Trigeminal Neuralgia

Current Concepts and Management

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Outline of Presentation

Introduction
Epidemiology
Etiology and Pathophysiology
Clinical Presentation
Diagnosis
Clinical Course
Medical Treatment
Surgical Treatment Options/ Anatomy
Stereotactic Radiosurgery (Gamma Knife)
Introduction and General Comments

Trigeminal Neuralgia (TN) is defined as paroxysmal, stereotyped attacks of intense and sharp pain in the distribution of one or more branches of the trigeminal nerve.

History:
- Areteaus of Cappadocia, 3000 years ago
- Nicholaus Andre, 1756
  - “Tic douloureux” = painful movements
- John Fothergill, 1773
  - “On a Painful Affliction of the Face,” London Medical Society

Incidence: 4-5 per 100,000 persons annually
Epidemiology

Females > Males, 3:2 ratio
Primary risk factor is age
• Classic TN usually begins after age 50
• Secondary TN often in 20-40 year-olds
Demyelinating disease (multiple sclerosis)
• 1% of MS patients have TN
• 2% of TN patients have MS
Hypertension appears to be an independent risk factor
Etiology

Entire mechanism not known
• Central, peripheral or both

Classification
• Classic (idiopathic)
• Secondary (symptomatic)

Classic TN
• Compression of trigeminal nerve root by aberrant loop of artery or vein (80-90%)
• No structural lesions identified (10-20%)
Etiology (continued)

Classic TN (cont’d.)
- Focal demyelination at root entry zone of pons
- Ectopic impulse generation
  - Ephaptic transmission
  - Ephaptic cross-talk

Secondary TN
- Similar mechanism as with compression by vascular loop and resultant focal demyelination
- Demyelinating diseases
  - Multiple sclerosis (MS)
  - Acute Disseminated Encephalomyelitis (ADEM)
  - Demyelination of root entry zone or sensory nucleus
Etiology (continued)

Secondary TN (cont’d.)

- Tumors of cerebello-pontine angle
  - Acoustic neuroma
  - Meningioma
  - Epidermoid cysts
- Inflammation of meninges (chronic meningitis)
  - TB, syphilis, Lyme, sarcoidosis
  - Carcinomatous meningitis
- Rarely due to aneurysm or arteriovenous malformation
Clinical Presentation

Usually involves V2 and V3 distributions
- 60%, pain goes from corner of mouth to angle of jaw
- 30%, pain goes from upper lip to eye

Rarely involves V1 (less than 5%)
- V1 more often affected by postherpetic neuralgia

Attacks generally last weeks or months
Remissions with recurrence is the norm
**Clinical Presentation (continued)**

Paroxysmal – maximum intensity at onset
Pain is sharp, stabbing, lancinating, shock-like
Pain is brief but may occur repetitively
  • Paroxysms up to several seconds
  • Burning-ache or dull pain may persist after paroxysm ends
Usually unilateral, occasionally bilateral
  • “never” simultaneous
Rarely awakens patient from sleep
Clinical Presentation (continued)

Pain often provokes facial grimacing or wince
- Tic douloureux

Triggers are common precipitants of pain
- Chewing, talking, smiling
  - May hold face to limit movement
- Drinking hot or cold liquids
- Touching face; makeup, shaving, washing
- Cold air hitting face
  - Often wear scarves
Diagnosis

International Headache Society Criteria – Classic TN

- Paroxysmal attacks of pain lasting seconds to minutes and affecting one or more divisions of trigeminal nerve
- Must include at least one of the following:
  - Pain is intense, sharp, superficial, or stabbing
  - Pain is precipitated by triggers
- Attacks are stereotypic for the patient
- No clinically evident neurologic deficit
- Not attributed to another disorder
Diagnosis (continued)

Secondary TN

• Attacks often don’t abate
• No refractory period
• Young age, 20-40 years
• Sensory deficit on exam
• Bilateral symptoms
• Lack of therapeutic response
• V1 involvement
Diagnosis (continued)

Neuroimaging
  • Brain MRI
    – May show secondary cause in up to 15% of patients
  • Head MRA may show vascular loop
  • Questionable utility
    – Sensitivity 52-100%
    – Specificity 29-93%

Electrophysiologic trigeminal reflex testing
Trigeminal evoked potential testing
Clinical Course

TN may remit for months or years after initial attack. Attacks tend to cluster and wax and wane over time.
• May become more frequent, severe, disabling
• May become more easily triggered
• Long-term medications more likely necessary
Exacerbations more frequent in Fall and Spring
Medical Treatment

Medical management is the initial treatment of choice
• Adequate treatment for about 75% of patients
• May periodically reduce or discontinue treatment
• Remissions common
Secondary TN less responsive to medications
• Initial treatment same as for classic TN
• Gabapentin may be more effective
Medical Treatment (cont.)

- **Effective**
  - Carbamazepine
  - Oxcarbazepine

- **Probably Effective**
  - Baclofen
  - Lamotrigine
  - Pimozide

- **Possibly Effective**
  - Clonazepam
  - Gabapentin
  - Pregabalin
  - Dilantin
  - Topiramate
  - Tizanidine
  - Valproate
Medical Treatment (continued)

Carbamazepine
• First-line agent
  - Diagnostic and therapeutic value
• Literature review AAN, 2008
  - 58-100% effective (placebo 0-40%)
• Start 100-200mg BID
  - Gradually increase by 200mg/day
  - Max dose 2400mg, divided 2-5 times daily
• Side effects; drowsiness, cognitive dysfunction, diplopia, GI upset, dizziness
Medical Treatment (continued)

Oxcarbazepine
- Second-line agent
- Analogous to carbamazepine, less side effects
- Start 300mg BID
  - Gradually increase by 300mg/day
  - Max dose 1800mg/day, dosed BID
- Side effects; drowsiness, cognitive dysfunction, GI upset, dizziness

Carbamazepine v. oxcarbazepine
- randomized, controlled studies (178 patients)
- Equal efficacy (>50% reduction in attacks in 88% of patients)
Medical Treatment (continued)

Baclofen
- 70% of patients report improvement (placebo 10%)
- Start 10mg BID
  - Increase by 10-20mg increments
  - Max dose 80mg/day, divided 2-4 times daily
- Side effects: sedation, fatigue, dizziness

Narcotics
- May be useful for acute attacks
- Provide short-term pain management while traditional medications are started
Medical Treatment (continued)

First-Line Medications
• Carbamazepine
• Oxcarbazepine

Second-Line Medications
• Baclofen

Additional Medications (add to 1st/2nd line)
• Lamotrigine
• Gabapentin
• Narcotics
Anatomy of trigeminal nerve

Enters/exits ventrolateral pons at root entry zone
Short course though CPA cistern
Enters Meckel’s Cave (dural reflection posterolateral to cavernous sinus/carotid artery, medial to temporal lobe)
Then divisions exit skull (V1 – SOF, V2 rotundum, V3 ovale)
NORMAL TRIGEMINAL NERVE
SURGICAL MANAGEMENT OF TRIGEMINAL NEURALGIA
Indications for surgery

Reserved for cases refractory to medical management, or when side effects of medication exceed risks and drawbacks of surgery
Surgical options

- Peripheral branch treatments
- Percutaneous trigeminal rhizotomy
- Microvascular decompression

Multiple other lesser used options: nerve sectioning, spinal trigeminal tract lesioning, motor cortex stimulation, branch stimulation symp

If tumor is present on imaging – treat the tumor
Meningioma

- Distorted Trigeminal Nerve Beneath Tumor
- Unaffected Trigeminal Nerve
Large Trigeminal Schwannoma
MS Plaques in Pons
Peripheral branch treatments

Blocks/neurectomy
• Local anesthetic (diagnostic), Phenol, alcohol
• Neurectomy
Stimulation (rare)
Anatomy
• V1
  – Supraorbital, supratrochlear
• V2
  – Blocked at rotundum or infraorbital branch
• V3
  – Blocked at ovale/inferior alveolar nerve
Percutaneous Trigeminal Rhizotomy

Recommended for patients with:
- Poor risk of GA
- Elderly
- Unresectable tumors
- MS
- Limited life expectancy ( < 5 yrs.... < 2 yrs)
- Those who need immediate relief

Recurrence rates, dysethesia rate similar among various techniques
Numbness can be as high as 98%
PTR

3 types
• Balloon
• Glycerol
• Radiofrequency
Balloon

Might be best for V1/V2 –
Preserves corneal reflex
RFR

V3 neuralgia
Can selectively treat without other lesions
Can curve electrode to treat V1/2
Glycerol

Shortest acting
Non selective
Complication rate

Dysethesia
  • Minor 9%
  • Major 2%
  • Anesthesia dolorosa 0.2-4%
Meningitis 0.3%
Alterations in salivation 20%
  • Decreased in 3%
  • Increased in 17%
Oculomotor paresis < 2%
Neuroparalytic keratitis 2-4%
Overall complication rate

Balloon Compression - 16% complication rate

RFR - 15% complication rate

Glycerol - 25% complication rate
**Technique for needle insertion**

Supine
Fluoroscopy
Insert electrode-needle 3cm lateral to oral commissure
Plapate buccal mucosa inside mouth to guide needle staying outside oral cavity passing medial to coronoid process of mandible toward plane intersecting 3cm anterior to EAC and medial aspect of pupil
On fluoro aim at intersection between top of petrous ridge and clivus (5-10mm below floor of sella)
Upon entering ovale masseter should contract and should see CSF
Radiofrequency Rhizotomy
Balloon Rhizotomy
Microvascular Decompression

Indications

• Unable to achieve adequate medical control of TN without significant medical risk factors, > 5yrs survival
• Failed other surgical/SRS treatments
• Need immediate relief (not able to eat, losing weight, incapacitated)
• More efficacious if defined vascular loop on MRI

MS is usually a contraindication
Microvascular Decompression, continued

Risks/Complications
• CSF leak (up to 10%)
• Facial numbness – 25% temporary, 2% permanent
• Permanent hearing loss < 2%
• < 1% diplopia, facial paralysis, brainstem stroke
• Bleeding, infection
Left trigeminal nerve distorted by inferiorly placed AICA (arrow)
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Percutaneous Technique</th>
<th>MVD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RFR</td>
<td>Glycerol</td>
</tr>
<tr>
<td>Initial success rate</td>
<td>91%</td>
<td>91%</td>
</tr>
<tr>
<td>Medium-term Recurrence</td>
<td>19% at 6 yrs</td>
<td>54% at 4 yrs</td>
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<tr>
<td>Long-term Recurrence</td>
<td>80% at 12 yrs</td>
<td></td>
</tr>
<tr>
<td>Facial numbness</td>
<td>98%</td>
<td>60%</td>
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Facial Pain: Is it Trigeminal Neuralgia?

Herbert Wang, MD
Radiation oncologist
Marc Goldman, MD
Neurosurgeon

South Sound Gamma Knife at St. Joseph
**Gamma Knife (SRS)**

Stereotactic Radiosurgery:
The precise delivery of a single fraction of high-dose ionizing radiation to an image-defined target.
Indications for Treatment

Brain Metastases*
Meningiomas
Acoustic Neuroma
Pituitary Tumors
Arteriovenous Malformation (AVM)
Trigeminal Neuralgia*
Movement Disorders*
Epilepsy
Obsessive Compulsive Disorder (OCD)
History Gamma Knife

Invented by Lars Leksell
  • Swedish Neurosurgeon
1951 Treatment Trigeminal Neuralgia
  • Modified Dental X-ray Tube coupled with a Stereotactic device
1968 Model S Treatment Craniopharyngioma plaster headpiece
1986 U model computer planning
1999 C unit APS (automatic positioning system)
2006 Perfexion larger cavity, rapid treatment, improved conformity, very low body dose
Professor Lars Leksell with the first Gamma Knife - 1968

Model S
**Gamma Knife ICON**

Multiple Co sources - 192 in ICON unit
Sources focus at a fixed isocenter
Patient is moved into desired position
In order to treat a volume multiple treatments(shots) given
Stereotactic frame
MRI imaging with frame creating reference system
Advancement in SRS

Imaging MRI
Dose Planning Software
Improved Delivery Systems
Leksell Frame
Leksell Gamma Knife Frame Attachment
Basic Schematic
And after five years of research and development ...this is the result

Leksell Gamma Knife® ICON

-A new and revolutionary platform for radiosurgery in the brain, and soon cervical spine and head & neck regions

-A technological breakthrough that will improve and expand Gamma Knife surgery

- Full clinical compatibility with Gamma Knife procedures & protocols based on 400,000 treated patients
Leksell Gamma Knife® ICON™
Treatable volume

Leksell Gamma Knife C

Leksell Gamma Knife ICON
Gamma Knife Team

- Neurosurgeon
- Radiation oncologist
- Physicist
- Support staff
- Radiation therapist
- Gamma Knife nurse
- Gamma Knife coordinator
Gamma Knife Results
University of Pittsburgh

- 220 Patients
- 93% Typical TN (Paroxysmal, sharp, electric shock, triggers)
- 7% Atypical TN (dull, aching or burning)
- 100% prior medical therapy
- 61% prior surgical therapy
University of Pittsburgh Results

• 70-90Gy max dose 2-4mm from pons, max surface dose 30%
• Mechanism of Action unclear
  – Baboon studies focal axonal degeneration at 80Gy partial necrosis at 100Gy
  – Mechanism of action not completely understood
University of Pittsburgh Results - Pain Relief

- Complete pain relief
  - 88% with Typical TN
  - 56% with Atypical TN
  - More likely if fewer branches
  - More likely if no prior surgery
- Onset of relief, median 2mo
  - Few responders after 6mo
University of Pittsburgh Results - Relapse

• 14% of patients relapsed at 2-58mo (mean 15mo)
University of Pittsburgh Results - Numbness

• 8% of patients
• Median onset 8mo. (range 1-19mo)
Side Effects

• Numbness 0-37%
  • Correlates with control
• Brain stem
• Bleeding
• Infection
University of Kentucky 2013

250 patients – dose = 90Gy
Mean duration of follow up 68.9 months
Pain relief in 85.6% of patients
  43.7% pain free without meds
  27.7% pain free with meds
  9.7% >90% reduction in pain
  8.4% 50-90% decrease in pain
  4.6% <50% reduction in pain
  5.9% pain becoming worse
University of Kentucky 2013

32.9% developed numbness
74% with numbness had complete pain relief
87.7% of patients would recommend GK to another patient
Patients with prior surgical treatments had increased latency to pain relief and were more likely to continue meds.
Retreatment with Gamma Knife

- University of Pittsburgh
  - 31 Patients
  - 48% complete pain relief +/- pain meds
  - 13% numbness
- Mayo Clinic
  - 75% excellent or good response (n=19)
  - 58% developed numbness
  - Numbness correlated with response (82% with numbness had excellent response)
- University of Maryland
  - 93% excellent or good relief (n=112)
  - 22% failure within one year (no failures after 9mo)
  - 11% Numbness
Local Case Study of GK Treatment for Trigeminal Neuralgia

- January 2005 – December 2016 case study of 139 patients, 18 were secondary treatments, five lost to follow up, leaving 116 cases available for retrospective analysis that included medical records, physical exams and patient phone interviews
- Single 4 mm shot of 75-85 Gy for primary treatment and 50-70 Gy for secondary treatment
Local Case Study Results and Conclusions

Median follow-up 12 months
83% of patients undergoing first GKSRS experienced pain relief at a median of 30 days post-treatment
Of these, 30% experienced recurrence of symptoms, at an average 10.5 months following treatment
No significant differences found between subgroups including patients with MS, atypical TN, or those who had undergone previous surgical treatment for TN
Local Case Study Results and Conclusions, continued

No difference in outcome between doses administered
For those receiving second GKSRS for TN, initial success rate was 90%, with 25% of those patients eventually having recurring symptoms
21% of cases developed some level of ipsilateral facial numbness
Study concludes Gamma Knife stereotactic radiosurgery is an effective treatment of trigeminal neuralgia

Presented at Leksell Gamma Knife Society Meeting, Dubai 2018
Surgical Salvage

• Allegheny General (MVD) – 54% excellent outcome: 11% fair to good outcome; 36% poor outcome
• Thickened arachnoid, adhesions between blood vessels and nerve, trigeminal nerve atrophy
• MVD completed in 97% of patients

• Mayo - 73% complete response
Gamma Knife Treatment Trigeminal Neuralgia

80Gy Typical Dose

Photo: Regis
Collimator system 8-16-8-16-8-16-16-16
Dynamic shaping
Safety

Peripheral Patient Dose Compared to Other Modalities
• At 30 cm from isocenter
  – PFX at least 10x less than CK
• At >60 cm from isocenter
  – PFX 30x less than C unit
  – PFX 100x less than CK
The results:

2-4 times better sparing of normal brain tissue

The results:

Extracranial dose in the order of 5-130x lower with Gamma Knife

Target

CyberKnife dose

- 31x Gamma Knife
- 28x Gamma Knife
- 129x Gamma Knife
- 115x Gamma Knife

Linac dose

- ~4.5x Gamma Knife
- 6x Gamma Knife
- ~7x Gamma Knife
- 5x Gamma Knife

Thank you for attending

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South Sound Gamma Knife at St. Joseph
For more information, a tour of the Gamma Knife, or patient consult, please call 253-284-2438 or 866-254-3353.

Learn more at endtrigempain.com

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