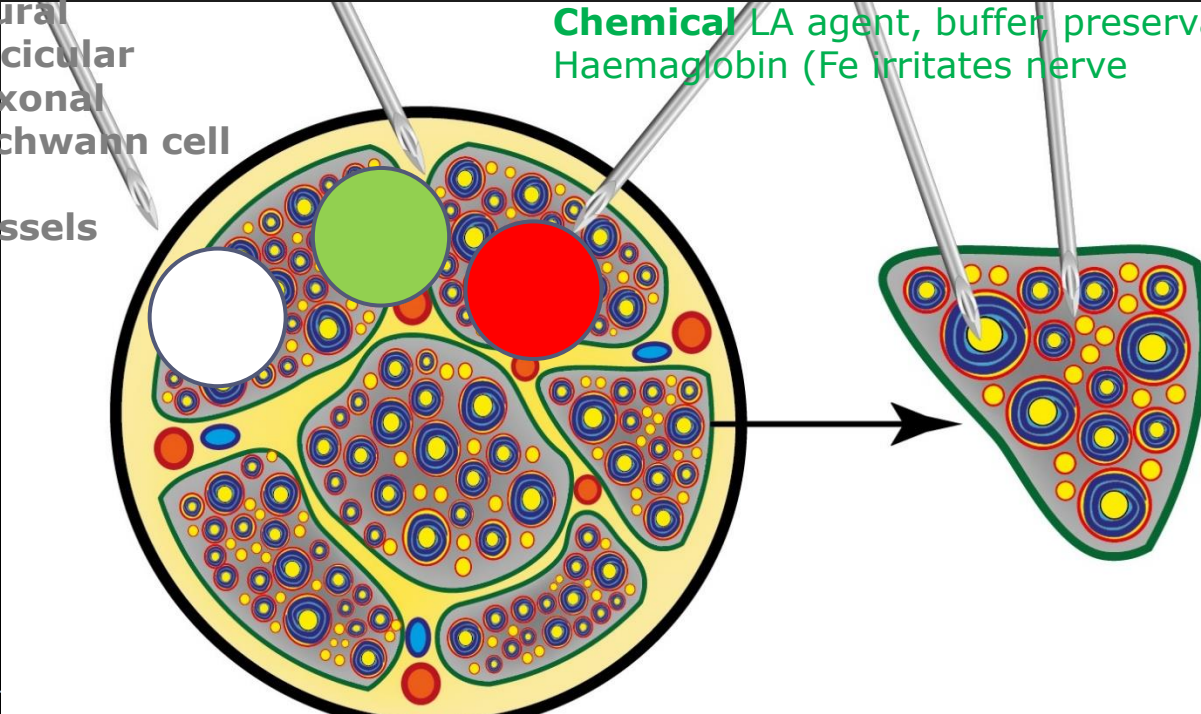
Extraneural
Intra neural
Intra fascicular
Neural axonal
Neural schwann cell
(myelin)
Blood vessels
Fat

Mechanism of trauma

Mechanical Direct needle/ indirect scarring

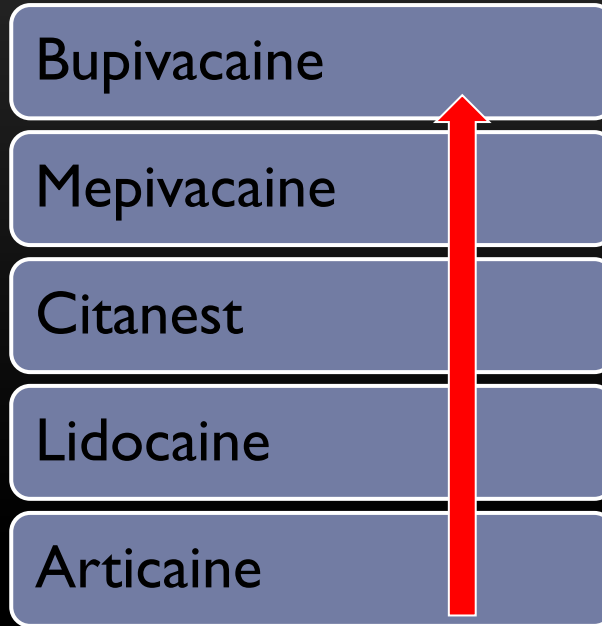
Pressure ischaemia from bleed or LA

Chemical LA agent, buffer, preservative, carrier
Haemoglobin (Fe irritates nerve)



Risks factors for Dental LA NIs

- **Block anaesthesia**
- **Lingual nerve > IAN**
 - Technique or Anatomy?
- **Concentration of LA agent**
- **Agent toxicity**
- **Multiple injections**
- **Severe pain on injection**
 - Smith and Lung 2006
- **Type of LA Agent**
 - Type of vasoconstrictor?
 - Sedated / anaesthetised patients?
 - Lack of LA aspiration?
- **Volume of LA?**
- **Speed of injection?**
- **Patient?**

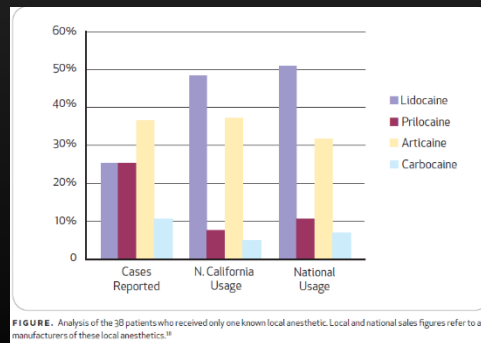


Increasing agent toxicity

Risk Factors LA concentration

Increased concentration of LA agent DOES increase risk of nerve injury!

- Hillerup & Jenson 2008
- Haas & Lennon 2009
- Garisto et al 2010
- Hillerup 2010
- Renton 2011
- Haas 2011
 - Articaine 21 times more likely to cause injury
- Hillerup et al 2011
- Hillerup et al 2011b
 - Rat nerve neurotoxicity 2vs 4% Articaine = concentration of Agent more likely neurotoxin than mechanical injury with saline
- Pogrel 2012
- Jacobs K report IFDAS 2015
- Piccini et al 2015
- Gaffen & Haas 2009



From Pogrel 2012

quently as the inferior alveolar nerve. During 2006–2008 alone, 64 cases of nonsurgical paresthesia were reported to PLP, a reported incidence of 1 in 609,000 injections. For the 2 local anesthetic drugs available in dental cartridges as 4% solutions, i.e., articaine and prilocaine, the frequencies of reporting of paresthesia were significantly greater than expected (χ^2 , exact binomial distribution; $p < 0.01$) based on their level of use by Ontario dentists. These data suggest that local anesthetic neurotoxicity may be at least partly involved in the development of postinjection paresthesia.

Risk factors for persistent neuropathy related to IDBs

In order to minimise complications related to dental LA you need to consider modifying the following risks;

- **Block anaesthesia** Nerve block injections should be undertaken without intent on direct patients who experience the 'funny bone' neuralgia due to the IDB needle being placed too inferior alveolar nerves experience persistent neuropathy
- **Lingual nerve > IAN** Is this technique related or anatomically related (less fascicle recovery). Perhaps the direct IDB approach may place the lingual nerve at risk if indirect technique.
- **Concentration of LA** Any increased concentration of any agent leads to increased neurotoxicity (21)
- **Volume of LA** There is no evidence to support this suggestion. LA concentration, neural damage additional neurotoxicity.
- **Multiple injections** Second or subsequent injections that impede directly on or in no associated with the usual 'funny bone' neuralgic pain. Thus the patient does not self-protect rendering the nerves more at risk of direct damage.
- **Severe pain on injection** 60% increased occurrence of persistent neuropathy after IDBs (21)
- **Type of LA Agent** Bupivacaine most neurotoxic of all LA agents
- **Type of vasoconstrictor?** The role of vasoconstrictor in nerve damage is unknown
- **Sedated or anaesthetized patients?** There is no evidence to support unresponsive themselves when neuralgia (funny bone reaction) occurs as the IDB needle ends to protect nerve.
- **Lack of LA aspiration?** Again there is no evidence to support that aspiration during persistent neuropathies but a pragmatic view may infer less chemical injected intra neurally chemical nerve injury.

Block injections

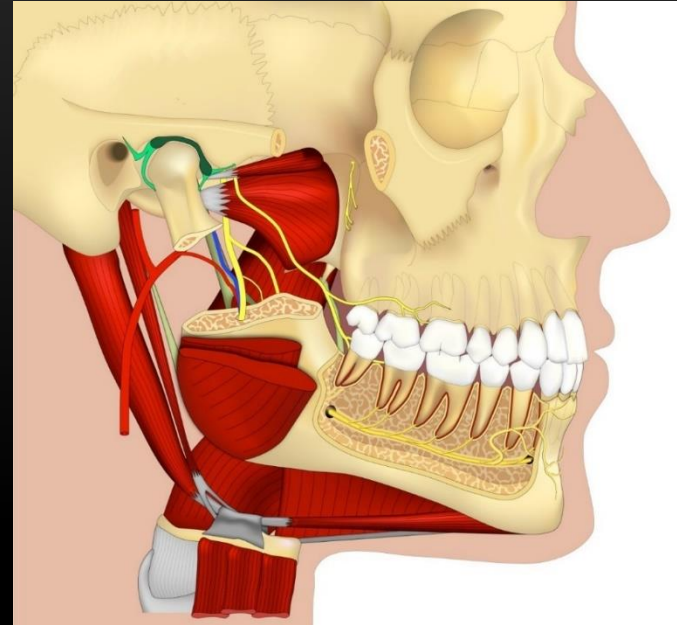
Multiple injections

Type and concentration of LA agents

Extreme pain during injections

How do we modify the risks of LA Nerve injury?

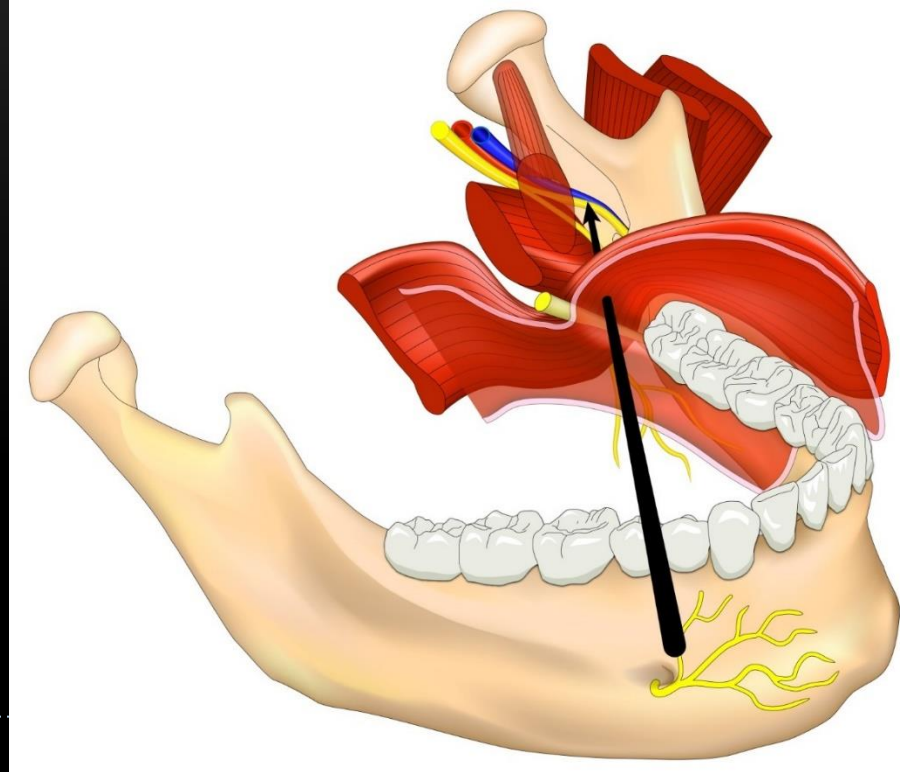
- ▶ Technique
 - ▶ Avoid blocks when possible
 - ▶ Infiltration technique
 - ▶ Avoid multiple blocks
 - ▶ Type of IDB Technique
 - ▶ + always Aspirate
- ▶ Agent
 - ▶ Avoid Bupivacaine
 - ▶ Use low conc IDBs
 - ▶ Use alternative IDB techniques
- ▶ Follow up
 - ▶ Patients who experience neuralgic pain during injections should be contacted post treatment and reassured
- ▶ Early management
 - ▶ Therapeutic approach limited evidence base
 - ▶ Vitamin B complex



Prevention –Technique

Is the direct Halstead technique more likely to injure the Lingual Nerve?

Direct Halstead technique may place LN at higher risk?



Consider an indirect Halstead or Gow Gates or Akinosis technique.....



OR



And WAIT>>>>>>>>>!

Prevention IDB failure

Avoid multiple blocks

Supplemental injections Intra osseous

The addition of the intraosseous injection after an inferior alveolar nerve block, in the first molar, will provide a quick onset and a high incidence of pulpal anesthesia (approximately 90%) for 60 minutes. Clinically, the supplemental intraosseous injection works very well

Intraosseous injection is more successful than the intra-ligamentary injection

BUT you're giving intravascular LA!

Dunbar D, Reader A, Nist R, Beck M, Meyers, W. Anesthetic efficacy of the intraosseous injection after an inferior alveolar nerve block. J Endod 1996;22:481-6. Guglielmo A, Reader A, Nist R, Beck M, Weaver J. Anesthetic efficacy and heart rate effects of the supplemental intraosseous injection of 2% mepivacaine with 1:20,000 levonordefrin. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1999;87:284-93. Stabile P, Reader A, Gallatin E, Beck M, Weaver J. Anesthetic efficacy and heart rate effects of the intraosseous injection of 4% et/40000-art/epine after an inferior alveolar nerve block. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2000;89:407-11.

https://www.aac.org/uploadedfiles/publications_and_research/endodontics_colleagues_for_excellence_newsletter/winter09ecfe.pdf

IDB failure

Supplemental techniques with IDB

Buccal Articaine infiltration for Irreversible Pulpitis

- ▶ 182 patients
- ▶ 122 achieved successful pulpal anesthesia within 10 minutes after initial IANB injection only 82 experienced pain-free treatment.
- ▶ **Articaine buccal infiltration (ABI)** and Intraosseous (IO) allowed more successful (pain-free) treatment
- ▶ **IANB + ABI** **84% pain free RX**
- ▶ **IANB + IO** **68% pain free Rx**
- ▶ **IANB + PDL** **48% pain free Rx**
- ▶ **IANB alone** **32% pain free Rx**

„Evidence of buccal infiltrations of articaine alone producing pulpal anesthesia in up to 92% of uninflamed pulps has been cited earlier“
Robertson D, et al. *J Am Dent Assoc* 2007;138:1104-12

„Mandibular buccal infiltration is more effective with 4% articaine with epinephrine compared to 2% lidocaine with epinephrine.“
Kanaa MD, Withworth JM, Meechan JG, *J Endod* 2012;38:421-425.

Kanaa MD, Whitworth JM, Meechan JG. *J Endod*. 2012 Apr;38(4):421-5. doi: 10.1016/j.joen.2011.12.006. Epub 2012 Feb 2. A prospective randomized trial of different supplementary local anesthetic techniques after failure of inferior alveolar nerve block in patients with irreversible pulpitis in mandibular teeth.

Avoid block injections where possible

Infiltration LA is more effective with less NIs and systemic side effects

The use of the mandibular infiltration anesthetic technique in adults

John G. Meehan, BSc, BDS, PhD, FDSRCS, FDSRCPs

Local anesthesia in the mandible traditionally has been provided by means of one of the inferior alveolar nerve block (IANB) techniques such as the Halsted, Gow-Gates or Akinosi-Vazirani methods. The regional block anesthetic technique may be more difficult technically to perform than is the infiltration anesthetic technique, and it has additional disadvantages, including the potential for causing nerve damage and the failure to counter any accessory nerve supply such as the dual supply of midline structures. The infiltration anesthetic technique often is used in the maxilla, although the use of regional blocks is possible.

A reason that infiltration techniques may not be the first choice in the adult mandible is because practitioners tend to think that the thick cortical plate prevents diffusion of solution into the cancellous bone and, therefore, to the nerves supplying the pulps of the teeth. There are holes in the body of the mandible, however, and these could permit diffusion of solution into the cancellous space. Such holes

ABSTRACT

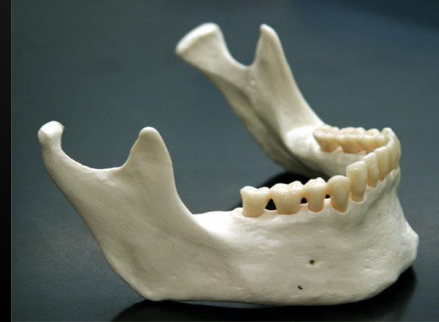
Background. The author describes the use of the infiltration anesthetic technique to anesthetize mandibular teeth in adults and explores its mechanism of action.

Methods. The author reviewed articles describing randomized controlled trials of the mandibular infiltration anesthetic technique in healthy participants.

Results. The author found that using the mandibular infiltration anesthetic technique can produce anesthesia in adult mandibular teeth. The success was dose dependent and the choice of anesthetic solution was significant; 4 percent articaine with 1:100,000 epinephrine was more effective than 2 percent lidocaine with 1:100,000 epinephrine. Combining buccal and lingual infiltrations increased success in the mandibular incisor region. The success of the mechanism of

Downloaded from jda.ada.org on February 12,

Infiltration dentistry is possible due to porosity of the mandible



With respect to maxillary infiltration anesthesia, some studies have found 4% articaine to be more effective than 2% lidocaine for lateral incisors but not molars (Evans et al., 2008), while others reported no clinical superiority for this injection (Oliveira et al., 2004; Vähätalo et al., 1993). However, a recent randomized controlled trial found a statistically significant difference supporting use of 4% articaine in place of 2% lidocaine for buccal infiltration in patients experiencing irreversible pulpitis in maxillary posterior teeth (Srinivasan et al., 2009).

Prevention LA nerve injury – Use Infiltration dentistry is applicable to most dentistry

Evidence based for;

- ▶ **Pulpal anaesthesia in the anterior mandible compared with inferior dental block(IDBs)**

Meechan JG The use of the mandibular infiltration anesthetic technique in adults. J Am Dent Assoc. 2011 Sep;142 Suppl 3:19S-24S.

- ▶ **Restoration of pulpitic mandibular molars in adults**

Zain M, et al Comparison of Anaesthetic Efficacy of 4% Articaine Primary Buccal Infiltration Versus 2% Lidocaine Inferior Alveolar Nerve Block in Symptomatic Mandibular First Molar Teeth. J Coll Physicians Surg Pak. 2016 Jan;26(1):4-8.

Poorni S, et al Anesthetic efficacy of four percent articaine for pulpal anesthesia by using inferior alveolar nerve block and buccal infiltration techniques in patients with irreversible pulpitis: a prospective randomized double-blind clinical trial. J Endod. 2011 Dec;37(12):1603-7

- ▶ **Exodontia in adults and children**

Thakare A, Bhate K, Kathariya R Comparison of 4% articaine and 0.5% bupivacaine anesthetic efficacy in orthodontic extractions: prospective, randomized crossover study. Acta Anaesthesiol Taiwan. 2014 Jun;52(2):59-63.

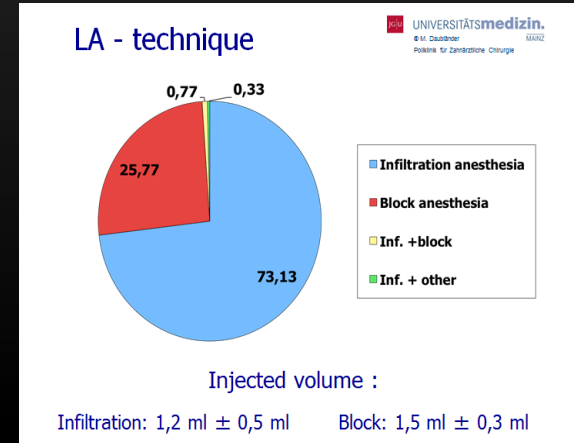
- ▶ **implant surgery**

Etoz OA, Er N, Demirbas AE. Supraperiosteal infiltration anesthesia safe enough to prevent inferior alveolar nerve during posterior mandibular **implant** surgery? Med Oral Patol Oral Cir Bucal. 2011 May 1;16(3):e386-9

- ▶ **periodontal surgery**

- ▶ **-- improved patient comfort Patients will undoubtedly prefer having full--**
 - ▶ **lingual sensation and shorter duration LA anaesthesia after dental treatment**

**2014 survey German dental LA practise
74% using infiltration dentistry!**



Courtesy Prof Monika Daublander

Buccal infiltration Articaine / Lidocaine for adult molars irreversible pulpitis or IDB plus Buccal Articaine

Review Article

Does Articaine Provide an Advantage over Lidocaine in Patients with Symptomatic Irreversible Pulpitis? A Systematic Review and Meta-analysis

Jason Kung, DDS, MS,* Marian McDonagh, PharmD,[†] and Christine M. Sedgley, MDS, MDSc, PhD*

Abstract

Introduction: Achieving profound pulpal anesthesia can be difficult in patients with symptomatic irreversible pulpitis. This study provides a systematic review and meta-analysis to address the population, intervention, comparison, outcome (PICO) question: In adults with symptomatic irreversible pulpitis who are undergoing endodontic treatment, what is the comparative efficacy of articaine compared with lidocaine in reducing pain and incidence of adverse events? **Methods:** A protocol was prepared and registered on PROSPERO. Electronic searches were conducted in MEDLINE, Scopus, Cochrane Library and ClinicalTrials.gov by using strict inclusion and exclusion criteria. Two independent reviewers assessed eligibility for inclusion and quality. Weighted anesthesia success rates and 95% confidence intervals (CIs) were estimated and compared by using a random-effects model. **Results:** Two hundred seventy-five studies were initially identified from the search; 10 double-blind, randomized clinical trials met the inclusion criteria. For combined studies, articaine was more likely than lidocaine to achieve successful anesthesia (odds ratio [OR], 2.21; 95% CI, 1.41–3.47; $P = .0006$; $I^2 = 40\%$). Maxillary infiltration subgroup analysis showed no significant difference between articaine and lidocaine (OR, 3.39; 95% CI, 0.50–31.62; $P = .19$; $I^2 = 59\%$). For combined mandibular anesthesia studies articaine was superior to lidocaine (OR, 2.20; 95% CI, 1.40–3.44; $P = .0006$; $I^2 = 30\%$), with further subgroup analysis showing no difference for mandibular block anesthesia (OR, 1.44; 95% CI, 0.87–2.38; $P = .16$; $I^2 = 0\%$). When used for supplemental infiltration after successful mandibular block anesthesia, articaine was

a significant advantage to using articaine over lidocaine for supplementary infiltration after mandibular block anesthesia but no advantage when used for mandibular block anesthesia alone or for maxillary infiltration. (J Endod 2015;41:1784–1794)

Key Words

Articaine, articaine, irreversible pulpitis, lidocaine, local anesthesia, meta-analysis, symptomatic irreversible pulpitis, systematic review, ultracaine

The clinical diagnosis of symptomatic irreversible pulpitis is based on subjective and objective findings signifying that the vital inflamed pulp is incapable of healing, with subjective descriptors that include lingering thermal pain, spontaneous pain, and referred pain (1). Root canal treatment has been described as significantly more painful for teeth with irreversible pulpitis and symptomatic apical periodontitis compared with teeth with necrotic pulps and asymptomatic apical periodontitis (2). In addition, achieving profound pulpal anesthesia can be challenging in these cases (3,4). For example, anesthesia may be sufficiently profound to access the pulp chamber, but canal instrumentation can result in severe pain (4). In a survey of Diplomates of the American Board of Endodontics, 84% of respondents reported experiencing difficulties in anesthetizing acutely painful mandibular molars (5). The inability to achieve pulpal anesthesia has been shown to increase a patient's fear and anxiety, exacerbate systemic medical issues, extend the appointment duration, and generate doubt in the operator; any of these factors can contribute to the impression that receiving root canal treatment is a painful procedure (6).

Lidocaine, also known as lignocaine, is an amino-amide anesthetic introduced to the market in 1948 that has been described as the most commonly used local anesthetic for dental use in the United States (7) and elsewhere (8,9). This anesthetic provides pulpal anesthesia for approximately 1 hour and soft tissue anesthesia for 3–5 hours (7). Articaine, the second most commonly used dental anesthetic, was first introduced to the European market in 1976 and entered the U.S. market in 2000 (10). By 2007, articaine was described as accounting for approximately 25% of total sales, second only to lidocaine at 54% (11). The chemical composition of articaine contains a unique thiophene ring instead of the benzene ring found in lidocaine and other amino local anesthetics.

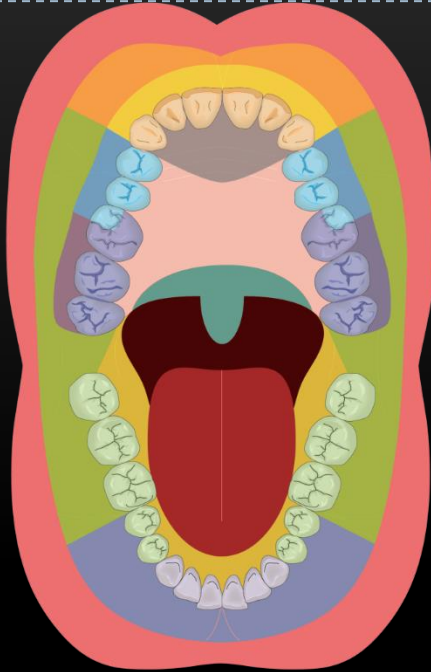
random-effects model. **Results:** Two hundred seventy-five studies were initially identified from the search; 10 double-blind, randomized clinical trials met the inclusion criteria. For combined studies, articaine was more likely than lidocaine to achieve successful anesthesia (odds ratio [OR], 2.21; 95% CI, 1.41–3.47; $P = .0006$; $I^2 = 40\%$). Maxillary infiltration subgroup analysis showed no significant difference between articaine and lidocaine (OR, 3.39; 95% CI, 0.50–31.62; $P = .19$; $I^2 = 59\%$). For combined mandibular anesthesia studies articaine was superior to lidocaine (OR, 2.20; 95% CI, 1.40–3.44; $P = .0006$; $I^2 = 30\%$), with further subgroup analysis showing no difference for mandibular block anesthesia (OR, 1.44; 95% CI, 0.87–2.38; $P = .16$; $I^2 = 0\%$). When used for supplemental infiltration after successful mandibular block anesthesia, articaine was significantly more effective than lidocaine (OR, 3.55; 95% CI, 1.97–6.39; $P < .0001$; $I^2 = 9\%$). There were

Infiltration dentistry is dependant upon

The site and procedure

Maxillary dentistry can be performed using Lidocaine 2% with adrenaline for all procedures
Buccal infiltration with intra-septal injections
No additional benefit using 4% Articaine infiltration over Lidocaine

Mandibular Molar Endodontic procedures may be only procedure to require IDBs



Mandibular 7s and 8s for perio, restorations or implants

Articaine 4% buccal infiltration and Lidocaine 2% lingual infiltrations OR for extractions, Articaine 4% buccal infiltration plus Lidocaine intr-ligamental

Mandibular 1st molars for perio, restorations or implants

Articaine 4% buccal and Lidocaine 2% lingual infiltrations OR for extractions buccal infiltration intra-ligamental
Endo for pulpitic first molar

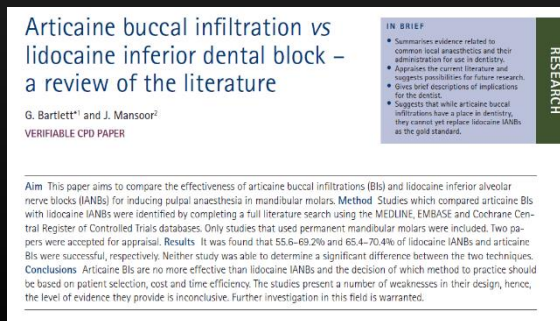
Mandibular incisors, canines and premolars for perio, restorations or implants and Endo

Submucosal infiltration in front or behind mental nerve area (NOT direct into nerve) Articaine 4% buccal infiltrations and extractions add lingual infiltration and or intra-ligamental

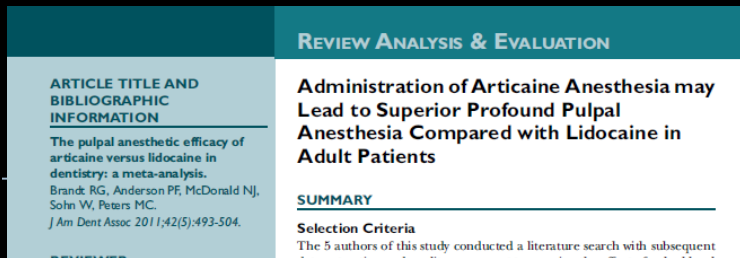
Articaine or Lidocaine infiltration?

Systematic reviews

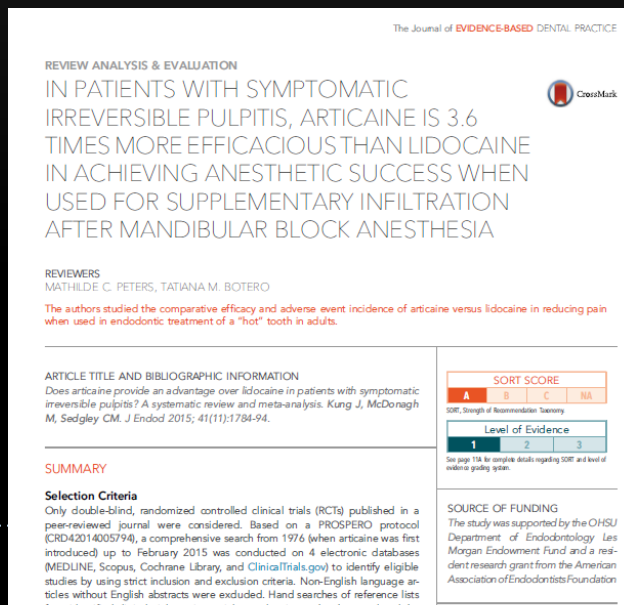
- ▶ Articaine BI vs Lidocaine IDB
- ▶ No Difference



Articaine better for pulpal anaesthesia (EPT) in pulpitic molars



- ▶ Lidocaine infiltration as effective as Articaine in maxilla
- ▶ Articaine 3.6 more effective in mandible

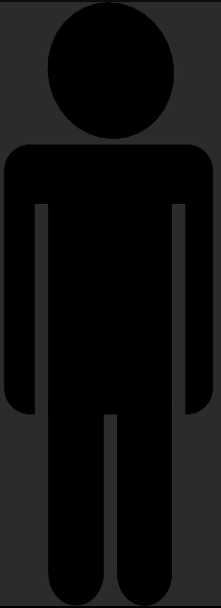


Summary Prevention LANIs

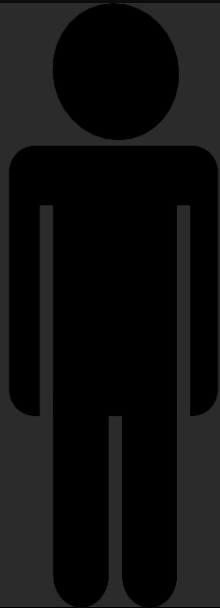
- ▶ Modify training
- ▶ Avoid IDBs where possible
- ▶ Avoid Direct Halstead IDB Technique (to prevent Lingual nerve injuries)
- ▶ Avoid multiple blocks use supplemental injections
- ▶ Use alternative IDB techniques (Akinosi or Gow Gates)
- ▶ Avoid high concentration IDBs (Articaine, Mepivacaine, Prilocaine)
- ▶ Stick to Lidocaine ID blocks for now!
- ▶ Always aspirate
- ▶ No IDBs under GA
- ▶ Consider infiltration dentistry where possible!

Renton T, Adey-Viscuso D, Meechan JG, Yilmaz Z. Trigeminal nerve injuries in relation to the local anaesthesia in mandibular injections. Br Dent J. 2010 Nov;209(9):E15

Overview



Why prevent these
nerve injuries?



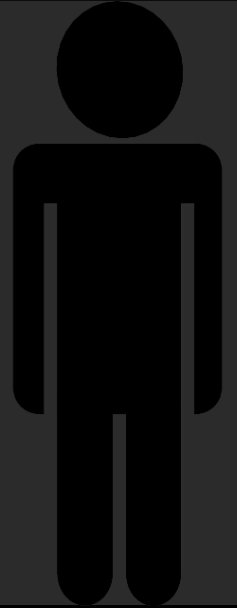
How to prevent
LA nerve injuries?



How to prevent
Endo nerve injuries?



How to manage
nerve injuries?

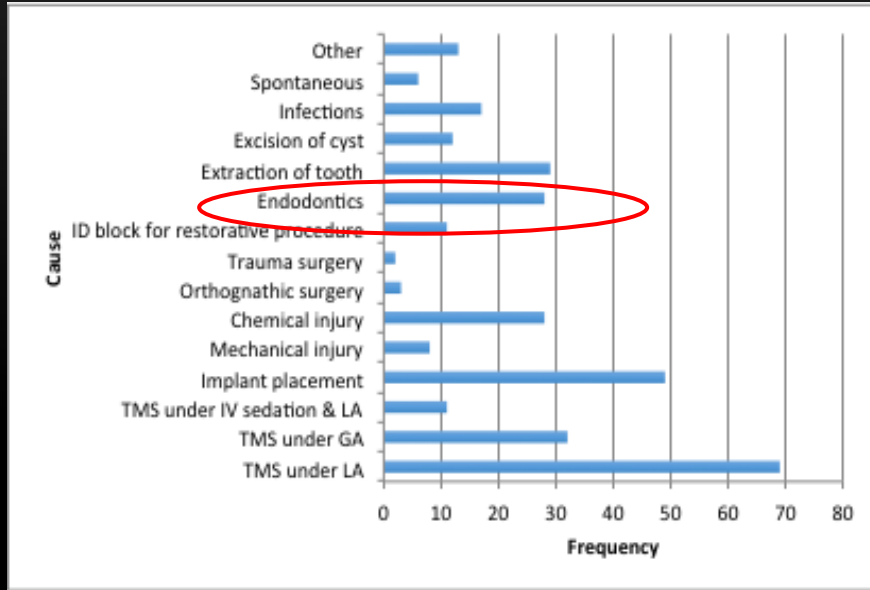


Summary and
work to do



Endodontic related IAN injury is third most common after TMS and Implants

Estimated Endo NI incidence estimated **0.96% cases (8/832)**



Endo and Implant nerve injuries are increasing

Cohort of 335 TNIs 2011-15

Renton, T., & Yilmaz, Z. (2011). Profiling of patients presenting with posttraumatic neuropathy of the trigeminal nerve. *J Orofac Pain*, 25(4), 333-344.

In survey of 2338 patients 7% sustained chronic neuropathic pain after a single endodontic procedure

Quintessence Int. 2011 Mar;42(3):259-69. The prevalence of persistent pain after nonsurgical root canal treatment. Klasser GD, Kugelmann AM, Villines D, Johnson BR

3. Knowles KI, Jergenson MA, Howard JH. Paresthesia associated with endodontic treatment of mandibular premolars. *J Endod*. 2003;29(11):768-70.

Cite this article as:
J Can Dent Assoc 2014;80:e13

Endodontic-Related Facial Paresthesia: Systematic Review

Flávio R. Alves, PHD; Mariana S. Coutinho, DDS;
Lucio S. Gonçalves, PHD

The term **paraesthesia** relates to symptoms of the patient (as in Pain or numbness) it is NOT a term used to mean **neuropathy** (or malfunction due to nerve injury).

Clinical

REVIEW

Endodontics-Related Paresthesia of the Mental and Inferior Alveolar Nerves: An Updated Review

Zahed Mohammadi, DMD, MSD

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ABSTRACT

Paresthesia is a burning or prickling sensation or partial numbness resulting from neural injury. Paresthesia resulting from periapical pathosis or various stages of root canal treatment is of great importance in the field of endodontics. The purpose of this paper is to review paresthesia caused by periapical lesions, local anesthesia, cleaning, shaping and



Figure 2: Schematic representation of the various causes of paresthesia due to endodontic problems. From the second premolar to the third molar, typical causes are extrusion or diffusion of intracanal medications, periradicular surgery, overfilling and over-instrumentation (beyond the apex), and apical periodontitis.

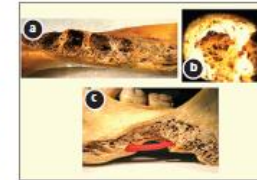


Figure 3: a) Jaw showing bone in the molar region. b) Higher magnification of the alveolar bone in the third molar region, notable for the presence of numerous vacuoles. c) Jaw illustrating the possibility of bacteria or endodontic materials or products diffusing through the vacuole to reach the inferior alveolar nerve (shown in red).

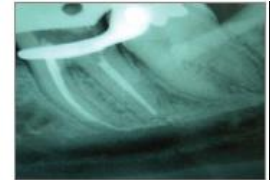


Figure 4: Overfilling of sealer bordering the cortex of the mandibular canal.

Many case reports

Dempf R, Hausamen JE. Lesions of the inferior alveolar nerve arising from endodontic treatment. Aust Endod J 2000;26(2):67-71.

Forman GH, Rood JP. Successful retrieval of endodontic material from the inferior alveolar nerve. J Dent 1977;5(1):47-50.

Gallas-Torreira MM, Reboiras-Lopez MD, Garcia-Garcia A, Gandara-Rey J. Mandibular nerve paresthesia caused by endodontic treatment. Med Oral 2003;8(4):299-303.

Tilotta-Yasukawa F, Millot S, El Haddioui A, et al. Labiomandibular paresthesia caused by endodontic treatment: an anatomic and clinical study. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006;102:e47-59.

Dempf R, Hausamen JE. Lesions of the inferior alveolar nerve arising from endodontic treatment. Aust Endod J 2000;26(2):67-71.

Qrstravik D, Brodin P, Aas E. Paraesthesia following endodontic treatment: survey of the literature and a case report. Int Endod J 1983;16:167-72.

Rowe AHR. Damage to the inferior dental nerve during or following endodontic treatment. Br Dent J 1983;153:306-7.

Morse DR. Infection-related mental and inferior alveolar nerve paresthesia: Literature review and presentation of two cases. J Endod 1997;23:457-60.

Vasilakis GJ, Vasilakis CM. Mandibular endodontic-related paresthesia. General Dent 2004;52:334-8.

Knowles KI, Jergenson MA, Howard JH. Paresthesia associated with endodontic treatment of mandibular premolars. J Endod 2003;29(11):768-70.

Only 5 reported case series of Endo related NIs

- ▶ Pogrel MA. Damage to the inferior alveolar nerve as the result of root canal therapy. J Am Dent Assoc. 2007;138(1):65-9. **61 cases**
- ▶ Knowles KI, Jergenson MA, Howard JH. Paresthesia associated with endodontic treatment of mandibular premolars. J Endod. 2003;29(11):768-70 **8 cases**
- ▶ Scolozzi P, Lombardi T, Jaques B. Successful inferior alveolar nerve decompression for dysesthesia following endodontic treatment: report of 4 cases treated by mandibular sagittal osteotomy. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2004 May;97(5):625-31. **4 cases**
- ▶ Grötz KA, Al-Nawas B, de Aguiar EG, Schulz A, Wagner W. Treatment of injuries to the inferior alveolar nerve after endodontic procedures. Clin Oral Investig. 1998 Jun;2(2):73-6 **11 cases**
- ▶ Devine M, Modgill O, Renton T. Mandibular division trigeminal nerve injuries following primary endodontic treatment. A case series. Aust Endod J. 2017 Aug;43(2):56-65. doi: 10.1111/aej.12209. Epub 2017 Jul 7. **28 cases**

Features of the patient presentation

The largest series of endodontic related trigeminal nerve injuries 61 patients over an 8 year period (Pogrel 2007).

- ▶ 8 asymptomatic
- ▶ 42 exhibited only mild symptoms (3 months old injuries)
- ▶ 10 patients experienced some resolution
- ▶ 11 pts were symptomatic and underwent surgical exploration. 5 of these within 48 hours others up to 10 days-3 months (4 experienced partial resolution and 2 no recovery).

CLINICAL PRACTICE

Damage to the inferior alveolar nerve as the result of root canal therapy

M. Anthony Pogrel, DDS, MD, FRCS, FACS

When root canal therapy is performed on mandibular teeth posterior to the mental foramen, damage to the inferior alveolar nerve is possible.¹ Most cases have been reported in connection with the lower second molars, but cases related to the first molars and the premolars also have been reported.² Three possible mechanisms can be envisaged:³

- mechanical trauma from overinstrumentation into the inferior alveolar canal;
- a pressure phenomenon from the presence of the endodontic point or sealant within the inferior alveolar canal^{1,4};
- a neurotoxic effect from the medicaments used to clean the canal or that are in the sealant.

Treatment involving contraindications.

ABSTRACT

Background. Endodontic treatment of mandibular molar teeth has the potential to damage the inferior alveolar nerve via direct trauma, pressure or neurotoxicity.

Methods. The author reviewed all cases of involvement of the inferior alveolar nerve resulting from root canal therapy in patients seen in a tertiary referral center during an eight-year period (1998 through 2005). The author had encouraged practitioners to refer patients immediately to a university clinic.

Results. The author saw 61 patients during the eight-year period. Eight patients were asymptomatic and received no treatment. Forty-two patients exhibited only mild symptoms or were seen more than three months after undergoing root canal therapy, and they received no surgical treatment. Only 10 percent of these patients experienced any resolution of symptoms. Eleven patients underwent surgical exploration. Five of these patients underwent exploration and received treatment within 48 hours, and all recovered completely. The remaining six patients underwent surgical exploration and received treatment between 10 days and three months after receiving endodontic therapy. Of these patients, four experienced partial recovery and two experienced no recovery at all.

Conclusions. Early surgical exploration and debridement may reverse

Pogrel MA Damage to the inferior alveolar nerve as the result of root canal therapy J Am Dent Assoc. 2007 Jan; 138(1):65-

9 Repton T, Yilmaz Z. J. Profiling of patients presenting with posttraumatic neuropathy of the trigeminal nerve.

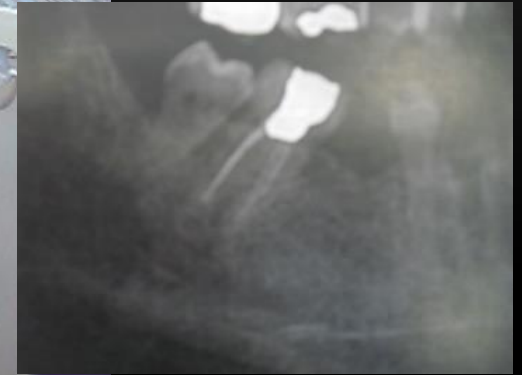
Orofac Pain. 2011 Fall; 25(4):333-44.

Features of Patient presentation

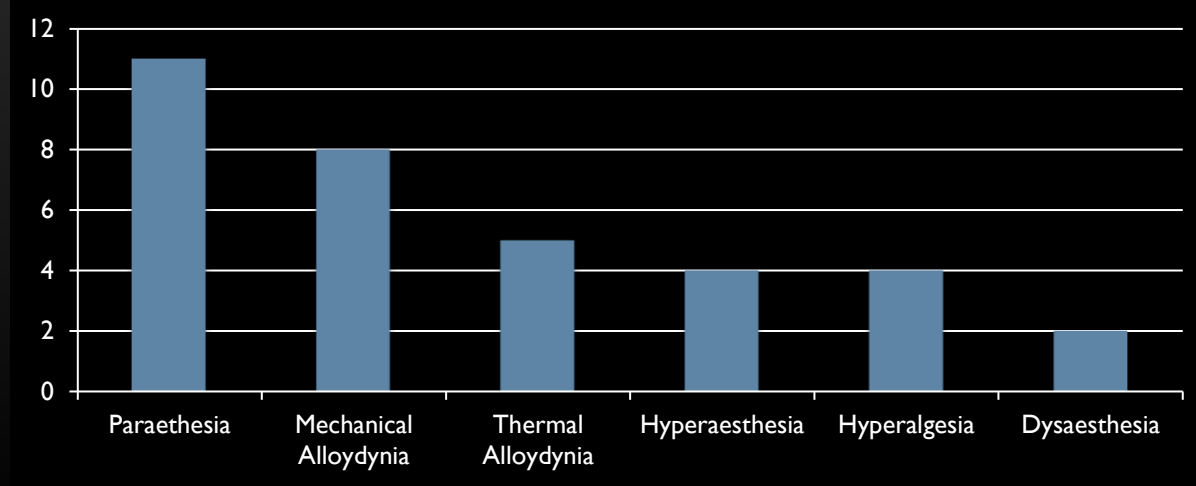
Our cohort of 28 patients with Endo related NIs

- ▶ **A retrospective review of 352 patients referred to a Specialist nerve injury clinic between 2007 and 2015** was conducted. 28 cases were identified with IAN injury secondary to primary endodontic treatment.
- ▶ The sample included 12 male and 16 female patients with an age range of 38-77 years and a mean age of 41.5 years.
- ▶ **24/28 patients experienced no resolution of neuropathy**, regardless of the extent to which the dermatome was affected or to which function was impaired. The remaining four patients had a temporary IAN injury which resolved within 6-12 weeks with a mean time of 8.5 weeks.
- ▶ Radiographs were available for 12 of the cases in this series. Review of these revealed that in 7 cases the root apices of endodontically treated teeth were superimposed upon the superior margin of the IAN canal or the mental foramen.
- ▶ **Ten cases reported experiencing intra-operative pain during endodontic treatment.** Fifteen patients reported immediate post-operative symptoms of either pain localised to the endodontically treated tooth or paraesthesia.
- ▶ **Delayed presentation IANI** However, in eleven cases there was a 24-48 hour asymptomatic post-operative period. Interestingly, one patient described the onset of symptoms three months post-operatively, whilst another described the onset of symptoms six months post-operatively.
- ▶ **In the 20 cases recorded, extra-oral dermatome involvement averaged 55% in comparison with 40% of intra-oral dermatome.**
- ▶ **Paraesthesia was the most common** formally diagnosed sequelae of nerve injury followed by mechanical and thermal allodynia
- ▶ The most common subjective complaint was the inability to bite, eat or brush teeth without pain.

Features of Endo PPTN



Consequences – NePain, numbness + altered sensation



95% of
patients
reported
neuropathic
pain

Devine M, Modgill O, Renton T Mandibular division trigeminal nerve injuries following primary endodontic treatment. A case series. Aust Endod J. 2017 Aug;43(2):56-65. doi: 10.1111/aej.12209. Epub 2017 Jul 7.

90% of the patients reported chronic pain with 50% experiencing allodynia (pain evoked to non-noxious stimuli) and hyperalgesia (increased pain to noxious stimuli, for example pin prick or partners bristles on kissing). Persistent pain after endodontics has been reported to occur in 3-13% of patients (23,24,25)

Polycarpou N, Ng YL, Canavan D, Moles DR, Gulabivala K. Prevalence of persistent pain after endodontic treatment and factors affecting its occurrence in cases with complete radiographic healing. Int Endod J. 2005 Mar;38(3):169-78.

Endodontic related nerve injuries

Possible mechanisms

- ▶ Mechanical compression canal due to overfill
- ▶ Direct mechanical damage due to over instrumentation
- ▶ Haemorrhage with direct and indirect neural ischaemia
- ▶ **Loss of apical seal and chemical leakage and damage**
- ▶ Inflammation / infection



- ▶ Fanibunda K, Whitworth J, Steele J (1998) The management of thermomechanically compacted gutta percha extrusion in the inferior dental canal. Br Dent J. 1998 Apr 11;184(7):330-2

Possible Mechanisms of Endo related nerve injury

▶ Chemical

- ▶ Agent
- ▶ Metabolites

Brodin P, Roed A, Aars H, Orstravik D. Neurotoxic effects of root filling materials on rat phrenic nerve in vitro. J Dent Res 1982;61:1020-3.
Brodin P. Neurotoxic and analgesic effects of root canal cements and pulp-protecting dental materials. Endod Dent Traumatol 1988;4:1-11-6
Serper A, Ucer O, Onur R, Etikan I. Comparative neurotoxic effects of root canal materials on rat sciatic nerve. J Endod 1998; 24:592-4. 17.
Kozam G, Newark NJ. The effect of eugenol on nerve transmission. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1977; 44:799-805.

▶ Mechanical

- ▶ Trauma to the inferior alveolar nerve following endodontic treatment occurs as a result of the following mechanisms:
- ▶ Mechanical trauma from over-instrumentation into the IAN canal
- ▶ Neurotoxicity following direct contact with the medicaments used in endodontic treatment with the IAN
- ▶ Pressure upon the IAN due to the presence of endodontic materials extruded in the IAN canal ^{9,10}
Subsequent haemorrhage

▶ Haemorrhage

Chemical iron content very irritant to neural tissue
Primary or secondary haemorrhage/ scarring epi or intra neural

▶ Infection

Other considerations

Toxicity of commonly used dental products

- | | |
|---|-------------------|
| ▶ BioOss | pH 8.4 |
| ▶ Socket Medicaments | |
| ▶ Alvogyl, Whiteheads varnish,
Corsodyl and Surgical | pH 5.8 |
| ▶ Endo Medicaments | |
| ▶ Formocresol | pH 12.45 +/- 0.02 |
| ▶ Sodium hypochlorite | pH 11-12 |
| ▶ Calcium hydroxide (Calyxl). | pH 10-14 |
| ▶ Antibiotic-corticosteroid
paste (Ledermix) | pH 8.13 +/- 0.01 |
| ▶ Neutral | pH 7.35-7.45 |
| ▶ Eugenol | pH 4.34 +/- 0.05 |
| ▶ Iodoform paste | pH 2.90 +/- 0.02 |



Neural damage by non-toxic dental materials

- ▶ Dental materials may exert damaging effects on nerve conduction as a result of their physical and chemical properties.
- ▶ Even chemically bland materials such as gutta percha may cause irreversible neural injury following their entry to the inferior dental canal in a molten, thermoplastic state, partially resulting from direct thermal damage, and partly from nerve compression as the material cools and contracts

Fanibunda K, Whitworth J, Steele J (1998) The management of thermomechanically compacted gutta percha extrusion in the inferior dental canal. Br Dent J. 1998 Apr 11;184(7):330-2

Chemical nerve injury may not be obvious radiographically

▶ Clinical confirmation

- ▶ History If the patient is suffering from neuropathy after the local anaesthetic has worn off and the post-operative radiographs confirm that there is no radio opaque material in the canal , chemical nerve injury may be presumed.
- ▶ Assessment Mapping of the neuropathic area will discriminate between IDB and endo nerve injury
- ▶ This may be an irreversible injury to the nerve and subsequent, even swift removal of the root canal filling or tooth is unlikely to resolve the nerve injury Is this correct?
- ▶ If there is material recognised within the canal, this would suggest injury, but if there is NO material in the canal, is the same presumption made?



Plain films and
CBCT no use in
detecting chemical
damage

Endodontic risk factors general



In our cohort of 28 patients there appeared to be several prominent risk factors which were;

- ▶ GDP (80% of referrals) in our study
- ▶ Detectable overfill / over-instrumentation occurred in 60% of cases
- ▶ Dental factors

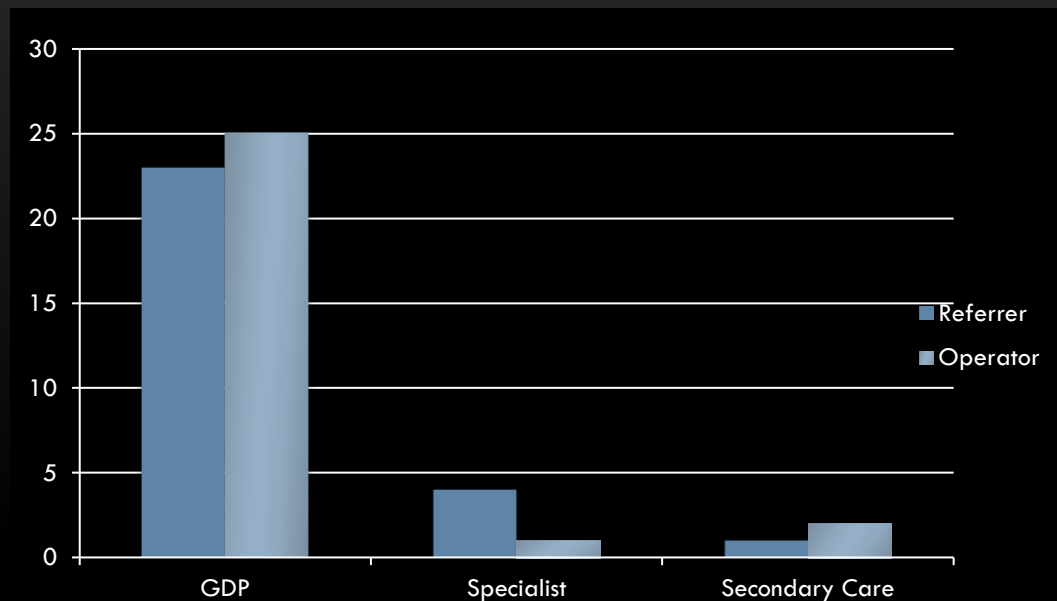
Proximity of tooth to IAN canal – 90% of the mandibular teeth in this series, were close to the IDC or premolars adjacent to the mental foramen

Devine M, Modgill O, Renton T Mandibular division trigeminal nerve injuries following primary endodontic treatment. A case series. Aust Endod J. 2017 Aug;43(2):56-65. doi: 10.1111/aej.12209. Epub 2017 Jul 7.

Scarano A, Di Carlo F, Quaranta A, Piattelli A. Injury of the inferior alveolar nerve after overfilling of the root canal with endodontic cement: a case report. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2007 Jul;104(1):e56-9

Köseoğlu BG, Tanrikulu S, Sübay RK, Sencer S. Anesthesia following overfilling of a root canal sealer into the mandibular canal: a case report. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2006 Jun;101(6):803-6

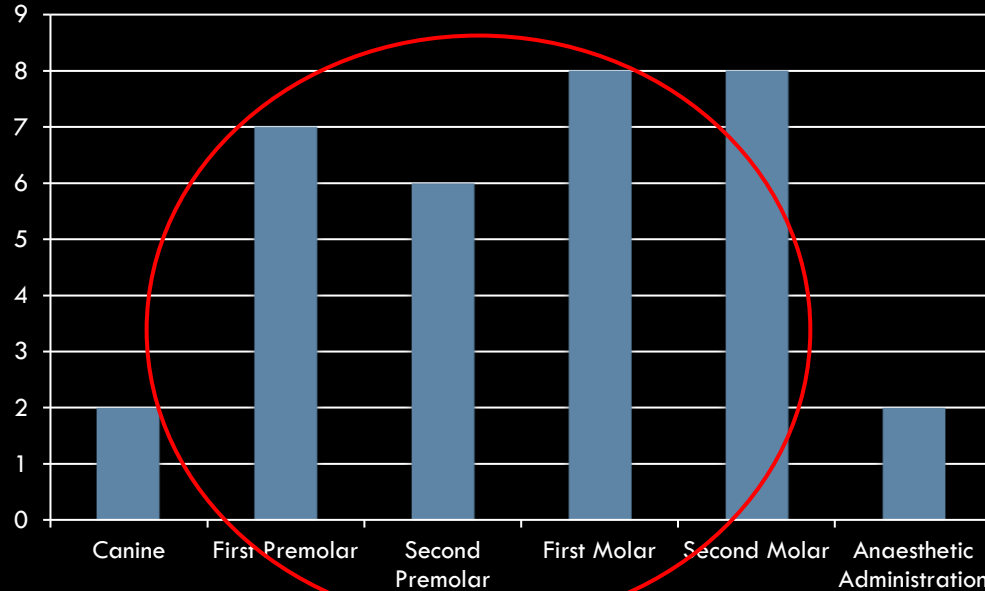
GDPs responsible for 80% of referrals



Devine M, Modgill O, Renton T Mandibular division trigeminal nerve injuries following primary endodontic treatment. A case series. Aust Endod J. 2017 Aug;43(2):56-65. doi: 10.1111/aej.12209. Epub 2017 Jul 7.

Inadequacies of GDP RCTs highlighted by Jenkins SM, Hayes SJ, Dummer PM. A study of endodontic treatment carried out in dental practice within the UK. Int Endod J. 2001 Jan;34(1):16-22

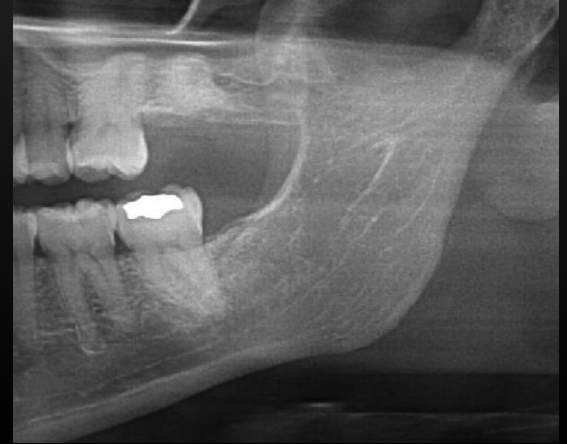
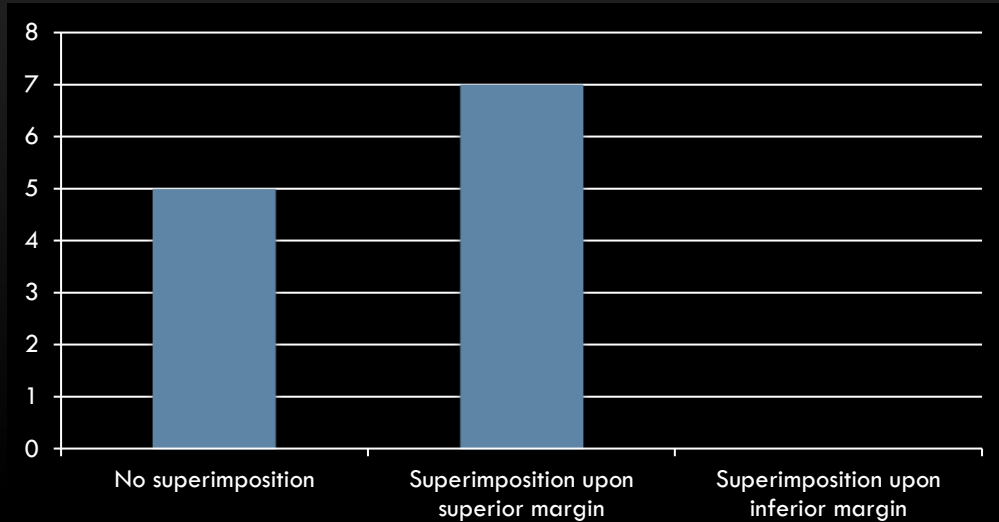
Dentition involved in Endo NI



Devine M, Modgill O, Renton T Mandibular division trigeminal nerve injuries following primary endodontic treatment. A case series. *Aust Endod J*. 2017 Aug;43(2):56-65. doi: 10.1111/aej.12209. Epub 2017 Jul 7.

A previous study report a significant correlation between the tooth location and the suggested cause of nerve injury was found. [Chikvashvili J](#)
Overcoming unforeseen incidents: what to do when an unlikely event occurs. [Compend Contin Educ Dent](#). 2011 Jun;32(5):44-8.

Proximity of apex to IDC in our cohort (based upon radiographs provided)



60% -7/12 available preop LCPAs illustrated preoperative proximity of apex of tooth and IDC

90% of post op LCPAs illustrated over fill and or over instrumentation into IDC

Poor Technique

Over preparation, overfill and over instrumentation of canal

- ▶ **Any tooth requiring endodontic therapy that is in close proximity to the IAN canal should require special attention.**
 - ▶ The practitioner should be trained in root length assessment and root canal preparation.
 - ▶ If the apex is proximal to the IAN canal if the canal is over instrumented there is increase risk of damage to the nerve. If the canal is over prepared and the apex opened the nerve may be damaged by;
- ▶ Physical injury precipitated by;
 - ▶ preparatory files
 - ▶ overfilling using pressurised thermal filling
 - ▶ pressure and ischaemia due to intra canal haemorrhage
- ▶ Chemical nerve injuries from leakage through the apex of;
 - ▶ irrigation - Sodium hypochlorite (39-54)
 - ▶ sealant- Calcium hydroxide(55) medicaments breach of the canal roof precipitating a vascular bleed resulting in haemoglobin irritation of the nerve due to the iron content.



Escoda-Francoli J, et al Inferior alveolar nerve damage because of overextended endodontic material: a problem of sealer cement biocompatibility? J Endod. 2007 Dec;33(12):1484-9.

Blanas N, Kienle F, Sándor GK. Inferior alveolar nerve injury caused by thermoplastic gutta-percha overextension. J Can Dent Assoc. 2004 Jun;70(6):384-7.

Techniques minimising apical extrusion of endo fillers

Apical extrusion of products may be improved by;

Ultrasonics

Endovac.

Guided RCT / Apex locators

Shortened working length?

Post operative RCT views must be arranged on the day of completion of the RCT and identification of any RCT product in the IAN canal should be reviewed carefully and removed within 48 hours.

[J Craniofac Surg](#). 2014 Sep;42(6):757-62. doi: 10.1016/j.jcms.2013.11.007. Epub 2013 Nov 16.

Nerve lesions following apical extrusion of non-setting calcium hydroxide: a systematic case review and report of two cases.

[Olsen JJ¹](#), [Thorn JJ²](#), [Korsgaard N³](#), [Pinholt EM⁴](#).

[Author information](#)

Abstract

We present two cases of apical extrusion of non-setting, calcium hydroxide paste which had been placed as an interappointment root canal dressing during routine endodontic treatment resulting in tissue necrosis of a large part of the mandible. Surgical intervention consisted of resections in both instances. In relation to the cases presented, a systematic review of similar cases in the literature between 1980 and April 2013 was conducted which resulted in eight cases meeting the criteria outlined. As with the two presented cases, half of these eight cases showed serious adverse effects and the use of an injectable system had most often been related to apical extrusion. Consequently, great care should be taken when applying the paste into the canal system.

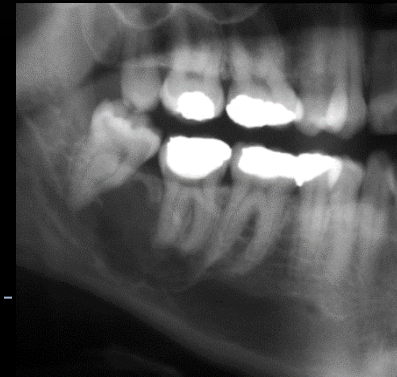


~~Apical extrusion of sodium hypochlorite activated with two laser systems and ultrasonics: a spectrophotometric analysis.~~

► Helvacioğlu Kıvanç B, Deniz Arısu H, Yanar NÖ, Silah HM, İnam R, Görgül G. BMC Oral Health. 2015 Jun 26;15:71

Learn from NaOCL accident risk factors

- ▶ There are several reports of extreme pain and swelling resulting from endodontic irrigation with NaOCl, with a multitude of associated complications including neuropathy.
- ▶ **Kleier et al** surveyed 342 diplomates of the American Board of Endodontics. Of the diplomates who responded, 132 reported experiencing a sodium hypochlorite accident. The risk factors included:
 - ▶ Women compared with men ($p < 0.0001$).
 - ▶ Maxillary teeth compared with mandibular teeth ($p < 0.0001$)
 - ▶ Posterior more than anterior teeth ($p < 0.0001$)
 - ▶ A diagnosis of pulp necrosis with radiographic findings of periradicular radiolucency were positively associated with such accidents ($p < 0.0001$).



Radiographic/ dental risk factors increasing risk for endo nerve injury

Predisposing tooth factor that may result in an adverse incident during root canal treatment	Potential adverse incident if tooth factor not recognised
Resorption defects where extent is not identified such as internal /external communicating with root canal and external surface of the root	Extrusion of endo filler /Hypochlorite accident
Suspicion of a perforation communicating with the external root surface	Extrusion of endo filler /Hypochlorite accident
Root fracture where there could be a potential communication of the root canal with external root surface	Extrusion of endo filler /Hypochlorite accident
Sclerosed root canal	Possible perforation with subsequent hypochlorite accident
Dens invaginatus	Possible perforation with Subsequent hypochlorite accident
Periapical lesions and other pathology (cysts)	Neurological injury (may occur if lesion close to IDC)
Lower molar teeth where root apices are is close proximity to the Inferior dental canal and or mental foramen	Neurological injury (over instrumentation, overfilling with obturation materials or sealer)

Periapical lesions

Case series 22 cases 94% permanent

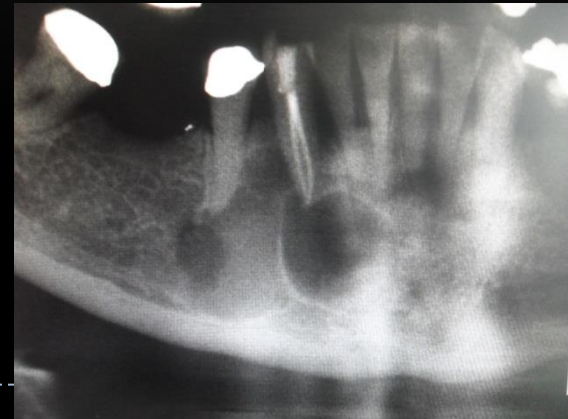
Devine M, Yilmaz Z, Hirani M, Renton T. A case series of trigeminal nerve injuries caused by periapical lesions of mandibular teeth. *Br Dent J*. 2017 Mar 24;222(6):447-455. doi: 10.1038/sj.bdj.2017.268.

Case reports that document neuropathies associated with apical periodontitis are scant, but usually involve premolars, and sensory disturbance in the distribution of the mental nerve. The incidence of mental paresthesia resulting from periapical infection or pathology was estimated at 0.96%.

von Ohle C, ElAyouti A. Neurosensory impairment of the mental nerve as a sequel of periapical periodontitis: case report and review. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2010 Oct;110(4):e84-9; Shadmehr E, Shekarchizade N. Endodontic periapical lesion-induced mental nerve paresthesia. *Dent Res J (Isfahan)*. 2015 Mar-Apr;12(2):192-6

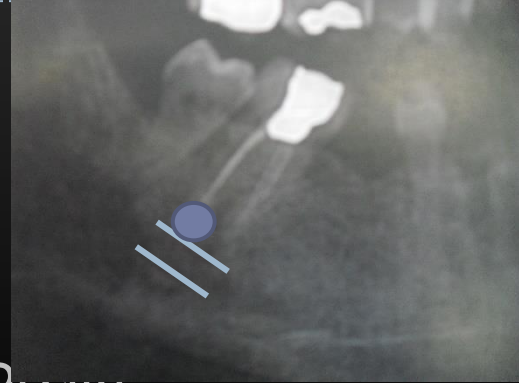
There is every expectation that carefully conducted root canal treatment that limits instruments and materials within the tooth, or indeed tooth extraction will allow symptoms to resolve. 0.24% of cases in the same study, mental paraesthesia was a complication of root canal treatment (caused by severe overfill in one case and iatrogenic perforation of mechanical instrumentation through the root and into the mental nerve in the second case).

Ahonen M, Tjäderhane L (2011) Endodontic-related paresthesia: a case report and literature review. *J Endod*. 2011 Oct;37(10):1460-4.



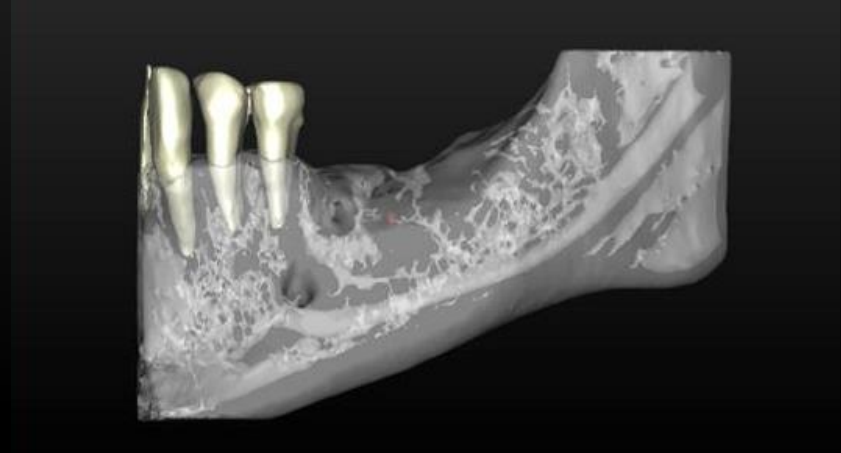
Risk periapical area leading direct access to IDC

- ▶ Endo related nerve injury
 - ▶ Apex of 30 adjacent to ID canal
 - ▶ Periapical area facilitates chemical spread



Bone loculae

- ▶ Large bone trabeculae may result in additional risk to the IAN during endo treatment



Managing preoperative risk

By good clinical and radiographic assessment

- ▶ Is a LCPA alone inadequate for mandibular endo?
- ▶ Indications for CBCT
 - ▶ Further CBCT assessment required if apex close to IDC on plain films?
 - ▶ Should CBCT be routine for planning RCT in teeth Parasympyseal region (Premolar and first molar teeth)?
 - ▶ **You MUST be able to read your own CBCTs**
 - ▶ Always get radiologist review to exclude pathology of all structures



Studies on location of IDC using plain films

- ▶ A classic study of the relationship between mandibular and premolar apices and the mental foramen have 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 D, Buchner A, Hershkowith A, Kaffe I. Roentgenologic study of the mental foramen. Oral Surg Oral Med Oral Pathol. 1976;41(5):682-6).
- ▶ 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 radiographic 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 respective second premolar (Phillips JL, Weller RN, Kulild JC. The mental foramen: 2. Radiographic position in relation to the mandibular second premolar. J Endod. 1992;18(6):271-4).
- ▶ In contrast, the apex of **each second premolar was between 0 and 4.7 mm from the respective mental foramen in various cadaveric studies** (Denio D, Torabinejad M, Bakland LK. Anatomical relationship of the mandibular canal to its surrounding structures in mature mandibles. J Endod. 1992;18(4):161-5).



Current Endo CBCT recommendations

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 considered "routine", and certainly CBCT examinations should not be done without initially obtaining a thorough medical history and clinical examination.

CBCT should be considered an adjunct to two-dimensional imaging in dentistry.

Limited field of view CBCT systems can provide images of several teeth from approximately the same radiation dose as two periapical radiographs, and they may provide a dose savings over multiple traditional images in complex cases.

NO MENTION OF RISK ASSESSMENT RE PREVENTION OF NERVE INJURY

Assessment

Who actually assesses the risk?

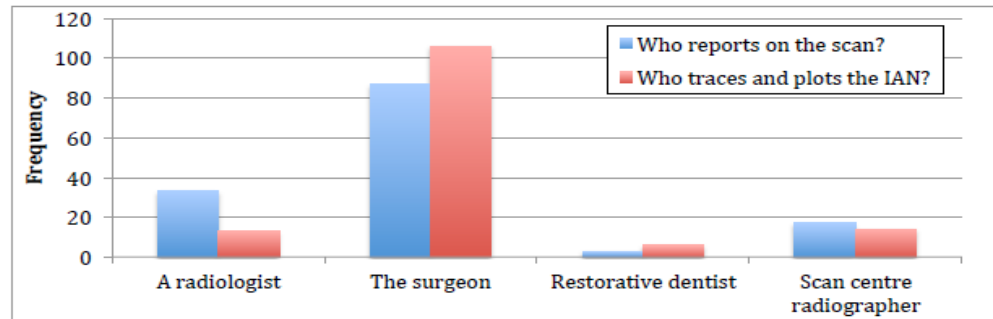
- Clinical
 - OH, Perio
 - Soft tissues and function
 - Hard tissue bone mapping, adjacent dentition
- Radiologic LCPA, DPT or CBCT?
 - Guidelines Faculty Dental Practitioners 9FGDP
 - SEDENTEXTCT
- Informed consent
- Who assesses the risk?

Cone Beam Computed Tomography in Implant Dentistry: A Systematic Review Focusing on Guidelines, Indications, and Radiation Dose Risks

Michael M. Bornstein, PD Dr Med Dent¹/William C. Scarfe, BDS, FRACDS, MS²/
Vida M. Vaughn³/Reinhilde Jacobs, DDS, MSc, PhD, Dr hc⁴

Purpose: The aim of the paper is to identify, review, analyze, and summarize available evidence in three areas on the use of cross-sectional imaging, specifically maxillofacial cone beam computed tomography (CBCT) in pre- and postoperative dental implant therapy: (1) Available clinical use guidelines, (2) indications and contraindications for use, and (3) assessment of associated radiation dose risk. **Materials and Methods:** Three focused questions were developed to address the aims. A systematic literature review was performed using a PICO-based search strategy based on MEDLINE and Cochrane to each focused

Figure 3: Indications of who reports on the scans (CBCT) and who traces and plots the IAN.



Radiographic risk assessment is routinely undertaken in M3M and Implant surgery

Planning for;

- IDC position (not nerve!)

Canal position

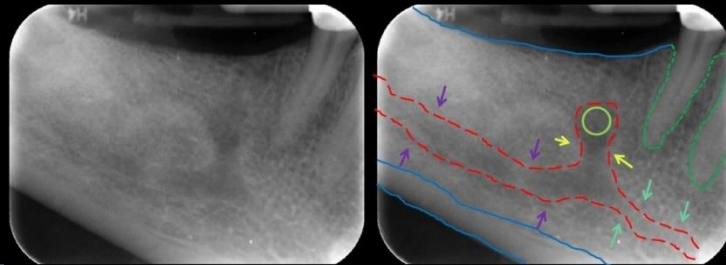
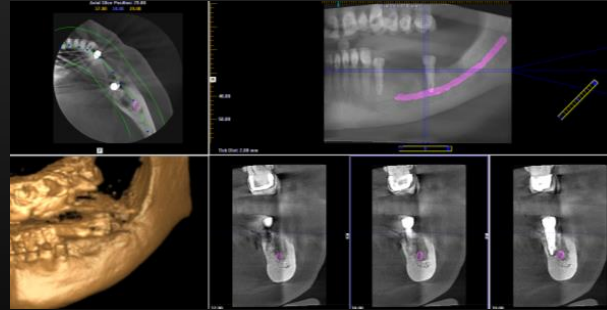
Mental loop

mandibular incisal extension

Accessory canals

Planning software?????

???????Safety zone?????????



Risk assessment Radiographic Proximity to the Inferior dental canal (IDC)

Mandibular teeth proximal to the IAN canal

- ▶ Apex of the tooth may be adjacent or intruding into the IDC canal and any small degree of leakage or overfilling may compromise the IAN.
- ▶ Assessment of the proximity of the tooth apex to the IAN canal has become significantly improved with Cone Beam CT scanning (CBCT) with the attendant risk of additional radiation and may not provide significantly more information than a plane long cone radiograph.
- ▶ Most of CBCT assessment of tooth positioning relation to the IAN canal is based on M3M prior to extraction

Is there a “safety zone” in the mandibular premolar region where damage to the mental nerve can be avoided if periapical extrusion occurs?

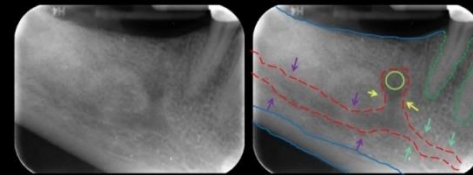
Wei Cheong Ngeow, BDS (Mal), FFDRCS (Ireland), FDSRCS (Eng), MDS (Mal), AM (Mal)

Posted on June 16, 2010

Tags: [adverse reactions](#) [endodontics](#) [radiology](#)

Anatomic Relationship between the Inferior Alveolar Nerve and Dental Apex

Tilotta-Yasukawa and colleagues¹¹ determined the proximity of the apex of the premolars and molars in relation to the mandibular canal, as well



... Tilotta-Yasukawa F, Millor S, El Haddoui A, Bravetti P, Gaudy JF. Labiomandibular paresthesia caused by endodontic treatment: an anatomic and clinical study. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2006 Oct;102(4):e47-59.

CBCT dose reduction

International Endodontic Journal

doi:10.1111/j.1365-2591.2011.01930.x

Diagnostic accuracy of limited-volume cone-beam computed tomography in the detection of periapical bone loss: 360° scans versus 180° scans

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³Department of Periodontology, Dental Institute, King's College London, London, UK; and ⁴Department of Dental Radiology, Dental Institute, King's College London, London, UK

Abstract

Lennon S, Patel S, Foschi F, Wilson R, Davies J, Mannocci F. Diagnostic accuracy of limited-volume cone-beam computed tomography in the detection of periapical bone loss: 360° scans versus 180° scans. *International Endodontic Journal*, 44, 1118–1127, 2011.

Aim To investigate the effect of reducing limited-volume cone-beam computed tomographs arc of rotation from 360° to 180° on the ability to diagnose small, artificially created apical lesions.

Methodology Small, artificial apical bone lesions were prepared with a bur in the apical region of the distal root of ten mandibular first molars, in human dry mandibles. The jaws were scanned in a fixed position with limited-volume CBCT making a 360° and 180° arc of rotation, before and after each periapical lesion had been created. A 4 × 4 cm field of view was used at 90 kV, with a current of 4 mA. Ten examiners blinded to the scan parameters and controls scored the presence/absence of bone lesions.

Intra-examiner reliability was determined after 2 weeks, reviewing half the data set. Statistical analyses with paired t-tests determined the diagnostic accuracy of the two modalities (360° vs. 180°) in terms of sensitivity, specificity, receiver operating characteristic area under the curve, positive predictive values and negative predictive values.

Results The mean values for sensitivity of the 360° and 180° scans were 0.91 and 0.89, respectively; their mean specificities were 0.73. No significant differences were reflected in the statistical analyses.

Conclusions Both 360° and 180° cone-beam computed tomography 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 ICRP guidance to use as low a dosage as reasonably achievable.

Keywords: 180°, CBCT, periapical bone loss, ROC, sensitivity, specificity.

Received 4 April 2011; accepted 5 July 2011

ORAL
&
IMPLANTOLOGY

COMPARISON OF DIFFERENT DOSE REDUCTION SYSTEM IN COMPUTED TOMOGRAPHY FOR ORTHODONTIC APPLICATIONS

E. FANUCCI, V. FIASCHETTI, L. OTTRIA*, M. MATALONI, V. ACAMPORA, R. LIONE*, A. BARLATTANI*, G. SIMONETTI

Department of Diagnostic and Molecular Imaging, Interventional Radiology and Radiation Therapy
* Department of Odontostomatological Sciences - Policlinic Tor Vergata, Rome, Italy

KING'S
College
LONDON

MRI for investigating NI

May diminish the need for CBCT

CONCLUSIONS:

MR neurography can be reliably used for the diagnosis of injuries to the peripheral trigeminal nerve related to molar tooth extractions, with good to excellent correlation of imaging with clinical findings and surgical results.

Role of MR Neurography for the Diagnosis of Peripheral Trigeminal Nerve Injuries in Patients with Prior Molar Tooth Extraction.

[Dessouky R^{1,2}](#), [Xi Y¹](#), [Zuniga J³](#), [Chhabra A⁴](#).

Author information

Abstract

BACKGROUND AND PURPOSE:

Clinical neurosensory testing is an imperfect reference standard to evaluate molar tooth extraction related peripheral trigeminal neuropathy. The purpose was to evaluate the diagnostic accuracy of MR neurography in this domain and correlation with neurosensory testing and surgery.

MATERIALS AND METHODS:

In this retrospective study, nerve caliber, T2 signal intensity ratio, and contrast-to-noise ratios were recorded by 2 observers using MR neurography for bilateral branches of the peripheral trigeminal nerve, the inferior alveolar and lingual nerves. Patient demographics and correlation of

differences in nerve thickness, T2 signal intensity ratio, and contrast-to-noise ratios and nerve injury (area under the curve, 0.83-0.84 for the inferior alveolar nerve and 0.77-0.78 for the lingual nerve). Interobserver agreement was good for the inferior alveolar nerve (intraclass correlation coefficient, 0.70-0.79) and good to excellent for the lingual nerve (intraclass correlation coefficient, 0.75-0.85). MR neurography correlations with respect to clinical neurosensory testing and surgical classifications were moderate to good. Pearson correlation coefficients of 0.68 and 0.81 and κ of 0.60 and 0.77 were observed for differences in nerve thickness.

CONCLUSIONS:

MR neurography can be reliably used for the diagnosis of injuries to the peripheral trigeminal nerve related to molar tooth extractions, with good to excellent correlation of imaging with clinical findings and surgical results.

Is CBCT better than PA radiography for apical proximity to IDC assessment?

Clinical Research

Comparing the *In Vivo* Diagnostic Accuracy of Digital Periapical Radiography with Cone-beam Computed Tomography for the Detection of Vertical Root Fracture

Rajesh Chavda, BDS,* Francesco Mannocci, MD, DDS, PhD, FHEA,* Manobaran Andiappan,[†] and Shanon Patel, BDS, MSc, MClinDent, MFDS RCS, MRD RCS*

Abstract

Introduction: The purpose of this study was to determine whether there is a difference in the *in vivo* diagnostic accuracy of digital radiography (DR) and cone-beam computed tomography (CBCT) imaging in the detection of vertical root fracture (VRF). The presence/absence of VRF was confirmed by visual inspection of the extracted root surface and was the reference standard against which both imaging modalities were compared. **Methods:** Twenty-one unsalvageable teeth from 20 patients that had been radiographed and scanned with CBCT imaging were included in the study. The teeth were atraumatically extracted and visually inspected under a microscope to confirm the presence/absence of fracture. The widest point of each fracture was recorded using an optical coherence tomography

Complete or incomplete vertical root fracture (VRF) develops longitudinally along the root (1). Incomplete root fractures are notoriously difficult to diagnose (2). Classic clinical findings include the presence of an isolated deep periodontal pocket (3) and crestally located sinus tracts (4). However, it is difficult to reach a definitive diagnosis on the basis of signs and symptoms alone because they are not specific to fractures and are very similar to endodontic or periodontal disease (5).

The presence of a VRF is usually associated with a poor prognosis of the affected tooth (6). Chen *et al* (7) evaluated the outcome of 857 endodontically treated teeth over a 5-year follow-up period. They reported that of the 64 teeth that required extraction, VRF was identified as the cause of extraction in 32.1% of teeth.

The diagnostic yield of conventional digital radiography (DR) is limited by its 2-dimensional nature (8). Rud and Omnell (9) evaluated 375 fractured teeth using DR and reported that only 35.7% of root fractures were detected radiographically. Meister *et al* (2) suggested that VRF is only directly detected with DR if there is separation of the root fragment and if the fracture traverses in the direction of the x-ray beam. If the

International Endodontic Journal

doi:10.1111/j.1365-2591.2011.01936.x

EDITORIAL

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Radiographs and CBCT – time for a reassessment?

Well-designed prospective clinical studies are essential to determine the outcome of endodontic treatment. The results from these studies allow us to estimate the prognosis of various treatments, thus greatly assisting the patient to make an educated informed decision on the best treatment option for their unique endodontic problem.

In endodontics for nearly 100 years this assessment

superior accuracy of CBCT in detecting periapical lesions (Özen *et al.* 2009, Patel *et al.* 2009). More recently, *in vivo* studies have concurred with these findings. Paula-Silva *et al.* (2009b,c) intentionally infected root canals in dog's teeth, these teeth were then sub-divided into different groups; some groups were root filled, the others were left as positive and negative control groups. Six months post-treatment the dogs were killed and a histopathological examination of

Recent studies of apical position relative to IDC and Mental foramen

Wang X, Chen K, Wang S, Tiwari SK, Ye L, Peng L. Relationship between the Mental Foramen, Mandibular Canal, and the Surgical Access Line of the Mandibular Posterior Teeth: A Cone-beam Computed Tomographic Analysis. *J Endod.* 2017 Aug;43(8):1262-1266. doi: 10.1016/j.joen.2017.03.043. Epub 2017 Jun 22.

INTRODUCTION: The purpose of this study was to investigate the relationships between the location of the mental foramen (MF) and the mandibular canal (MC) and the surgical access line (SAL) of the mandibular posterior teeth using cone-beam computed tomographic (CBCT) scans. **METHODS:** CBCT scans of 204 subjects ranging in age from 18-76 years old were evaluated. The vertical and horizontal distances from the MF to the SAL of the mandibular premolars and first molars and the vertical distance from the MC to the SAL of the second premolars and first molars were measured via CBCT scans.

RESULTS: The average vertical distance between the MF and the SALs showed significant increases sequentially from the first premolars to the distal roots of the first molars, and the **shortest average distance of 2.74 mm** was obtained for the first premolars. The SALs of the second premolars were the closest to the MF in the horizontal direction with an average distance of 1.5 mm. In 19.9% of the cases, the vertical and horizontal distances between the MF and the SALs of the second premolars were less than 2 mm. In addition, the MF was located superior to the root apices in 6.62% of the cases. The majority of the SALs were located at a vertical distance from the MC that was more than 2 mm. **Men and women exhibited significant differences in both the horizontal distance from the MF to the SALs of the first premolars and the vertical distance from the MC to the SALs of the second premolars.**

CONCLUSIONS: To improve the success of endodontic microsurgery, adequate knowledge of the anatomic relationships between the location of the MF and MC and the SAL of the mandibular posterior teeth is indispensable to surgeons.

Aksoy U, Aksoy S, Orhan K. A cone-beam computed tomography study of the anatomical relationships between mandibular teeth and the mandibular canal, with a review of the current literature. *Microsc Res Tech.* 2017 Dec 29. doi: 10.1002/jemt.22980

The purpose of this study was to evaluate age- and sex-related changes in the anatomical relationships between the roots of the molars and premolars and the mandibular canal using cone-beam computed tomography (CBCT) images. A total of 243 patients (116 males, 127 females) aged 16-83 years for whom previous CBCT scans were available were enrolled in this study. The patients were subcategorized by sex and age (Group I, <21 years; Group II, 21-40 years; and Group III, >40 years). The distances between the mandibular canal and the molars and premolars were measured. The mandibular canal was significantly closer to the root apices of the second and third molars than to the apices of other evaluated teeth ($p < 0.05$). All measurements were significantly higher in male than in female subjects ($p < 0.05$). Group I subjects exhibited significantly shorter distances between the mandibular canal and root apices of the first and second premolars, and the molars, than those of Group II and III subjects ($p < 0.05$). Direct contact relationships were found in 1.6%, 3.3%, 3.3%, 16%, and 32.2% of teeth (running from the first premolar to the third molar, respectively). Age and sex influenced the anatomical relationships between mandibular teeth and the mandibular canal, and these should be considered when planning endodontic and surgical procedures to avoid potential nerve injury.

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Prevention of Endodontic related neuropathy: Risk factors

- A. Inadequate preoperative assessment and planning due to;**
- Lack of knowledge
 - GDP (80% of referrals) GDP endodontic success rates are significantly
 - The American Association of Endodontists have made several recommendations for patients
 - Inability to read the radiographs or CBCT
 - Inadequate informed consent-all options provided and related risk/benefit
 - Lack of identification of existing pre-surgical neuropathy (periapical lesions).

Tooth apex position

Proximity to IDC

Related root morphology

85%)
Proximal of these

- B. Premolar teeth & Proximity of tooth apex to IDC – 90% of the mandibular teeth in this series, were close to the IAN canal or premolars adjacent to the mental foramen. Proximity to the apex to the IAN/ breach and seal and over chemical or instrumentation**
- Tantanapornkul et al, reported the specificity and sensitivity of CBCT for the tooth roots in 161 mandibular third molars 161; for it was CBCT 93% which were not significantly different.
 - Patel et al (34) have reported on the use of CBCT in managing cone periapicals.

Poor technique

Lack apical seal

Over instrumentation

Over filling

to
63%

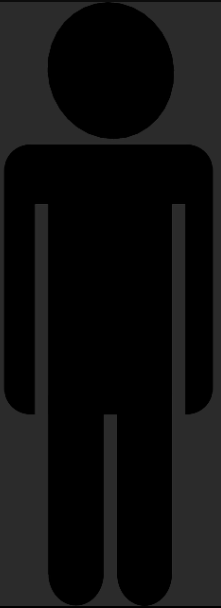
- C. Poor technique**
- Breach of apex causing pain during surgery on irrigation or during instrumentation and damage to periapical tissue
 - Over instrumentation
 - Overfill Detectable overfill occurred in 60% of cases and over instrumentation during preparation

- D. Early recognition and intervention for Endodontic related nerve injuries**
- ALWAYS undertake HOME CHECK , review patient and confirm neuropathy
 - Neuropathy related to endodontics can be delayed and the patient must be seen 4 days post treatment (Renton et al unpublished).
 - If nerve injury is suspected, you will already be aware of the proximity of the tooth to the IAN, breach of apex, over instrumentation or deposition of endodontic material into the IAN
 - If there is suspected the material, the apex and or tooth must be removed within 48 hours or placement in a socket to maximise recovery from nerve injury. If the patient is insistent on keeping the tooth urgent referral of the patient may be indicated for

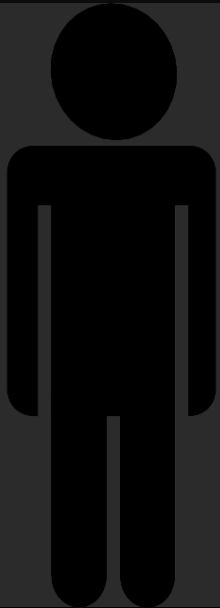
Postoperative

Late recognition and late tooth or overfill removal

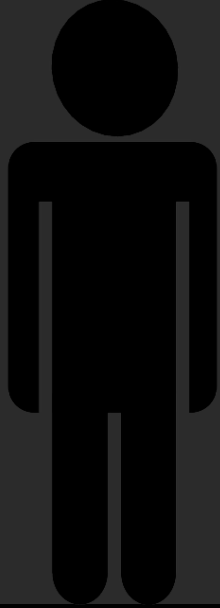
Overview



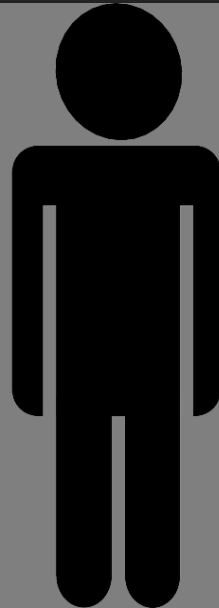
Why prevent these
nerve injuries?



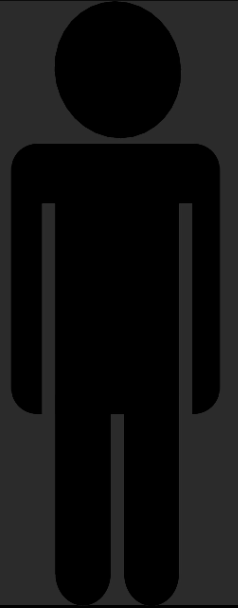
How to prevent
LA nerve injuries?



How to prevent
Endo nerve injuries?



How to manage
nerve injuries?



Summary and
work to do



Management of Trigeminal Post traumatic neuropathy

Currently, there is **no consensus** on the optimal management of neuropathic pain exists and practices vary greatly worldwide.

Possible explanations for this include **difficulties in developing agreed diagnostic protocols and the coexistence of neuropathic, nociceptive and, occasionally, idiopathic pain in the same patient.**

Int. J. Oral Maxillofac. Surg. 2012; 41: 629–637
doi:10.1016/j.ijom.2011.11.002, available online at <http://www.sciencedirect.com>

*International Journal of
Oral &
Maxillofacial
Surgery*

Review Paper
Oral Surgery

Managing iatrogenic trigeminal nerve injury: a case series and review of the literature

T. Renton, Z. Yilmaz
King's College London Dental Institute,
Denmark Hill Campus, London, UK

T. Renton, Z. Yilmaz: Managing iatrogenic trigeminal nerve injury: a case series and review of the literature. Int. J. Oral Maxillofac. Surg. 2012; 41: 629–637. © 2011 International Association of Oral and Maxillofacial Surgeons. Published by Elsevier Ltd. All rights reserved.

Abstract. This study describes the management of 216 patients with post-traumatic iatrogenic lingual nerve injuries (LNIs; $n = 93$) and inferior alveolar nerve injuries (IANI; $n = 123$). At initial consultation, 6% IANI and 2% LNI patients had undergone significant resolution requiring no further reviews. Reassurance and counselling was adequate management for 51% IANI and 55% LNI patients. Systemic or topical medication was offered as pain relief to 5% of patients. Additional cognitive behaviour therapy (CBT) was offered to 8% of patients. Topical 5% lidocaine patches reduced pain and allodynia in 7% of IANI patients, most often used without any other form of management. A small percentage of IANI patients (4%) received a combination of therapies involving CBT, surgery, medication and 5% lidocaine patches. Exploratory surgery improved symptoms and reduced neuropathic area in 18 LNI and 15 IANI patients resulting in improved quality of life. In conclusion, the authors suggest a more diverse and perhaps holistic strategy for management of patients with iatrogenic trigeminal nerve injuries and recommend pragmatic assessment criteria for measurement of treatment success in these patients.

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Available online 10 February 2012

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Treatments for accidental damage during surgery to the nerves supplying sensation to the tongue, lower lip and chin

Published:
16 April 2014

Authors:
Coulthard P, Kushnerev E, Yates JM, Walsh T, Patel N, Bailey E, Renton TF

Primary Review Group:
Oral Health Group

Review question

The main question addressed by this review is how effective are different treatments and what are the best timings for these treatments following accidental damage during surgery to the nerves that supply sensation to the tongue, lower lip and chin.

Background

The nerves (alveolar and lingual) supplying sensation to the tongue, lower lip and chin, may be injured as a result of surgical treatments to the mouth and face, including surgery to remove lower wisdom teeth. The vast majority (90%) of these

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Crowd**

**Become a
citizen scientist**

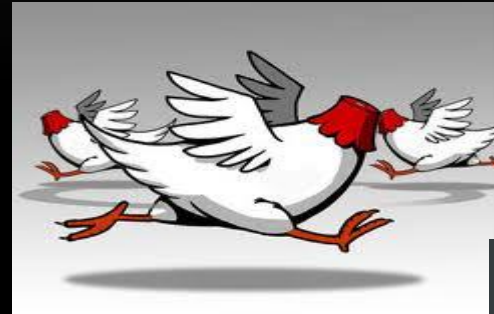
Authors' conclusions:

There is clearly a need for randomised controlled clinical trials to investigate the effectiveness of surgical, medical and psychological interventions for iatrogenic inferior alveolar and lingual nerve injuries. Primary outcomes of this research should include: patient-focused morbidity measures including altered sensation and pain, pain, quantitative sensory testing and the effects of delayed treatment.

Management of Implant nerve injury

Don't panic.....Say sorry!

- ▶ Sorry is NOT an admission of guilt it just shows you care!
- ▶ Disclose
- ▶ Apologise
- ▶ Remediate



Assessment

- ▶ History event related initiation of pain
 - ▶ Severe pain during procedure (funny bone pain)
 - ▶ High level post surgical pain (indicative of nerve injury)
- ▶ **Remember onset of Endo related chemical nerve injury may be delayed by 2-3 days**

[J Endod](#). 2009 Jul;35(7):958-61. doi: 10.1016/j.joen.2009.04.017.

Clinical investigation of patients who develop neuropathic tooth pain after endodontic procedures.

[Oshima K¹](#), [Ishii T](#), [Ogura Y](#), [Aoyama Y](#), [Katsuumi I](#).

Author information

Abstract

INTRODUCTION:

This study aimed to determine the characteristics of patients with neuropathic tooth pain (NTP) who were selected from a group of patients who developed persistent pain after undergoing endodontic procedures.

METHODS:

Of 271 patients who had chronic persistent pain that did not respond to previous endodontic procedures and were referred to the Endodontic Team of the Nippon Dental University Hospital, 16 patients (5.9%; mean age, 46.8 years; 13 women) who fulfilled the diagnostic criteria for NTP were recruited. The inclusion criteria for the patients were the presence of chronic persistent pain and other pain-related symptoms, despite the absence of major pathology.

RESULTS:

Pain predominantly occurred in the maxilla (14 patients). In 10 patients (62.5%), NTP developed after retreatment. Daily application of tricyclic antidepressants produced pain relief in 11 patients (68.8%).

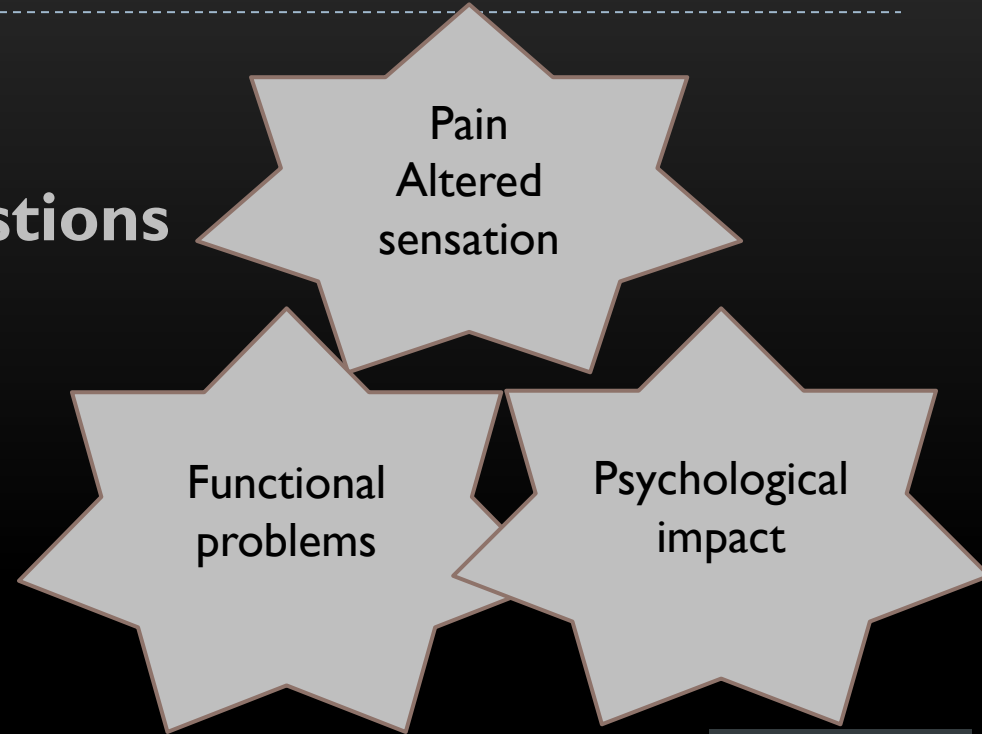
CONCLUSIONS:

These results indicated that NTP is a rare type of chronic intractable endodontic pain and that careful diagnosis of NTP is important.

Key patient assessment factors should drive management

▶ Important patient questions

- ▶ Altered sensation / Numbness / Pain
- ▶ Functional impact
- ▶ Psychological impact



Management of nerve injury

Important procedural questions

- **Mechanism**
- **Duration**
- **Extreme pain during treatment**
- **Post treatment** (may be delayed 2-3 days)
 - Extreme pain initially
 - Pain altered sensation
 - Functional
 - psychological



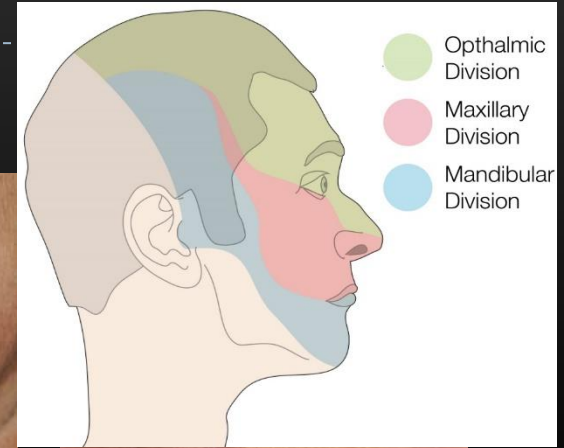
Patient with trigeminal and trochlear neuropathy
Courtesy of Dr Sal Ruggiero

Thexton A, SJ Crean, Hankins M. Simplifying assessment of recovery of the lingual nerve from injury. BDJ. 2006; 10:569-573 Renton T, Thexton A, McGurk M.
New method for the objective evaluation of injury to the lingual nerve after operation on third molars. Br J Oral Maxillofac Surg. 2005 Jun;43(3):238-45. Renton T,
Thexton A, McGurk M. Objective evaluation of iatrogenic lingual nerve injuries using the jaw-opening reflex. Br J Oral Maxillofac Surg. 2005 Jun;43(3):232-7

Management of nerve injury

Confirm Nerve injury / Neuropathy

- Identify the extent of injury
 - Size neuropathic area
 - Subjective function
 - Mechanosensory function
 - Disability
 - Pain / discomfort
 - **Allodynia**
 - **Hyperalgesia**
 - **Spontaneous or elicited?**



Renton T, Thexton A, SJ Crean, Hankins M. Simplifying assessment of recovery of the lingual nerve from injury. BDJ 2006 10:569-573
Renton T, Thexton A, McGurk M. New method for the objective evaluation of injury to the lingual nerve after operation on third molars. Br J Oral Maxillofac Surg. 2005 Jun;43(3):238-45.
Renton T, Thexton A, McGurk M. Objective evaluation of iatrogenic lingual nerve injuries using the jaw-opening reflex. Br J Oral Maxillofac Surg. 2005 Jun;43(3):232-8

Assessment of neuropathic area

Know your anatomy!

Implant extraction or endodontic procedure

undertaken with resultant numbness of mouth & lip with pain

Neuropathic area should affect 'DISTAL' domain of dermatome

In some cases only socket area can be affected with localised hypersensitivity



Neuropathic area you can use dental vitality tests but not very reliable

Extraoral area may be complete **or partial**
Below illustrates 40% affected

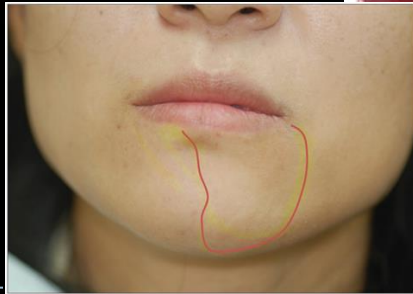


Assessment of neuropathic area

Know your anatomy!

Neuropathic area you can use dental vitality tests but not very reliable

Extraoral neuropathy affecting 9 of area0%



Inferior dental block
undertaken with resultant numbness of mouth&lip with pain

Neuropathic area should affect 'DISTAL' domain of dermatome

Can a prognostic assessment be based on patient presentation?

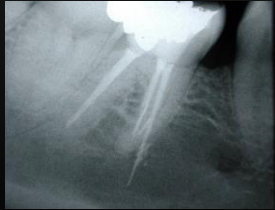
No its NOT possible!



Assessment of nerve injury

Indication for investigations

Radiology Post surgical radiographs (panoral for wisdom teeth and LCPA for endo NIs) are required to confirm causality though mainly a clinical diagnosis



Post surgical CBCTs only required for M3M lingual and Inferior alveolar nerve injury

Use plain film only

CBCT -unnecessary irradiation of the patient

Provides no further information and does not change treatment

High resolution MRI may be of use

Management of dentistry related nerve injury

- Prevention is best!
- Treatment must depend upon the mechanism and duration of nerve injury
- Treat
 - Pain
 - Functional disability
 - Psychological impact
- Counselling
 - Reaffirm nerve injury is permanent
 - Be honest with the patient
 - Reassurance and explanation
- Medical for pain +/- depression
 - Topical
 - Systemic
- Surgical
- Remove implant within 30 hours

Int. J. Oral Maxillofac. Surg. 2012; 41: 629-637
doi:10.1016/j.ijom.2011.11.002, available online at <http://www.sciencedirect.com>

*International Journal of
Oral &
Maxillofacial
Surgery*

Review Paper
Oral Surgery

Managing iatrogenic trigeminal nerve injury: a case series and review of the literature

T. Renton, Z. Yilmaz
King's College London Dental Institute,
Denmark Hill Campus, London, UK

Abstract. This study describes the management of 216 patients with post-traumatic iatrogenic lingual nerve injuries (LNIs; $n = 93$) and inferior alveolar nerve injuries (IANI; $n = 123$). At initial consultation, 6% IANI and 2% LNI patients had undergone significant resolution requiring no further reviews. Reassurance and counselling was adequate management for 51% IANI and 55% LNI patients. Systemic or topical medication was offered as pain relief to 5% of patients. Additional cognitive behaviour therapy (CBT) was offered to 8% of patients. Topical 5% lidocaine patches reduced pain and allodynia in 7% of IANI patients, most often used without any other form of management. A small percentage of IANI patients (4%) received a combination of therapies involving CBT, surgery, medication and 5% lidocaine patches. Exploratory surgery improved symptoms and reduced neuropathic area in 18 LNI and 15 IANI patients resulting in improved quality of life. In conclusion, the authors suggest a more diverse and perhaps holistic strategy for management of patients with iatrogenic trigeminal nerve injuries and recommend pragmatic assessment criteria for measurement of treatment success in these patients.

Acco
Avail

KING'S
College
LONDON

Main goals of management is to the provide the patient with

- ▶ An understanding of their condition and realistic expectations underpins their compliance with treatment and optimises outcomes
- ▶ Reassurance that lessons have been learnt and prevention of future similar problems is being undertaken



Management principles of patient with NI

- ▶ Early - Remedial
- ▶ Later
 - ▶ Psychological
 - ▶ Medical
 - ▶ Surgical
 - ▶ Tooth replacement

Management of dentistry related nerve injury

We cannot fix nerve injuries!

Wait for resolution

- Lingual nerve injuries related to LINGUAL ACCESS third molar surgery
- LA
- Trauma
- Orthognathic

Consent patient properly...forearmed is for warned

Risk assessment in planning

Check on patients post operatively HOMECHECK

Acknowledge problem

No sit and WAIT !!!!!

You MUST reassure your patient but don't give them false expectations!

Seek advice- Trigeminalnerve.org.uk Medication and REFERRAL

URGENT treatment < 30 hours

- ▶ Suspected nerve trauma
- ▶ Implants
- ▶ Endodontics (neuropathy may develop 2-3 days post treatment)

Within 2 weeks

- ▶ Buccal approach Lingual nerve
- ▶ Inferior alveolar nerve injuries related to third molar surgery

Mechanism

Duration

Treatment

Known/suspected nerve section

TMS IANI –retained roots

Implant

Endodontic

Implant / Endodontic

TMS IANI large neuropathic area, pain and disability

TMS LNI – large neuropathic area, pain and disability

TMS IANI –

TMS LNI–

LA, fracture, orthognathic, other surgery

<30 hours

<30 hours

<30 hours

>30 hours

<3 months

<3 months

>6 month

>6 month

Immediate exploration

Immediate exploration

Remove implant

After development of neuropathy

Remove tooth / overfill

Treat therapeutically

Consider exploration

Consider exploration

Treat therapeutically

Treat therapeutically

Treat t therapeutically

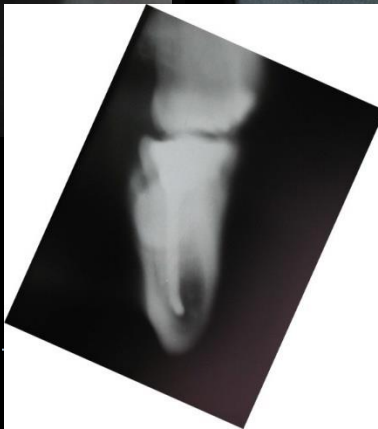
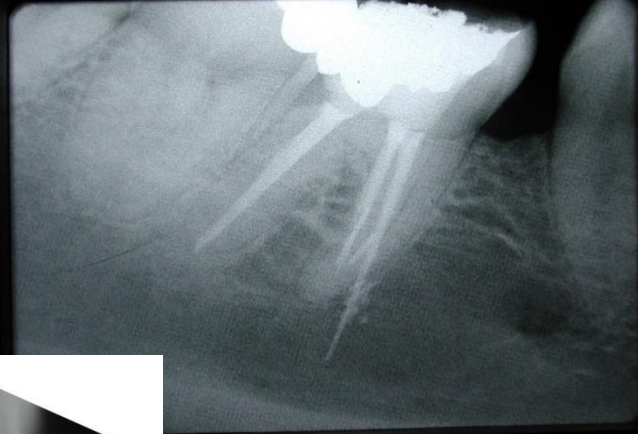
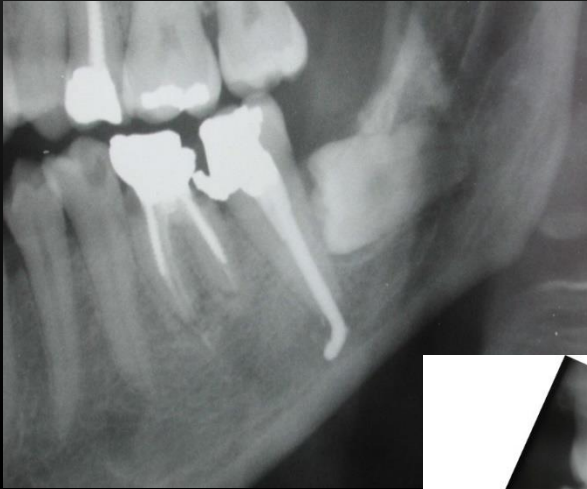
Management LA nerve injuries

- ▶ If the patient feels pain during Injection.....
 - ▶ Stop injecting
 - ▶ Withdraw needle and continue injection
- ▶ Or your patient contacts you the following day after a low risk procedure with neuropathic symptoms
- ▶ Reassure your patient (75% get better!)
- ▶ Follow up next morning and confirm if neuropathy is present
- ▶ Consider medical intervention (limited evidence base)
 - Vitamin B Complex
 - Steroids
 - NSAIDs

Management of Endo related nerve injuries

Does the post op radiograph demonstrate over fill, over instrumentation?

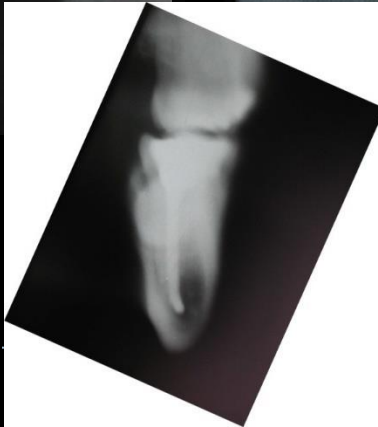
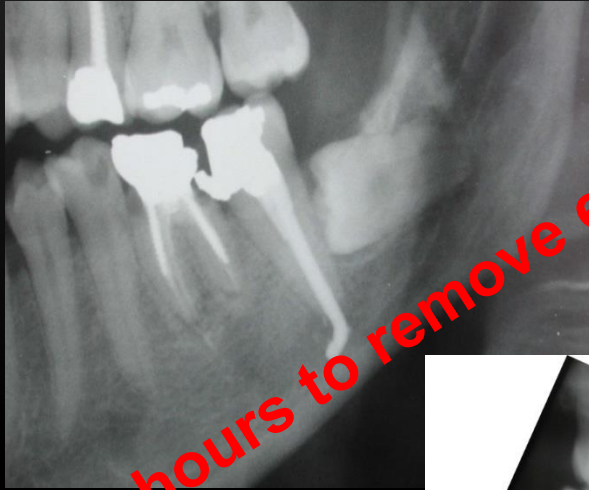
Chemical related neuropathy delayed presentation up to 2-3 days



Management of Endo related nerve injuries

Does the post op radiograph demonstrate over fill, over instrumentation?
Chemical related neuropathy delayed presentation up to 2-3 days.....

When neuropathy becomes apparent swift action is needed



30 hours to remove endo overfill OR tooth

Acute Management Endo NIs

- ▶ Post operative LCPA demonstrates overfill or over instrumentation?
- ▶ If neuropathy develops
 - ▶ **Urgent referral to OS or OMFS for IAN exposure and clean**
 - ▶ **Or Remove Endo and or tooth**
- ▶ Routinely check on patient early post op @24, 36, 60 hours. If pt has neuropathy immediately after LA has worn off;
 - ▶ REMOVE Endo < 24 hours (Pogrel unpublished)
 - ▶ Extract tooth (Devine M, Yilmaz Z, Hirani M, Renton T. A case series of trigeminal nerve injuries caused by periapical lesions of mandibular teeth. Br Dent J. 2017 Mar 24;222(6):447-455. doi: 10.1038/sj.bdj.2017.268.)
 - ▶ Apicectomy nerve decompression (no evidence)
 - ▶ Steroids Yatsushashi et al and Gatot & Tovi have also recommended steroid therapy for early postoperative neuritis and NSAIDs?
 - ▶ Vitamin B Complex (no evidence)
 - ▶ NSAIDS (no evidence)



Refer

Early IANI surgery for Endo related NIs



Pogrel 2007 11 cases acute surgical intervention 5 improvement, 2 none. Recommends URGENT surgical irrigation and removal of overfill

Urgent surgery (<24 hours) may be successful in maximising neural resolution after Endo related nerve injury

Early postoperative detection of Neuropathy

Early intervention after nerve injury can improve resolution?

▶ Acute management < 30 hours (delayed onset neuropathy)

▶ (LA IDB lasts 3 hours and 25 minutes)

▶ Check on Patient after 6 hours (Home check)

▶ IAN NEUROPATHY? (extreme pain/ mixed symptoms large neuropathic area)

▶ Yes

▶ Consult patient, check for area of neuropathy and signs of nerve injury

▶ Confirmed

▶ **Remove Endo / tooth < 30 hours with neuropathy**

▶ + High dose oral NSAIDs (600-800mgs Ibuprofen PO QDS)

▶ Prednisolone 5 day step down does 50-40-30-20-

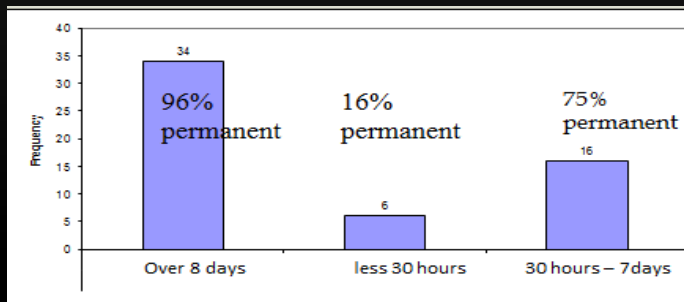
▶ Vitamin B Complex?

▶ (check medical history!)

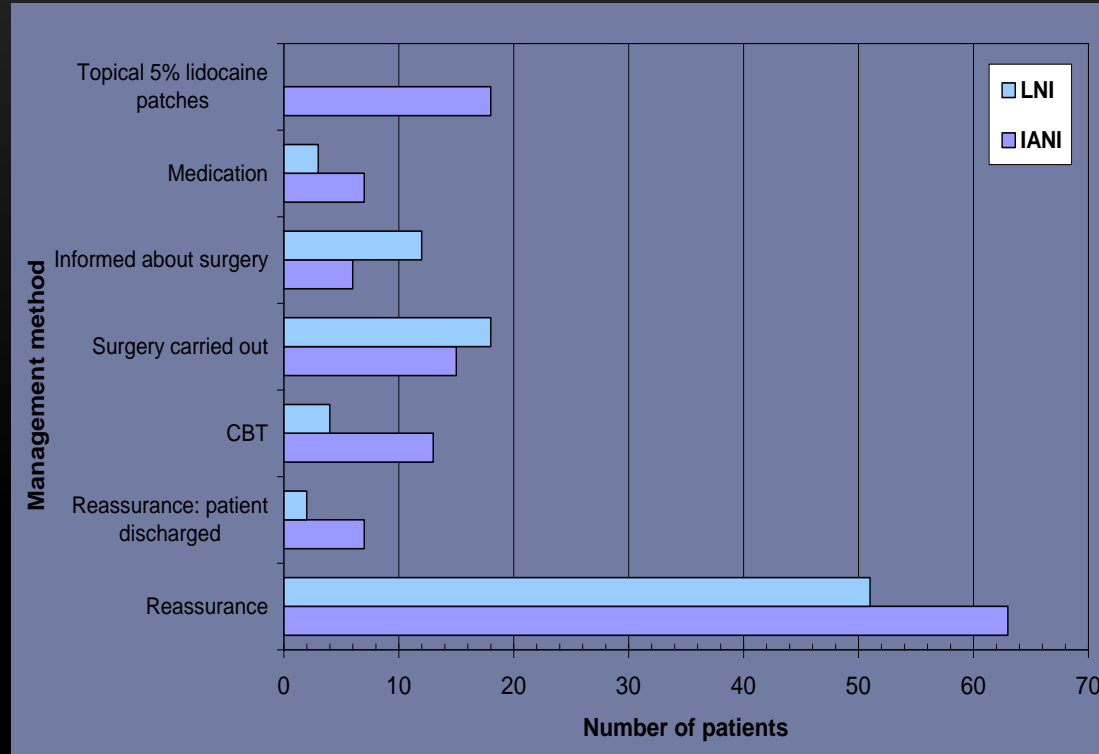
▶ Review

Only use plain films

Removing implant or endo filled tooth < 30 hours does Improve NI resolution



Management of patients is often complex in attempting to reduce pain, improve function and remediate psychological sequelae

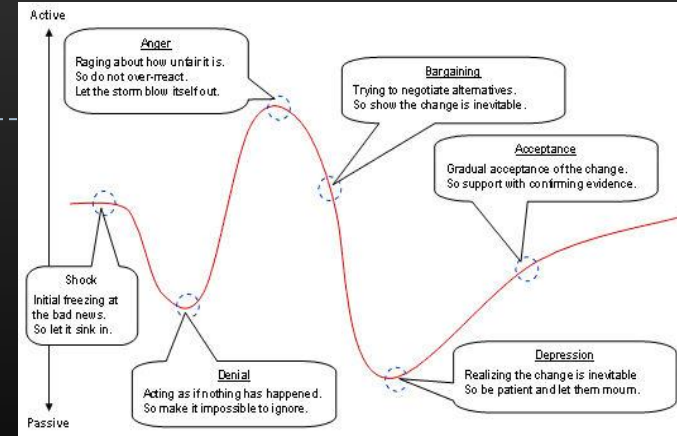


A small percentage of IANI patients (4%) received a combination of therapies involving CBT, surgery, medication and 5% lidocaine patches

Psychological interventions

- ▶ Management of existing mental health problems
- ▶ Cognitive behavioural therapy
- ▶ Mindfulness
- ▶ NLP

- ▶ Smith J et al Psychological morbidity of iatrogenic trigeminal nerve injuries Accepted J Orofacial pain August 2012 MPS annual report Dec 2011



8 The impact of error on the patient



Dr Lisa Page is a consultant psychiatrist to the Facial Pain Clinic at the King's Dental Institute in London where she has helped develop a unique multi-disciplinary approach to the management of trigeminal nerve injuries.

What happens to a dental patient after a mistake?

Patients generally agree to dental treatment expecting a good outcome. Consequently they are often ill-prepared should an injury occur. When major mistakes happen, patients usually experience an initial period of disbelief and shock. For many there may be a protracted period before the extent of the injury is confirmed and it is not uncommon for the patient to be in denial during this stage. Initial

Management- Pain medication - topical

- ▶ **Botox injections**
- ▶ Peripheral local anaesthetic block
- ▶ Check effect on local musculature
Facial nerve
- ▶ **Topical LA patches**



Ngeow WC, Nair R. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2010 Mar;109(3):e47-50.

Injection of botulinum toxin type A (BOTOX) into trigger zone of trigeminal neuralgia as a means to control pain.

Management- Pain medication systemic

- ▶ **Neuralgic pain**
 - Oxcarbazepine
 - Neurontin (Lyrica) Pregabalin
 - Gabapentin
- ▶ **Burning chronic pain**
 - Nortriptyline > Amitriptyline
- ▶ 15% Pts persisted with systemic meds
- ▶ 18% IANI used topical medication



Medical Management of Ne Pain caused by Endo NIs

- ▶ **Oshimi et al reported that 16 patients of 271 patients presenting with chronic orofacial pain, were diagnosed with chronic neuropathic tooth pain subsequent to endodontic retreatment.**
- ▶ Most of these patients were treated for maxillary teeth,
- ▶ **70% of the patients responded to tricyclic antidepressant therapy** which highlights the importance of establishing whether the patient has neuropathic pain. In our study all the patients presented too late for surgical decompression or it was not indicated.
- ▶ Thus **2 patients were managed with Oxcarbazepine** for neuralgic pain elicited with touch or cold and with **topical Clonazepam intraorally to manage the severe gingival discomfort.**
- ▶ **2 patients were prescribed topical 5% patches** (12 hours on nocte and 12 hours off daily) for debilitating mechanical allodynia in the extraoral 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
- ▶ Recommendations for treatment of trigeminal neuropathic pain are also well described by Renton & Zakzewska

Medical Ne pain management

- ▶ Alonso-Ezpeleta O, Martín PJ, López-López J, Castellanos-Cosano L, Martín-González J, Segura-Egea JJ. Pregabalin in the treatment of inferior alveolar nerve paraesthesia following overfilling of endodontic sealer. J Clin Exp Dent. 2014 Apr 1;6(2):e197-202.

CASE REPORT

Inferior alveolar nerve injury resulting from overextension of an endodontic sealer: non-surgical management using the GABA analogue pregabalin

1. J. López-López¹,
2. A. Estrugo-Devesa¹,
3. E. Jané-Salas¹ and
4. J. J. Segura-Egea²

Article first published

DOI: 10.1111/j.1365-2

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Issue



López-López J, Estrugo-Devesa A, Jané-Salas E, Segura-Egea JJ I alveolar nerve injury resulting from overextension of an endodon management using the GABA analogue pregabalin. Int Endod J. 2 doi: 10.1111/j.1365-2591.2011.01939.x. Epub 2011 Aug 23.

AIM: To describe a case of endodontic sealer (AH Plus) penetration within after root canal treatment with resolution of pain and paraesthesia after including treatment with prednisone and pregabalin.

SUMMARY: A 37-year-old woman underwent root canal treatment of the molar tooth. Postoperative periapical radiographs revealed the presence sealer in the mandibular canal. The day after, the patient reported severe paraesthesia/anaesthesia in the region innervated by the left inferior alvi Diagnosis of injury to the inferior alveolar nerve because of extrusion of . The non-surgical management included 1 mg kg⁻¹ per day prednisone, regimen on a daily basis, and 150 mg per day pregabalin, two doses per progress with periodic follow-up visits. One month after the incident, the were gone.

KEY LEARNING POINTS: This case illustrates the care required when per treatment, especially when the root apices are in close proximity to the alveolar nerve canal. The complete resolution of paraesthesia and the co the present case suggests that a non-surgical approach combining pred

Haviv Y, Zadik Y, Sharav Y, Benoliel R. Painful traumatic trigeminal neuropathy: an open study on the pharmacotherapeutic response to stepped treatment. J Oral Facial Pain Headache. 2014 Winter;28(1):52-60. doi: 10.11607/jop.1154.

AIMS: To evaluate pharmacotherapeutic success in patients with painful traumatic trigeminal neuropathy (PTTN) and to identify patient or pain characteristics that may predict treatment outcome.

METHODS: Pharmacotherapy was instituted for PTTN patients and was based on widely accepted protocols for neuropathic pain and conducted in an open fashion. Outcome was assessed by employing prospective diaries recording pain intensity measured with an 11-point (0 to 10) verbal pain score (VPS). Individual characteristics in the patients and their influence on outcome were analyzed. Treatment results in the PTTN patients were compared with those in classical trigeminal neuralgia (CTN) patients, who were used as a comparative cohort. Data were analyzed with a Pearson chi-square test for nominal variables and with an independent samples t test or analysis of variance for continuous variables.

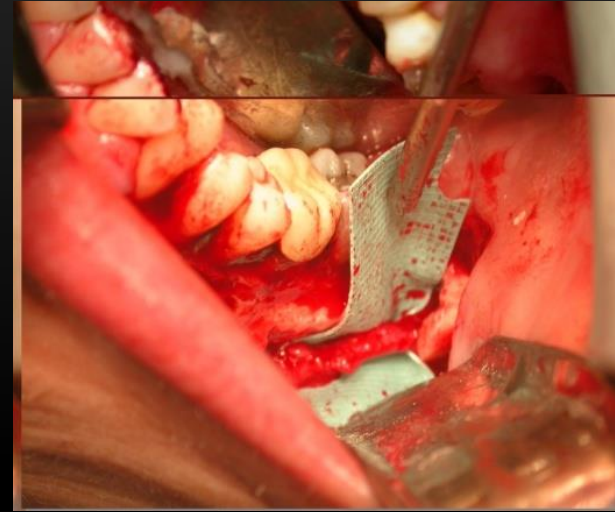
RESULTS: A total of 145 patients were included: 91 with PTTN and 54 with CTN. In PTTN patients, 11% had a ≥ 50% reduction in pain intensity. Higher VPS scores in the PTTN patients were associated with a significantly reduced response to therapy (P = .03). No other pain-related or demographic parameters were associated with treatment outcome in the PTTN patients. Also the response rate of PTTN patients was significantly inferior to that of CTN patients, 74.1% of whom attained a significant reduction in pain intensity (P < .001).

Late Management of nerve injury

If injury is > 36 hours days old or more

Manage therapeutically

- Surgery - removal of implant **doesn't work**
- Reassure patient
 - Psychological support
- Pain management **Medical management**
 - Topical Lidocaine patches, Capsaicin, Amitriptyline
 - Systemic Pregabalin / Tricyclic antidepressants



Surgery does NOT 'fix' injuries or resolve pain

Rodriquez-Lozano F, Sanchez-Perez A, Moya-Villaescusa MJ, Rodriguez-Lozano A, Saez-Yuguero MR. Neuropathic orofacial pain after dental implant placement: review of the literature and case report. OOOE 2010; **109**: e8-e12. Renton T, Yilmaz Z. Profiling of patients presenting with posttraumatic neuropathy of the trigeminal nerve. J Orofac Pain. 2011 Fall;25(4):333-44. Renton T, Dawood A, Shah A, Searson L, Yilmaz Z. Post-implant neuropathy of the trigeminal nerve. A case series. Br Dent J. 2012 Jun 8;212(11):E17. doi: 10.1038/sj.bdj.2012.497

Surgical Management Mx of Endo NIs with Microscopic endo Rx

► Systematic review

► 109 Articles

► 28 analysed

► 84 patients

Rosen E, Goldberger T, Taschieri S, Del Fabbro M, Corbella S, Tsesis I. The Prognosis of Altered Sensation after Extrusion of Root Canal Filling Materials: A Systematic Review of the Literature. *J Endod.* 2016 Jun;42(6):873-9. doi: 10.1016/j.joen.2016.03.018. Epub 2016 Apr 28.

INTRODUCTION: The aim of this study was to systematically review and evaluate the literature regarding the prognosis of altered sensation after extrusion of root canal filling materials and the possible factors influencing it.

METHODS: A systematic search of the literature was performed to identify studies that reported on altered sensation after extrusion of root canal filling materials during endodontic treatments. The articles were evaluated for their relevance based on strict inclusion criteria, and the identified suitable articles were subject to data extraction and analysis.

RESULTS: Initially, **109 possibly relevant articles were identified. After screening and full-text evaluations, 28 articles that met the inclusion criteria were analyzed, reporting on a total of 84 patients** with altered sensation after extrusion of root canal filling materials. All the included studies, except 1 case series, were case reports. Under the limited available data, the extracted data showed that 91% of the patients had fully or partially recovered over time. Most of

CONCLUSIONS: The current scientific knowledge regarding the prognosis of nerve injuries caused by over extruded endodontic materials relies primarily on case reports. Within the limitations of the published data, it seems that the tooth locations, types of extruded materials and the obturation technique, and treatment after the injury may affect the nerve injury prognosis.

Yatsushashi T, Nakagawa K, Matsumoto M, Kasahara M, Igarashi T, Ichinohe T, Kaneko Y. Inferior alveolar nerve paresthesia relieved by microscopic endodontic treatment. *Bull Tokyo Dent Coll.* 2003 Nov;44(4):209-12.

Gatot A, Tovi F. Prednisone treatment for injury and compression of inferior alveolar nerve: report of a case of anesthesia following endodontic overfilling. *Oral Surg Oral Med Oral Pathol.* 1986 Dec;62(6):704-6

Grötz KA, Al-Nawas B, de Aguiar EG, Schulz A, Wagner W. Treatment of injuries to the inferior alveolar nerve after endodontic procedures. *Clin Oral Investig.* 1998 Jun;2(2):73-6

Scolozzi P, Lombardi T, Jaques B. Successful inferior alveolar nerve decompression for dysesthesia following endodontic treatment: report of 4 cases treated by mandibular sagittal osteotomy. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2004 May;97(5):625-31

Brünic A, Gürkan-Köseoglu B, Olgac V. Surgical approach to iatrogenic complications of endodontic therapy: a report of 2 cases. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2009 May;107(5):e50-3

Limited evidence for Surgical Mx of Endo NI

- ▶ 2 Case reports
- ▶ 7 patients
- ▶ 7 patients
- ▶ 9 patients
- ▶ 19 patients

May improve resolution of nerve injury (mechanosensory)

Very limited evidence regarding Neuropathic pain

Scala R, Cucchi A, Cappellina L, Ghensi P. Cleaning and decompression of inferior alveolar canal to treat dysesthesia and paresthesia following endodontic treatment of a third molar. *Indian J Dent Res.* 2014 May-Jun;25(3):413-5. doi: 10.4103/0970-9290.138362.

Endodontic overfilling involving the mandibular canal may cause an injury of the inferior alveolar nerve (IAN). We report a case of disabling dysesthesia and paresthesia of a 70-year-old man after endodontic treatment of his mandibular left third molar that caused leakage of root

Bianchi B Ferri A, Varazzani A, Bergonzani M, Sesenna E. Microsurgical Decompression of Inferior Alveolar Nerve After Endodontic Treatment Complications. *J Craniofac Surg.* 2017 Jul;28(5):1365-1368. doi: 10.1097/SCS.0000000000003672.

Iatrogenic injury in oral surgery is the most frequent cause of sensory disturbance in the distribution of the inferior alveolar nerve(IAN) and mental nerve.Inferior alveolar nerve damage

Biglioli F, Kutanovaite O, Autelitano L, Lozza A, Moneghini L, Bulfamante G, Allevi F. Surgical treatment of painful inferior alveolar nerve injuries following endodontic treatment: a consecutive case series of seven patients. *Oral Maxillofac Surg.* 2017 Dec;21(4):461-466. doi: 10.1007/s10006-017-0656-8. Epub 2017 Sep 20.

Lampert RC, Nesbitt TR, Chuang SK, Ziccardi VB Management of endodontic injuries to the inferior alveolar nerve. *Quintessence Int.*2016;47(7):581-7. doi: 10.3290/j.qi.a36176.

OBJECTIVE: Functional sensory recovery from microsurgical intervention for inferior alveolar nerve (IAN) injuries resulting from endodontic treatment were evaluated using a

Byun SH, Kim SS, Chung HJ, Lim HK, Hej WH, Woo JM Kim SM, Lee JH. Surgical management of damaged inferior alveolar nerve caused by endodontic overfilling of calcium hydroxide paste. *Int Endod J.* 2016 Nov;49(11):1020-1029. doi: 10.1111/iej.12560. Epub 2015 Nov 5.

AIM: To evaluate the neurosensory outcome of management of damaged inferior alveolar nerves caused by endodontic overfilling and to assess the efficacy of delayed surgical intervention

Biglioli F, Allevi F, Lozza A Surgical treatment of painful lesions of the inferior alveolar nerve. *J Craniomaxillofac Surg.* 2015 Oct;43(8):1541-5. doi: 10.1016/j.jcms.2015.07.036. Epub 2015 Aug 5.

Nerve-related complications are being reported with increasing frequency following oral and dental surgery, and typically involve the inferior alveolar nerve (IAN). We assess herein the etiology of neuropathic pain related to IAN injuries, and describe the various surgical treatment techniques available. Between 2007 and 2013, 19 patients were referred to the Maxillofacial Surgery Department of San Paolo Hospital (Milan, Italy) with pain in the area supplied by the IAN, which developed following endodontic treatment, oral surgery and maxillofacial surgery. All patients underwent IAN surgery by several different microsurgical procedures. Most of the patients affected by pain before surgery experienced complete or partial amelioration of symptoms. All patients receiving sural nerve grafts were pain-free 12 months after surgery. In five patients the operation was unsuccessful. In 78.94% of cases, a significant increase in nerve function was observed. Pain following IAN surgical damage may be addressed

Surgical Mx Neuropathic pain

Does NOT respond to late surgery!

ANESTHESIA/FACIAL PAIN

The Presence of Neuropathic Pain Predicts Postoperative Neuropathic Pain Following Trigeminal Nerve Repair

John R. Zuniga, DMD, MS, PhD,* David M. Yates, DMD, MD,†
and Ceib L. Phillips, MPH, PhD‡

Purpose: The risk for the continuation or recurrence of neuropathic pain following trigeminal nerve repair has never been examined. The objective of this study was to determine which risk factors might be associated with the continuation or recurrence of neuropathic pain following trigeminal nerve micro-neurosurgery.

Patients and Methods: An ambispective study design was used to assess subjects who underwent trigeminal nerve repair of the inferior alveolar nerve and lingual nerve between 2000 and 2010. The primary outcome was the presence or absence of neuropathic pain at 3, 6, and 12 months after surgery. Explanatory variables, including age at surgery, gender, presence of neuropathic pain before surgery, site of nerve injury, etiology of nerve injury, classification of nerve injury, duration of nerve injury, and type of repair performed, were abstracted from patient charts. Fisher exact tests were used to compare the demographic and injury characteristics of patients who presented with pain before surgery and those who did not. The McNemar test was used to assess whether there was a significant change in neuropathic pain report from before to after surgery. The level of significance was set at .50.

Results: Of the 65 patients analyzed, two-thirds were women; the average age was 36 ± 16.1 years, and the median time between the injury and surgery was 6.4 months (interquartile range, 6.7 months). Lingual

Conclusions: The presence of neuropathic pain prior to trigeminal micro-neurosurgery is the major risk factor for the continuation or recurrence of postoperative neuropathic pain. These findings suggest that trigeminal nerve surgery is not a risk factor for developing neuropathic pain in the absence of neuropathic pain before surgery.

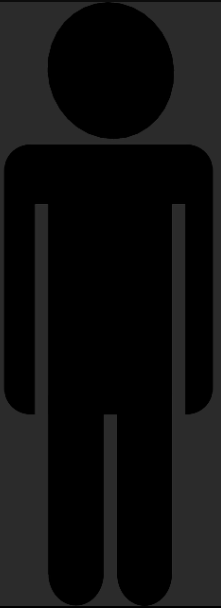
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J Oral Maxillofac Surg 72:2422-2427, 2014

Advanced pain Management of Endo NIs Ne Pain

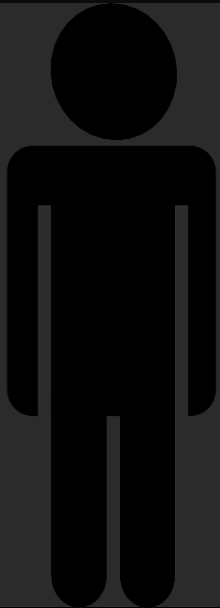
Pulsed and conventional radiofrequency treatment: which is effective for dental procedure-related symptomatic trigeminal **neuralgia**?

Kim JH, Yu HY, Park SY, Lee SC, Kim YC. **Pain** Med. 2013 Mar;14(3):430-5.

Overview



Why prevent these
nerve injuries?



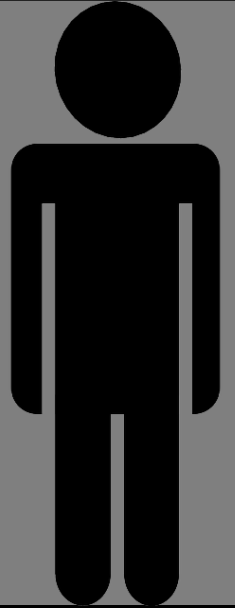
How to prevent
LA nerve injuries?



How to prevent
Endo nerve injuries?



How to manage
nerve injuries?



Summary and
work to do



But as the Sioux say.....Umche Echi!e!



Tara Renton Kings College London

LA nerve injury issues

- ▶ Consent
- ▶ Prevention
- ▶ Recognition
- ▶ Management

Recommendations

Block injection patient consent?

Spinal block injections

Royal College of Anaesthetists UK 2012 annual National Audit

Risk of permanent motor or sensor neuropathy after epidural or spinal injection was reported 1 in 52K (injections)

Routine warning is recommended for these interventions

Dental Block injections

Germany Since law suit in Germany 2009 now consent re IDB injections risk of nerve injury is routine

USA Previously published recommendation in USA 1939!

Daniel L Orr, William J Curtis **Obtaining written informed consent for the administration of local anesthetic in**

dentistry. Journal of the American Dental Association (1939) (Impact Factor: 1.82). 12/2005; 136(11):1568-71

purpose of this study was to examine the frequency with which dentists obtain written informed

consent for the administration of local anesthetic in dentistry. A survey to 252 dentists:--

Recommendations

Should LA practice change?

► Tailored LA /Technique specific infiltration dentistry

- Infiltration dentistry avoids the use of IDBs, thus preventing LA-related nerve injury, for which there is no cure
- Change LA training at dental school
- This technique requires less skill, less discomfort for the patient during the injection and avoids unnecessary lingual anaesthesia after dental treatment.

Infiltration dentistry is dependant upon

The site and procedure

Maxillary dentistry can be performed using Lidocaine 2% with adrenaline for all procedures
Buccal infiltration with intra-septal injections
No additional benefit using 4% Articaine infiltration over Lidocaine

Mandibular Molar Endodontic procedures may be only procedure to require IDBs



Mandibular 7s and 8s for perio, restorations or implants
Articaine 4% buccal infiltration and Lidocaine 2% lingual infiltrations OR for extractions, Articaine 4% buccal infiltration plus Lidocaine intr-ligamental

Mandibular 1st molars for perio, restorations or implants
Articaine 4% buccal and Lidocaine 2% lingual infiltrations OR for extractions buccal infiltration intra-ligamental
Endo for pulpitic first molar

Mandibular incisors, canines and premolars for perio, restorations or implants and Endo
Submucosal infiltration in front or behind mental nerve area (NOT direct into nerve) Articaine 4% buccal infiltrations and extractions add lingual infiltration and or intra-ligamental

Recommendations

Management LA nerve injuries

- ▶ **There is no evidence base for managing dental LA related nerve injuries**
we only know that 25% are permanent
- ▶ **You may not be negligent** in causing the LA related nerve injury (**yet**) but you should at least treat your patients humanely and prevent nerve injuries where possible
- ▶ **There is no ‘magic bullet’ to fix them**, we have to sit and wait and reassure the patient.
- ▶ **Guidance development for managing LA caused sensory neuropathy**
 - ▶ Routinely contacting patients who experience pain during IDBs
 - ▶ Should we **institute early medical intervention?**
 - ▶ **What is the role** of Vitamin B complex, Steroids and or NSAIDs? (check medical history first and request the patient's General medical practitioner to prescribe the medication)



Endo nerve injury issues

- ▶ Consent
- ▶ Recognition of preoperative neuropathic pain
- ▶ Prevention
 - ▶ Risk assessment
 - ▶ Modified technique
- ▶ Early post operative recognition of PTN and PPTTN
- ▶ Management
- ▶ Use accepted terminology, ICD (diagnostic and outcome) and OPSC coding



Recommendations

Endo nerve injury Consent

Depends upon risk assessment

- ▶ Generalist or specialist?
- ▶ Tooth position in relation IDC
- ▶ Other radiological and dental risk factors
 - Root fractures, Root pathology and periapical pathology
 - Large bony loculae, cysts pathology,
- ▶ Patient propensity to develop CPSP

Giuliani M, Lajolo C, Deli G, Silveri C Inferior alveolar nerve paresthesia caused by endodontic pathosis: a case report and review of the literature Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2001 Dec;92(6):670-4. Review.

Lobb WK, Zakariasen KL, McGrath PJ. Endodontic treatment outcomes: do patients perceive problems? J Am Dent Assoc. 1996 May;127(5):597-600.

Kleier DJ, Averbach RE, Mehdipour O. The sodium hypochlorite accident: experience of diplomates of the American Board of Endodontics. J Endod. 2008 Nov;34(11):1346-50. Epub 2008 Aug 30.

Recommendations

Encourage referrals to specialists for high risk cases

- ▶ In the case of surgical endodontic procedures, only practitioners with adequate training and experience should consider operating close to the inferior alveolar and mental nerves and current guidelines suggest that 3-dimensional imaging
- ▶ European Society of Endodontology, Patel S, Durack C, Abella F, Roig M, Shemesh H, Lambrechts P, Lemberg K (2014) European Society of Endodontology position statement: the use of CBCT in endodontics. Int Endod J. 2014 Jun;47(6):502-4

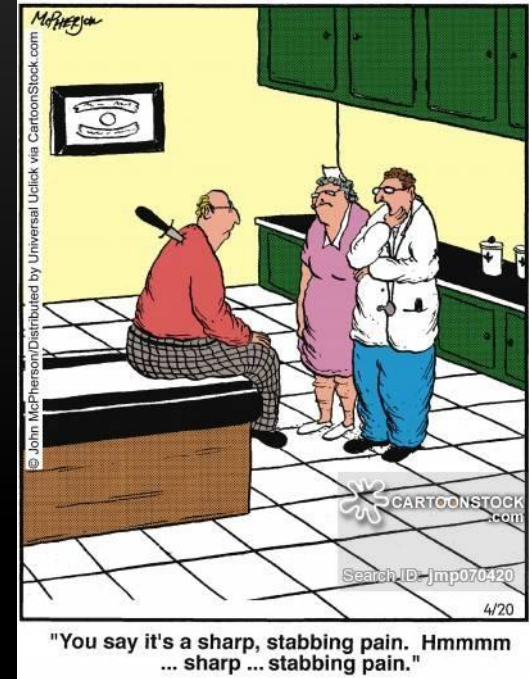
Recommendations

Pre screening for neuropathic pain

- ▶ Identify patients presenting Neuropathic pain rather than odontogenic pain
- ▶ Identify patients at risk of developing of Chronic post surgical pain (CPSP)
- ▶ Chronic pain DOES NOT RESPOND to peripheral SURGERY
- ▶ Pre screening tools
 - ▶ DN4, PainDetect, LANSS questionnaires

Screen for Ne Pain-Quintessence Int. 2011 Mar;42(3):259-69. **The prevalence of persistent pain after nonsurgical root canal treatment.** Klasser GD, et al

Shackleton TA. Failure of root canal treatment misdiagnosed as neuropathic pain: case report. J Can Dent Assoc. 2013;79:d94 Kaufmann R. Failure of root canal treatment misdiagnosed as neuropathic pain. J Can Dent Assoc. 2014;80:e28



Recommendations

Guidelines to minimise Endo NI

Guidelines for recognising reporting and learning from Endo related nerve injuries

Training Any tooth requiring endodontic therapy that is in close proximity to the IAN canal should require special attention. The practitioner should be trained in root length assessment and root canal preparation (European Endo Soc referral)

RISK ASSESSMENT

Radiographic guidelines for specific radiological risk assessment

- ▶ **Plain film SAFETY ZONE**
- ▶ **Should CBCT be considered an adjunct to two-dimensional imaging in dentistry.**
- ▶ **If overfill detected on discharge LCPA is CBCT really necessary?**

AAE and AAOMR joint position statement. Use of cone-beam-computed tomography in endodontics. American Association of Endodontists; American Academy of Oral and Maxillofacial Radiography. Pa Dent J (Harrisb). 2011 Jan-Feb;78(1):37-9.

Technical Guidelines to

Minimise over instrumentation and overfill and chemical leakage into IDC

- Working length
- Create apical plug
- Cold lateral condensation
- Apical extrusion of products may be increased by ultrasonics and minimised by using Endovac
- Always use a side venting needle with luer lock syringe
- Never bend the needle in the canal
- Never inject the hypochlorite into the canal it should be a very gentle passive movement of hypochlorite into the canal
- Never take the hypochlorite needle to the full working length
- Use of Rubber Dam
- Ensure that the needle is tightly bound to the luer lock syringe

Escoda-Francoli J, et al Inferior alveolar nerve damage because of overextended endodontic material: a problem of sealer cement biocompatibility? J Endod. 2007 Dec;33(12):1484-9. Blanas N, Kienle F, Sándor GK. Inferior alveolar nerve injury caused by thermoplastic gutta-percha overextension. J Can Dent Assoc. 2004 Jun;70(6):384-7.

Apical extrusion of sodium hypochlorite activated with two laser systems and **ultrasonics**: a spectrophotometric analysis. Helvacioğlu Kivanç B, Deniz Arısu H, Yanar NÖ, Silah HM, İnam R, Görgül G. BMC Oral Health. 2015 Jun 26;15:71

International Endodontic Journal
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EDITORIAL

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PAIN SPECIAL ISSUE

Trigeminal nerve injuries

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Keywords

endodontic, local anaesthetic, nerve injury, neuropathic pain, trigeminal

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Abstract

Trigeminal nerve injury is the most problematic consequence of dental surgical procedures with major medico-legal implications. In trigeminal nerve injuries related to dentistry, 70% are reported to have chronic neuropathic post-traumatic pain. Neuropathic pain states require different therapeutic approaches such as anticonvulsants, which are not effective in nociceptive pain. Major causes of nerve injuries in the orofacial region are endodontics and administration of local anaesthetics. Endodontic treatment of premolar and mandibular teeth has the potential to damage the inferior alveolar nerve via direct trauma, pressure or neurotoxicity. Persistent pain after endodontics has been reported to occur in 3–13% of patients, whilst surgical endodontics resulted in chronic neuropathic pain in 5% of patients. Most sensory nerve injuries related to dentistry are permanent; only local anaesthetic nerve injuries have a 75% likelihood of recovery. Nerve injury from local anaesthetics shows an incidence of 1

Part A: Endodontic-related

Endodontic treatment of teeth has the potential to nerve via direct trauma. Trigeminal nerve injury is a consequence of dental surgical legal implications (1). TI injury has remained stable 30 years; however, the nerve injury has increased with implant surgery and endodontic treatment to the third division. 3rd molar removal or non-surgical treatment and complex clinical and pain in the orofacial region, eating, kissing, shaving, brushing and drinking, interaction we take for granted have a significant negative impact on the quality of life, and the iatrogenic psychological effects. Persistence of any depends on the mechanism increased age of the patient.

Chapter 25

Emergencies in need of urgent referral

Tara Renton

Introduction

Urgent hospital referral is thankfully seldom needed for patients undergoing endodontic treatment, yet when serious complications do occur, clinicians must be well informed and act promptly to safeguard patient wellbeing and minimize the risks of long-term harm.

Unexpected incidents or patient reactions can arise in the most carefully regulated of practices, and are invariably distressing to both patient and clinician. It is paramount that the clinician maintains professional composure while calmly and proactively managing a potentially damaging situation, and the clinician must not wait for the patient to complain before initiating appropriate action [1]. They should also take a proactive interest in the ongoing progress of their patient and keep accurate, contemporaneous clinical records [2].

Conditions arising during endodontic treatment that may require urgent hospital referral include procedural accidents, adverse responses to procedures and materials, and clinical observations that raise concern. These will be considered under the following headings:

- Neurological injuries resulting from endodontic procedures and materials

Neurological injuries resulting from endodontic procedures and materials

Endodontic procedures are generally conducted under local anesthesia, and involve the use of instruments and materials that are capable of causing physical or chemical damage to nerve trunks. The inferior alveolar nerve and its branches are at particular risk during endodontic procedures, and care should be taken to avoid local anesthetic techniques that risk neurological injury and to contain endodontic instruments and materials within the tooth. The consequences of neurological injury include anesthesia (complete loss of sensation), paresthesia (altered sensation, typically burning, tingling, or prickling) or dysesthesia (abnormal and unpleasant sensation to light touch) [3], all of which may interfere the social interaction that people take for granted [4], and impact on both psychological wellbeing [5] and quality of life [6]. Advanced concept 25.1 summarizes the functional difficulties experienced by patients with trigeminal nerve injuries.

Local anesthetic-related neuropathies

Local anesthesia can be challenging in endodontics

Risk assessment of endodontic-related nerve injuries: part two

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

In part one of this clinical article, the author examined the risk factors and consequences of endodontic-related nerve injuries. Here, the author looks at the risk assessment, diagnosis and management of endodontic-related nerve injuries, as well as recommendations using the literature.

Minimising 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 more 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 orthodontics for potential nerve damage (Knowles, Jergenson, Howard, 2003; Baxmann, 2006; Scarno 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 CBCT) to ensure that accidental apical leakage or over-instrumentation will more likely cause nerve injury if the apex is adjacent to the IDC (Ngew, 2010).

In the first of two articles, Tara Renton presents a literature review for the post-endodontic neuropathy of the trigeminal nerve

Sensory disturbances or peripheral neuropathies such as anaesthesia, hypoesthesia, hyperaesthesia, and paraesthesia may present in the trigeminal system, due to many local and systemic factors. Endodontic procedures may cause local

injury in relation to dental procedures. This may also result in a higher incidence of permanent damage for inferior alveolar nerve injuries compared with lingual nerve injuries (Pogrel, 2005). Causes of inferior alveolar nerve injury include local injections, third molar surgery, implants, ablative surgery, trauma and orthognathic

is and dentists take for granted the rather tenacious of the dental pulp (the only organ in the body that is not subject to all stimuli) and to avoid to caustic high pH chemicals that would irritate tissues elsewhere in the body. Thus, many of chemicals routinely used in dentistry can cause reversible tissue damage in structures close to the

trigeminal nerve injuries remain a significant clinical problem. Altered sensation and pain in the region may interfere with speaking, eating, chewing, applying make-up, tooth brushing and so on, just about every social interaction we take for granted. These injuries have a significant negative impact on the quality of life and the iatrogenesis of end to significant psychological effects (Smith

TURN TO PAGE 60

CPD

CPD AIMS AND OBJECTIVES

This clinical article aims to enable the reader to consider and assess risk factors associated with increased risk of endodontic-related nerve injury.

EXPECTED OUTCOMES

Correctly answering the questions on page 60, worth one hour of verifiable CPD, will demonstrate that the reader understands the risk factors and diagnostic features associated with endodontic-related nerve injuries, and understands the urgency of recognising, assessing and managing the nerve injury if the resolution is not maximised.

Endodontic nerve injuries

Nerve pain affected by endodontic procedures of the inferior alveolar nerve (IAN) (Alves, Coutinho, 4). Maxillary branches of the trigeminal nerve are less likely to be damaged usually due to poor technique (Pekka, Pechetti, 2008)

specific study examining cases of paraesthesia after endodontic treatment of mandibular premolars, the 0.96% (8/832) (Knowles, Jergenson, Howard, 2003). In a study of 2,338 patients, 7% sustained chronic pain after a single endodontic procedure (Klasser

s of endodontic-related nerve injuries are case reports and analysis of the clinical impact for the patient or management issues and are solely case

should be reviewed carefully and removed within 48 hours (Helvacioğlu Kivanc, 2015). A systematic 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 considered 'routine', and certainly cone beam computed tomography (CBCT) examinations 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).

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Recommendations

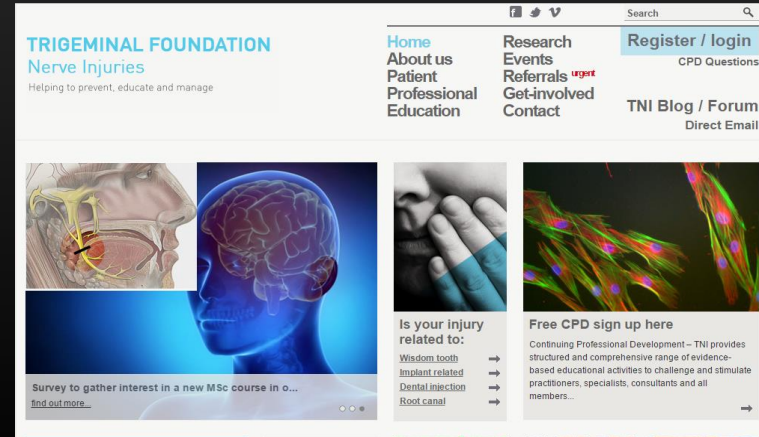
Endo NIs Management options

- ▶ **Acute management (< 30 hours)** Confirm overfill/ neuropathy
 - ▶ Consider re endo (Escoda-Francoli et al (37) Yatsushashi et al (62))
 - ▶ If extensive over fill in IDC -urgent referral for extraction, apicectomy OR IAN decompression
- ▶ **Later management**
 - ▶ None or minimal symptoms
 - ▶ reassure and review (duty of candour)
 - ▶ Mild symptoms – small neuropathic area, low discomfort
 - ▶ reassurance / topical Versatis patches (5% Lidocaine patches)
 - ▶ Gatot & Tovi (63) recommended steroid therapy for early postoperative neuritis.
 - ▶ Moderate symptoms- larger neuropathic area, functional and psychological implications, discomfort pain
 - Systemic medical management (Nortriptyline, Pregabalin)
 - Referral for psychological support
 - Review
 - ▶ Severe symptoms
 - Systemic medical management (Nortriptyline, Pregabalin)
 - Referral for psychological support
 - Review
 - Pain management referral

We need more evidence

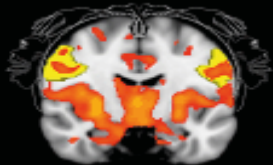
Thank you

Thanks to Andrew Mason Dundee University for illustrations



Websites

Trigeminalnerve.org.uk
Orofacialpain.org.uk



OROFACIAL PAI

King's College Hospital
NHS Trust



CE Verification Number: D180451

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