

Prevention of iatrogenic injury and case reports

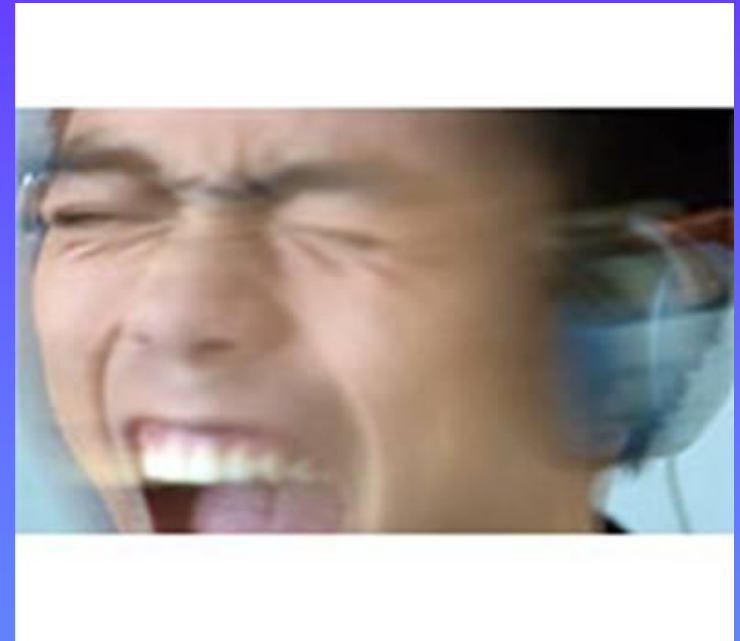
T Renton

Addenbrookes study day

2009

Outline

- When do trigeminal nerve injuries happen?
- How do we prevent them?
- Can we manage them?
- Pain an update



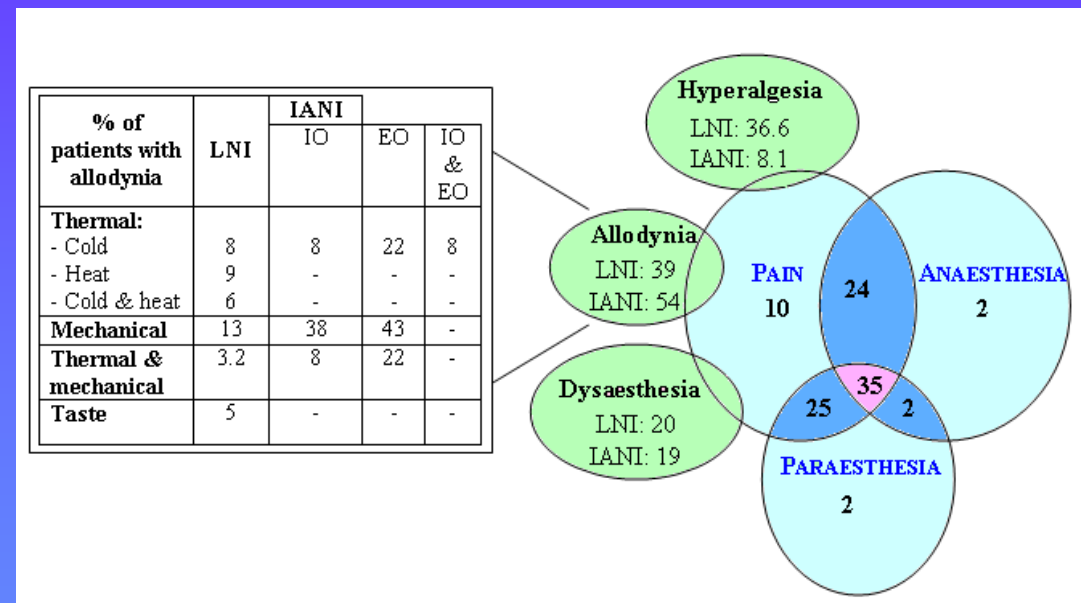
– **Subjects:**

- 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).

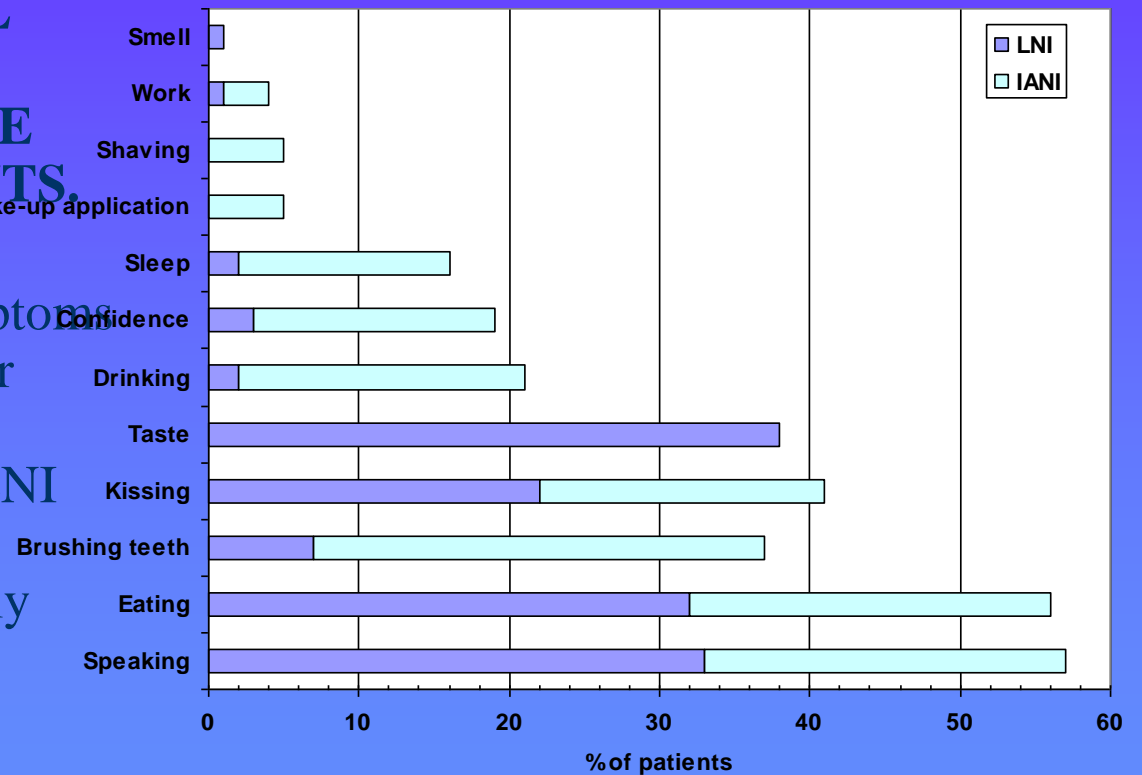
Iatrogenic trigeminal nerve injury

- 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 allodynia.
- 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.

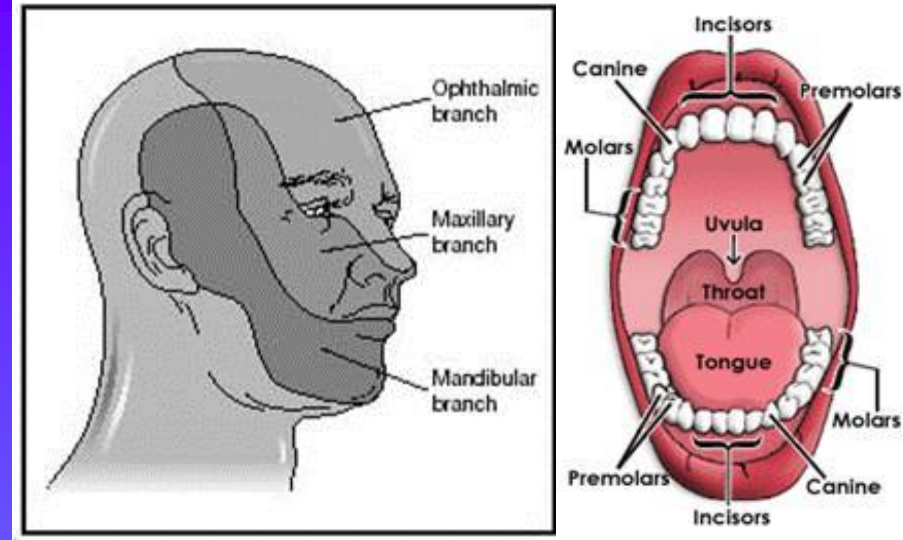


The problem

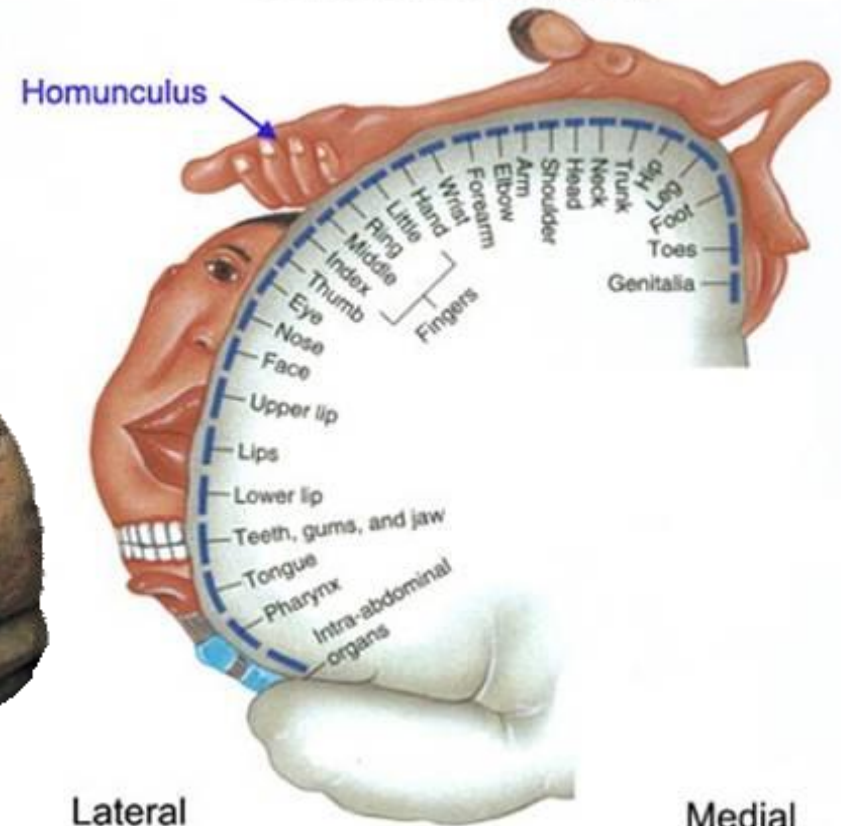


Trigeminal nerve specific geminal nerve

- Consent
 - Closed injury
 - Most resolve
 - Type of nerve injury
 - Type of patient
 - Neuroplasticity
-
- Current surgical management is inadequate



Somatosensory Map



Painful peripheral sensory nerve neuropathy

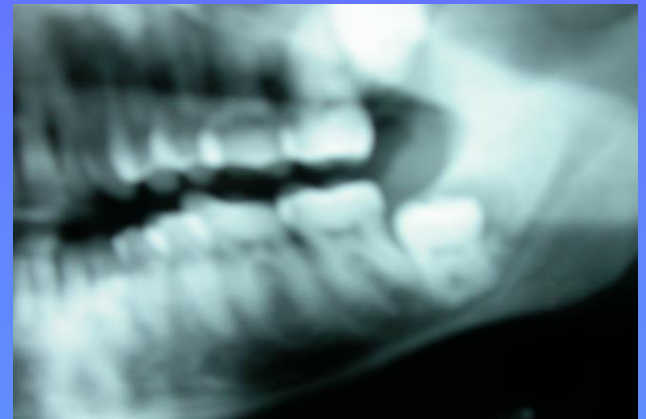
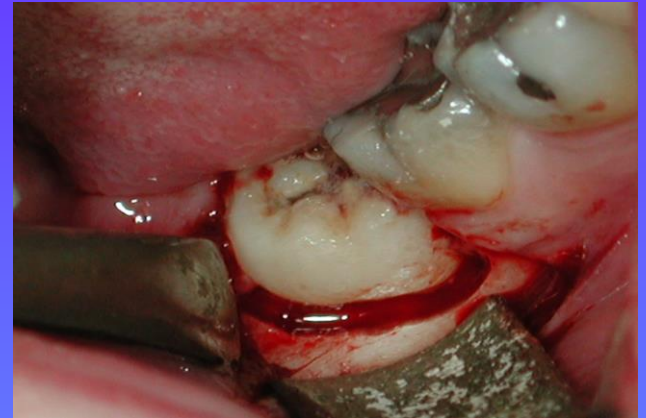
- Diabetes
- HIV
- Chemotherapy
- MS
- Post surgical traumatic neuropathy
- Infection
- Parkinson's
- Malignancy
- Drugs - Growth hormone injections

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

- ## Septocaine 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 88vs 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

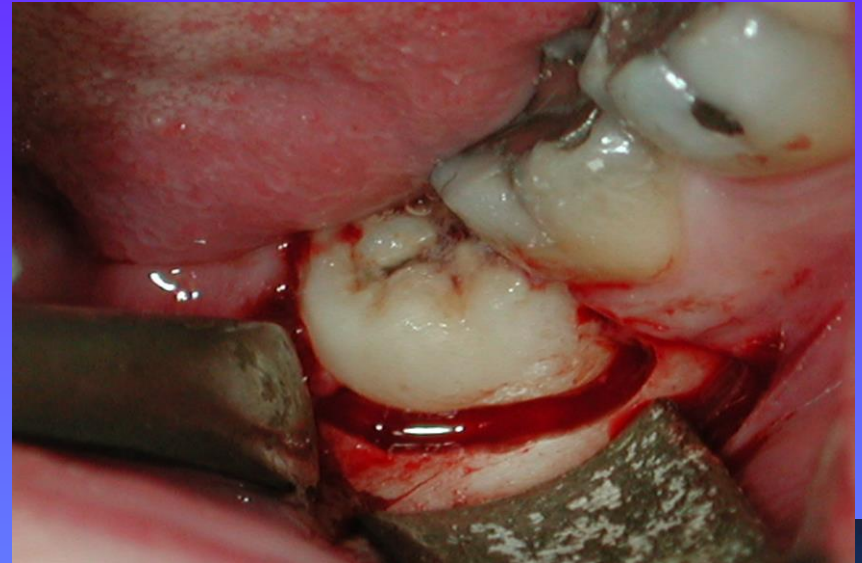
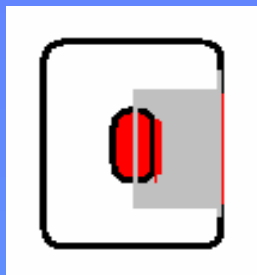
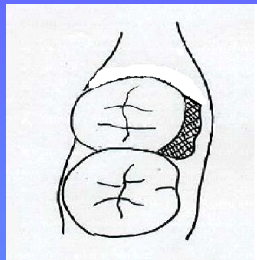
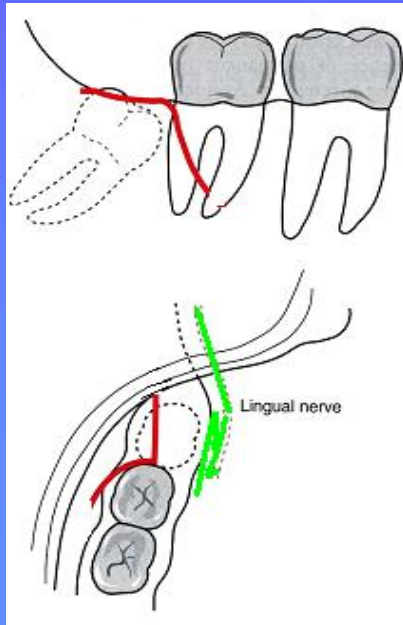
- Prospective case series 1384 patients undergoing third molar surgery (n=2134)
- Significant risk factors associated with lingual nerve injury
 - Difficulty of surgery
 - Patient age
 - Depth of application
 - Surgeons surgical skill
 - Scoring of lingual plate
 - Exposure of the nerve



Renton T, McGurk M. Brit J Oral Maxillofac Surg 2001; 39: 423-428.

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

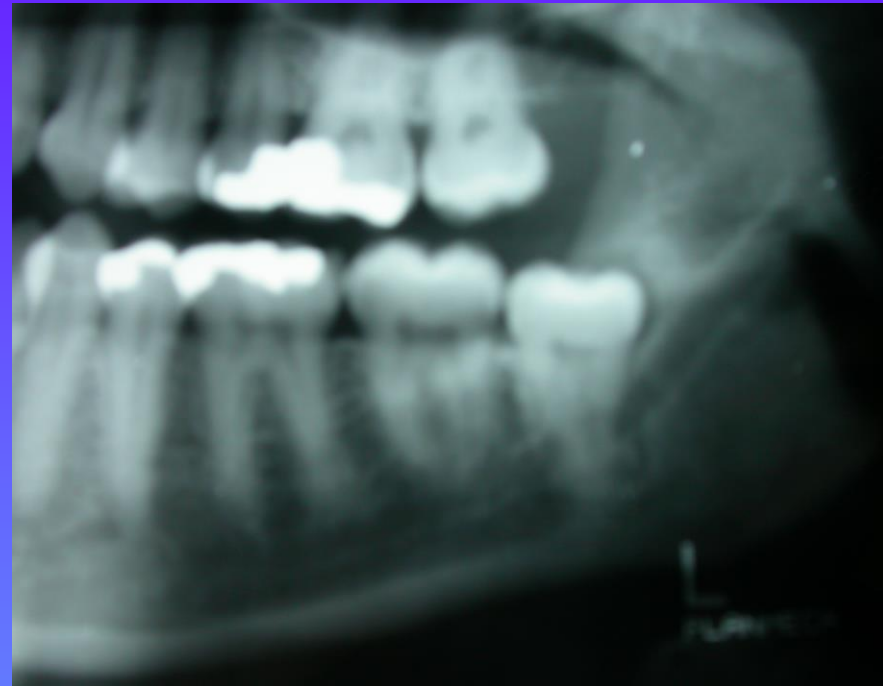


USA-If a lower third molar is high risk -----CBCT

IAN -Radiographic factors

- OLD

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



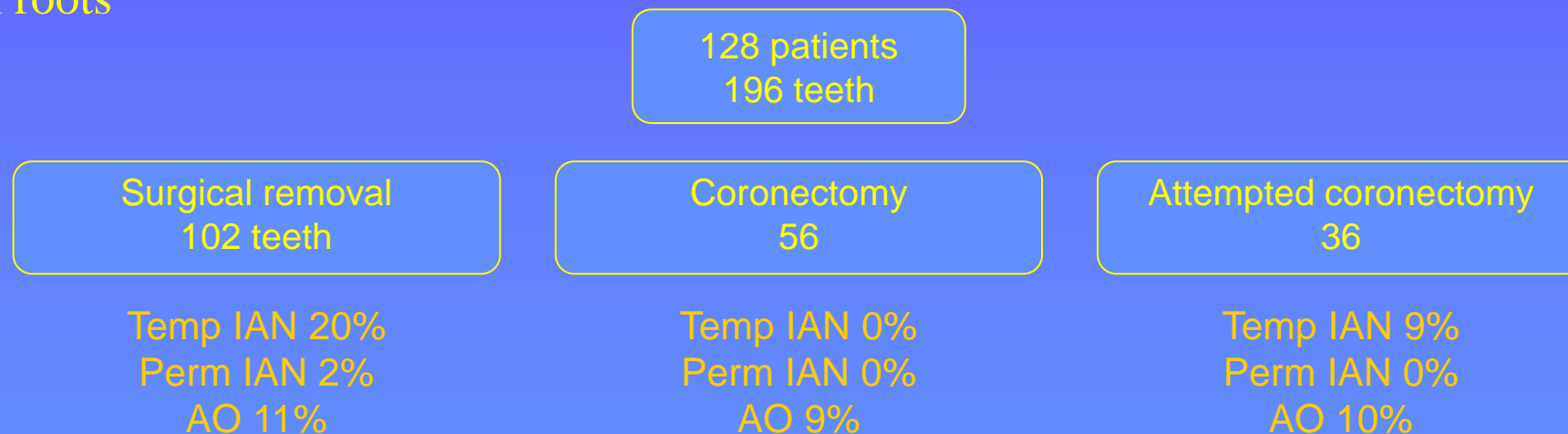
NEW

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



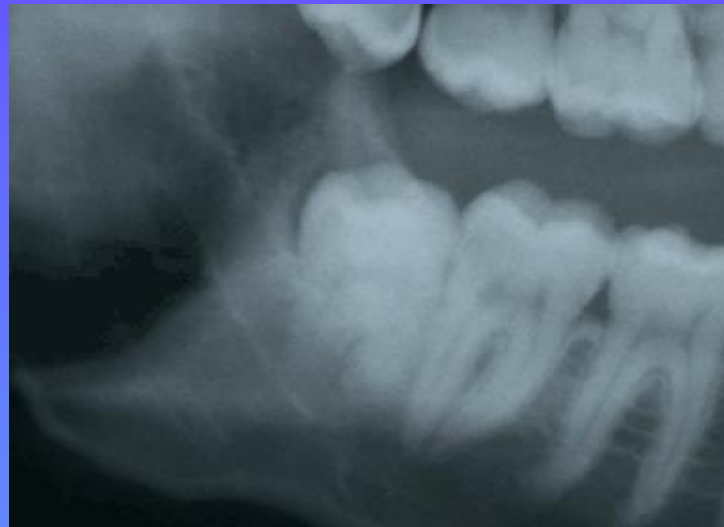
Inferior alveolar nerve

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



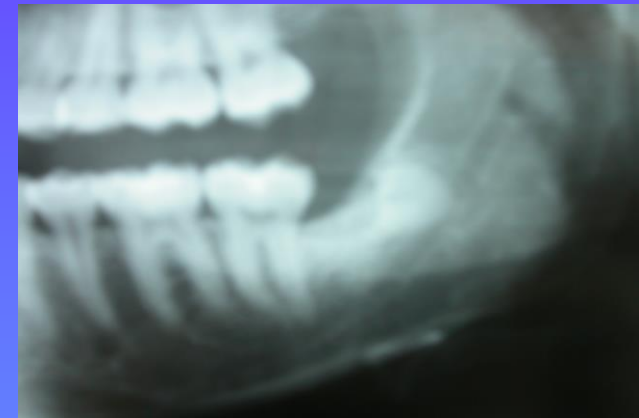
Renton T *et al.* A prospective randomized study assessing coronectomy versus removal in third molar surgery. BJOMS 2004

Video of procedure of coronectomy



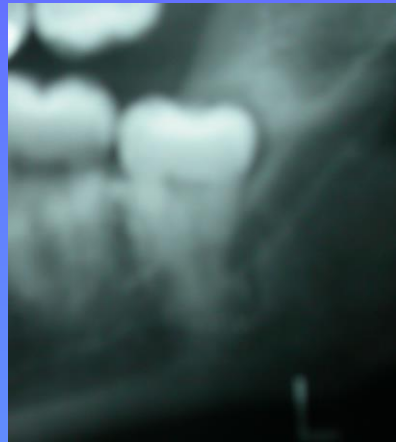
Coronectomy complications

- Recent case complications
 - Eruption
 - Infection >1 episode 'dry socket'
 - Remove roots
 - Infection plus IAN paraesthesia
 - Temporary
 - Permanent
 - Take care with iodoform products



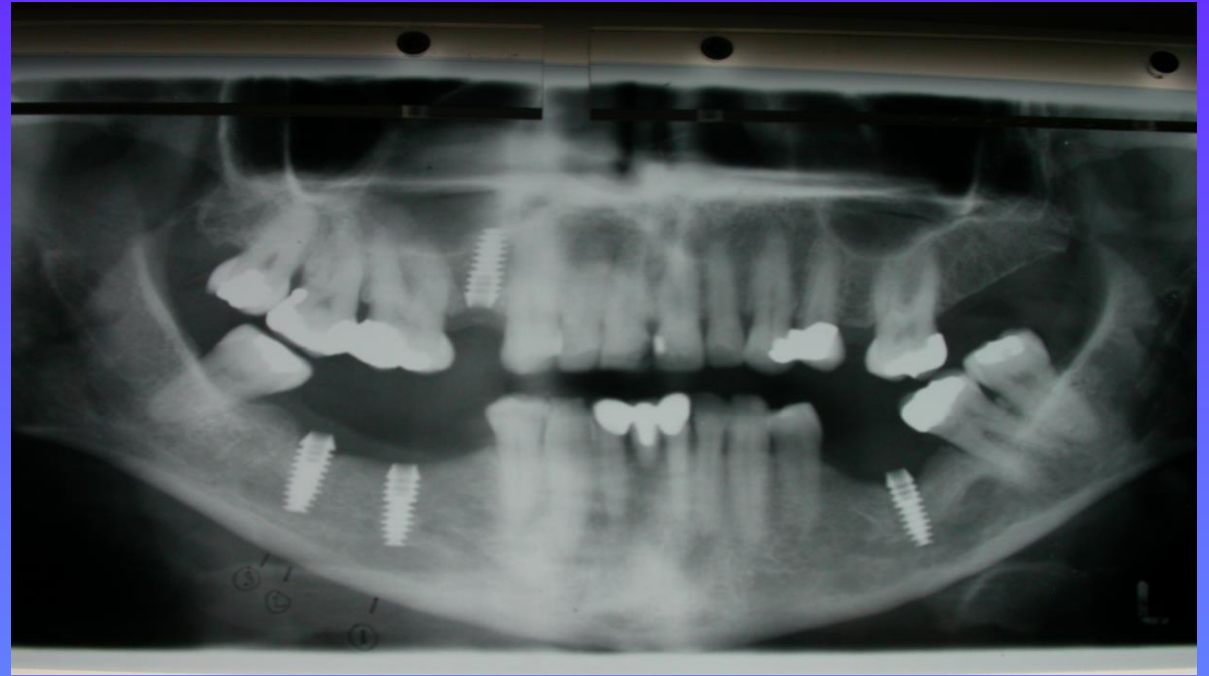
Tooth sectioning

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

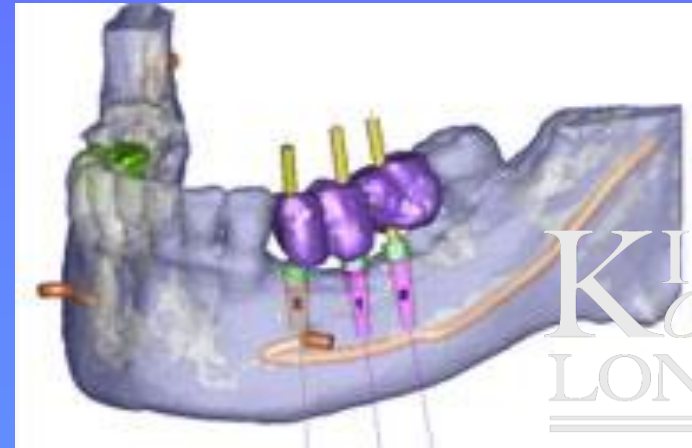
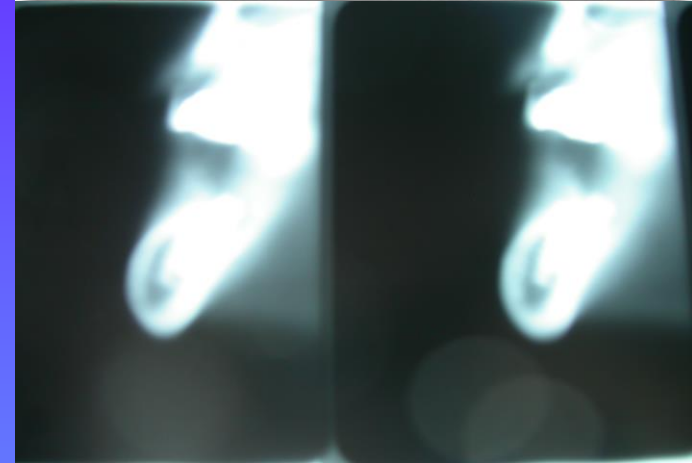


Implant related nerve injury

- Planning
- Preparation
- Placement
- Post operative
- Advanced implant surgery
 - Bone harvesting

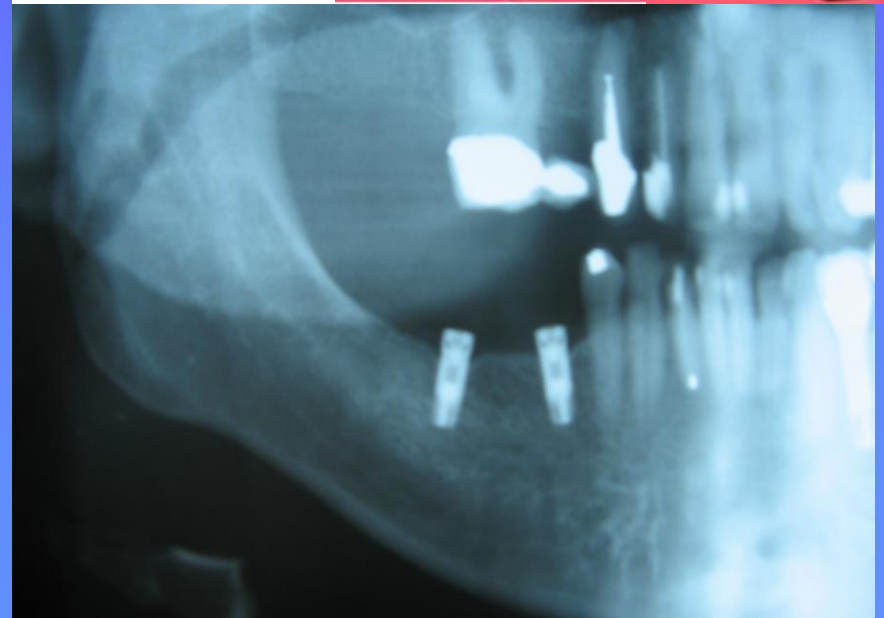
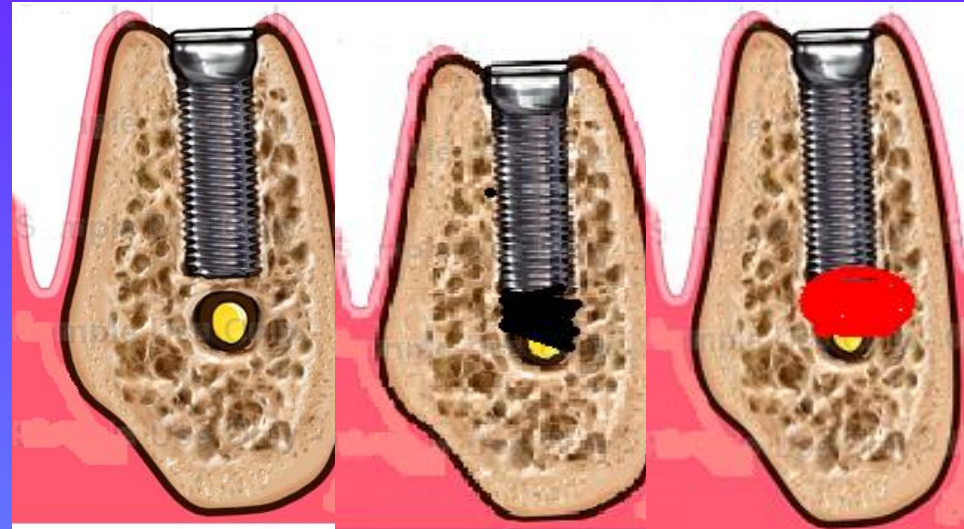


- What radiography?
 - Cone Beam CT Scan
- Planning
 - Software
 - Simplant
- Assessment of IAN position
- Safety zone $>2\text{mm}$ IAN canal
- ? Should be $>4\text{mm}$
- What is the actual position of nerve?



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

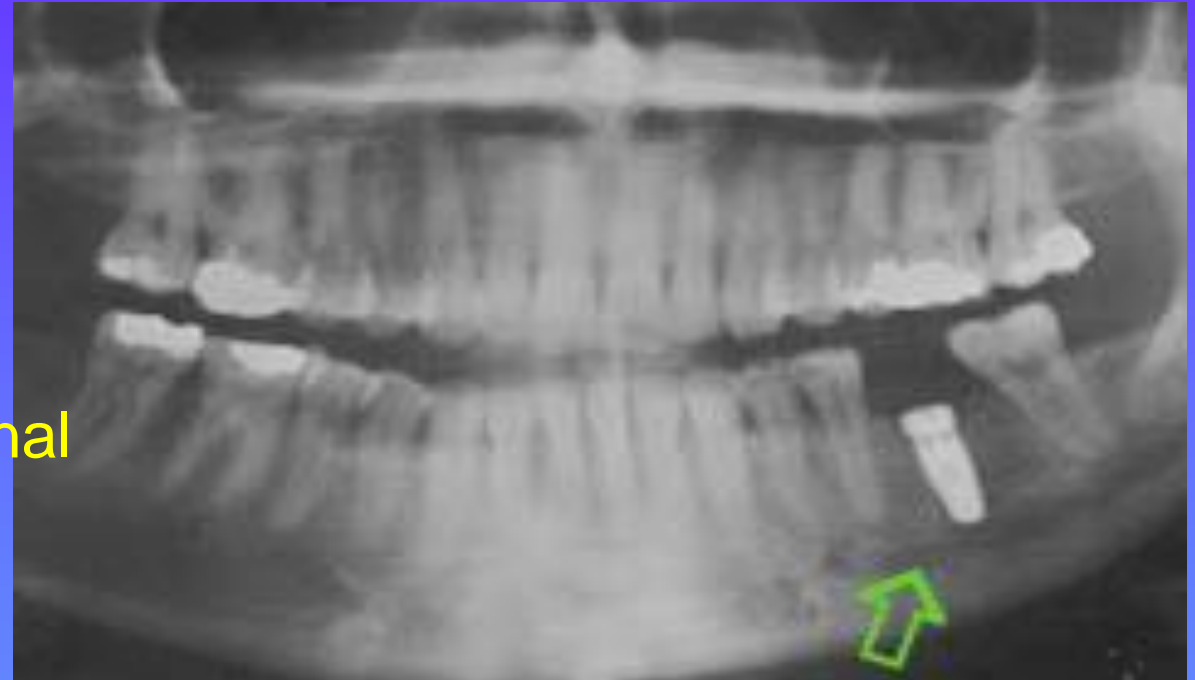


Pre-operative risk factors

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

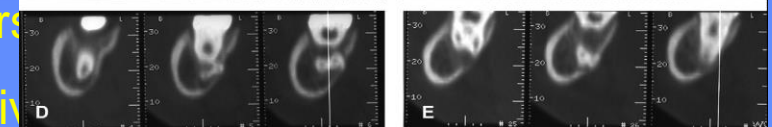
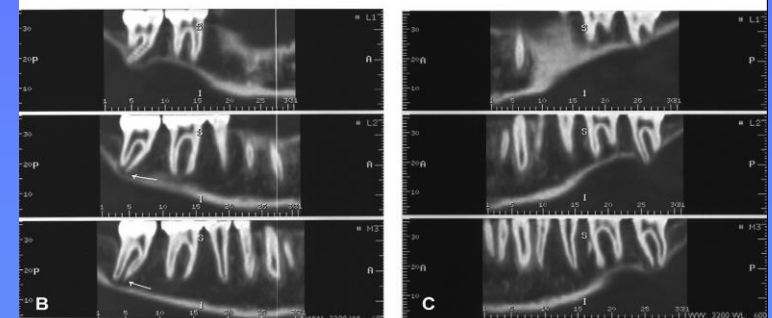
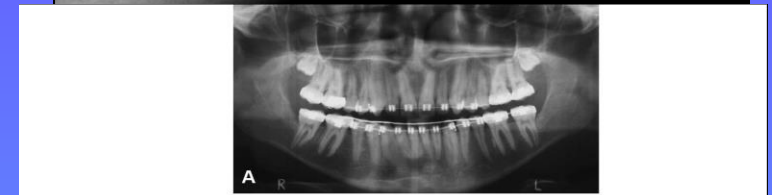
Toxicity of commonly used dental products

- 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 (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



Orthodontic related nerve

- 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 buccalisation 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 div

- 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 functionTo improve function
 - Patient daily function
 - Eating, drinking, speaking, sleeping

- To restore sensation.....it will NEVER be normal
 - General sensory mechano-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

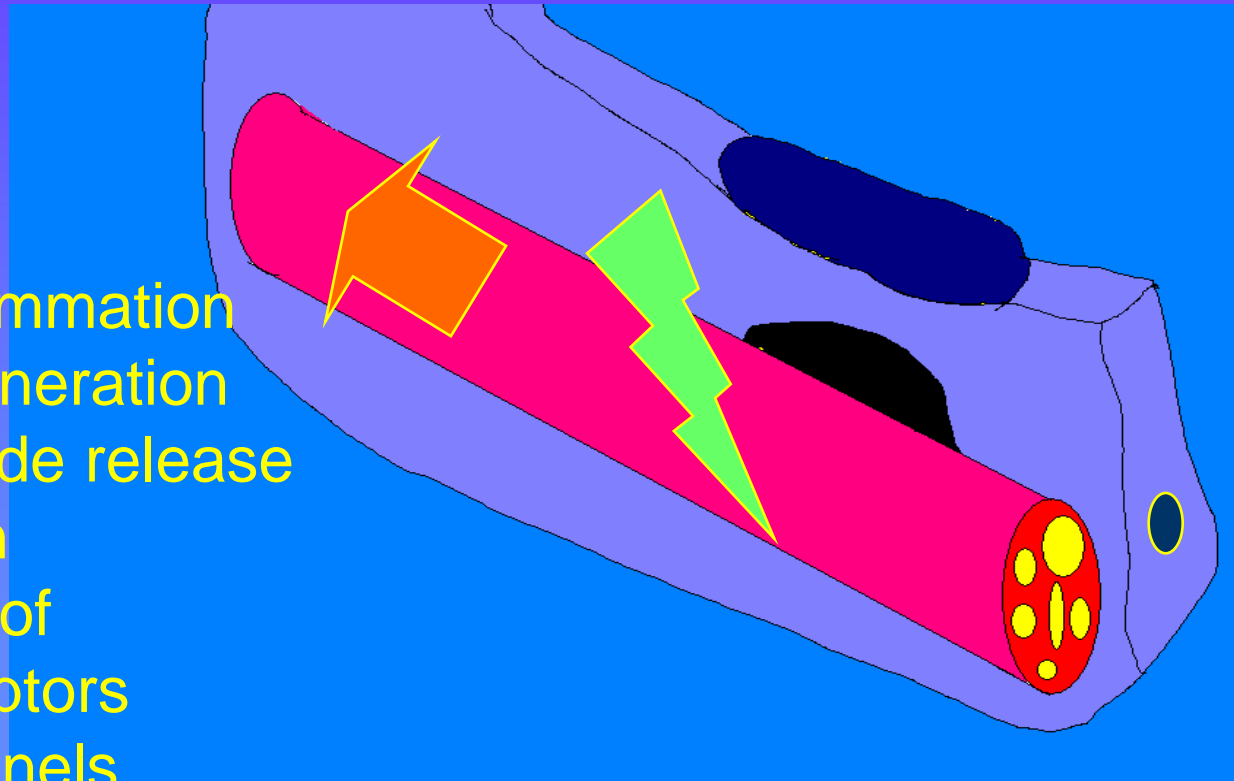
Treat symptom

Why is duration of injury so important?

Neuroplasticity

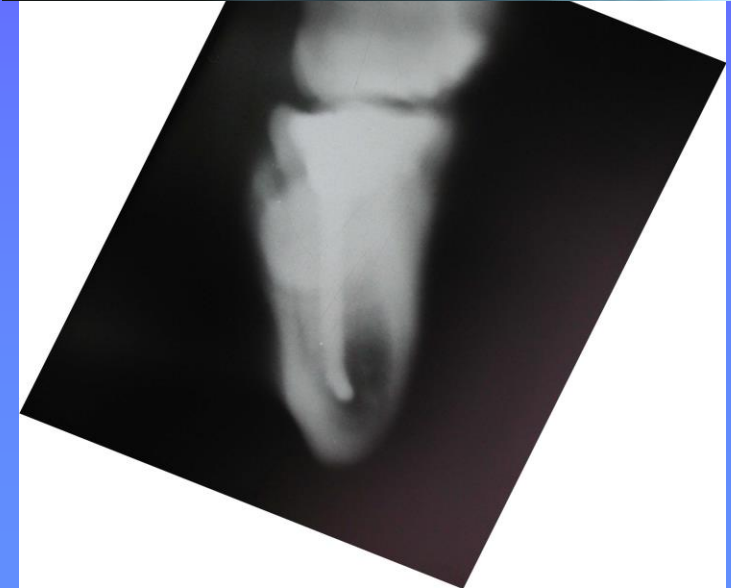
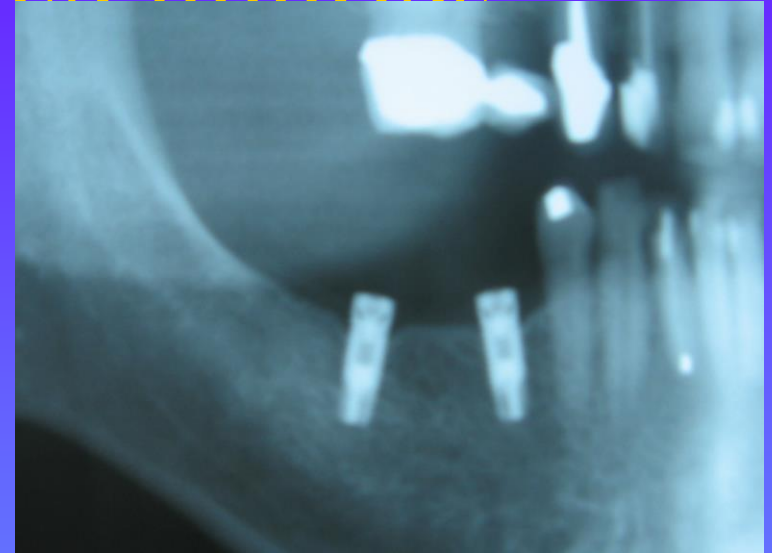
Permanent central changes after 3 months

- 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

No

Remove implant/endo
Review

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

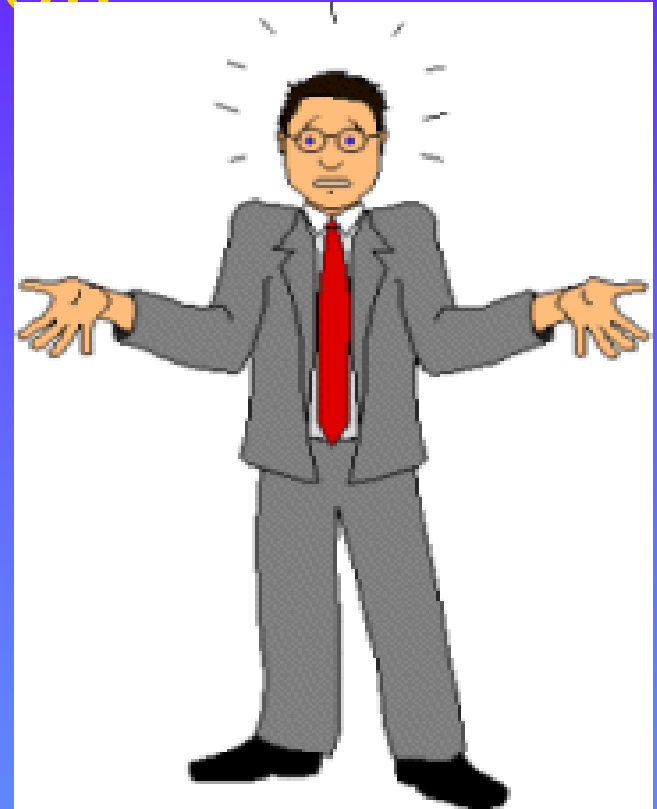
- What are we treating?
 - Functional disability
 - Pain
 - Large neuropathic areaSensation will never be normal
- How do we treat?
 - Counselling
 - Medical
 - Surgery

Management tools

- **Counselling**
 - LA, Orthognathic, Fracture or injuries older 12months
 - 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
- Why does this delay happen? **16 months**



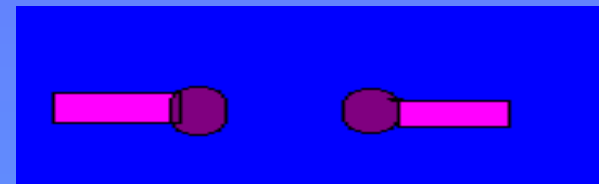
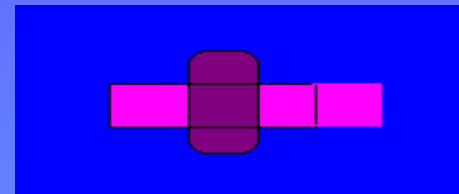
Why is the timing of nerve repair so paramount?

- Peripheral consequences of nerve injury
- Central consequences of nerve injury
- Improved outcomes
 - Susarla et al 2007
 - Ziccardi 2007

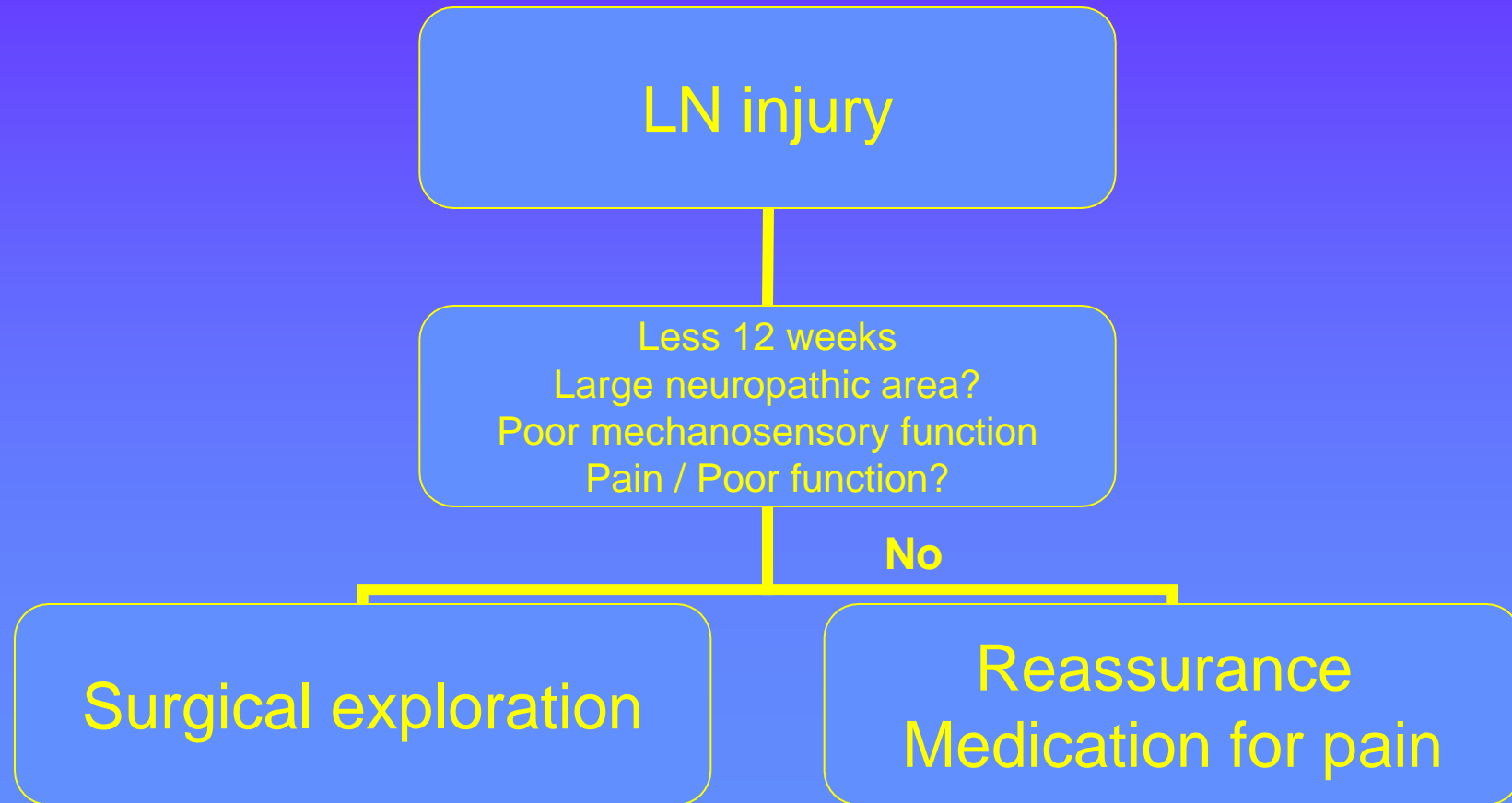


Nerve surgery

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

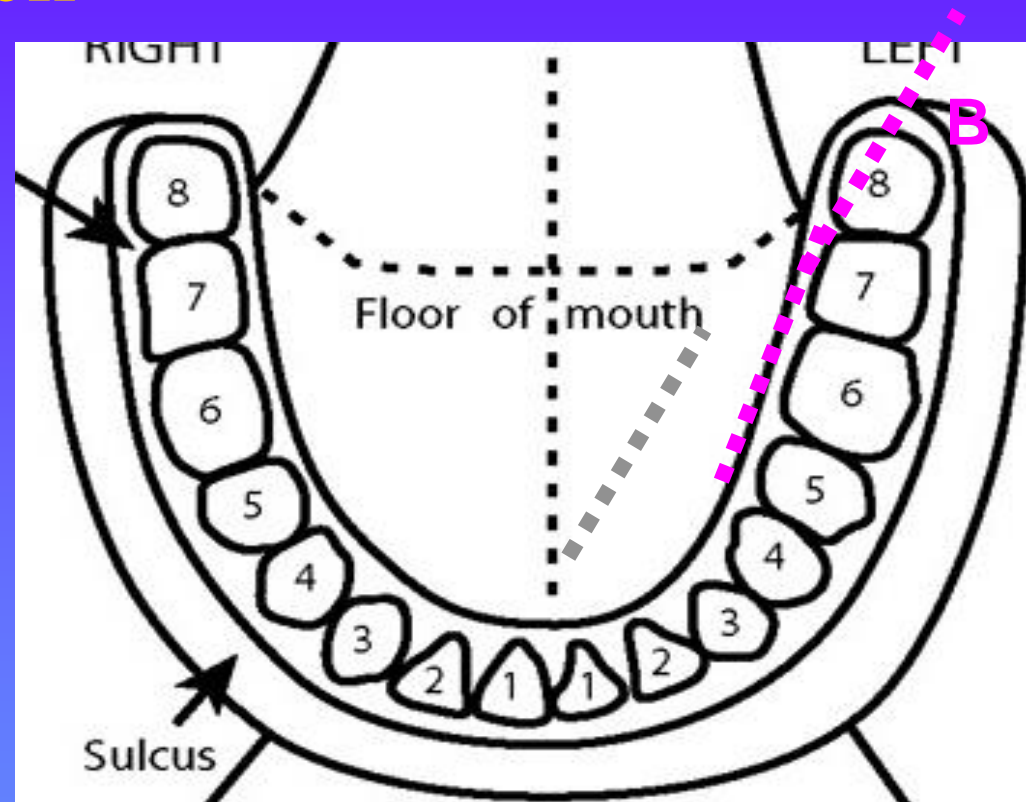
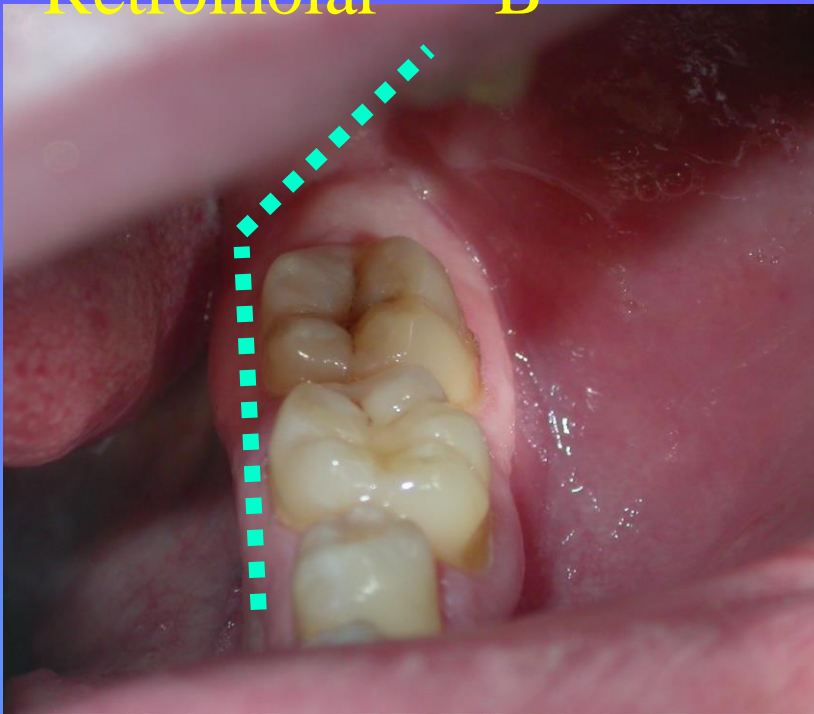


Third molar surgery



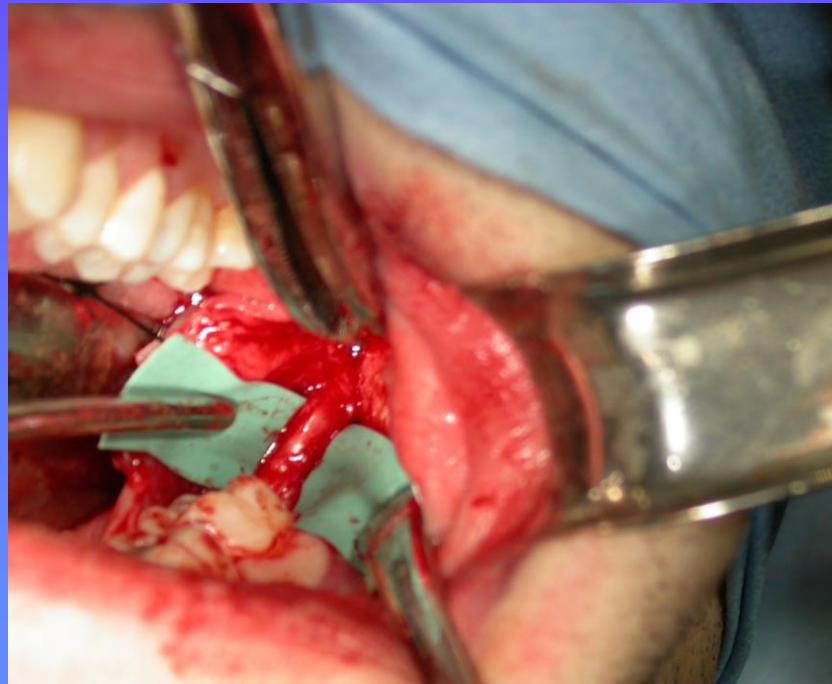
lingual nerve surgery approach

- Extra oral approach
- Intra oral approach
 - Floor of mouth A
 - Retromolar B



Lingual nerve exploration

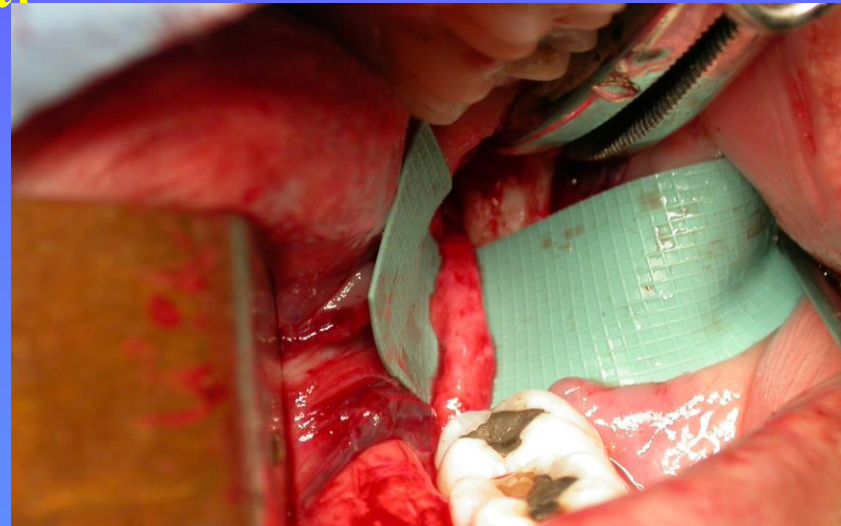
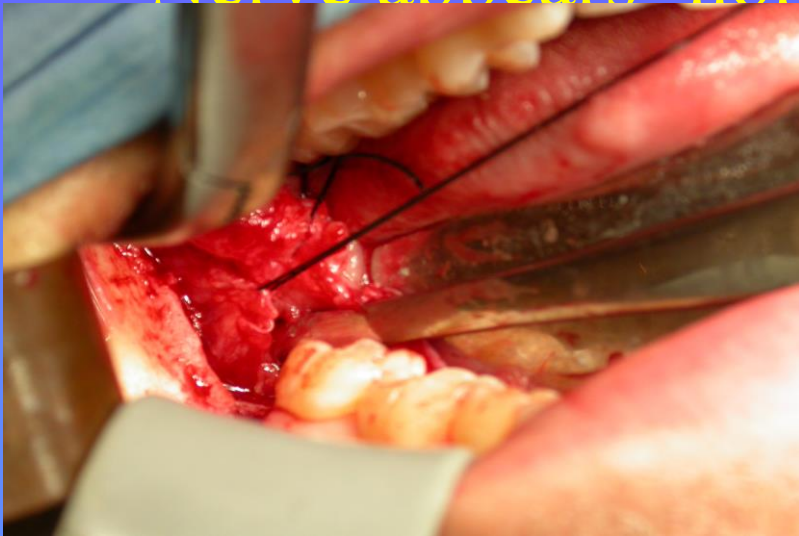
- Retromolar approach
- Nerve appears 'normal' leave



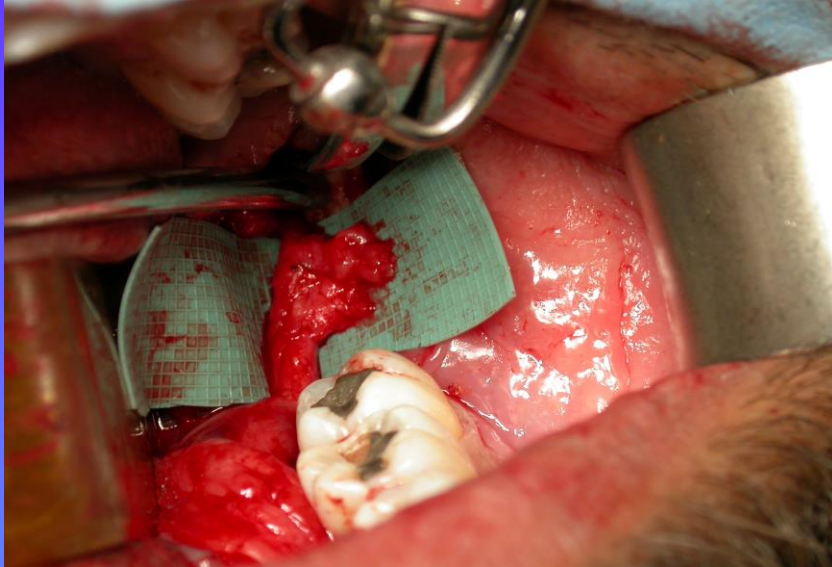
oral nerve decompression

external neurolysis

- Explore
- Release scar tissue around nerve
- Nerve appears 'normal'

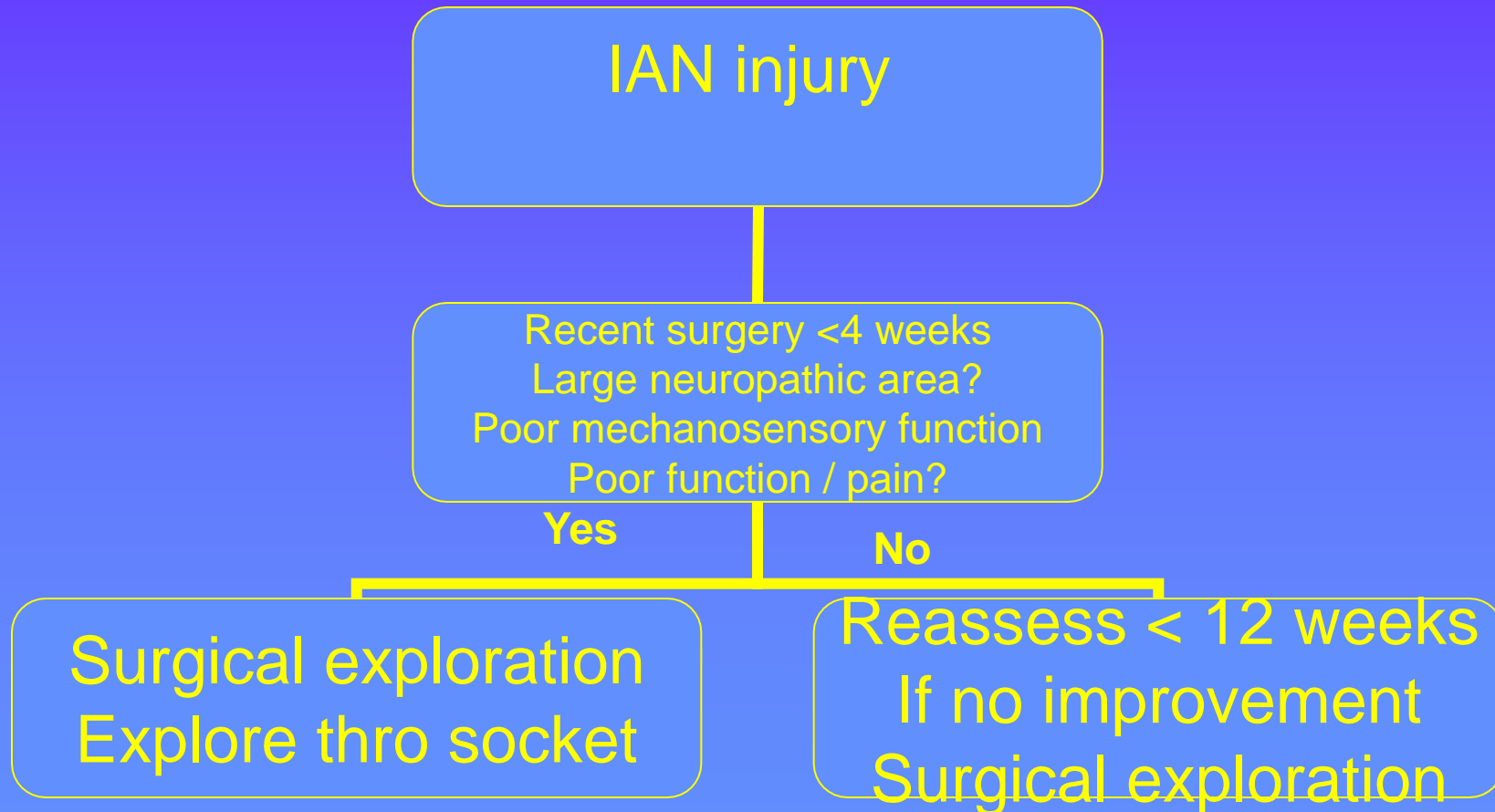


Lingual nerve excision neuroma with anastomosis



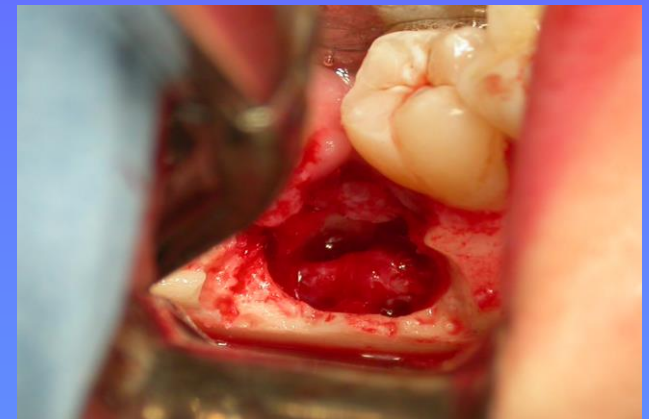
- After release of scar tissue a neuroma is evident
- Excise neuroma back to healthy nerve tissue
- Re approximate with epineural sutures
- 4-6 x 6/0 Vicryl sutures

Third molar surgery

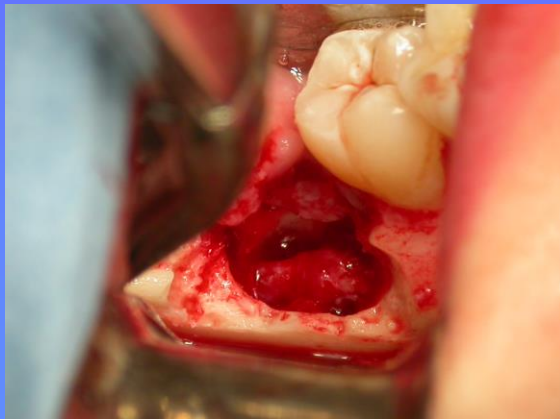


Inferior alveolar nerve surgery

- Radiographic evaluation of socket
- Visualise IAN via socket if appears normal leave
- If neuroma present expand approach using lateral corticotomy

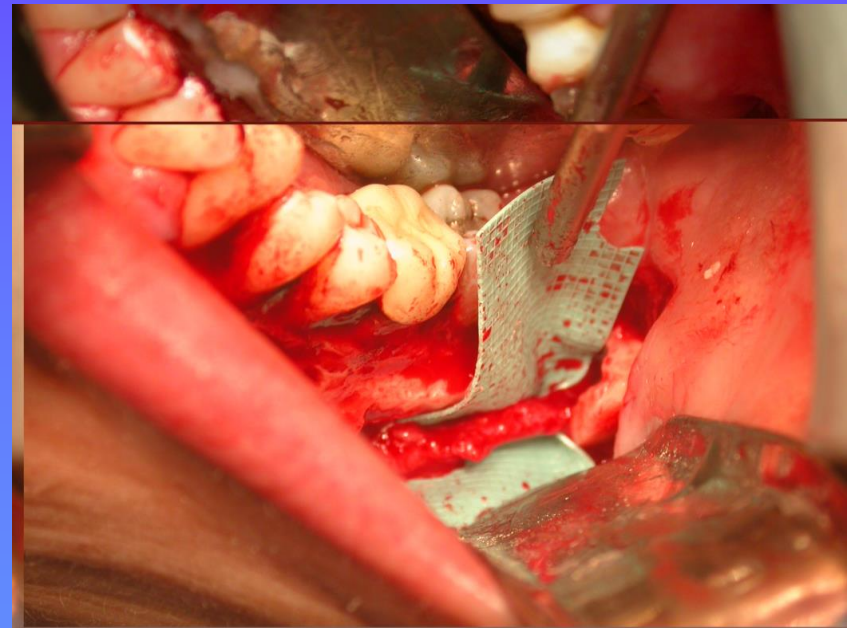
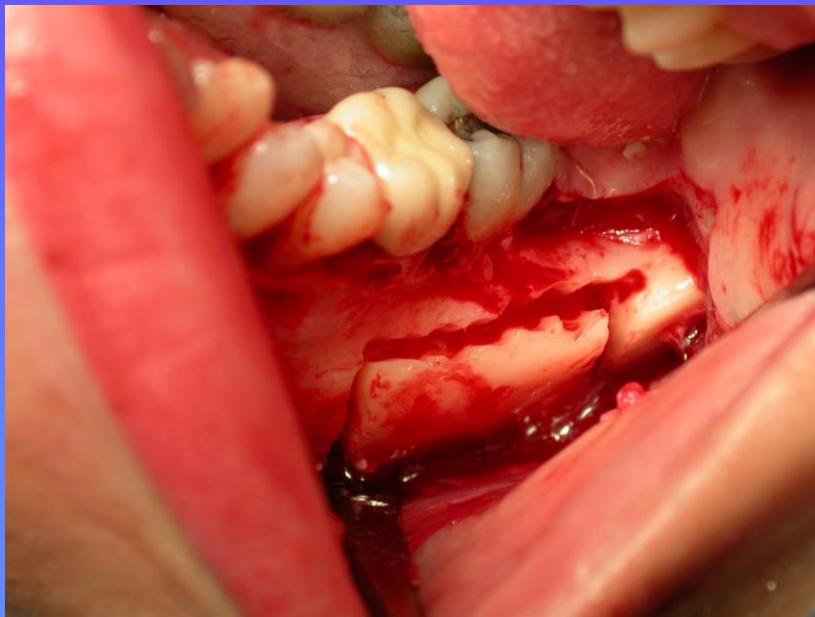


Early inferior alveolar exploration



Inferior alveolar nerve repair

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



In Summary

Prevention is better than 'cure'

Thank you

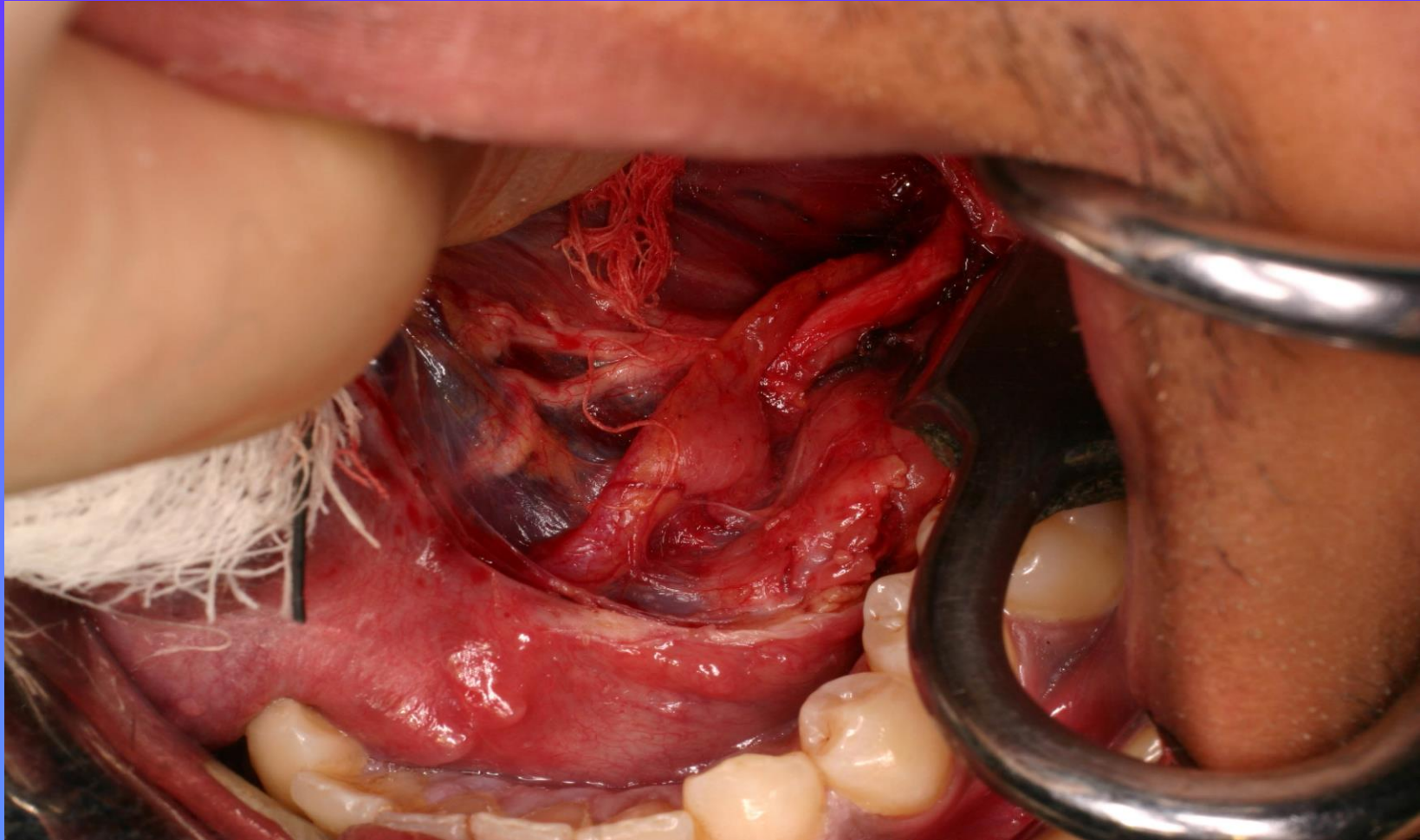
- Have we got the ‘nerve’ to prevent these injuries



- Acknowledgements

To my patients and colleagues @
KCL

Lingual nerve exploration

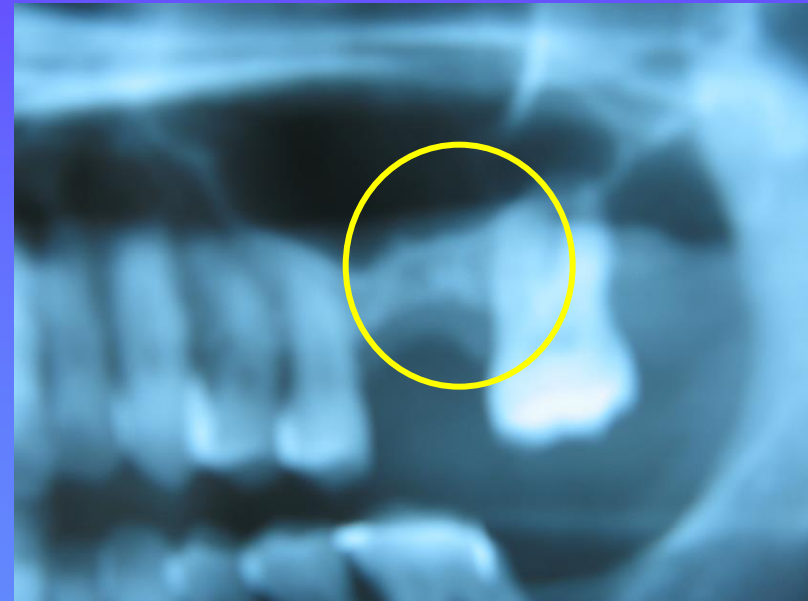


- Dentist
- Mararthon man
- <http://www.youtube.com/watch?v=TPQ7KMCrPLE>
- La funny
- <http://www.youtube.com/watch?v=tao1WHjKAsc>
- mr bean
- <http://www.youtube.com/watch?v=abJyp4bAi0I>
- eddie izzard
- http://www.youtube.com/watch?v=_pnSgq2C-yg
- negotiating
- <http://www.youtube.com/watch?v=EugZYm5jM-Q>
- monty python
- <http://www.youtube.com/watch?v=mDARaqDrcU4>
- 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-1tNblpH4>
- 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=1JzZ7p-47P8>
- phenotype
- <http://www.youtube.com/watch?v=jHWJqzlHl3w>
- medical art
- <http://www.youtube.com/watch?v=7B08itXiXok>
- macrophage
- <http://www.youtube.com/watch?v=KiLJl3NwmpU>

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



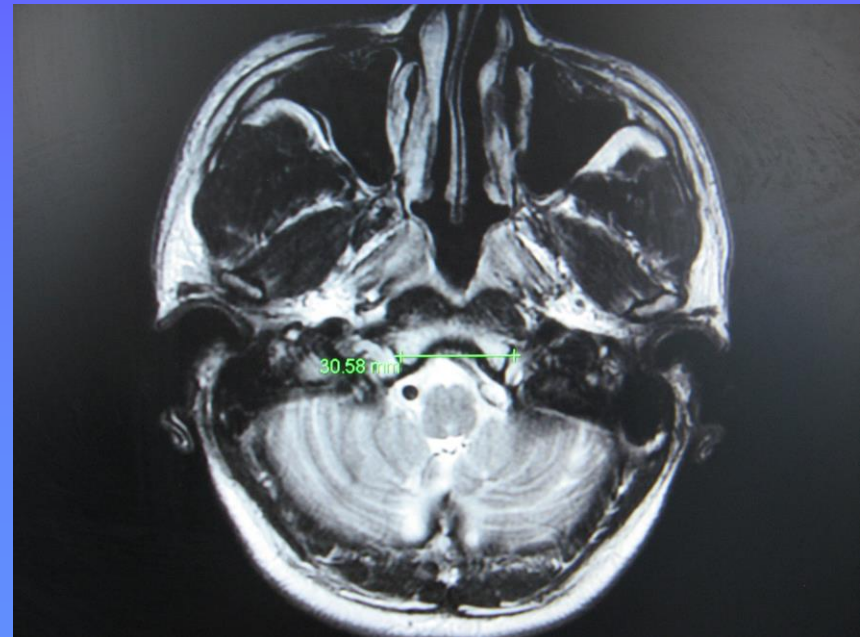
Case 4

- 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 demyelinated 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

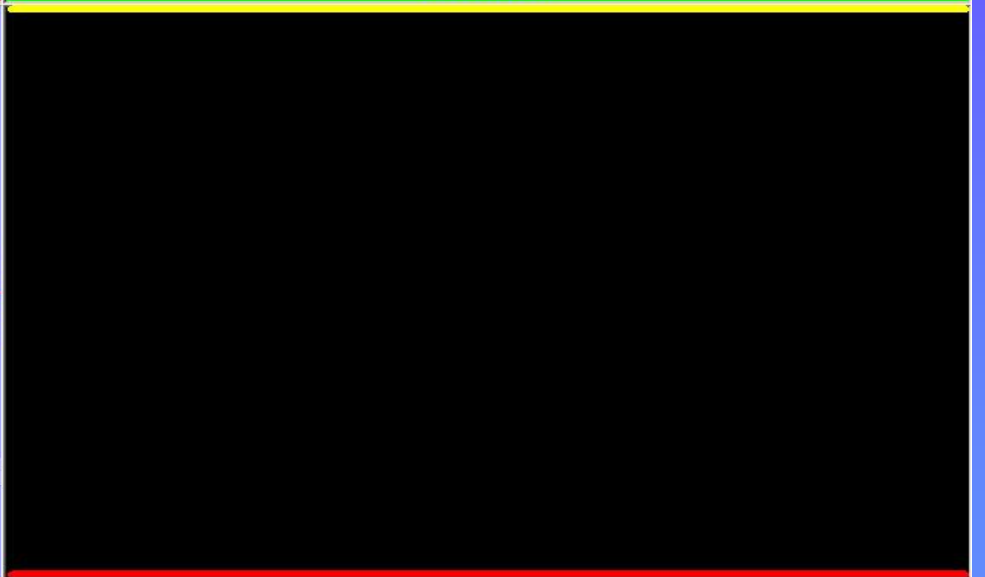
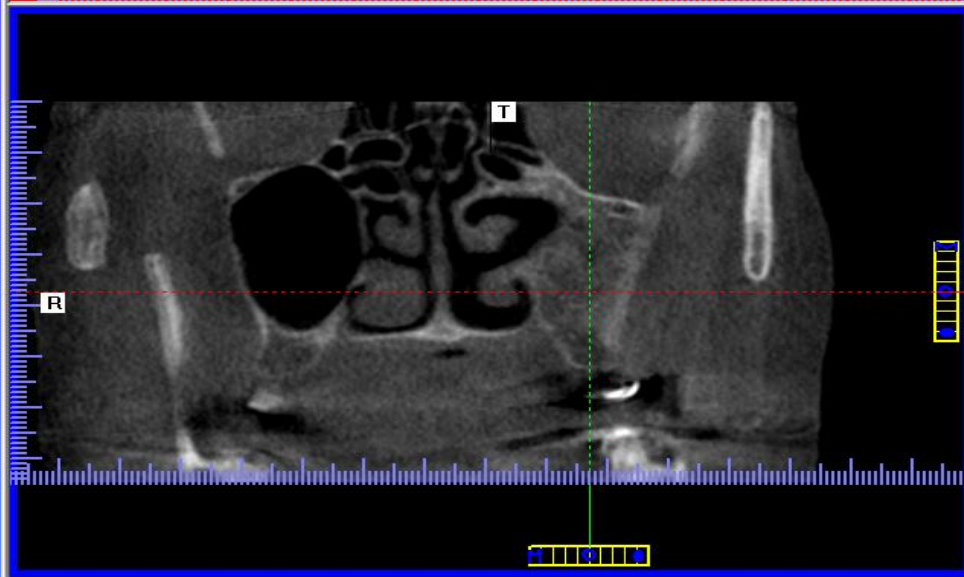
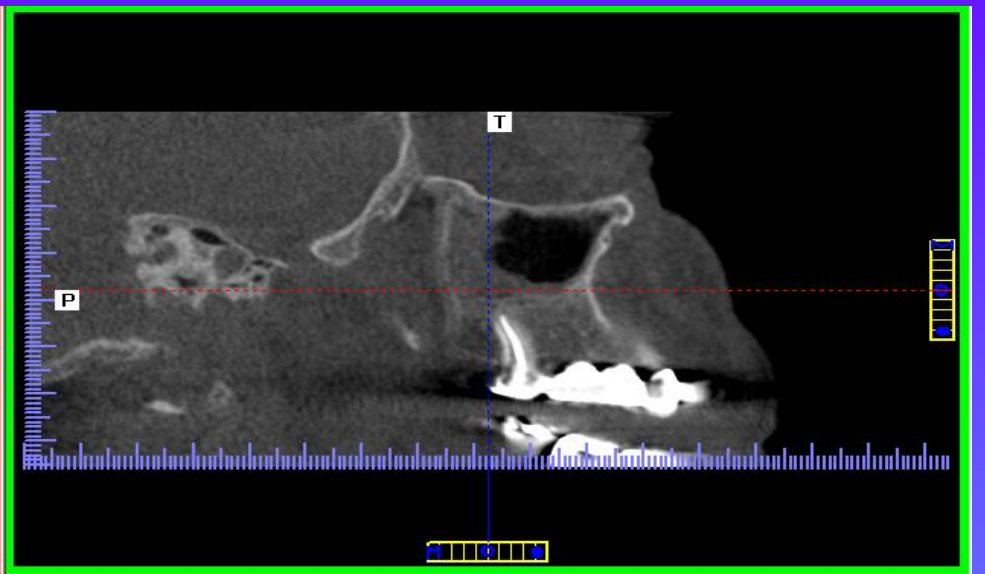
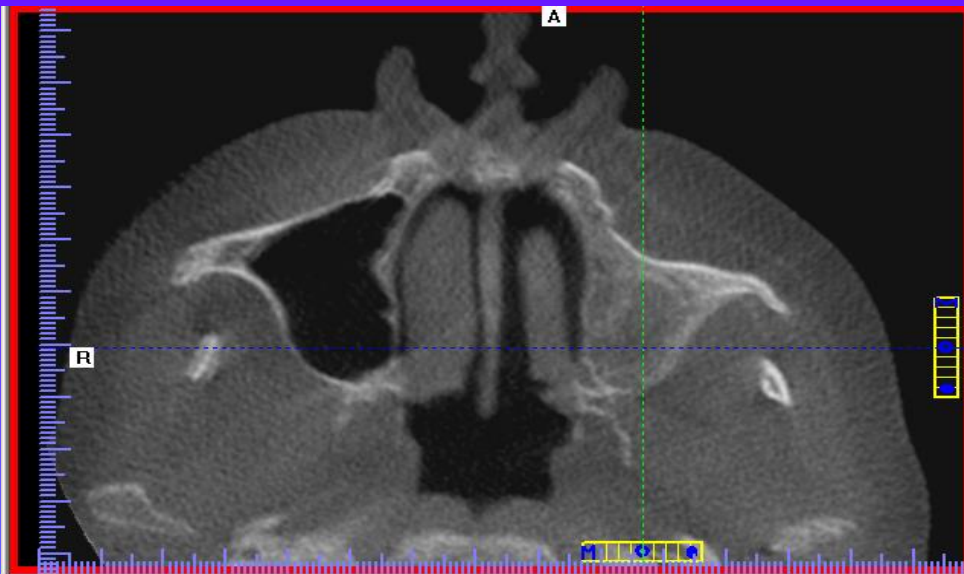
July 1997 diagnosis through nasal biopsy.

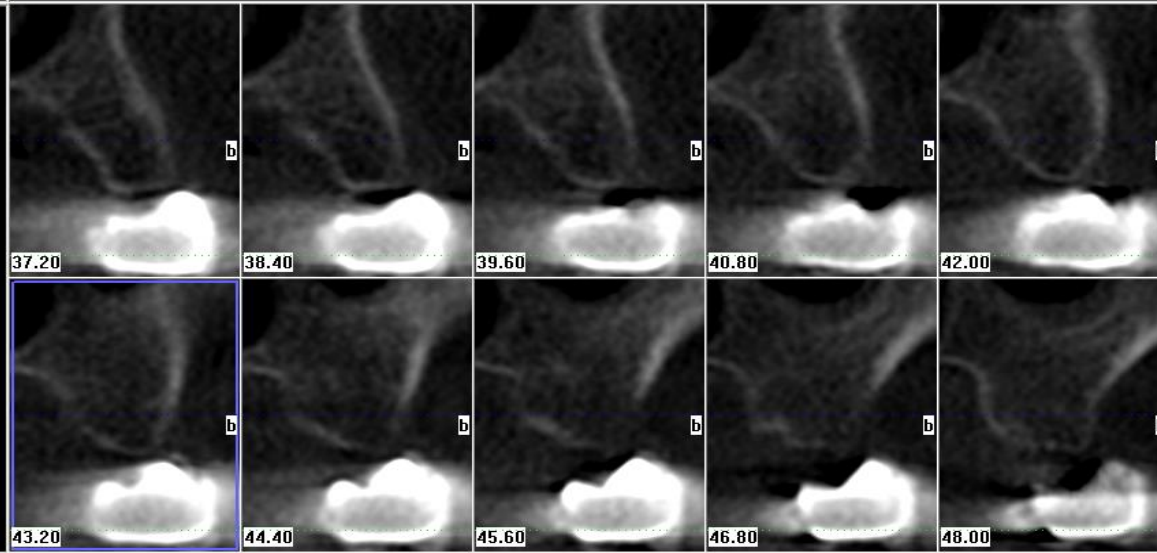
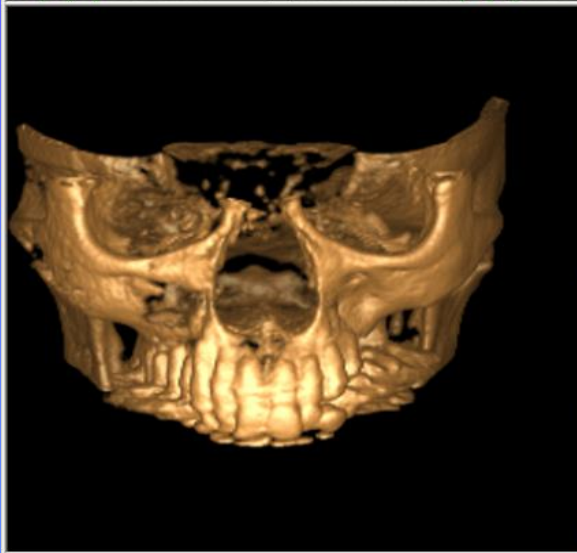
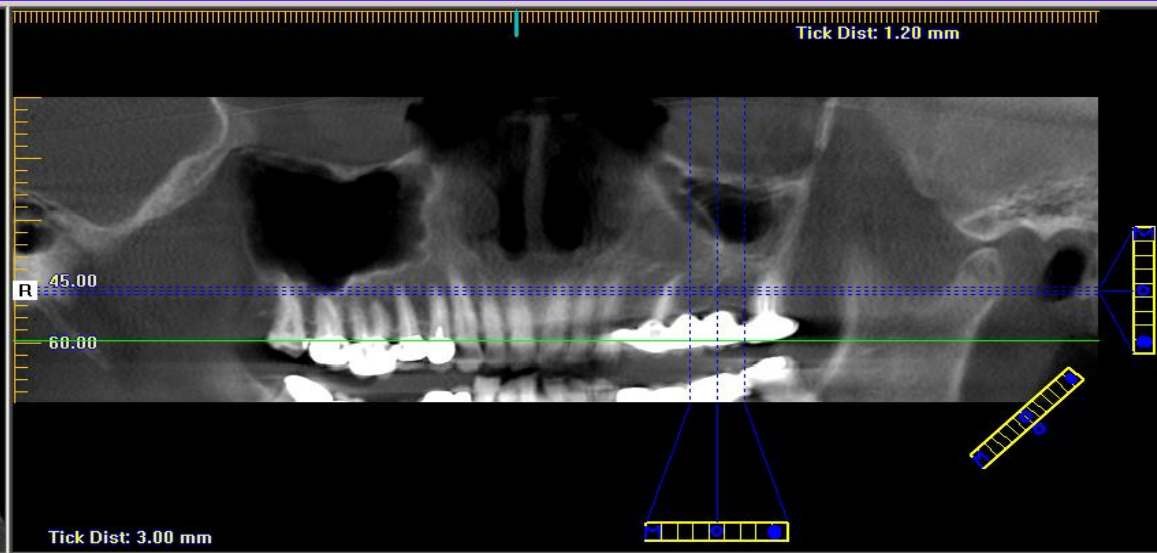
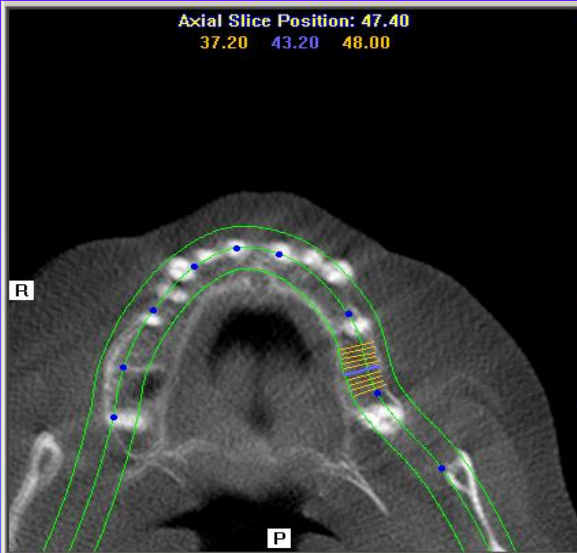
Cyclophosphamide infusion for 6/12

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

