Trigeminal Nerve Injury and Management

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Outline

• Review of anatomy
• Mechanisms of injury
• Injury classification
• Diagnosis, neurosensory testing
• Management
• Outcome
An Anatomic Study of the Lingual Nerve in the Third Molar Region

Hossein Behnia, DMD,* Arash Kheradvar, MD,†
and Mahmoud Shabrokht‡

- 669 LN from 430 cadavers
- 14% LN above lingual crest
- At its typical location, mean distance is $V=3\text{mm}$, $H=2\text{mm}$
- 22% LN in direct contact with lingual plate
Microanatomy

• 4 connective tissue sheaths
  – Mesoneurium
  – Epineurium
  – Perineurium
  – Endoneurium
• Vaso nervorum
• Lymphatic
• Nerve fiber
Neural Fascicular Patterns

IAN and lingual nerves are polyfascicular

more resistant to needle injury

almost impossible to align fascicle
Fiber types

A-alpha
- Largest myelinated fibers
- 6-8 um diameter
- Conduction velocities of 70-120 m/s
- Associated with muscle spindles, tendon afferents, and skeletal muscle efferent fibers

A-beta
- Myelinated neuron
- 6-8 nm diameter
- Conduction velocities of 30-70 m/s
- Sensibility of touch
Fiber Types

A- delta
- Smallest myelinated neurons
- 2.5-4 um
- Conduction velocities of 12-30 m/s
- Sense of temperature and fast pain

C-fibers
- Unmyelinated
- 1 um diameter
- Transmit at 0.5 -2m/s
- Transmit stimuli encoded for slow or second pain, temperature, and efferent sympathetic fibers
Terminology

• Anesthesia – absence of any response
• Paresthesia – abnormal sensation, spontaneous or evoked, not unpleasant
• Dysesthesia – unpleasant, abnormal sensation
• Hyperaesthesia – increased sensitivity to either of painful or nonpainful stimulation
  – Alloodynia- pain from an ordinarily non-painful stimulus
  – hyperalgesia
• Neuralgia – pain in the distribution of a nerve or nerves
• Neuropathy – a disturbance of function or pathologic change of function of a nerve, excluding description of injury
Mechanism of injury

- Compression
- Stretch
- Laceration
- Compartment syndrome
- Chemical injury
Mechanism of Injury

- Traumatic
  - Jaw fracture

- Iatrogenic
  - Local anesthesia
  - Oral Surgery: Extractions, Implants, bone grafting, orthognathic surgery, ablative surgery
  - Periodontal surgery
  - Endodontics
  - Chemical: endodontic materials, hemostatic agents
3rd Molar extraction

- Ranges from 0.4% to 22%, most typically reported as 5%
- Spontaneous recovery will occur in as many as 75% of these in 6 months to 1 year
- Results in a 0.5% to 2% permanent paresthesia rate for IAN and LN
Risk Factors for IAN/LN injury with 3rd molars

- Age >35
- Depth of impaction
- General anesthesia?
- Angulation
- Lingual or distoangular
- Integrity of the lingual cortex
- Need for tooth sectioning
- Surgeon experience
- Operative time
- Intraoperative exposure of the nerve
- **Rood’s panoramic indicators**
Rood’s features of mandibular 3rd molar and IAN anatomy

• Loss of cortication of the canal
• Constriction of the canal
• Deflection of canal
• Shadowing of roots
• Narrowing of root
• Darkening /bifid root apex

• Incidence of nerve injury can be 20-36%
Nerve injury with local anesthesia injection

- Pogrel estimated incidence at 1:26,000 to 1:160,000

Occurrence of paresthesia after dental local anesthetic administration in the United States

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Overall incidence: 1 in many millions
- Prilocaine 4%: 1 in 2 millions
- Articaine 4%: 1 in 4 millions
• Potential mechanisms:

  - Chemical injury possibly related to anesthetic concentration (4%)
  - Direct neural trauma, laceration from a barbed needle
  - Intraneural hematoma
Injection injuries

• Difficult to predict or prevent
• Electric shock sensation uncommon in those who sustain injury
• Non-anatomic distribution of symptoms possible
• More common in females
• Lingual nerve more commonly affected (greater stretch with mouth opening??)
• Majority of cases resolve in 8 weeks
• If lasting more then 8 weeks then only 1/3 resolve spontaneously
• Dysesthesia more common with this type of injury
• Surgery is a poor option
Injury from endodontic treatment

• Over instrumentation
• Extrusion of endodontic material
• Management involves prompt surgical exploration, wash out, external neurolysis or nerve graft as needed
Injury from dental Implants

• Most common with posterior mandibular implants
• Injury happens most likely from twist drills rather than direct compression of fixture
• Hematoma causing compartment syndrome
• Management involves removal of implant once recognized in the post op period
• Dysesthesia are very common with these injuries
Strategies to avoid injury

- Pre operative CBCT
- Drill stops
- Short implants
Hemostatic agents

- Surgicel has immediate damaging effects on nerve function
- It appears that bone wax, bovine collagen fibrils (Avitene), gelfoam are benign to nerve function
Classification of Nerve Injuries

• Seddon Classification
• Sunderland
• Dellon and Mackinnon modification of Sunderland
Seddon

• Neuropraxia
• Axonotmesis
• Neurotmesis
Neuropraxia

- A conduction block due to anoxia from interruption of epineurial or endoneurial blood supply – includes interfascicular edema
- No axonal degradation or demyelination
- Complete recovery within 24 hrs to 2 months
- A physiologic not anatomic injury
- If ischemia is prolonged, a higher grade injury will result from infarction and subsequent fibrosis
- (Sunderland first degree injury)
Axonotmesis

- Axonal injury with subsequent degeneration and regeneration
- Occurs without disruption of endo/peri/epineurium
- Initial anesthesia with Tinel’s sign
- Complete recovery within 12 months, onset of sensory return within 2-4 months

(Sunderland 2\textsuperscript{nd} degree injury)
Neurotmesis

• Severe disruption of the connective tissue components of the nerve truck with compromised sensory and functional recovery
• Sunderland 3\text{rd}, 4\text{th}, 5\text{th} degree injury depending on which of the three layers are disrupted
• Immediate anesthesia with possible development of paresthesia or neuropathia
Sunderland
Sunderland Grade 6 injury

- Described by Dellon and McKinnon in 1988
- Recognizes the heterogeneity of presentation and diagnostic ambiguity typical of peripheral nerve injuries wherein features of all classes may be present
Consequences of injury

- Complex structural, metabolic and physiologic changes
- Changes occur the length of nerve, not just at site of injury
- “injury current” generated with influx of Na+, and Ca+ ions triggering pleiotropic enzymatic and transcriptional activity.
Ineffective Healing - neuromas

- Disorganized mass of collagen fibers and randomly oriented small nerve fascicles
- Classified according to their gross morphology
Management
Patient Evaluation

• History
• Subjective sensation, 0-100%
• Objective neurosensory testing
• Clinical exam
Clinical Exam

• Ideally 1st test conducted within 2 weeks following injury to establish postop baseline
  – Then follow once a month
Clinical Exam

• Neurosensory test
  – Mapping of involved dermatome
  – Static light touch
  – Brush directional discrimination
  – Two point discrimination
  – Pin prick/nociception
  – Thermal discrimination

• Determine presence of sensory deficit, type and magnitude of deficit
• Document objectively the level of sensation for future comparison
Mapping of the involved area
Stimulus localization

- Estimate the amount of synesthesia
- With wooden end of cotton swab
- Should localize within 1-2mm of stimulus
Two point discrimination

- Assess the density and quantity of functional sensory receptors and afferent fibers
- A-delta, C-fibers
- Boley gauge/Caliper at 1 mm increments
### Two point discrimination

<table>
<thead>
<tr>
<th>Test area</th>
<th>Average normal threshold distance (mm)$^a$</th>
<th>Upper normal limit (mm)$^b$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forehead</td>
<td>13.0</td>
<td>22.0</td>
</tr>
<tr>
<td>Cheek (hairy)</td>
<td>9.0</td>
<td>17.0</td>
</tr>
<tr>
<td>Upper lip (skin)</td>
<td>4.5</td>
<td>8.0</td>
</tr>
<tr>
<td>Upper lip (mucosal)</td>
<td>3.0</td>
<td>6.0</td>
</tr>
<tr>
<td>Lower lip (mucosal)</td>
<td>3.5</td>
<td>6.5</td>
</tr>
<tr>
<td>Lower lip (skin)</td>
<td>5.0</td>
<td>9.0</td>
</tr>
<tr>
<td>Chin</td>
<td>9.0</td>
<td>18.0</td>
</tr>
<tr>
<td>Tongue (tip)</td>
<td>3.0</td>
<td>4.5</td>
</tr>
<tr>
<td>Tongue (dorsum)</td>
<td>5.0</td>
<td>12.0</td>
</tr>
</tbody>
</table>

$^a$ Values determined from the literature.

$^b$ Distance greater than this is considered abnormal.
Brush directional discrimination

- A-alpha, A-beta, lanceolate endings, Paccinian and Messiner corpuscles
- Proprioception
- Series of random directions, using cotton swap
Static light touch

• Merkel cell, Ruffini ending, and A-beta integrity required
• Weinstein-semmes filament/von frey filaments
Nociception

- Assess free nerve endings – C and A-delta fibers
- Use 27 gauge needle
- Press without indentation → patient able to feel = normal response
- Press with indentation → abnormal response
Thermal discrimination

• Adjunctive, and not very useful
• Integrity of small diameter myelinated and unmyelinated fibers
• Warmth attributed to A-delta fibers and cold to C-fibers
Diagnostic nerve blocks

• Aid to localize site of injury
• Useful in neuropathic pain
• Helps determine whether pain is centrally or peripherally mediated or what degree of each
Clinical Exam

• Evaluation of wound
• Palpation for Tinel’s sign (lingual nerve)
• Palpation for neuroma (lingual nerve)
• Panorex: rule out foreign bodies/root tips compressing nerve
Medical management

• Mostly limited to dysesthesia/neuropathic pain

<table>
<thead>
<tr>
<th>Table 41-7</th>
<th>Topical Medications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Category</strong></td>
<td><strong>Example</strong></td>
</tr>
<tr>
<td>Topical anesthetics</td>
<td>5% viscous lidocaine gel; 20% benzocaine gel; 2.5% lidocaine with 2.5% prilocaine</td>
</tr>
<tr>
<td>Neuropeptides</td>
<td>Capsaicin cream (0.025% or 0.075%)</td>
</tr>
<tr>
<td>Nonsteroidal anti-inflammatory drugs</td>
<td>Ketoprofen 10–20% PLO base; diclofenac 10–20% PLO base</td>
</tr>
<tr>
<td>Sympathomimetics</td>
<td>Clonidine 0.01% PLO base or patch</td>
</tr>
<tr>
<td>N-methyl-D-aspartate blocking agents</td>
<td>Ketamine 0.5% PLO base</td>
</tr>
<tr>
<td>Anticonvulsants</td>
<td>Carbamazepine 2% PLO base</td>
</tr>
<tr>
<td>Tricyclic antidepressants</td>
<td>Amitriptyline 2% PLO base</td>
</tr>
<tr>
<td>Antispasmodics</td>
<td>Baclofen 2% PLO base</td>
</tr>
</tbody>
</table>

PLO = pleronic lecithin organogel.

Table 41-6 | Systemic Pharmacologic Agents |
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Local anesthetics</td>
<td></td>
</tr>
<tr>
<td>Corticosteroids</td>
<td></td>
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<tr>
<td>Nonsteroidal anti-inflammatory agents</td>
<td></td>
</tr>
<tr>
<td>Antidepressants</td>
<td></td>
</tr>
<tr>
<td>Narcotic analgesics</td>
<td></td>
</tr>
<tr>
<td>Anticonvulsants</td>
<td></td>
</tr>
<tr>
<td>Muscle relaxants</td>
<td></td>
</tr>
<tr>
<td>Benzodiazepines</td>
<td></td>
</tr>
<tr>
<td>Antisympathetic agents</td>
<td></td>
</tr>
</tbody>
</table>
Surgical management

• Dilemma: allowing enough time for spontaneous recovery but not so much to impair surgical outcome

• Why is time thought to be critical?
  – Distal nerve degeneration
  – Ganglion cell death
  – Central cortical changes
Surgical Management

• Decide whether or not to repair or observe
• Take into account the type, mechanism, severity, and location of nerve injury, patient’s desires with respect to treatment.
Surgical management

Indications:

• Evidence of nerve compression – immediate removal of the object (root tip, bone fragment, implant)
• Endodontic material – may require immediate washout, decompression
• Witnessed transection – may require immediate repair

• Closed injury: follow monthly. Repair if no improvement at 1-3 months for LN, 3-6 months for IAN
• Or pain at 4 months
Unobserved nerve injury

NST

Lingual nerve
  Surgery 1–3 mo

Inferior alveolar nerve
  Surgery 3–6 mo
Outcomes

The Results of Microneurosurgery of the Inferior Alveolar and Lingual Nerve

M. Anthony Pogrel, DDS, MD, FRCS

The criteria used in this study to offer surgery were 1) a witnessed transection and 2) complete anesthesia over the affected area 2 months after injury. Also, 3) the lack of protective reflexes at 4 months after causation and no improvement during the proceeding 2-month period constituted a criterion. Protective reflexes are considered to be present when the patient has approximately 30% of normal feeling or better.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>No. of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good improvement</td>
<td>10</td>
</tr>
<tr>
<td>Some improvement</td>
<td>18</td>
</tr>
<tr>
<td>No improvement</td>
<td>22</td>
</tr>
<tr>
<td>Worse</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Surgery &lt; 10 wk</th>
<th>Surgery &gt; 10 wk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good improvement</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Some improvement</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>No improvement</td>
<td>1</td>
<td>21</td>
</tr>
<tr>
<td>Worse</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>9</td>
<td>42</td>
</tr>
</tbody>
</table>
Outcome

Nerve Injuries from Mandibular Third Molar Removal

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RESULTS

Time from Nerve Injury to Surgical Repair
(638 nerves)
FIGURE 41-12  Nerve stump preparation.  
A, Neuroma; resection at the “clinical margin” of the neuroma fails to complete nerve preparation. 
B, Neuroma resection in 1 mm increments. C, Mushrooming fascicle.

FIGURE 41-13  Direct epineurial neurorrhaphy.
Table 41-10  Size of Donor Nerve Grafts Relative to Injured Nerve

<table>
<thead>
<tr>
<th>Injured Nerve</th>
<th>Sural (2.1 mm)</th>
<th>Greater Auricular (1.5 mm)</th>
<th>Greater Auricular Cable (3.0 mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inferior alveolar (2.4 mm)</td>
<td>88%</td>
<td>63%</td>
<td>125%</td>
</tr>
<tr>
<td>Lingual (3.2 mm)</td>
<td>66%</td>
<td>47%</td>
<td>94%</td>
</tr>
</tbody>
</table>

Adapted from Brammer JP and Epker BN.68

Table 41-11  Materials for Entubulation (Conduit) Repair

Autogenous materials
- Collagen
- Muscle
- Fascia
- Vein

Alloplastic materials
- Polyglycolic acid
- Polyester
- Polytetrafluoroethylene (PTFE)
- Expanded PTFE
- Silicone, polymeric silicone

Figure 41-14  Greater auricular nerve cable graft.

Figure 41-15  Entubulation (conduit) nerve repair.
Postop course

- Variable period of complete anesthesia, typically 3 month
- Regrowth occurs at 1mm/d therefore 3 cm per month
- Occurs more slowly with nerve graft
- Dysesthesia is always possible after any nerve surgery
Key points

• Spontaneous recovery happens in some but not all patients. Difficult to predict who will fall into which category (let us make that decision)
  – witnessed transection may require immediate repair
  – Otherwise we follow with repeat neurosensory testing, and repair when indicated:
    • for LN at 1-3 months, IAN at 3-6 months, if paresthesia is significant and no improvement
    • Pain at 4 months
    • If paresthesia is improving, continue to follow

• IAN recovers more often than lingual nerve because of bony conduit
Key points

• Injection injuries are poor surgical candidates
  – Most resolves after 8 weeks, if not, only 1/3 will improve

• Dysesthesia is very difficult to manage. Response to surgery is highly unpredictable. Most patients need long term management with medications
Thank You

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