Learning from Patients’ wounds
Prevention – Risk factors and Proactive planning to prevent nerve injuries and chronic pain

October 2016
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Outline

• Introduction
  – The trigeminal system
  – Post traumatic neuropathy (PTN)
    • Defns
    • Presentation- The patient’s story
    • Mechanisms of Trigeminal PTN
  – Chronic post surgical pain
    • Defns
    • Risk factors

• Prevention of trigeminal nerve injuries is possible by risk assessment:
  – Mandibular third molar surgery
  – Dental implants
  – Endodontics
  – Local anaesthetic
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The trigeminal system

Blue circle shows trigeminal nerve ganglion and nuclei in central nervous system (CNS) unlike other sensory nerves where ganglia and nuclei in PNS.
Sensory feedback for all cranial functions

- Brain: Consciousness + neural regulation
- Breathing
- Sight
- Smell
- Taste

The face: the organ that underpins communication

*Vth nerve underpins identity and very existence*

Thus any threat or actual harm to the Vth nerve region comprises a massive threat to your very existence

*All patients are physiologically wired to run from the dentist!*
Particular issues with Trigeminal pain?

- Vth cranial nerve is the largest sensory nerve
- Part of reptilian brain - Primordial survival instincts
- Constant unavoidable activity
- Underpins daily pleasure in health
  - Eating
  - Drinking
  - Speaking
  - Smiling
  - Sexual interaction
- Underpins our identity!
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Types 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


What is this thing called pain? Clifford J. Woolf

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Definitions

- **Neuropathic pain (IASP)**
  Pain caused by a lesion or disease of the somatosensory nervous system.

- **Neuropathy (IASP)**
  A disturbance of function or pathological change in a nerve: in one nerve, mononeuropathy; in several nerves, mononeuropathy multiplex; if diffuse and bilateral, polyneuropathy.

- **Note**: Neuritis (q.v.) is a special case of neuropathy and is now reserved for inflammatory processes affecting nerves.
  - sensory (touch, heat, pain)
  - motor (movement)

ICD 2016 Disorders of trigeminal nerve G50 - >

- Includes disorders of 5th cranial nerve
- Clinical Information A disorder characterized by involvement of the trigeminal nerve (fifth cranial nerve).
- A non-neoplastic or neoplastic disorder affecting the trigeminal nerve (fifth cranial nerve).
- Diseases of the trigeminal nerve or its nuclei, which are located in the pons and medulla. The nerve is composed of three divisions: ophthalmic, maxillary, and mandibular, which provide sensory innervation to structures of the face, sinuses, and portions of the cranial vault. The mandibular nerve also innervates muscles of mastication. Clinical features include loss of facial and intra-oral sensation and weakness of jaw closure. Common conditions affecting the nerve include brain stem ischemia, infratentorial neoplasms, and trigeminal neuralgia

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Confusion in classification

IHS Classification ICHD-II

Table of contents
- Part I: The primary headaches
  - Migraine
  - Tension-type headache
  - Cluster headache and other trigeminal autonomic cephalalgias
  - Other primary headaches
- Part II: The secondary headaches
- Part III: Cranial neuralgias, facial pain and other headaches
- Appendix
- Definition of Terms


Orofacial Pain
Guidelines for Assessment, Diagnosis, and Management
Fourth Edition

6. Episodic and Continuous Neuropathic Pain

7. Intracranial Pain Disorders
- Odonotogenic Pain
- Neuralgic Autonomic Cephalalgia
- Stress-related Headache

American Academy of Orofacial Pain
Reny de Leeuw, DDS, PhD
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Tension HA
Migraine
Cluster HA
MoH
Giant cell arteritis
Trigeminal autonomic cephalalgias


Persistent idiopathic (ATFP / ATO)
Confusing nomenclature for Trigeminal PTN

- **Trigeminal neuropathy post intervention PTN**

- **Trigeminal Neuropathic pain TNP**
  - Differences and similarities between atypical facial pain and trigeminal neuropathic pain Heli Forssell, Olli Tenovuo, Pekka Silvoniemi, and Satu K. Jääskeläinen Neurology October 2, 2007 vol. 69 no. 14 1451-1459

- **Persistent dento alveolar pain PDAP**

- **Painful post traumatic trigeminal neuropathy PTTN**

- **Trigeminal neuralgia TN**
  - Don’t confuse with
  - Non-odontogenic tooth pain
  - Chronic tooth pain
  - Atypical odontalgia
  - Phantom tooth pain
  - What about neuropathic dental pain preceding surgery?

Trigeminal neuropathy No NePain +/- neuropathic area

Painful (NePain?) with no identifiable cause
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Nerve injuries related to dentistry
Neuropathic pain

- **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])
Presentation History of patients with Trigeminal PTN (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%

LNIs related to:
- TMS  75%
- LA  21%
- Salivary  4%

Pain descriptors
- Presenting with neuropathic pain 70% (n= 352)

Functionality
- Significantly daily functional impact 65%
- Increased with associated pain

Psychologically
- 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%

### Pain descriptors

<table>
<thead>
<tr>
<th>CBT</th>
<th>Subjective Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extraorally</td>
<td>Neuropathic Area (%)</td>
</tr>
<tr>
<td>70 (2-100)</td>
<td>3.1 (0-10)</td>
</tr>
<tr>
<td>Intraorally</td>
<td>66 (0-100)</td>
</tr>
</tbody>
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<tr>
<td>Extraorally</td>
<td>Neuropathic Area (%)</td>
</tr>
<tr>
<td>68 (8-100)</td>
<td>1.75 (1-2)</td>
</tr>
<tr>
<td>Intraorally</td>
<td>69 (0-100)</td>
</tr>
</tbody>
</table>

Table 1: Summary of Neuropathic Area Affected and Subjective Function (SF). Hypersensitivity to touch is indicated by a subjective function (SF) value of above 10, as a value of 10 indicates normal perception. A SF value of less than 10 indicates a reduced SF and 0 indicates no SF.

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Pain constant or episodic?
Both?

- Site
- ONSET = injury
- Character
- Radiation
- Associated factors
- Timing episodic?
  - Frequency
  - Duration
- Exacerbating factors
  - Stress, tiredness, Illness
  - Cold touch movement
- Or alleviating factors
- Severity
- IMPACT ????
  - Functional
  - Social
  - Psychological

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Chronic post-surgical pain following the placement of dental implants in the maxilla: A case series

Devine, Marie / Taylor, Sarah / Renton, Tare

Purpose: To present ten cases of chronic post-surgical neuropathic pain (CPSP) arising after placement of maxillary dental implants, in order to raise awareness of this potential complication of treatment.

Materials and methods: Data collected from the case notes of consecutive patients presenting to the orofacial pain clinic, with neuropathic pain arising after placement of maxillary dental implants.

Results: Nine out of 10 patients were female, with an average age 55.4 years. Six patients had a significant medical history (depression, peripheral neuropathic pain, irritable bowel syndrome and fibromyalgia). Six patients had simple implants placed, four had multiple implants. Four patients experienced pain during implant placement. Onset of pain was immediate in nine patients. Pain intensity (visual analogue scale) ranged from 2 to 9 (average 5.6). Pain was constant in all patients. Exacerbating factors included stress, tiredness, low mood and cold weather. Implants were removed in two patients however pain did not resolve. Pain management was complex; including medication (anti-epileptics and tricyclic antidepressants), Botulinum toxin injections and cognitive behavioural therapy, however pain did not completely resolve in nine cases.

Conclusions: Persistent pain after dental implant placement may occur with no apparent organic cause and without any neurosensor deficits. Practitioners must be aware of chronic post-surgical neuropathic pain as a possible complication of implant placement, particularly in patients with a significant medical history. Consideration should be given as to whether these patients are suitable for implant rehabilitation. Patients reporting very severe and prolonged postoperative pain following implant surgery should be considered at risk of CPSP and referred to a specialist in orofacial pain.
Features of neuropathic pain

Pain
Alldynia pain with non noxious stimulus
pain on touch/cold/hot
Cold allodynia a particular feature of extra oral
dermatome in patients with IANIs
Some LNI patients report tastent and warm
alldynia
Hyperpathy pain continues when stimulus removed
Hyperalgesia increased pain to painful stimulus
Altered sensation - Hyperaesthesia
- Paraesthesia –pins and needles, formication,
many descriptions
- Dysesthesia – uncomfortable sensations often
burning
Anaesthesia - Numbness - hypoesthesia

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
Presentation
Consequences - Neuropathic pain
Revised definition of neuropathic pain and its grading system: an open case series illustrating its use in clinical practice.


Abstract

The definition of neuropathic pain has recently been revised by an expert committee of the Neuropathic Pain Special Interest Group of the International Association for the Study of Pain (NeuPSIG) as "pain arising as direct consequence of a lesion or disease affecting the somatosensory system," and a grading system of "definite," "probable," and "possible" neuropathic pain has been introduced. This open case series of 5 outpatients (3 men, 2 women; mean age 48 +/- 12 years) demonstrates how the grading system can be applied, in combination with appropriate confirmatory testing, to diagnosis neuropathic conditions in clinical practice. The proposed grading system includes a dynamic algorithm that enhances the physician's ability to determine with a greater level of certainty whether a pain condition is neuropathic. Its clinical use should be further validated in prospective studies.
LNI and IANI patients complained that their symptoms interfered mostly with their speech, eating and kissing. More IANI patients than LNI patients stated that their symptoms interfered greatly with brushing their teeth, drinking and sleep.

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Presentation
Psychological consequences

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


Patients with severe pain showed particularly elevated levels of depression and pain catastrophizing, as well as substantially reduced HRQoL and coping efficacy levels.

Pain intensity level was a significant predictor in all models except anxiety, uniquely contributing between 17% and 26% of variance to the prediction of pain catastrophizing, depression, coping efficacy, and generic and oral HRQoL.

Different Pain, Different Brain: Thalamic Anatomy in Neuropathic and Non-Neuropathic Chronic Pain Syndromes


Presentation

Medicolegal consequences

• Settlements getting more expensive
  – Implant related cases settlements $1-3 million (2011)
• Elective surgery and avoidable = Negligent
• Implant, Endo, LNIs related to TMS, LA high conc IDBs
• Issues
  – Poorly managed pain, poor or no consent (communication), delayed recognition, delayed referral, poor risk assessment poor technique
Prognosis
Resolution PTN

Permanency of NIs

- TMS 0.01-2%
- LA IDB 25%
- Implant 6-87%
- Endo 86-87%
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  – Local anaesthetic
How does chronic pain happen due to surgery?

Why do patients have pain after surgery?

Because they’ve had an operation stupid!
How does this chronic pain happen due to surgery?

- **Peripheral sensitization of nociceptors**
- **Central sensitization**
- **Altered bulbospinal modulation.**
  - Both descending facilitatory and inhibitory influences run from brainstem to spinal cord. In chronic pain, levels of descending inhibition can be reduced while facilitation is enhanced. There are established techniques for evaluating the degree of descending pain modulation in operation in volunteers or patients.
- **Altered cortical circuitry and connectivity (Plasticity)**
  - to be predictive of the emergence of chronic pain.

**Figure 1:** (Left) rCBF increases representing the post-surgical pain experience in primary somatosensory cortex (outlined in yellow). (Right) CBF increases in descending modulatory structures during analgesic response to ibuprofen.
How does this chronic pain happen due to surgery?
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Chronic post surgical pain
well recognised related to general surgery

- Chronic pain after surgery is a well recognised problem and affects upwards of 20-30% of patients undergoing limb amputation, thoracotomy and breast surgery.
- There is confusing nomenclature for surgical induced pain without identifiable neuropathy and nerve damage these include:
  - Surgically induced neuropathic pain
  - Chronic post surgical pain
  - Post traumatic neuropathy
  - Postoperative neuropathic pain
  - Phantom limb pain

Over the last 10 years it has become evident that significant numbers of patients suffer from chronic pain as a result of routine surgery with over 30-40% of patients presenting in chronic pain clinics being diagnosed with CPSP. Macrae (2008) suggested a definition including:

- Pain developed after surgery
- Minimum 2 month duration
- Other causes of pain have been excluded (infection, persistent malignancy, misdiagnosis)
- Excluded preoperative pain from other cause
- 80% display NePain features +/- neuropathic area


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CPSP = Preventable pain!

Prevalence

- Estimated that over 40% of patients attending UK pain clinics have CPSP
- 30% get persistent pain and 10% are severely affected
- > 30% of migraine sufferers = post traumatic pain
- 12982 participants
  - 3111 had surgery within 3 years
  - Persistent pain 40.4% Mod severe 18.3%
- 5130 patients attending UK pain clinics
  - 22.5% post surgical (induced pain)
  - 18.7% post injury (induced pain)

Crombie et al Pain Clinics 1992;5:436-7

Kehlet et al, 2006 Lancet

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Estimated incidence of chronic pain (%)</th>
<th>Estimated chronic severe (disabling) pain (&gt;5 out of score of 10) %</th>
<th>US surgical volumes (1000s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amputation</td>
<td>30-50%</td>
<td>5-10%</td>
<td>158 (lower limb only)</td>
</tr>
<tr>
<td>Breast surgery (lumpectomy and mastectomy)</td>
<td>20-30%</td>
<td>5-10%</td>
<td>479</td>
</tr>
<tr>
<td>Thoracotomy</td>
<td>30-40%</td>
<td>10%</td>
<td>Unknown</td>
</tr>
<tr>
<td>Inguinal hernia repair</td>
<td>10%</td>
<td>2-4%</td>
<td>699</td>
</tr>
<tr>
<td>Coronary artery bypass surgery</td>
<td>30-50%</td>
<td>5-30%</td>
<td>598</td>
</tr>
<tr>
<td>Caesarean section</td>
<td>10%</td>
<td>4%</td>
<td>220</td>
</tr>
</tbody>
</table>

*Gall bladder surgery not included, since operative 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 Inpatient Procedures, USA, 1996.)

Table 1: Estimated incidence of chronic postoperative pain and disability after selected surgical procedures.
CPSP PTN Risk factors Patient

• **Age of patient** higher risk of persistent neuropathy over 50 years
• **Pre-existing NePain conditions** Migraine, Fibro Myalgia
• **Pre-existing nerve pathology**

Although the exact mechanism is unclear, patients with *underlying nerve pathology* are more susceptible to peripheral nerve complications, including prolonged duration of block and increased neurotoxicity to local anaesthetic agents.23

Many post-procedure neural injuries occur within nerves with pre-existing pathology.24 This may be related to the **increased sensitivity of already damaged nerves**, such as in patients with *diabetic neuropathy* or those having been exposed to *neurotoxic chemotherapy*25 or to the disruption of neural blood supply.

It is unknown whether the use of *epinephrine as an adjuvant in peripheral nerve blocks predisposes these at-risk patients to further nerve injury*, that is, a ‘double-crush’.

Risk factors for CPSP or Post Traumatic NePain

- >50 years (except breast surgery and inguinal hernia repair)
- Multiple ‘insults’
  - High level Peri-surgical pain
  - Repeated surgery and or infection
- Psychological
- Genetic
- Medical
  - Migraine headaches
  - Raynaud’s disease
  - Erythromelalgia
  - Irritable bowel syndrome
  - Fibromyalgia

**Features**
Non respondent to anti inflammatory analgesics (NSAIDs, Paracetamol)
Better in mornings
Does not disturb sleep
Worsens during day
Worsens with stress, tiredness and illness
Either
  - Constant burning
  - Elicited neuralgic
  - Or combination

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Psychosocial risk factors predictive of Chronic pain after surgery

- **Cognitive**
  - Fear of surgery and anxiety
  - Fear of pain
- **Personality disorder**
  - Increased preoperative anxiety
  - Introverted personality
  - Catastrophizing
  - Poor coping skills
  - Hypervigilance state
- **Psychological vulnerability – pain related fear**
- **Social support**
- **Solicitous responding**
  - Empathetic spouse encouraging negative behaviour
  - Munchausen

Commonly used and recommended NePain tools:

- DN4
- Pain Detect
- LANSS
Conventional neuropathic pain screening tools do not work for Trigeminal PTN.
Pre screening for neuropathic pain in dentistry
Should it be routine?

Important to
• Identify primary orofacial and dental neuropathic pain to prevent inappropriate treatments
• Chronic neuropathic pain DOES NOT RESPOND to peripheral SURGERY
• Surgery can make Neuropathic pain worse
• Pre screening tools
  – DN4, PainDetect, LANSS questionnaires


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Chicken or the egg?
Differential diagnosis????????

• Pain before surgery?
  Primary OFP or dental neuropathic pain
    – Atypical odontalgia
    – Persistent dento alveolar pain (PDAP I)
    – Pre TN??
    – Dental primary neuropathic pain

• Pain due to surgery?
  Secondary /Post traumatic neuropathic pain (PTN)
  /Chronic post surgical pain (CPSP)
  (+/- neuropathic area demonstrable?)

Chronic post surgical pain (CPSP)
  Post traumatic neuropathy (PTN)
  Persistent dentoalveolar pain (PDAP II)
  Phantom toothache
  Atypical odontalgia (AO)
  Are they all the same phenomenon?
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Trigeminal Post Traumatic Neuropathy
Causes (+/- pain)

Summary of 535 TNIs assessed by TR 2016
We cannot fix nerve injuries!

**Wait for resolution**
- Lingual nerve injuries related to LINGUAL ACCESS third molar surgery
- LA
- Trauma
- Orthognathic

**URGENT treatment < 30 hours**
- Suspected nerve trauma
- Inferior alveolar nerve injuries related to third molar surgery
- Implants
- Endodontics

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
Mandibular third molar surgery
Lingual and IAN injuries - Mechanisms

**Lingual nerve**
- Poor surgical technique
  - Lingual access surgery
  - Distal bone removal and lingual nerve injury
    - Use Buccal approach
    - Minimal access
  - ‘aberrant’ Lingual nerve anatomy
    - 11-18% of lingual nerve above alveolar crest distal to M3Ms

**Inferior alveolar nerve**
- Risk assessment
  - Perforation of tooth roots by IDC
  - Roots proximal to IDC
- Use of coronectomy when appropriate
Diagnosis?
Get it right!

• Listen
• Patient factors
• Systemic risks
M3M related trigeminal nerve injuries

Recommendations–

- Surgery indicated
- Patent expectations and risk aware
- Planning risk assessment
- Technique
  - Buccal access to minimise LNI
  - Coronectomy to minimise IANI in high risk cases
- Immediate referral of intraoperative suspected nerve injuries
- Home check essential
  - Radiographic required to check for retained roots and CBCT if exploration is indicated < 2 weeks

Joint decision making consent

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Treatment options

• Reassurance no RX required for M3
  With or without diagnosis of different condition causing symptoms and requiring management
  Contraindications to M3 Surgery
• Surveillance M3
• Prophylactic surgery M3
• Interventional surgery M3
• Therapeutic surgery M3
What are the risk factors?

LNI & IANI
- Age of the patient
- Time of surgery
- Intra-operatory exposure of the nerve
- Un-erupted tooth

LNI
- Technique access for the lower third molar extraction
- the surgeon's inexperience.

IANI
- The radiological examination is useful to evaluate the nerve damage and to decide on the surgical technique

Acta Odontol Scand. 2013 Jul 4. The importance of a good evaluation in order to prevent oral nerve injuries: A review. Céspedes-Sánchez JM, Ayuso-Montero R, Marí-Roig A, Arranz-Obispo C, López-López J. 662 were obtained from the search, from which 25 were selected accomplishing the inclusion criteria. Moreover, seven important articles were selected from the references of the ones mentioned, obtaining a total of 32 articles for the review.
Prevention
Risk factors for M3M NIs?

**LNI & IANI are at risk when:**
- Age of the patient > **25 years**
  - ethnicity
  - weight
- Time of surgery
- Intra-operative exposure of the nerve
- Dental factors
  - Un-erupted tooth
  - Depth impaction
  - Poor condition of adjacent teeth

**LNI**
- Lingual access for the lower third molar extraction
- Surgeon's inexperience.

**IANI**
- Radiographic assessment of Proximity to IDC
- Root morphology

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- **Winters lines** 1960
- **Wharfe** 1980
- **Pell & Gregory** 1934

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662 were obtained from the search, from which 25 were selected accomplishing the inclusion criteria. Moreover, seven important articles were selected from the references of the ones mentioned, obtaining a total of 32 articles for the review.
Prevention
LNI related to M3M surgery

Spot the lingual nerve!

Findings @ Lingual nerve exploration
Prevention LNI related to M3M surgery - Buccal minimal access
Remember

Soft tissue + bone removal = Inflammation = swelling and pain = complications

Surgical time + volume =
Prevention of lingual nerve injury
Prevention - Risk assessment of M3M related Inferior Alveolar Nerve injury (IAN)

• Age of the patient
• Intra-operative exposition of the nerve
• Intraoperative reported pan during surgery
• Surgeon's inexperience.
• Dental factors proximity to nerve
• Radiographic markers (CBCT):
  • Cortical perforation of the IAC by the root or crown of the 3rd molar correlated with darkening of the root seen on the panoramic radiograph.
  • A cortical defect 3mm long or more in the IAC was associated with an increased risk of operative exposure of the IAN.

How do I assess the difficulty?
The reassessment of ectopic molars

**Page content (text): Assessment of surgical difficulty of M3Ms,**

A. Application point depth. How this is measured?
B. Diagrammatic summary of tooth angulation
C. Crown width,
D. Crown condition of 8 caries gross caries heavily restored
E. Root width
F. Root morphology
G. Root surface area compared with adjacent tooth
H. Enlarged follicular size
I. Associated Cyst
J. Periodontal status 8 and 7
K. Restorative condition of adjacent 7
L. Long rooted lower M3MM3Ms or atrophic mandible
M. **The relationship or proximity** of upper M3MM3Ms to the maxillary antrum and of lower M3Ms to the inferior dental canal.
Assessing root morphology

- Between 20-48% of M3Ms are at high risk based upon panoral assessment.
Prevention - Risk assessment of Inferior Alveolar Nerve (IAN) injury

Radiographic factors

- Diversion of the canal
- Darkening of the root
- Interruption of the canal LD

NEW
- Juxta-apical area
- Deviation of canal
- Narrowing / darkening of roots

Prevention Risk assessment of Inferior Alveolar Nerve (IAN) injury

Risk

- 0.5% of cases permanently
- 2% of cases temporarily

**BUT if the teeth are superimposed on the IAN canal**

- 20% temporary
- 2% permanent

Risk factors

- increased age
- difficulty of surgery
- proximity to the IAN canal

Assessment nerve ‘at risk’

• Associated radiographic signs?

• Consider CBCT to clarify relationship
Perforation is very rare
How close does the nerve have to be?
The nerve doesn’t have to ‘perforate’ tooth...

‘Snake’ nerves

Dalili Z, Mahjoub P, Sigaroudi AK. Comparison between cone beam computed tomography and panoramic radiography in the assessment of the relationship between the mandibular canal and impacted class C mandibular third molars. Dent Res J. 2011;8:203

Prevention of IAN injury

? Role CBCT in localising IAN

• Localising IAN proximal
• to lower teeth
• DISTANT from nerve???????
Low risk - removal

- IAN IDC distant
- IDC Buccal to M3M roots
- IDC inferior to roots
High risk IANI - Coronectomy

• Risk factors
  – Decortication of canal > 3mm
  – Distortion of the IDC – dumbbell shape
  – IDC lingual to roots
  – Bifid nerve
  – Roots sandwiched between lack of lingual plate and IDC
Risk assessment of IAN injury

- IAN canal cortication loss
- Distortion of IDC
- Lingual IDC to M3M roots
- Bifid IDC
- Loss of lingual plate

Notes on coronectomy. Renton T. Br Dent J. 2012 Apr 13;212(7):323-6
DO not rely on radiologists report

Read the CBCT your self!

CBCT Radiation dose reduction
Remove the tooth or coronectomy?

Distant- remove  ‘Snake like’ or Perf-Coronectomy

Prevention of IAN injury
Two key questions

1. what assessment criteria on a plain film indicate need for CBCT?
2. what criteria on CBCT indicate need for coronectomy or removal?

Answer we need prospective randomised study of >280K patients with bilateral M3Ms in order to tell you!!!!!!!!!!
M3M Removal or Coronectomy?

- Patient healthy?
- Patient reliable?
- Tooth vital?
- Tooth high risk-confirmed on CBCT inter radicular IAN?

- Yes to all
  Coronectomy

- No to any?
  Removal
If coronectomy is contraindicated

Removal of high risk teeth indicated when........

• If the tooth is **non vital**
• Patient immunocompromised
• Patient unreliable
• then roots should be sectioned to minimise IAN injury

• Pt MUST be warned of increased risk!
• 10X normal risk
Prevention of M3M IANI
Technique decision Coronectomy

Less than 2% of high risk M3Ms need a coronectomy

www.trigeminalnerve.org.uk
Prevention of IAN injury

Coronectomy
Prevention of IAN injury

Coronectomy Risks
Consent is complex

1. Intra-operative mobilisation of M3M roots
2. Early post operative infection ‘dry socket’
3. Late post operative infection (with eruption)

Second surgery

• Article first published online: 14 JUN 2010 DOI: 10.1111/j.1752-248X.2010.01079.x
Risk management Tailored treatment
Risk Management
Tailored treatment
Risk assessment Mandibular Implants
Optimists
Pessimists
Undecided
Guidance for implant risk reduction (ADI and ITI)

Diagnosis and Management of Inferior Alveolar Nerve Damage Associated with Dental Implant Surgery

Tara Renton, Maria Centre

The image shows a page from a publication discussing guidance for implant risk reduction, specifically focusing on the Inferior Alveolar Nerve Damage (IANI) associated with dental implant surgery. The page includes an introduction section and a section on diagnosis and management. The text is formatted in a professional manner, typical of a medical or dental journal. The page also features an image of a dental implant model and a logo for the Association of Dental Implantology (ADI) and the ITI (International Team for Implantology).
Issues related to Implant nerve injury

- **Consent**
  - Indication for treatment
  - Guidelines
  - Risks

- **Assessment**
  - Clinical
  - Radiographic

- **LA protocol**
  - Articaine as infiltration only
    Peterson 2004; Heller & Shankland 2001

- **Planning assessment**
  - Clinical
  - Radiographic

- **Technique**
  - most drills longer than implants

- **Post operative care**

Renton T. Prevention of iatrogenic inferior alveolar nerve injuries in relation to dental procedures. SADJ. 2010 Sep;65(8):342-4, 346-8, 350-1
Consent for Implant nerve injury
Indication for treatment?

Treatment need?

Method of Consent?
71% practitioners used an individualized consent letter that contains case-specific information as part of the consent process.
39% (n=56) relied on a pro-forma consent form that warned about only the common complications.
NO WARNING OF NERVE INJURY!!!!!!!!!!!!!
Recent study @ KCL on 60 implant nerve injury patients
95% of implant nerve injury neuropathic pain
82% permanent
Less than 24% of patients are appropriately warned of NI

Consent for Implant nerve injury
Painful neuropathy

Clinical outcome of conservative treatment of injured inferior alveolar nerve during dental implant placement


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3Department of Occupational and Environmental, Konkuk University School of Medicine, Chungju, Korea

Abstract

Objective: Inferior alveolar nerve (IAN) damage may be one of the distressing complications occurring during implant placement. Because of nature of closed injury, a large proportion is approached non-invasively. The purpose of this study was to analyze the outcomes of conservative management of the injured nerve during dental implant procedure.

Materials and Methods: Sixty-four patients of implant related IAN injury, who were managed by medication or observation from January 1997 to March 2007 at the Department of Oral and Maxillofacial Surgery, Seoul National University Dental Hospital, were retrospectively investigated. The objective tests and subjective evaluations were performed to evaluate the degree of damage and duration of sensory disturbance recovery. Tests were performed on the day of the first visit and every two months afterward. Patient’s initial symptoms, proximity of the implant to the IAN, time interval

Table 1. Protocols of conservative management

<table>
<thead>
<tr>
<th>Month</th>
<th>Medication</th>
<th>Physiotherapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Prednisolone</td>
<td>Dysesthesia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Neurotin 500 mg tid, then 600-800 mg tid</td>
</tr>
<tr>
<td>1-2</td>
<td>Vitamin B12, L (Becosan T tid)</td>
<td>TCA, (Amantadine)</td>
</tr>
<tr>
<td></td>
<td>NSAID (Aspirin 1 T tid)</td>
<td>Tramadol 175 mg hr</td>
</tr>
<tr>
<td>3</td>
<td>Gingko-toboba (Ginkosan 1 T tid)</td>
<td>Proximal Tramadol 150 mg hr</td>
</tr>
<tr>
<td>4-8</td>
<td>B12, 1, 6, NSAID, Ginkorin</td>
<td>Evaluation for operation</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>Neurotin+TCA, pm) Tramadol</td>
</tr>
</tbody>
</table>

(tid: three times a day, NSAI: nonsteroidal anti-inflammatory drugs, T: tablet, TCA: tricyclic antidepressant, hr. hour, min. at bedtime, pm. pm or as required, EAST: electrical acupuncture stimulation therapy, GGB: stellate ganglion block)

Fig. 1. Change of symptom (total-65).
Group I: first visit time to our department after nerve damage (3 months, group II: treatment time to our department after nerve damage (6 months, group III: implant removal or decompression, group IV: no treatment or medication)

Consent for Implant nerve injury
Permanency of injury

Irritative and sensory disturbances in oral implantology. Literature review

Cristina Palma-Carrió 1, Jose Balagué-Martínez 1, David Peñarrocha-Diago 2, Maria Peñarrocha-Diago 1

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http://www.medoral.org/cgi/content/full/16/2/e194-8.pdf
Assessment clinical & Radiographic

Preoperative assessment
Clinical assessment
Radiographic assessment
Patients expectations and treatment options ….Risk:Benefit

• Radiographic EAO Sedentext guidance

25% of edentulous patients present with a degree of altered IAN function, thus reinforcing the guidelines on the necessity of preoperative neurosensory evaluation.

Assessment radiographic

• **What radiography?**
  - LCPA
  - Panoral
  - Cone Beam CT Scan

• **Planning**
  - Software
    - Simplant/ other software

• **Assessment of IAN position**
  - Safety zone >2mm IAN canal
  - ? Should be >4mm
  - What is the actual position of nerve?????

IAN plotted on Simplant using 5 points!
80% of clinicians questioned get technician to draw in
Can you interpret the full CBCT yourself?
Assessment radiographic
Who actually assesses risk?

- Explore patients expectations
- History
- Clinical
- Radiologic DPT or CBCT?
  - Guidelines
- 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, DOS, 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 conducted by searching various databases. The results were analyzed for their applicability to dental implant therapy.

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

- A radiologist
- The surgeon
- Restorative dentist
- Scan centre radiographer
Assessment radiographic

Where is the nerve?

Periapical radiographs were the most popular choice of diagnostic imaging 63%

The most common reason to prescribe cross-sectional imaging when operating within the posterior mandible was to accurately determine the safety zone.

Most followed EAO or FGDP guidelines during diagnostic imaging.
Assessment radiographic

Planning for;
- Bone quantity and quality
- IDC position (not nerve!)
  - Canal position
  - Mental loop
  - mandibular incisal extension
- Accessory canals
- Planning software ?????
- ??????Safety zone ?????????
Prevention of Implant nerve injury

Safety Zone?

Consider short implants?
Prevention of Implant nerve injury

Inadequate radiography

Beware the anterior loop /mental foramen!!!

- Adequate imaging?
- Here or there?
- Is it bifid?
Risk assessment

Anterior extension of IAN

Data from five hundred (500) consecutive patients sent to i-dontics center from 9 centers located in 3 states for 3D dental CT studies, were evaluated.

Nearly 97% of all mandibles had an anterior extension; nine patients did not have a measureable anterior extension of the IAN as seen on a 3D cone beam study.

Fourteen patients (4.73%) did not have an extension on the right side; eleven patients (3.72%) did not have an extension on the left side.

The average length of the anterior extension extending from the mesial rim of the mental foramen is 12.0 mm on the right and 11.8 mm on the left.

A continuous loop, defined as an extension of the canal that emanates from both the right and left mental foramina and is seen to connect in the midline was viewed on 77 patients (26.01%).
Prevention of Implant nerve injury

Most nerve injuries occur when:

- Parasympathetic region
- During preparation of implant bed
- Implants >10mm
- Severe pain during prep or implant placement
- Severe pain post surgery
Minimising risk  Operative Implant preparation

Managing operative risk
• Minimise length of implant choice where possible
• Good planning >2mm safety zone
• Infiltration anaesthesia
• Implants should not need to be longer than 8-10 mm
• Drill stops stock or tailored
• Use system with shorter prep drill than implant
• ITI recommendation top after 60% planned depth OR 6mm LCPA and check position

Intraoperative risks
• Pain on injection of LA
• Sudden give during preparation
  – Mylohyoid ridge fracture
  – Into Inferior alveolar nerve canal
• Brisk persistent bleed on preparation
  – Consider delaying placement of implants
• Intense sudden pain during implant bed preparation- Any protrusion into the IDC or breech causes severe neuralgic type pain intra-operatively FUNNY BONE PAIN!
  Stop and reassess


Recommendations  Prevention is possible
Early intervention after nerve injury can improve resolution?

HOME CHECK

- Acute management < 30 hours
  - (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 implant < 30 hours
- + High dose oral NSAIDs (600-800mgs Ibuprofen PO QDS)
- Prednisolone 5 day step down does 50-40-30-20-10mg PO
  - Vitamin B Complex?
  - (check medical history!)
  - Review

What does NOT work

- Implant removal > 30 hours X
- Back up implant X
- Apicect implant X
- Nerve graft / repair X

The patient is more important than the implant!
Surgery Radiographic evaluation of socket confirms Implant OR preparation bed is breeching IDC? CBCT NOT NEEDED
Only use plain films
Removing implant < 30 hours does Improve NI resolution

![Bar chart showing pain relief percentages]
Management of Implant nerve injury > 30 hours

• Prevention is best!
• Treatment depend upon mechanism and duration
  • 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 or endo material within 30 hours
Management Evidence

- There is low evidence base for managing dental implant related nerve injuries. We only know that 82% are permanent and 95% painful long term.
- There is no ‘magic bullet’ to fix them, we have to sit and wait and reassure the patient.
- You will be negligent in causing the nerve injury but you should at least treat your patients humanely and prevent nerve injuries where possible.
- In order to maximise resolution of any sensory neuropathy it is recommended to institute early medical intervention.
  - but check medical history first! and request the patient’s General medical practitioner to prescribe the medication.

http://trigeminalnerve.org.uk/
Risk assessment mandibular endodontics
Endodontics-Related Paresthesia of the Mental and Inferior Alveolar Nerves: An Updated Review

Zahed Mohammadi, DMD, MSD

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
Endodontic related nerve injuries

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 ad chemical leakage
• Inflammation / infection
Mechanical nerve injury

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.
- pHs of Endo materials very Alkaline and toxic to nerve tissue.
- 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.

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 occurred in 60% of cases and over instrumentation during preparation
- Reported severe pain during surgery
- Dental factors: Accessory canals, Root fracture, apical lesions
- 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
- Possible 2-3 day delay in neuropathy development

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.

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.
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 rot 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.

Techniques minimising apical extrusion of endo fillers

Apical extrusion of products may be increased by ultrasonics and minimised by using Endovac.

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.

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 (48) 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).
<table>
<thead>
<tr>
<th>Predisposing tooth factor that may result in an adverse incident during root canal treatment</th>
<th>Potential adverse incident if tooth factor not recognised</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resorption defects where extent is not identified such as internal /external communicating with root canal and external surface of the root</td>
<td>Extrusion of endo filler /Hypochlorite accident</td>
</tr>
<tr>
<td>Suspicion of a perforation communicating with the external root surface</td>
<td>Extrusion of endo filler /Hypochlorite accident</td>
</tr>
<tr>
<td>Root fracture where there could be a potential communication of the root canal with external root surface</td>
<td>Extrusion of endo filler /Hypochlorite accident</td>
</tr>
<tr>
<td>Sclerosed root canal</td>
<td>Possible perforation with subsequent hypochlorite accident</td>
</tr>
<tr>
<td>Dens invaginatus</td>
<td>Possible perforation with subsequent hypochlorite accident</td>
</tr>
<tr>
<td>Periapical lesions and other pathology (cysts)</td>
<td>Neurological injury (may occur if lesion close to IDC</td>
</tr>
<tr>
<td>Lower molar teeth where root apices are is close proximity to the Inferior dental canal and or mental foramen</td>
<td>Neurological injury (over instrumentation, overfilling with obturation materials or sealer)</td>
</tr>
</tbody>
</table>
Radiographic
Proximity to the Inferior dental canal (IDC)

Mandibular teeth proximal to the IAN canal

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- Most of CBCT assessment of tooth positioning relation to the IAN canal is based on M3M prior to extraction.

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


Proximity of apex to IDC in our cohort

60% -7/12 available LCPAs illustrated proximity of apex of RT tooth and IDC
Periapical lesions

In one retrospective study, the incidence of mental paresthesia resulting from periapical infection or pathology was 0.96%. In another 0.24% of cases in the same study, mental paresthesia 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).
Neuritis and or neuropathy associated with periapical lesions

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.


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.

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.

MAX-I-PROBE IRRIGATION PROBES

Root Canals:
Design produces upward flushing motion for complete canal irrigation
Side port dispersal prevents solution and debris from being expressed through the apex
Closed, rounded end reduces risk of apex damage
Flexible 28 ga and 30 ga Max-i-Probes safely reach places no other probes can!
Available as 40 probes, 100 probes or 100 probes/100 syringes
Diagnostic accuracy of limited-volume cone-beam computed tomography in the detection of periapical bone loss: 360° scans versus 180° scans

S. Lennon, S. Patel, F. Foschi, R. Wilson, J. Davies, F. Mannocci

Abstract


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

Methodology Artificial, 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 jars 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 4.5 x 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.

Results Intra-examiner reliability was determined after 2 weeks, reviewing half the data set. Statistical analysis with partial areas determined the diagnostic accuracy of the two modalities (180° vs. 360°) in terms of sensitivity, specificity, receiver operating characteristic area under the curve, positive predictive value and negative preective value.

Results The mean values for sensitivity of the 360° and 180° scans were 0.91 and 0.89, respectively; their mean specificities were 0.72. No significant differences were reflected in the statistical analysis.

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 guidelines to use as low a dosage as reasonably achievable.

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

Research article

Comparison of different dose reduction system in computed tomography for orthodontic applications

E. Fanucci, V. Fiaschetti, L. Ottria, M. Mataloni, V. Acampora, R. Lionello, A. Barbattani, G. Simonetti

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Studies on location of IDC

- A classic study of the relationship between mandibular 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.
  

- 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
  

- In contrast, the apex of each second premolar was between 0 and 4.7 mm from the respective mental foramen in various cadaveric studies.
  
Prevention of Endo nerve injury possible?

- Safety Zone for endo in mental foramen region? What should it be?
- Should contact between root and IDC be a recommendation for referral to specialist?
Assessment radiographic
Who actually assess risk?

• Explore patients expectations
• History
• Clinical
• Radiologic DPT or CBCT?
  – Guidelines
• Informed consent

• Who assess risk?

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

Planning for:
• IDC position (not nerve!)
  Canal position
  Mental loop
  mandibular incisal extension
  Accessory canals
  Planning software
  Safety zone
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.

Strategies to prevent hypochlorite accident

- Recognising any of the above factors which could predispose to a hypochlorite accident
- Always use a side venting needle with luer lock syringe
- Never bind 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
Pre screening for neuropathic pain

- Chronic post surgical pain (CPSP)
  - Post traumatic neuropathy (PTN)
  - Persistent dentoalveolar pain (PDAP)
  - Phantom toothache
  - Atypical odontalgia (AO)
  - Neuropathic toothache
- Are they all the same phenomenon????????
- Chronic pain DOES NOT RESPOND to peripheral SURGERY
- Pre screening tools
  - DN4, PainDetect, LANSS questionnaires

Endo Recommendations (1):

- Based on current evidence, practitioners undertaking endodontic treatment should:
  - GDPs should not attempt RCT in teeth close to IDC refer for specialist care
  - Screen out neuropathic pain pre RCT
  - Risk assess including Identify dental risk factors (+/- CBCT case dependent)
    - teeth in close proximity to the inferior alveolar nerve and take special care to prevent over-instrumentation and the extrusion of irrigants and materials into the periapical tissues.
    - Root fractures
    - Resorption
    - Apical pathology
  - Prevent overfill or extrusion consider:
    - Creating an apical stop or dentine apical plug
    - Make sure the preparation has taper and hence resistance form
    - Obturating shorter
    - Using cold lateral condensation to gain apical control
    - Do not use resin based sealers such as AH plus sealer
  - Avoid over instrumentation
    - Care with instrumentation and patency filing may have to work shorter
    - Care using intracanal medicament (e.g. calcium hydroxide) do not syringe down to full working length,
    - deliver more coronally
    - use a file to deliver the calcium hydroxide toward the apical part of the canal
Endo (2)

- Record any events that may indicate operative nerve injury, including
  - Extreme pain during LA IDB, canal instrumentation, irrigation, medication or filling.
  - Sudden and profuse haemorrhage arising from the apex of the tooth.
- Take appropriate post operative periapical radiographs to check for any extrusion of dressing or filling materials into the inferior dental canal or around the mental foramen.
- Homecheck and if signs of persistent or new neuropathy;
  - Remove overfill urgently (30 hours)
  - NOT antibiotics!!!!!
  - Vit B, NSAIDs, Steroids? Prednisolone step down 15mg 5 days, 10mg 5 days and 5mg 5 days and high dose NSAIDs, 600mg Ibuprofen) and make a timely referral to an appropriately trained micro neurosurgeon if necessary.
  - OR
  - Long term therapeutic management
Risk assessment Local anaesthesia LA
Local anaesthetic nerve injuries

• Possible mechanisms
Possible mechanisms

Mechanism of trauma
Mechanical Direct needle/ indirect scarring
Pressure ischaemia from bleed or LA
Chemical LA agent, buffer, preservative, carrier
Haemaglobin (Fe irritates nerve)

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

http://trigeminalnerve.org.uk/
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**
- **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 LANI
Pain on injection

PAIN on injection?
• 60% more likely to experience persistent neuropathy
• Review your pt next day
• Reassure 75% are temporary
• Early Medical intervention required?

Smith and Lung 2006
Dentistry is the ONLY healthcare profession taught to aim for nerves blindly during block injections!
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 2 vs 4% Articaine = concentration of Agent more likely neurotoxin than mechanical injury with saline
- Pogrel 2012
- Jacobs K report IFDAS 2015
- Piccini et al 2015
- Gaffn & Haas 2009
Articaine (4%) IDB no more clinically effective than 2% Lidocaine IDB for pulpitic molars but very effective as buccal supplementary buccal infiltration.

---

**Results:** The pulpal anesthesia success for articaine (76%) was slightly more than with lidocaine (58%) as measured with pulp tester as well as for the pain reported during the procedure the success rate of articaine (88%) was slightly more than that of lidocaine (82%) although the difference between the two solutions was not statistically significant.

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**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, Ph.D., 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, is 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.*

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www.trigeminalnerve.org.uk
Techniques to avoid Nerve injury

- **Technique**
  - Use Infiltration technique
  - Avoid blocks
  - Type of IDB Technique
    - + always Aspirate
- **Agent**
  - Avoid Bupivicaine
  - Use low conc IDBs
- **Follow up**
- **Early management**

[Source: http://trigeminalnerve.org.uk/]
Prevention – Modify Technique IDB

Direct technique may place Lingual nerve at higher risk?
Techniques to avoid Nerve injury

Should we always reach for the IDB?

http://trigeminalnerve.org.uk/

NO!
Infiltration Local anaesthesia
More effective LA-less systemic side effects

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)

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Infiltration techniques to avoid Nerve injury
‘Smart LA’ sub mucosal infiltration

- Intra ligamental for M3Ms
- Articaine 4% Buccal Infiltration +/- IDB Lidocaine 2%
- Articaine 4% Buccal Infiltration Post + ant near Mental foramen +/- Lingual Inf Lidocaine 2%
  BI Articaine 4%>Lidocaine2%. Prilocaine 4% BUT 55% success
- Buccal infiltration + Lingual both Lidocaine 2% Provides 90+% pulpal anaesthesia compared with 40-45% IDB

Prevention – Use Infiltration dentistry

We already have the evidence that demonstrates that infiltration dentistry provides significantly better for;

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


- **Pulpitis mandibular molars in adults**


- **is suitable for exodontia in adults and children**


- **is ideal for implant surgery**


- **is suitable for 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!

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**LA - technique**

- Infiltration: 1,2 ml ± 0,5 ml
- Block: 1,5 ml ± 0,3 ml

Injected volume:

- Infiltration anesthesia
- Block anesthesia
- Inf. +block
- Inf. + other

**Courtesy Prof Monika Daublander**
Prevention of LANI

Most importantly prevention of nerve injuries is possible? The long term significant problems seen in patients with these nerve injuries (9) 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 nerve injuries are permanent
- The injury is related to high levels of dysthaesesia 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.

http://trigeminalnerve.org.uk/
Should LA practice change?

- **Consent for LA**  
  Patents are routinely warned of a risk of nerve injury when routinely undergoing epidural or spinal injections (17). Reports the estimated that nerve injury resulting from neuroaxial blocks (epidurals, spinals and combined epidural with spinals) resulted in sensory or motor nerve injury in 1 in 24-54K patients (and paraplegia or death in 1 in 50-140K patients). Already in Germany most of Europe and US patients are routinely warned about risks associated with IDBs (46).

- **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 and which is occurring more frequently than we were taught at dental school (1 in 14,000 blocks causes persistent neuropathy of which 25% are permanent). By avoiding IDBs there is less risk of injury to the lingual and inferior alveolar nerves which though rare is debilitating to the patients and has no cure. This technique requires less skill, less discomfort for the patient during the injection and avoids unnecessary lingual anaesthesia after dental treatment.
Key messages...
Changing practice

• We can prevent most of these nerve injuries

• We cannot ‘fix’ patients with these nerve injuries

• We can improve informed consent –

Hyperaesthesia and pain are more likely than numbness

• Lingual nerve / inferior alveolar nerve injuries are NOT mainly temporary?

• **DO NOT SIT AND WAIT** for resolution for IAN injuries related to M3M, Implant and Endo

• Home check will facilitate timely urgent intervention and resolution of nerve injuries
Challenges

Prevention of chronic pain is possible

- Holistic management of patients with PTN
- Significant impact of iatrogenesesis
- **Prevention is possible**
  - management of patients expectations-Consent
  - Poor surgical planning
  - Inability to read CBCT scans and lack of risk assessment
  - Poor surgical practice
  - Lack of follow up with 24 hours
- We need more evidence in prevention and management!

## Management of Implant nerve injury

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Duration</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Known/suspected nerve section</td>
<td></td>
<td>Immediate exploration</td>
</tr>
<tr>
<td>TMS IANI – retained roots</td>
<td>&lt;30 hours</td>
<td>Immediate exploration</td>
</tr>
<tr>
<td>Implant</td>
<td>&lt;30 hours</td>
<td>Remove implant</td>
</tr>
<tr>
<td>Endodontic</td>
<td>&lt;30 hours</td>
<td>Remove tooth / overfill</td>
</tr>
<tr>
<td>Implant / Endodontic</td>
<td>&gt;30 hours</td>
<td>Treat therapeutically</td>
</tr>
<tr>
<td>TMS IANI large neuropathic area, pain</td>
<td>&lt;3 months</td>
<td>Consider exploration</td>
</tr>
<tr>
<td>and disability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TMS LNI – large neuropathic area, pain</td>
<td>&lt;3 months</td>
<td>Consider exploration</td>
</tr>
<tr>
<td>and disability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TMS IANI –</td>
<td>&gt;6 months</td>
<td>Treat therapeutically</td>
</tr>
<tr>
<td>TMS LNI –</td>
<td>&gt;6 months</td>
<td>Treat therapeutically</td>
</tr>
<tr>
<td>LA, fracture, orthognathic</td>
<td></td>
<td>Treat therapeutically</td>
</tr>
</tbody>
</table>
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www.Trigeminalnerve.org.uk
www.orofacialpain.org.uk

Oral surgery
Books 1 and 2

Tara Renton
Editor

New KCL Orofacial pain Masters programme starting October 2017
Orofacial Pain
Demystifying chronic pain in the head, face and mouth