Current Interventional Therapies for Low Back Pain

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Stanford University
Introduction

1. Axial Pain (facet origin)

2. Radicular Pain
Outline – Facet pain

Significance

Diagnosis

Brief literature review of treatment options
  - RF
  - Steroids
  - MBB
Facet-Joint Diagnosis

Physical Examination?

- No specific exam maneuvers or collection of maneuvers that can accurately diagnosis z-joint pain

Medical Imaging?

- Imaging abnormalities are ubiquitous after age 60
- Patients can have imaging abnormalities and no pain
- Patient can have no imaging abnormalities and pain
Stated Another Way

There are no patient history items, physical exam maneuvers, or imaging studies that can accurately predict those that have Z-joint mediated pain.
How can we diagnose?

Diagnostic Injections

- Target?
  - Intra-articular injections?
  - Medial Branch Blocks?
- Single Blocks?
- Dual Blocks?
- Dual Comparative Blocks?
Single Block Limitations

Positive Predictive Value
- 63-68%

False Positives
- 32-37%

(Dreyfuss 2000)
Dual Blocks?

Dual positive blocks (reproducible relief regardless of the duration) the sensitivity is greatly enhanced (100%) but at the sacrifice of specificity (65%) as judged against placebo (Lord 1995)
Modified Comparative Blocks

Where two different length anesthetics are used on separate occasions, and ascribing a positive response to each dependent on minimum duration of relief with each agent (i.e. >2 hrs with lidocaine and >3 hrs with marcaine)

Enhance Specificity -88%

(Lord 1995)
Intra-Articular?

Using a unique dual block criteria

- Definite or complete relief with first IA injections, and >50% relief with second block

PPV only 31% with a 69% occurrence of false positive responses

PPV for IA Z-joint blocks is much lower than MBBs

(Schwarzer 1994)
Summary of Optimal Selection

**Single Blocks (IA or MBB) are not adequate due to an unacceptable occurrence of FP responses**

**Ideal minimum selection criteria:**

> 80% relief from comparative or modified MBBs
Why does this matter?

Excluding RF, most of the literature does not select patients via validated techniques

Non-Specific In = Non-Specific Out

Back Pain ≠ Back Pain
Unfortunately for Low Back Pain

Trials on:
Physical therapy
Chiropractic
Massage
Oral Medications
Acupuncture

Clearly include subjects with facet pain, but are not exclusive to them.
(Likely 10-50% based on prevalence data)

The results are not overwhelmingly favorable.
Interventional outcomes?

Radiofrequency Neurotomy
Steroids
Radiofrequency

Multiple well done studies (Dreyfuss, MacVicar)

≈60% obtain >80% relief
>80% obtain >50% relief

Duration - at least 6 months
Median duration of effect 17-33 months

When chosen by strict criteria with strict technique
Steroids for Facet-joint Pain?

To Date:
26 Published Reviews in the Literature
7 Published Randomized Controlled Trials

- All with Significant selection flaws that limit usefulness
- or at best single blocks (Carette 1991)
- Results: Variable
Selection via SPECT Scanning?
Utility of positive facet on SPECT

- With objective evidence of active disease facet injections are superior to “therapeutic” medial branch blocks
  - 61% vs 26%
- Predicts successful facet corticosteroid injections
  - 97% (+) vs 45% (-)
- Reduces number of injections & cost while improving outcome
  - 87% (+) vs 31% (none) vs 13% (-)

SPECT

**ADVANTAGES:**
- Functional interrogation of tissues
  - Distinguish active from inactive degenerative sites
  - Uncover active sites with normal morphology
- Sensitive to bone turnover and inflammation
- Full body survey

**DISADVANTAGES:**
- Poor spatial resolution
- High radiation

**BEST USE:**
- Distinguish between soft tissue and bone/joint sources of pain
- Screen for occult injury
- Guide targeted interventions
Selection Via MRI Findings?

**Joint Edema or Synovitis**


Selection via Joint Edema

FRIEDRICH ET AL.

145 asymptomatic

Only 21 (14%) positive

CZERVIONKE ET AL.
Retrospective study from Mayo Clinic

Overall prevalence of 41%

100% correlation in subjects with unilateral pain and facet synovitis
New Data – Kennedy, Smuck, et al.

28 SUBJECTS WITH DUAL COMPARATIVE MEDIAL BRANCH BLOCK CONFIRMED Z-JOINT PAIN
IA STEROID VS SALINE VIA FLUOROSCOPIC GUIDANCE
PRIMARY OUTCOME – NEED FOR RF
SECONDARY OUTCOMES – CATEGORICAL 50% DECREASE IN PAIN, ODI, SF-36, MEDICATION USE, ETC
FOLLOW-UP 6 WEEKS, 3 MONTHS, 6 MONTHS, AND 1 YEAR
Outcomes

**Primary Outcome:**
**Categorical need for a Radiofrequency (RF) ablation**
- IA steroid 70%
- IA saline 76.1%

**Secondary Outcomes:**
- Mean time to RF 6.1 vs 6.5 weeks
- Pain, ODI, SF-36 not valid
Conclusions

INTRA-ARTICULAR CORTICOSTEROIDS WERE NOT MORE EFFECTIVE THAN SALINE IN REDUCING THE NEED FOR A RADIOFREQUENCY ABLATION OF THE MEDIAL BRANCHES IN THOSE WITH DUAL MEDIAL BRANCH BLOCK CONFIRMED Z-JOINT PAIN

FLAWS:
- Small
- Appropriate placebo?
- Weeded people out by doing “therapeutic” MBB
- Did the patients respond to RF?
In conclusion

**Facet Pain**

**RF = High Quality, Reproducible Research**

**Steroids = May be valid in select patient populations, but when applied universally not valid**

**MBB = Great for diagnosis, not for treatment**
RADICULAR PAIN

PREDICTING RESPONSE TO STEROIDS
Back Pain ≠ Back Pain ≠ Back Pain

**Different Pathologies Have Different:**

- Causes
- Natural Histories
- Possibly Treatment Responses
Low Back Pain?

LBP is a SYMPTOM . . .

NOT A DIAGNOSIS
Medicine Example

Cough ≠ Cough

- Bacterial Pneumonia vs
- Viral Pneumonia vs
- Asthma vs
- GERD vs
- CHF

Study: Are antibiotics effective for cough?

- Depends on: accurate inclusion criteria
PREDICTIVE FACTORS

1. WHERE AND HOW STEROIDS ARE GIVEN
# PREDICTIVE FACTORS

**What about Systemic Steroids?**

- **PO**
- **IV/IM**

<table>
<thead>
<tr>
<th>RCTs</th>
<th>Active</th>
<th>Control</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Porsman</td>
<td>IM steroid</td>
<td>Placebo</td>
<td>No diff</td>
</tr>
<tr>
<td>Hedeboe</td>
<td>IM steroid</td>
<td>Placebo</td>
<td>No diff</td>
</tr>
<tr>
<td>Naylor</td>
<td>IM steroid</td>
<td>Placebo</td>
<td>No diff</td>
</tr>
<tr>
<td>Friedman</td>
<td>IM steroid</td>
<td>Placebo</td>
<td>No diff</td>
</tr>
<tr>
<td>Ghahreman</td>
<td>IM steroid</td>
<td>Placebo</td>
<td>No diff</td>
</tr>
<tr>
<td>Finckh</td>
<td>IV steroid</td>
<td>Placebo</td>
<td>No diff</td>
</tr>
<tr>
<td>Haimovic</td>
<td>PO steroid</td>
<td>Placebo</td>
<td>No diff</td>
</tr>
</tbody>
</table>

Alternative - EPIDURAL STEROIDS

E V O L U T I O N  O F  I N J E C T I O N  T E C H N I Q U E

PREDICTING RESPONSE – Where given

TRANSFORAMINAL VS INTERLAMINAR

- Retrospective Cohorts
  - Schufele - Pain Physician 2006 (n=40 HNP)
    - TF ESI > Interlaminar ESI
  - Smith - Pain Med 2010 (n=39 – SS only)
    - TF ESI = Interlaminar ESI (stenosis)

- Prospective RCTs
  - Thomas - Clin Rheumatol 2003 (n=31 HNP)
    - TF ESI > Blind interlaminar ESI
  - Kraemer - Eur Spine J 1997 (n=133 HNP)
    - Perineurl > Interlaminar > placebo + IM
  - Lee – Clin J Pain 2009 (n=192 – SS and HNP)
    - TF ESI > Interlaminar ESI (stenosis, not HNP)
  - Gharibo – Pain Physician 2011 (n=38 – Subacute HNP)
    - TF ESI > Interlaminar ESI
  - Rados– Pain Med 2011 (n=64 – Chronic HNP)
    - TF ESI = Interlaminar ESI
    - TF=half dose with longer funct. gain
PREDICTIVE FACTORS

2. **Who they are given to**
WHO THEY ARE GIVEN TO

**SUCCESS OF EPIDURAL STEROIDS**

- Reported success rates between 50-90%
- Success is 2-3x that of placebo $^1,^2$
- NNT <3

**WHO ARE THE NON-RESPONDERS?**
**WHO ARE THE BEST RESPONDERS?**

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WHO THEY ARE GIVEN TO

Jen

BRAD

JOHN

L5-S1 EXTRUSION

L4-5 PROTRUSION

L3-4 STENOSIS
WHO THEY ARE GIVEN TO

- Patient variables to predict success?
  - Demographic
  - Anthropomorphic
  - History
  - Exam
  - Radiographic
WHO THEY ARE GIVEN TO

- **Patient variables to predict success?**
  - Demographic
  - Anthropomorphic
  - History
  - Exam
  - Radiographic
WHO THEY ARE GIVEN TO

HISTORY
WHO THEY ARE GIVEN TO

- **History**
  - Symptom duration
    - Evaluated in 3 studies of modern transforaminal injections

### Table 3
Successful outcome from transforaminal injection of steroids correlated against duration of symptoms. The $P$ value pertains to a chi-squared test of the data. For each data set, the sensitivity (Sens) and specificity (Spec), and positive likelihood ratio (LR) of short duration of symptoms being a predictor of outcomes are shown, as well as the respective success rates in patients with short duration and long duration of symptoms.

<table>
<thead>
<tr>
<th>Reference Study</th>
<th>Duration (months)</th>
<th>Response</th>
<th>Yes</th>
<th>No</th>
<th>$P$</th>
<th>Sens</th>
<th>Spec</th>
<th>LR</th>
<th>Success Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jeong et al. [40]</td>
<td>&lt;6</td>
<td></td>
<td>96</td>
<td>38</td>
<td>0.01</td>
<td>0.67</td>
<td>0.51</td>
<td>1.4</td>
<td>72 ± 8</td>
</tr>
<tr>
<td></td>
<td>&gt;6</td>
<td></td>
<td>48</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>55 ± 10</td>
</tr>
<tr>
<td>Lee et al. [41]</td>
<td>&lt;6</td>
<td></td>
<td>12</td>
<td>2</td>
<td>0.62</td>
<td>0.44</td>
<td>0.67</td>
<td>1.3</td>
<td>85 ± 16</td>
</tr>
<tr>
<td></td>
<td>&gt;6</td>
<td></td>
<td>15</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>79 ± 18</td>
</tr>
<tr>
<td>Ghahreman et al. [77]</td>
<td>&lt;6</td>
<td></td>
<td>26</td>
<td>22</td>
<td>0.52</td>
<td>0.74</td>
<td>0.33</td>
<td>1.1</td>
<td>50 ± 14</td>
</tr>
<tr>
<td></td>
<td>&gt;6</td>
<td></td>
<td>10</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>48 ± 21</td>
</tr>
<tr>
<td>Combined</td>
<td>&lt;6</td>
<td></td>
<td>136</td>
<td>62</td>
<td>0.03</td>
<td>0.65</td>
<td>0.47</td>
<td>1.2</td>
<td>89 ± 6</td>
</tr>
<tr>
<td></td>
<td>&gt;6</td>
<td></td>
<td>73</td>
<td>55</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>57 ± 9</td>
</tr>
</tbody>
</table>

WHO THEY ARE GIVEN TO

- **HISTORY**
  - Symptom duration
    Associated with outcome in 1/3 studies
    Significant in pooled data

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WHO THEY ARE GIVEN TO

**HISTORY**

- Symptom duration

  Evaluated Success rates are not statistically different

Table 3: Successful outcome from transforaminal injection of steroids correlated against duration of symptoms. The $P$ value pertains to a chi-squared test of the data. For each data set, the sensitivity (Sens) and specificity (Spec), and positive likelihood ratio (LR) of short duration of symptoms being a predictor of outcomes are shown, as well as the respective success rates in patients with short duration and long duration of symptoms.

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<th>Spec</th>
<th>LR</th>
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<tr>
<td></td>
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<td>Yes 96</td>
<td>0.01</td>
<td>0.67</td>
<td>0.51</td>
<td>1.4</td>
<td>72 ± 8</td>
</tr>
<tr>
<td></td>
<td>&gt;6</td>
<td>No 38</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>55 ± 10</td>
</tr>
<tr>
<td>Lee et al. [41]</td>
<td>&lt;6</td>
<td>Yes 12</td>
<td>0.62</td>
<td>0.44</td>
<td>0.67</td>
<td>1.3</td>
<td>86 ± 16</td>
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<tr>
<td></td>
<td>&gt;6</td>
<td>No 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Ghehraman et al. [77]</td>
<td>&lt;6</td>
<td>Yes 28</td>
<td>0.52</td>
<td>0.74</td>
<td>0.33</td>
<td>1.1</td>
<td>59 ± 14</td>
</tr>
<tr>
<td></td>
<td>&gt;6</td>
<td>No 11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>48 ± 21</td>
</tr>
<tr>
<td>Combined</td>
<td>&lt;6</td>
<td>Yes 136</td>
<td>0.03</td>
<td>0.85</td>
<td>0.47</td>
<td>1.2</td>
<td>89 ± 6</td>
</tr>
<tr>
<td></td>
<td>&gt;6</td>
<td>No 73</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>57 ± 9</td>
</tr>
</tbody>
</table>

WHO THEY ARE GIVEN TO

EXAM
WHO THEY ARE GIVEN TO

+ EXAM

**Physical Exam**

<table>
<thead>
<tr>
<th>Table 3 Contingency table for presence of neurologic features and response to transforaminal injection of steroids</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Neurologic Feature</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Sensory change</td>
</tr>
<tr>
<td>Present</td>
</tr>
<tr>
<td>Absent</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Neurologic sign</td>
</tr>
<tr>
<td>Present</td>
</tr>
<tr>
<td>Absent</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

WHO THEY ARE GIVEN TO

EXAM

Positive electrodiagnostic exam
- Improved functional outcome
- Improved pain
- No influence

WHO THEY ARE GIVEN TO

RADIOLOGY
WHO THEY ARE GIVEN TO

- **Radiology**

Spinal Stenosis < Disc Herniation
WHO THEY ARE GIVEN TO

**RADIOLOGY**

- Disc morphology (size & shape)
  - Large extrusion & sequestrations ²,³
  - Small protrusions ⁴

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WHO THEY ARE GIVEN TO

- **RADIOLOGY**
  - Nerve Compression Grade

---

WHO THEY ARE GIVEN TO

**Radiology**

- Nerve compression grade

---

**Table 4** The correlation between response to transforaminal injection of steroids and the grade of nerve compression

<table>
<thead>
<tr>
<th>Reference Study</th>
<th>Grade</th>
<th>Yes</th>
<th>No</th>
<th>Sens</th>
<th>Spec</th>
<th>LR</th>
<th>Success Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choi et al. [59]</td>
<td>Low</td>
<td>44</td>
<td>13</td>
<td>0.86</td>
<td>0.52</td>
<td>1.8</td>
<td>77 ± 11</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>7</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td>33 ± 20</td>
</tr>
<tr>
<td>Ghahreman et al. [100]</td>
<td>Low</td>
<td>30</td>
<td>10</td>
<td>0.79</td>
<td>0.70</td>
<td>2.6</td>
<td>75 ± 13</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>8</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
<td>26 ± 15</td>
</tr>
</tbody>
</table>


**Table 8** Contingency table for response to transforaminal injection of steroids and grade of compression of the nerve root affected

<table>
<thead>
<tr>
<th>Grade of Nerve Root Compression</th>
<th>Response to Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paracentral herniations</td>
<td></td>
</tr>
<tr>
<td>Grade I</td>
<td>13</td>
</tr>
<tr>
<td>Grade II</td>
<td>12</td>
</tr>
<tr>
<td>Grade III</td>
<td>4</td>
</tr>
<tr>
<td>Grade IV</td>
<td>3</td>
</tr>
<tr>
<td>Low-grade (I, II)</td>
<td>25</td>
</tr>
<tr>
<td>High-grade (III, IV)</td>
<td>7</td>
</tr>
</tbody>
</table>

| Foraminal herniations           |                       |
| Grade I                         | 5                     | 1                     |
| Grade II                        | 1                     | 0                     |
| Grade III                       | 0                     | 3                     |
| Low-grade (0, I)                | 5                     | 1                     |
| High-grade (II, III)            | 1                     | 3                     |

| Combined                        |                       |
| Low-grade                       | 30                    | 10                    |
| High-grade                      | 8                     | 23                    |

FUTURE POSSIBILITIES

WHO TO INJECT?

- Patients with lumbar HNP and radiculopathy
  - Specific biomarkers predict response to ESI and surgery. ¹,²,³

**Response to ESI correlated to improvement (P<0.001)**

<table>
<thead>
<tr>
<th>Fibronectin–aggrecan complex present</th>
<th>Responders to Injection</th>
<th>Nonresponders to Injection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12</td>
<td>2</td>
</tr>
</tbody>
</table>

| Fibronectin–aggrecan complex absent  | 1                       | 11                        |

Figure 3. Receiver-operating-characteristic (ROC) curve for the two-by-two contingency table comparing the presence of the fibronectin-aggrecan complex to PCS s core. The y-axis is the sensitivity and the x-axis is the specificity (also known as the false-positive rate). The curve is generated by allowing the cutoff value of PCS s core to vary. ROC analysis is a graphical representation of the tradeoff between sensitivity and specificity inherent in any test. Here, the tradeoff is controlled by choosing a cutoff value for PCS. The difference between the ROC curve and the null hypothesis curve is highly significant (P < 0.001), indicating an effective test.

Wearable Health Lab

**Faculty and Staff**
- Matthew Smuck, MD (Director)
- Christy Tomkins-Lane, PhD
- Agnes Martinez-Ith
- Ming-Chi Kao, MD, PhD

**Students & Post-Docs**
- Justin Norden
- Aman Sinha
- Vibhu Agarwal
- Amir Muaremi, PhD
- Patricia Zheng, MD

**Collaborations with:**
- William Haskell, PhD (Stanford Prevention Center)
- Andy Haig, MD (University of Michigan)
- Scott Delp, PhD (Stanford Mobilize Center)

Supported by: NIH U54EB020405 Stanford Mobilize Center
FUTURE POSSIBILITIES
Center for Medical Mobile Technology

PROFILES OF PHYSICAL PERFORMANCE (PoPP)
LUMBAR SPINAL STENOSIS DECOMPRESSION NORMALIZES OBJECTIVE MEASURES OF PHYSICAL PERFORMANCE

SUBJECTIVE MEASURES:
Significant differences persisted in all self-reported measures (except the SF-36 physical function and bodily pain subscales).

OBJECTIVE MEASURES:
Differences normalized in the SPWT (time and speed) and accelerometry thresholds.
WHO BENEFITS THE MOST?

Jen  Brad  John

L5-S1 EXTRUSION  L4-5 PROTRUSION  L3-4 STENOSIS
WHO BENEFITS THE MOST?

JEN WINS

L3-4 STENOSIS

L5-S1 EXTRUSION

L4-5 PROTRUSION
Thank You!

Matthew Smuck, MD
Chief, Physical Medicine & Rehabilitation
Associate Professor, Orthopaedics
Director, Wearable Health Lab
Stanford University