FIRESCAN USE IN LOCALIZATION OF BACK PAIN

26th Annual Update in PM&R
March 17, 2012

Zach Beresford, M.D.
Assistant Professor
University of Utah
I have no financial disclosures.
ACKNOWLEDGEMENTS

Stuart Willick, MD

Columbian matador Manalo Beltran takes the full force of revenge during a bullfight in Bogota in September 1997. The goring resulted in what was described as ‘horrendous injuries’.
Non-specific Diagnoses

Non-specific Treatments

Non-specific Outcomes
OUTLINE

• Case Presentations
• Anatomy

MOTIVATION:
• Limitations of current diagnosis for chronic LBP
  - H&P
  - Imaging modalities
• FireScan
  – Description
  – Pros and cons
  – Retrospective data review
• Future directions
DEMOSTRATION CASE 1
LOW BACK PAIN - FOOTBALL

• Division I offensive lineman presented with right low back pain that was present with standing, weight lifting and blocking, and improved with sitting. Symptoms had been increasing since the middle of the season and were now interfering with performance.

• Sugar Bowl was in ten days.

• X-rays and MRI showed mild, multi-level DJD.

• Is a procedure indicated? If so, which one? Can imaging help?
DEMONSTRATION CASE 2
Thoracolumbar pain

• 31 yo woman with several years of left thoracolumbar pain, worsening despite appropriate treatment. Pain began after an MVA.

• Exam reveals ttp paraspinals at left T-L junction, pain with extension/rotation, neurologic exam normal

• X-rays normal

• What do you do next?
DEMONSTRATION CASE 3

• 18 yo female gymnast
• Chronic low back pain worse with activity, now with increased extension-based right lower back pain unresponsive to rest, appropriate therapy
• History of navicular stress fracture
• X-rays normal
• Initial MRI scan normal
• What do you do next?
DIFFERENTIAL DIAGNOSIS
Short vs Long

Sometimes the pain generator is obvious.
Sometimes not as much.
DIFFERENTIAL DIAGNOSIS OF AXIAL LOW BACK PAIN

- Facet pain (15-40%)
- Fracture: acute or repetitive overload Fx of pars, pedicle, endplate)
- Spondylolysis/listhesis
- Disc pain
- Myofascial pain
- Kissing spine (Basstrup’s disease)
- Visceral pain
FACET JOINT ANATOMY

• Formed by SAP and IAP
• Obliquely oriented in lower lumbar spine
• True synovial joint
  – Articular cartilage
  – Joint capsule
  – Synovial membrane
  – Nocioceptive fibers
  – Proprioceptive fibers
Facet Joint Variability
- by level
- by individual
- age/arthrosis
- presence of transitional anatomy
HISTORY AND PHYSICAL UNRELIABLE FOR:

- Diagnosis of discogenic pain
  *Schwartz et al* Spine ‘95:20(17)

- Diagnosis of facetogenic pain
  *Dreyer and Dreyfuss* Arch PM&R ‘96:77(3)
  *Jackson* Spine ‘88

- Diagnosis of SI joint pain
  *Fortin et al* Spine ‘94:19(13)
  *Maigne et al* Spine ‘96:21(16)
FACET JOINT PAIN REFERRAL PATTERNS ARE NOT DIAGNOSTIC.

Mooney 1976
IMAGING OPTIONS

- **X-rays:** low predictive value for posterior element pain
- **MRI:** low predictive value; improved anatomic resolution of posterior elements vs xray
- **CT:** best anatomic resolution, but low predictive value for posterior element pain
UTILITY OF STANDARD IMAGING

- Jarvik, Deyo, Ann Int Med 2002 (Literature review)
  - X-ray, CT and MRI have limited utility in the diagnosis of facet pain.

- Saal Spine 2002 (Literature review)
  - “These [standard imaging] studies alone were not adequate for predicting the patients who would respond to controlled diagnostic blocks of the facet joint.”
• **Kjaer Spine 2005 (prospective, controlled, blinded study)**
  - Performed MRIs on 412 40 year-olds
  - ~½ of subjects had axial LBP
  - Radiologists blinded to subject status

• **Results:** Poor correlation between anatomic findings and subjects’ clinical history.
Facet joint synovial cyst
Facet joints have variable anatomy; Facet injections can be technically challenging.
“MAKING THE DIAGNOSIS”

Anesthetizing the joint is the only reliable way of assessing the facet joint as a pain generator

- Intra-articular injection
- OR
- Medial branch block
DIAGNOSTIC POWER OF INJECTIONS IS LIMITED BY:

- False positives (up to 40%)
  - Dual block paradigm
- False negatives
- Time, cost, risk
- Technically challenging facet joint anatomy
- Not helpful for stress responses and stress fractures of the pars, pedicles and endplates.
Specific Diagnoses

Specific Treatments

Improved Outcomes
INCREASE IN SPINAL PROCEDURES PERFORMED

• Surgery, epidurals, facet joints

• Medicare data from 1991-2002:
  – 5.5 % increase in LBP patients.
  – 0.2% increase in charges for physical therapy
  – 59.4% increase in charges for facet injections

Weiner Pain Med 2006
OTHER IMAGING OPTIONS

• **Nuclear Medicine?**
  - **Bone scan**: high sensitivity for abnormal bone turnover, but low anatomic specificity
  - Use of Tc-99m MDP ([technetium-99m-methylene diphosphonate](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2294296/))
    - calcium pyrophosphate analog
    - increased deposition at sites of bone remodeling
BONE SCANS

• Bone scan with SPECT: improved anatomic resolution (still difficult to discern level; facet vs pars vs pedicle)
  – Provides 3D information

• SPECT – Single-photon emission computed tomography

LBP example
• Reviewed 209 bone scans in young athletes with axial LBP

• 66/209 (32%) had uptake in the pars interarticularis

• 36/209 (17%) had uptake elsewhere (facets, sacral stress fractures, vertebral endplates, pedicles, transitional pseudoarticulations

• 107/209 (51%) had no uptake

• Take Home: There are multiple causes of axial LBP
Bone Scan with SPECT

- 47 patients with chronic low back pain
  - Randomized to 2 groups
    - A: Facet injections based on bone scan
    - B: Injections based on clinical evaluation
  - Patients with positive bone scan had better outcomes at 1 month
  - Decreased Medicare costs from $2191 to $1865
    - Pneumaticos 2006
FireScan

• Digitally fusion of a bone scan with SPECT to a CT scan (manually vs automatic)

• Called “FireScan” because areas of increased bone turnover light up

• Advantages: sensitivity of the bone scan plus the anatomic specificity of the CT scan
DEMONSTRATION CASE 1

- 300 lb offensive tackle with progressive, extension-based, right low back pain.
- Unable to localize a specific pain generator by history, physical examination, X-rays and MRI.
- DDx: facet joint pain; SI joint pain; occult pars/pedicle stress; disc pain; other
- Sugar Bowl is in ten days.
FOOTBALL - FireScan

FireScan Dx: R L5-S1 facet arthrosis
DEMONSTRATION CASE 1
BACK PAIN - FOOTBALL

- Treatment: Right L5-S1 facet injection with anesthetic and steroid.
- Outcome: Pain score fell from 7/10 to 1/10.
- Resumed progressive, flexion-based core exercise program one day after injection.
- Resumed low impact cardiovascular exercise two days after injection.
- Resumed blocking drills six days after injection.
- Competed without limitations in 10 days.
- Helped team win 2009 Sugar Bowl.
DEMONSTRATION CASE 2
Thoracolumbar pain

- 31 yo with extension-based left thoracolumbar pain
- Sounds like posterior element pain
- Difficult to localize exact pain generator, level based on available information
CASE 2 FireScan
Thoracolumbar pain

coronal  sagittal  axial
THORACOLUMBAR PAIN

- Increased uptake left T12-L1 facet joint
- Pain completely relieved with MBB
- 100% of pain relieved with RFN
- Pain returned after 9 months, positive response to repeat RFN
CASE 3
GYMNAST

• 18 yo gymnast
• Extension-based right LBP
GYMNAST

• Increased uptake with fracture in right L3 pars region
• Treatment ongoing
Initial retrospective chart review

- 25 facet blocks (IA vs MBB) in 19 patients
- only one joint blocked at a time

• Average pre-procedure pain score: 5.0
• Average post-procedure pain score: 1.0
INITIAL FIRESCAN CASE SERIES - CONCLUSIONS

- A FireScan can accurately predict short-term response to a facet injection.
- A FireScan can help identify the pain generator in the posterior elements of the spine.
- The CT portion of the FireScan helps guide approach and trajectory to target structure.
UOC Radiofrequency Neurotomy Algorithm

• Suspected facet-mediated pain unresponsive to at least 3 months of conservative care

• At least 2 of the following 3
  – Positive FireScan
  – Positive response(s) to IA facet injection
  – Positive response(s) to MBB
UTILITY OF THE FIRESCAN TO LOCALIZE PAIN GENERATORS WITH AXIAL SPINE PAIN

Willick et al in progress

• Retrospective review of 107 cases of recalcitrant axial spine pain in which a FireScan was ordered.
• Preliminary data analyzed
• 50% lumbar spine; 37% cervical spine; 7% thoracic spine; 6% sacrum.
FIRESCAN RETROSPECTIVE REVIEW

• Increased uptake seen on 93% of scans.
• 12% of patients with diffuse uptake
• Most common areas of increased uptake
  – Facet 81%, Disc/endplate 27%
• Other areas with increased uptake less common
  – SI joint, spinous processes, pars, posterior spinal fusion, burst fracture
FIRESCAN OUTCOME REVIEW

• 92% of the FireScans assisted medical decision making.

• 61/100 of the FireScans clearly improved patient outcome (7 lost to follow-up).
  – Targeted injections, therapy, bracing ...

• 75 patients received injections

• 32 patients did not receive injections
Retrospective Injection Analysis

- 57 patients with facet targeted injection
  - 38/57 with improved outcome (66%)

- 43 patients received facet joint steroid injections
  - VAS 4.9 -> 1.5 post procedure

- 12 patients received medial branch blocks
  - VAS 5.5 -> 1.3 post procedure
Retrospective Injection Analysis

• 27 patients went on to radiofrequency neurotomy
  – 23/27 with significant pain relief post-procedure
FireScan Drawbacks

- Availability
- Cost (~$1200 per study vs $800-$1,500 per injection vs ~$1,200-$2,000 per MRI)
- Time
- Radiation exposure
- Limited existing studies have been retrospective
FireScan Questions

- Will it change treatment?
  - Unknown ability to predict long-term response to procedures or other treatments
  - Long term response with facet steroid injection?
  - Does a negative FireScan predict poor outcome with injection?
FireScan Advantages

• Objective test of abnormal bone turnover (rather than subjective test of pain).

• Improved diagnostic accuracy.

• Fewer interventional procedures, ? fewer levels
  – RF drawbacks

• (?) decreased cost.

• (?) decreased time.

• CT provides best anatomic resolution: to assess cortication around stress fractures; to plan route of approach to target structure.
Future Directions

• Does a positive FireScan predict response to facet injections, radiofrequency neurotomy

• Prospective studies to determine if FireScan improves outcome, decreases costs, number of procedures
Other Future Directions

– PET/CT NaF: Increased resolution and sensitivity for sites of abnormal bone turnover vs bone scan

– PET/CT 18F FDG (fluorodeoxyglucose): used in oncology, cardiology
  – More sensitive for identifying sites of inflammation

– “Low dose” Spine CT
  • Prone exam, focused on spine, decreases radiation dose
  • May be able to use with PET, Bone scan with SPECT
FIRESCAN INDICATIONS

- Axial spine pain without radicular component
- No red flag signs or symptoms
- Symptoms not discogenic in nature
- Failure of conservative treatment
- Pressing time concerns
- Non-diagnostic standard imaging
CONCLUSIONS

• H&P, X-ray, CT, and MRI have low sensitivity, specificity and predictive values for the diagnosis of axial spine pain.

• Bone scans have high sensitivity but low specificity.
CONCLUSIONS

- FireScan (Bone Scan w SPECT fused with CT) may help localize the pain generator in axial spine pain
- Prospective research is needed to calculate Sensitivity/Specificity, PPV/NPV
- Research needed to determine if outcomes improved