RF Denervation for Lumbar Facet Joint Pain

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Prevalence by Source of Low Back Pain

Table 1  Prevalence and mean age by source of LBP

<table>
<thead>
<tr>
<th>Source of LBP (N = 170)</th>
<th>Count</th>
<th>Prevalence (%)</th>
<th>95% CI prevalence (%)</th>
<th>Mean age (SD)</th>
<th>95% CI age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervertebral disc</td>
<td>71</td>
<td>41.8</td>
<td>(34.6, 48.3)</td>
<td>43.7 (10.3)</td>
<td>(41.5, 46.1)</td>
</tr>
<tr>
<td>Lumbar facet joint(s)</td>
<td>32</td>
<td>19.5</td>
<td>(12.2, 27.6)</td>
<td>59.6 (13.1)</td>
<td>(56.0, 63.3)</td>
</tr>
<tr>
<td>Sacroiliac joint(s)</td>
<td>31</td>
<td>18.2</td>
<td>(13.2, 24.7)</td>
<td>61.4 (17.7)</td>
<td>(54.9, 67.9)</td>
</tr>
<tr>
<td>Vertebral insufficiency fracture</td>
<td>5</td>
<td>2.9</td>
<td>(1.3, 6.7)</td>
<td>79.0 (11.8)</td>
<td>(64.3, 93.7)</td>
</tr>
<tr>
<td>Pelvic insufficiency fracture</td>
<td>3</td>
<td>1.8</td>
<td>(0.6, 5.1)</td>
<td>71.3 (11.7)</td>
<td>(42.2, 100.4)</td>
</tr>
<tr>
<td>Boerhaave's disease</td>
<td>3</td>
<td>1.8</td>
<td>(0.6, 5.1)</td>
<td>75.3 (4.7)</td>
<td>(63.6, 87.1)</td>
</tr>
<tr>
<td>Fusion hardware</td>
<td>5</td>
<td>2.9</td>
<td>(1.3, 6.7)</td>
<td>59.6 (19.4)</td>
<td>(35.4, 83.8)</td>
</tr>
</tbody>
</table>

LBP = low back pain; CI = confidence interval; SD = standard deviation.

DePalma MJ, et al.  What is the source of chronic low back pain and does age play a role?  
Prevalence of Low Back Pain


Algorithmic Approach

Algorithmic Approach


Indications

- **Medial Branch Block**
  - To determine whether Z-joint (facet joint) is the origin of lumbar axial pain

- **Radiofrequency Neurotomy**
  - To provide relief of lumbar axial pain which has been determined to be caused by Z-joint
RF Denervation

- Aims to destroy afferent nerve supply to the Z-joint (Facet) joint
- Uses RF current to create lesion
- *Nerve regeneration is assumed to occur in 9-12 months (Pain may recur)*

Advantage of RF Medial Branch Denervation

- Controlled lesion size
- Good monitoring of lesion temperature
- Precise X-ray guided placement of electrode
- Rapid recovery
- Low incidence of morbidity
- Ability to repeat procedure if and when neural pathway regenerates
Relative Contraindications

- Medial Branch Block
  - Anticoagulation?

- RF
  - Anticoagulation?
  - Automatic Implantable Defibrillator
  - Cardiac Pacemaker

ISIS Anticoagulant Guidelines

<table>
<thead>
<tr>
<th>Procedure</th>
<th>WITH ANTICOAGULANTS</th>
<th>CEASING ANTICOAGULANTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extracorporeal</td>
<td>very low</td>
<td>minor</td>
</tr>
<tr>
<td>RF Neuromodulation</td>
<td>unknown</td>
<td>minor</td>
</tr>
<tr>
<td>Lumbar Disc Stimulation</td>
<td>unknown, but theoretically low</td>
<td>minor</td>
</tr>
<tr>
<td>Cervical or Thoracic Disc Stimulation</td>
<td>unknown, but theoretically low</td>
<td>primarily minor</td>
</tr>
<tr>
<td>Lumbar TESI</td>
<td>very low</td>
<td>potentially significant</td>
</tr>
<tr>
<td>Cervical or Thoracic TESI</td>
<td>unknown</td>
<td>potentially serious</td>
</tr>
<tr>
<td>Intervertebral ESI</td>
<td>3x greater</td>
<td>potentially serious</td>
</tr>
</tbody>
</table>

Pacemaker / AICD

- Clear with Cardiology
  - Reprogram pacer to asynchronous mode
  - Set rate at 60
- If unable to obtain cardiology clearance
  - Use bipolar RF denervation technique with two probes

Medial Branch Blocks

Indications

- INDICATION: The desire or need to know if the patient’s pain is mediated by the medial branches of the lumbar dorsal rami

- GOAL: Select patient who will have a positive response to RF denervation
Anatomy of the Medial Branch

Cohen SP, Srinivasa NR. Pathogenesis, Diagnosis, and Treatment of Lumbar Zygapophysial (Facet) Joint Pain. Anesthesiology 2007; 106:591-614

Anatomy of the Lumbar Medial Branch

Medial Branch Blocks vs Z-Joint Intraarticular Injections

- Lumbar Z-Joint Intraarticular Injections
  - Intraarticular flow is required for facet joint blocks to be diagnostic
  - Intraarticular flow cannot always be achieved (osteophytic lipping)
  - Less therapeutic specificity due to possible medial capsular leakage into the epidural space
    - Is the relief from Z-Joint injection or is the relief from epidural flow of medication?

Medial Branch Blocks

- What is positive response?
  - 50% improvement in Visual Analog Score?
  - 80% improvement in Visual Analog Score?
  - Functional outcome scale (Oswestry)?
- How does % relief affect outcome of RF denervation?
False Positive Rate

- 40% patients will sustain relief due to placebo effect
- Single diagnostic blocks lead to incorrect diagnosis in a substantial portion of cases

<table>
<thead>
<tr>
<th>Percent Relief</th>
<th>False Positive Rate</th>
<th>Positive Predictive Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;50% Relief (^1)</td>
<td>38%</td>
<td>31%</td>
</tr>
<tr>
<td>&gt;80% Relief (^2)</td>
<td>27%</td>
<td>63%</td>
</tr>
</tbody>
</table>


Medial Branch Blocks

- IF NO RELIEF –
  - Another source of pain must be considered
- IF PAIN IS RELIEVED –
  - Ensure that the observed response is not a false-positive
- Control Blocks are REQUIRED to exclude false-positive responses
- Inclusion of false positive cases will undermine outcome of RF denervation
Control Blocks

- Most rigorous form is placebo injection of saline under double-blind conditions
  - Ethical considerations argue against this practice
- Comparative local anesthetic blocks are more practical
  - Block 1: Bupivacaine 0.5% = 3-4 hours relief
  - Block 2: Lidocaine 2-4% = 1-2 hours relief

RF Outcome As A Function of MBB Pain Relief

- 262 Patient – Multicenter study
  - 145 Patients: 50-80% Relief with diagnostic block
  - 117 Patients: > 80% Relief with diagnostic block

- RF Outcome: > 50% relief post-RF
  - 50-80% Group: 52% relief post-RF
  - > 80% Group: 56% relief post-RF

RF Outcome As A Function of MBB Pain Relief

• Conclusion: More stringent pain relief criteria for lumbar Z-joint RF denervation
  – Is unlikely to improve success rates
  – May lead to misdiagnosis
  – May lead to withholding a potentially valuable treatment


Considerations for performing Diagnostic MBB

• VAS Score for pain logging
  – VAS must be greater or equal to 4/10
  – Can only confirm 80% relief at 5/10 pain level
• “Pain Diary” to document pain relief with a pain diary for 6 hours after block
• Pain Medication
  – HOLD PRIOR TO PROCEDURE
  – NO IV PAIN MEDS INTRAPROCEDURE
  – HOLD 6 HOURS AFTER PROCEDURE
• Return to activity immediately after procedure
Dual Block Protocol

Suspected Z-Joint Pain

First Block: Bupivacaine
>xx% Pain Relief

Yes

No

Second Block: Lidocaine
>xx% Pain Relief

Yes

No

Consider Alternate Pain Generator

Proceed to RF Denervation

Response on Pain Diary

• Positive Response

BEFORE SHOT:

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Pain Score</th>
<th>Activity</th>
<th>Pain Score</th>
<th>Activity</th>
<th>Pain Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No Pain</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
<td>No Pain</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
<td>No Pain</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
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<tr>
<td>3</td>
<td>Yes</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
<td>No Pain</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
<td>No Pain</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
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<tr>
<td>4</td>
<td>Yes</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
<td>No Pain</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
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<td>1-2-3-4-5-6-7-8-9-10</td>
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<tr>
<td>6</td>
<td>Yes</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
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<tr>
<td>7</td>
<td>Yes</td>
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<td>No Pain</td>
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<tr>
<td>7d</td>
<td>Yes</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
<td>No Pain</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
<td>No Pain</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
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</table>

• Negative Response

BEFORE SHOT:

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Pain Score</th>
<th>Activity</th>
<th>Pain Score</th>
<th>Activity</th>
<th>Pain Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No Pain</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
<td>No Pain</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
<td>No Pain</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
</tr>
<tr>
<td>3</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
<td>No Pain</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
<td>No Pain</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
<td>No Pain</td>
</tr>
<tr>
<td>4</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
<td>No Pain</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
<td>No Pain</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
<td>No Pain</td>
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<tr>
<td>6</td>
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<td>No Pain</td>
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<td>No Pain</td>
</tr>
</tbody>
</table>

12/3/2013
No Block Protocol

• Randomized multicenter trial
• 151 patients, suspected lumbar facet pain
  – GROUP 0 (n = 51)
    • RF Denervation based on clinical findings only
  – GROUP 1 (n = 50)
    • RF denervation: Single Block > 50% relief
  – GROUP 2 (n = 50)
    • RF denervation: Dual Block > 50% relief
    • Blocks performed with Lidocaine and Bupivacaine

Cohen SP, et al. Multicenter, Randomized, Comparative Cost-effectiveness Study Comparing 0, 1, and 2 Diagnostic Medial Branch (Facet Joint Nerve) Block Treatment Paradigms before Lumbar Facet Radiofrequency Denervation. *Anesthesiology*; 2010:395-405

No Block Protocol

• Positive Outcome: > 50% pain relief with positive Global Perceived Effect persisting for 3 months
• Results – Positive Outcome
  – Group 0: 17 (33%)
  – Group 1: 8 (16%)
  – Group 2: 11 (22%)

Cohen SP, et al. Multicenter, Randomized, Comparative Cost-effectiveness Study Comparing 0, 1, and 2 Diagnostic Medial Branch (Facet Joint Nerve) Block Treatment Paradigms before Lumbar Facet Radiofrequency Denervation. *Anesthesiology*; 2010:395-405
No Block Protocol

Conclusion

• Costs per successful treatment (using 2010 Medicare Reimbursement – inclusive of hospital facility fees)
  – GROUP 0: $6,286
  – GROUP 1: $17,142
  – GROUP 2: $15,241

• **Conclusion:** Proceeding to RF denervation without diagnostic block is the most cost-effective treatment paradigm.

Medial Branch Needle Placement

Medial Branch Blocks

• Contrast is required to
  – Rule out vascular flow
  – Confirm proper needle placement
• Vascular flow would cause a false negative response
• 0.5 ml of Anesthetic injected
  – Lidocaine 1 – 4% without epinephrine
  – Bupivacaine 0.5% without epinephrine

Contrast Confirmation of Flow
Lumbar RF Denervation Complications

• 92 patients / 116 procedures / 616 lesions
• 6 complications (1%)
  – 3- localized pain at RF site > 2 weeks
  – 3 – neuritic pain lasting < 2 weeks
    • Left buttock dysesthesia
    • Burning sensation in the hip and thigh
    • Burning pain in the right lower back and anterior right lower limb

RF Denervation Procedure

- Disrupt afferent nerve supply to the Z-joints
- RF Generator: 400kHz radiofrequency with closed loop control of power to achieve desired probe tip temperature
- Probe: Thermocouple monitors temperature continually
- Lesion performed at 85 C for 90 seconds
- Nerve regeneration expected 9-12 months (pain may recur)

Electrode

- Placement of insulated electrode with uninsulated tip in proximity of tissue to be ablated
- Radiofrequency energy is delivered to the tissue
- Heat is generated at site of uninsulated tip
RF Electrodes

- Sterile disposable RF electrode
  - 18, 20, or 22 gauge
  - 5 or 10mm non-insulated active tip
  - Curved tip or straight tip
- Monopolar Lesion: Reference electrode is dispersive surface electrode (like Bovie)
- Bipolar Lesion: Reference electrode is second RF electrode

RF Neurotomy

- Neurotomy
  - Temperatures of at least 70-80 deg C used to create irreversible lesions
  - Typical temperatures 85 C
  - Temperatures > 90 C can cause carbonization of tissues
  - Needles placed parallel to target
- Pulsed RF (considered “experimental” in US)
  - Temperatures of 45 deg C
RF Generator

Electrode Dimension
Lesion Size

<table>
<thead>
<tr>
<th></th>
<th>SMK</th>
<th>RRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>w</td>
<td>0.7 mm</td>
<td>1.6 mm</td>
</tr>
<tr>
<td>r</td>
<td>2.3 w</td>
<td>1.6 w</td>
</tr>
<tr>
<td>Std dev</td>
<td>0.4 w</td>
<td>0.3 w</td>
</tr>
<tr>
<td>d</td>
<td>1.4 w</td>
<td>0.4 w</td>
</tr>
<tr>
<td>Std dev</td>
<td>0.4 w</td>
<td>0.2 w</td>
</tr>
</tbody>
</table>

Std dev

Lesion is Elliptical
Lesion Size Dependent on Cannula Gauge

- **18 Gauge Needle Creates 2mm larger diameter lesion**

A = 20 Gauge        B = 18 Gauge


Enlarging Monopolar Lesion Rotating Electrode

- Lesion size enlarged by rotating curved tip cannula 180 degrees

Enlarging Lesion Bipolar Technique


RF Cannula Placement

RF Cannula Placement


RF Cannula Placement


Fluoroscopic Views

Case Discussion

- 7/6/2012 - 48 year old with 8 year history of axial lumbar pain and intermittent right groin pain radiating to medial thigh but not below the knee.
- Onset after falling
- Neuro exam negative
- No comorbidities

Case Discussion - MRI
Case Discussion

• ESI x 3 in 2005, not fluoroscopically guided
• 2/24/2012
  – L3L4 interlaminar epidural steroid injection with fluoroscopic guidance
  – Resolution right leg pain
• 4/5/2012
  – L4L5 interlaminar epidural steroid injection with fluoroscopic guidance
  – No resolution of lumbar axial pain
Case Discussion - FJI

• 7/16/2013 - Bilateral Intraarticular Facet Joint Injection
Case Discussion – Follow-up

- 7/16/2012 – Facet Joint Injection: Bilateral L45, L5S1
  - Pre-procedure VAS score = 4/10
  - Unable to provoke higher level
  - No pain diary

- 7/31/2012 - Followup
  - “Best I have felt in 5 years.”
  - “Occasional pain with prolonged walking”

11/27/2012 – Followup
- Pain returned
- Worse with prolonged sitting or standing.
- No change in location

- Decision to proceed with:
  - Bilateral L3, L4 medial branch, L5 dorsal ramus diagnostic blocks
Case Discussion - LMBB

Bilateral L3, L4 medial branch, L5 dorsal ramus diagnostic blocks
Case Discussion – Response to LMBB

- Positive Diagnostic Response to L3, L4 medial branch, L5 dorsal ramus diagnostic block

BEFORE SHOT:  | No Pain 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Worst Pain Imaginable
|-------------|-----------|---|---|---|---|---|---|---|---|---|---|-------------------------------
(1hr) 1/10    | No Pain 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Riding in car
(2hr) 7/10    | No Pain 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Set on the couch
(3hr) 3/10    | No Pain 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Walk expected for 20 min
(4hr) 3/10    | No Pain 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Sit elevated
(5hr) 4/10    | No Pain 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Wash food
(6hr) 4/10    | No Pain 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Wash food

Case Discussion – Proceed to RF Denervation