When do trigeminal nerve injuries happen?
How do we prevent them?
Can we manage them?
Pain an update
– Subjects:
  – 93 LNI patients (mean age 38.4 years [range 20-64);
  – % Male:Female ratio 37:63)
  – 80 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 in secondary care trust:
  – LNI = 50% IANI = 32%
- **Causes of injury**
  - **LNI:** Third molar surgery (TMS) 72%; Local analgesia inferior dental block 16%; Direct lingual trauma 2%
  - **IANI:** TMS 57%; Implants 14%; Local analgesia inferior dental block 11%; Endodontics 5%.
  - **Permanency:** A large majority, 61% of LNI patients and 73% of IANI patients, had permanent nerve injury.
  - **Dermatome:** The neuropathic area varied between 5-100% of the affected dermatome (intra- and/or extra-orally).
Iatrogenic trigeminal nerve injury

- **Figure 1:** INCIDENCE OF ALTERED SENSATION AND PAIN AMONGST LNI AND IANI PATIENTS.

- Patients with LNI and IANI (shown as % values) predominately suffered with a mixture of pain, anaesthesia and paraesthesia (35%). A large majority of LNI patients presented with hyperalgesia, particularly of the lingual aspect of the gingivae, with also cold, heat and/or mechanical allodynia. Some LNI patients (5%) also demonstrated taste alldynia.

- IANI patients mostly demonstrated allodynia, especially extra-orally to cold. Pain scores at their worst (x/10) ranged between 4-8 for LNI patients and 5-12 for
Figure 2: FUNCTIONAL PROBLEMS EXPERIENCED BY THE LNI AND IANI PATIENTS.

- 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.
The problem
Problems specific to trigeminal nerve

- Consent
- Closed injury
- Most resolve
- Type of nerve injury
- Type of patient
- Neuroplasticity

- Current surgical management is inadequate
Painful peripheral sensory nerve neuropathy

- Diabetes
- HIV
- Chemotherapy
- MS
- Post surgical traumatic neuropathy
- Infection
- Parkinson’s
- Malignancy
- Drugs - Growth hormone injections
Consequences of lingual and inferior alveolar nerve injuries

• Pain
  – 40-60% post surgical trauma sensory nerve neuropathy is painful
• Functional
  – Eating, speaking, drinking, sleeping, kissing, make-up, shaving, tooth brushing
• Poorly managed
• Litigation
Iatrogenic trigeminal nerve injuries

• Are they avoidable?
  – Planning
    • Avoid unnecessary surgery
    • Identify the patient at risk
    • Informed consent
  – Execution
    • Modify technique
  – Post operative care
    • Home check
How can we prevent the injuries?

- When is the LN or IAN at risk?
  - Local analgesia
  - Wisdom teeth
  - Implants
  - Endodontics
  - Orthodontics
  - Orthognathic surgery
  - Fractures
  - Pathology
Avoidance of surgery: Guidelines

- **UK**
  - BAOMS
  - RCS
  - NICE

- **USA**
  - AAOMS
  - 83% undertake prophylactic surgery
Avoidance of surgery

- Do we know how effective the removal of the opposing over erupted maxillary third molar is in reducing recurrent pericoronitis in the lower third molar region?
- Currently undertaken by 38% US oral surgery practitioners
Local analgesia

Articaine ↑

- Haas & Lennon 55% Hillerup & Jenson 52% Renton 58%
- Prilocaine ↑
- Mepivocaine
- Lidocaine
- Bupivacaine
- Concentration based? Articaine + Prilocaine 4%
- Articaine 21 times more likely to cause injury

- Incidence
  - 1:800,000 OR 1:30,000
- Technique
- Type of analgesic agent
- Multiple blocks
Types of Articaine

ESPE Germany
- 4% 1:200,000 Epinephrine
- 4% 1:100,000 Epinephrine
- 4% 1:400,000 Epinephrine

• Ultracain USA
  - 2% no Epinephrine
  - 2% 1:100,000 Epinephrine
  - 2% 1:200,000 Epinephrine

• Septociaine UK
  - 4% 1:200,000 Epinephrine
  - 4% 1:100,000 Epinephrine
Recent studies

- Comparison of Articaine and lidocaine IDB Mikesell P et al 2005 - no difference
- Comparison of supplemental buccal infiltration articaine v lidocaine after IDB Haase et al 2008 (73 subjects articaine IDBs + either A or L infiltration A>L 88 vs 71% EPT testing first molar - no difference)
- Articaine infiltration for anaesthesia first mandibular molar: RCT, Corbett I et al 2008 (31 pts 1:100 000. A Infiltration Vs Lidocaine IDB 1st molar – Articaine infilt buccal ad lingual = IDB with lidocaine)
- Kanaa et al 2005 articaine inf>lidocaine
- PRCT Speed of injection Articaine V lidocaine infiltration anaesthesia. Kanaa M et al 2005 (31 pts single operator MB fold 1st molar-EPT - Slower IDB more effective than rapid)

- Articaine 4% 100,000 E
- Lidocaine 2% 100,000 E
- Articaine 4% 100,000 E
- Lidocaine 2% 80,000 E
Prevent Local Analgesia induced injuries?

- Avoid Articaine blocks?
- Avoid multiple blocks
- Stick to Lidocaine ID blocks for now!

- Is the future Articaine as infiltration only with no ID blocks?
Lingual nerve risk factors in surgery

- Prospective case series 1384 patients undergoing third molar surgery (n=2134)
- Significant risk factors associated with lingual nerve injury
  - Difficulty of surgery
    - Patient age
    - Depth of application
  - Surgeons surgical skill
    - Scoring of lingual plate
    - Exposure of the nerve

Routine use of the ‘buccal’ approach?

- 99% US oral surgery practitioner
- 52% after defining the buccal approach
Video of ‘proper’ buccal approach
Inferior alveolar nerve injury in third molar surgery

- occurs in up to
  - 3.6% of cases permanently
  - 8% of cases temporarily
- if the teeth are radiographically superimposed on the IAN canal
  - 20% temporary
  - 2% permanent
- risk factors
  - increased age
  - difficulty of surgery
  - proximity to the IAN canal

USA-If a lower third molar is high risk ------CBCT
IAN - Radiographic factors

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

- **NEW**
  - Juxta-apical area
  - Deviation of canal
  - Narrowing / darkening of roots
Inferior alveolar nerve

- Prospective randomised study 196 TMS procedures
- Factors associated with failed coronectomy
  - Female patient
  - Conical roots
  - Age

Video of procedure of coronectomy
Coronectomy complications

• Recent case complications
  – Eruption
  – Infection >1 episode ‘dry socket’
    • Remove roots
  – Infection plus IAN paraesthesia
    • Temporary
    • Permanent
    • Take care with iodoform products
Tooth sectioning

- If the tooth is high risk and non-vital
- then roots should be sectioned to minimise IAN injury
Implant related nerve injury

- Planning
- Preparation
- Placement
- Post operative
- Advanced implant surgery
  - Bone harvesting
• What radiography?
  – Cone Beam CT Scan
• Planning
  – Software
    • Simplant
• Assessment of IAN position
• Safety zone >2mm IAN canal
• ? Should be >4mm
• What is the actual position of nerve?
does this happen?

- During preparation OR placement?
- Depth / Length
  - Direct trauma drill longer than implant
  - Indirect trauma
- Debris / implant / bleed
  - Direct compression
  - Indirect compression
- Mechanism
  - Primary ischaemia
  - Secondary ischaemia
Intra-operative risk factors

Sudden ‘give’ during preparation

Extrusion of debris into canal

Intra-operative IAN bleed

Do not place implant!

Place later at 2-3 days
Prevention

– **Intraoperatively**
  - Do NOT place implant with bleed -place 2-3 days later

– **Postoperatively**
  - Routinely check on patient early post operatively at 6 hours
  - If patient has neuropathy immediately after local analgesia has worn off:
    – Consider removing the implant in less than 24 hours
    – Steroids and NSAIDS
    – Refer
Inferior alveolar nerve - Endo
Post operative protocol same as implants

- Post operative LCPA
  - Overfilled? Remove endo/tooth
- Routinely check on patient early post op <24 hours
- If pt has neuropathy immediately after LA has worn off:
  - REMOVE Endo!
  - Extract tooth
  - Apicectomy nerve decompression
  - Steroids and NSAIDS
  - Refer
Other considerations
Toxicity of commonly used dental products

- **BioOss**
  - pH 8.4

- **Socket Medicaments**
  - Alvogyl, Whiteheads varnish, Corsodyl and Surgicel (pH 5.8)

- **Endo Medicaments**
  - Formocresol
    - pH 12.45 +/- 0.02
  - Sodium hypochlorite
    - pH 11-12
  - Calcium hydroxide (Calyx1)
    - 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
Orthodontic related nerve injuries

- Willey et al 2004
  - 17 yr M Class II Div 2 15months edgewise. CO pain left mandible, LCPA LL5 apex adjacent mental foramen.
  - Resolved after 5 weeks
- Stirrups 2 cases buccallisation of lower premolars
- Reported cases of intrusion of lower second 2nd molar
  - Krogstad
  - Tang
  - Morse D 1997
  - Farronato G et al., 2008
- All temporary

Carter and Keen 3 anatomical patterns intramandibular course
Type 1 close to teeth roots Type 2 lower pathway Type 3 divide
• Prevention is better than cure

• Warn the patient properly

• We CAN avoid many of these injuries
Numb chin ‘syndrome’

- Infection tooth root proximal to canal
- Cysts odontogenic Tx
- Denture induced
- Neoplasia
- Post radiotherapy
- Chemotherapy
- Connective tissue disease
- Diabetes
- Vasculitis
  - Sickle cell disease
  - Lymes disease
  - Post vaccinal
  - Temporal arteritis
- Metastatic pulmonary clear cell Ca 56 yr F
- 47 yr M prostatic metastatic Ca
- 77 yr F metastatic breast Ca. 10 yrs post mastectomy
- 37 yr F metastatic breast Ca. 4 months post mastectomy and chemo
- 68 yr M metastatic colonic Ca. 10 yrs post mastectomy

➢ 5 cases Laurencet F et al., 2000
The injury has happened
Management?

• Temporary or permanent?
• Assessment
  – Mechanism
  – Duration
  – Identify the extent of injury
    • Size neuropathic area
    • Subjective function
    • Mechanosensory function
    • Disability
    • Pain / discomfort

• Patients expectations
• Treatment
Mistaken assumptions

Lingual nerve / inferior alveolar nerve injuries
• Are mainly temporary?
  – 88% of lingual nerve injuries resolve in the first 10 weeks post third molar surgery

• Are they the same?
  – LN injuries are NOT the same as IAN injuries
  – IAN injuries are more likely to be permanent
  – IAN injuries should be addressed earlier

• Hyperaesthesia and pain are more likely than numbness
Why do we need to treat?

• Disability
  – Sever discomfort OR pain
• Functionality
  – Large neuropathic area
  – Numbness /painful
  – interfering with eating and drinking
• Can’t cope!
What is the patient complaining of?

• Pain or discomfort?
• Functional problems?
• Questions?
• Expectations?
  – Normal sensation will NEVER return after 3-6 months
  – Will not increase risk of cancer or other pathology
Aims of intervention

• To restore function .......... To improve function
  – Patient daily function
    – Eating, drinking, speaking, sleeping

• To restore sensation .......... it will NEVER be normal
  – General sensory mechnano-sensory function
  – Special sensory taste

• To reduce pain or altered sensation
  – Constant pain → Intermittent → No pain
    ← Elicited pain ← Spontaneous pain
Management will depend on......

- Mechanism and Duration of nerve injury?
  - Endo > 24-48 hours
  - Implant > 24-48 hours
  - Wisdom teeth > 6months
  - LA
  - Orthognathic
  - Fracture

- Size neuropathic area
- Pain and or hypersensitivity
- Patient’s inability to cope with disability

Treat symptoms!
Why is duration of injury so important?

Neuroplasticity
Permanent central changes after 3 months

- neuro inflammation
- neurodegeneration
- neuropeptide release

Alteration in expression of receptors, channels, enzymes, nerve gene
Implant / Endo nerve injuries

- Radiograph
  - ? CBCT evidence of disrupted canal or bone fragment
- If less than 24 hours
- REMOVE
  - Implant even if implant ‘distant’ from IAN canal
  - Endo/tooth
IAN injury

Endo /Implant related? Less 24 hours

- Yes: Remove implant/endo Review
- No: Leave in situ Reassure pt Medication for pain
Is the injury permanent?

- Neuropathic area > 50% surface
- Subjective function score <4/10
- Disability >6/10
- At 8 weeks = Indicative of permanent injury

Renton T, Thexton A, SJ Crean, Hankins M. Simplifying assessment of recovery of the lingual nerve from injury. BDJ 200;10:569-573
Assessment of neuropathy

- **Mechanosensory**
  - Neuropathic area
  - Subjective function
  - Light touch
  - Sharp blunt

- **PAIN VAS**
  - At rest
  - Dynamic allodynia
  - Cold allodynia
  - Capsaicin

- **Thermo sensory**

- Biopsy
Treatment options

• What are we treating?
  – Functional disability
  – Pain
  – Large neuropathic area
    Sensation will never be normal
• How do we treat?
  – Counselling
  – Medical
  – Surgery
Management tools

- Counselling
  - LA, Orthognathic, Fracture or injuries older 12 months
    - Reaffirm nerve injury is permanent
    - Reassurance and explanation
- Medical symptomatic therapy (pain or discomfort)
  - Topical agents for pain
  - Systemic agents for pain
- Surgical exploration
  - remove implant or endo material within 24 hours
  - Explore IAN injuries thro socket less than 4 weeks
  - Explore LN injuries before 12 weeks
Surgical intervention

- Why do we operate?
- When do we operate?
- What technique should be used?
- How do we assess the outcome?
- Why only surgery?
When do we operate?
Delay of referral for repair

- Seddon’s dictum (1943) ‘if a purely expectant policy is pursued the most favourable time for operative intervention will always be missed’
- Mean delay before repair for 21 studies is

16 months

- Why does this delay happen?
Why is the timing of nerve repair so paramount?

• Peripheral consequences of nerve injury
• Central consequences of nerve injury
• Improved outcomes
  – Susarla et al 2007
  – Ziccardi 2007
Nerve surgery

- Exploration
- Decompression
- Neuroma in continuity (NIC) excision and re-approximation
- End neuromata (EN) excision and re-approximation with minimal tension
Third molar surgery

LN injury

- Less 12 weeks
- Large neuropathic area?
  - Poor mechanosensory function
  - Pain / Poor function?
    - No
      - Surgical exploration
      - Reassurance
        - Medication for pain
Lingual nerve surgery approach

- Extra oral approach
- Intra oral approach
  - Floor of mouth A
  - Retromolar B
Lingual nerve exploration

- Retromolar approach
- Nerve appears ‘normal’ leave
Lingual nerve decompression
external neurolysis

- Explore
- Release scar tissue around nerve
- Nerve appears ‘normal’
Lingual nerve excision neuroma with anastomosis

- After release of scar tissue a neuroma is evident
- Excise neuroma back to healthy nerve tissue
- Re approximate with epineural sutures
- 4-6 x 6/0 Vicryl sutures
Third molar surgery

IAN injury

Recent surgery < 4 weeks
Large neuropathic area?
Poor mechanosensory function
Poor function / pain?

Yes
Surgical exploration
Explore thro socket

No
Reassess < 12 weeks
If no improvement
Surgical exploration
Inferior alveolar nerve surgery

• Radiographic evaluation of socket
• Visualise IAN via socket if appears normal leave
• If neuroma present expand approach using lateral corticotomy
Early inferior alveolar exploration
Inferior alveolar nerve repair

- Older injury with socket healed
- Lateral corticotomy
- Grafts NOT indicated
In Summary

Prevention is better than ‘cure’
Thank you

• Have we got the ‘nerve’ to prevent these injuries?

• Acknowledgements
  To my patients and colleagues @ KCL
Lingual nerve exploration
• Dentist
• Marathorn man
• http://www.youtube.com/watch?v=TPQ7KMCrPLE
• La funny
• http://www.youtube.com/watch?v=tao1WHjKAsc
• mr bean
• http://www.youtube.com/watch?v=abf4hAjIoI
• eddie izzard
• http://www.youtube.com/watch?v=pnSgq2C-yg
• negotiating
• http://www.youtube.com/watch?v=EugZym5jM-Q
• monty python
• http://www.youtube.com/watch?v=mDaRAdceU
• dentist song
• http://www.youtube.com/watch?v=K1phr_MLnIM
• trident squirrel
• http://www.youtube.com/watch?v=xAVALXH9nxU
• sedation darth vada
• http://www.youtube.com/watch?v=YvGBtLaz0zw
• Letterman
• http://www.youtube.com/watch?v=AL-1tNh1pH4
• bam chukka wow wow
• http://www.youtube.com/watch?v=2rY00VfDDew
• TN
• http://www.youtube.com/watch?v=U-XO4ZGgwWY
• DNA
  http://www.youtube.com/watch?v=eOvMNOMRRm8
• SNPs
  http://www.youtube.com/watch?v=5raJePXu0OQ
• where do genes come from
  http://www.youtube.com/watch?v=lJzZ7p-47P8
• phenotype
  http://www.youtube.com/watch?v=jHWJqzlHI3w
• medical art
  http://www.youtube.com/watch?v=7B08itXiXok
• macrophage
  http://www.youtube.com/watch?v=KiLJI3NwmpU
Case 1

- 56 year old female
- 4.5 years left facial pain
- 12 specialists
- Drugs
- MRI and CT
- Upper left retained 6 root
Case 2

- 64 year old female
- 5 years chronic orofacial pain
- 8 specialists
- Drugs
- MRI
- Retained upper right 5 root and associated sinus inflammation
Case 3

- 46 year old banker
- 5 years before knocked off bike by car
- Chronic maxillary pain
- 24 specialists
- Drugs
- CT and MRI scanning

- Diagnosis non vital 11, 21 and 22 associated with undiagnosed maxillary alveolar fracture
Case 4

- 44 year old single mum
- 6 month ago
- Spontaneous
- Increasing trismus
- Tumour left maxillary tuberosity
Case 5

- 37 year Spanish male
- Pain left side face focussed LL7
- Tic type pain triggered by any oral activity
- cannot eat / sleep disturbance
- Xla LL7 1 year ago

- Solitary demylinated T2 hyperintense lesion medial left cerebellar peduncle-?Tx
Case 6

- 58 yr old Pakistani Insurance broker female
- 3 years facial pain left side
- Left IoN partial Neuropathy
DoB: 31/10/48
July 1997 diagnosis through nasal biopsy.
Cyclophosphamide infusion for 6/12
Since March 1998 Methotrexate
Presenting Symptoms: Pain UL following RCT
and C+B work in India.
Numbness L palate
Case scenarios
Trigeminal neuralgia?

- Classical
- Multiple sclerosis
- Tumours
- Odontalgias caused by LA peripheral nerve injuries