Evidence Based Medicine in Spinal Surgery

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- Synthes
  • Consultant
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Back Pain

- Degenerative Disc disease
- Disc herniation
- Spinal stenosis
- Congenital anomalies
  - Spondylolisthesis = “Slippage”
- Trauma
  - Sprains and Strains
  - Fractures
- Facet-joint pain
- Sacro-iliac joint pain
- Neoplasm, infection, referred pain
Types of low back pain

• Radicular pain; Sciatica
  – Herniated disc
  – Foraminal stenosis

• Neurogenic claudication
  – spinal stenosis

• Chronic low back pain
  – DDD
  – “instability”

• Referred pain: hips, knees
How Often Is Low Back Pain Not Coming From the Back?

Jonathan N. Sembrano, MD, and David W. Polly, Jr, MD

Figure 5. Venn diagram showing the distribution of pain generators (spine, hip joint, and SI joint) being responsible for symptoms in 200 patients complaining of low back pain, after diagnostic workup.
For 95% of patients:
Non-operative management

• At least 6 weeks
• Limited bedrest, early mobilization
• Exercises / PT
  – Aerobic, stretching, isometric
100 patients with low back pain
100 patients with low back pain
100 patients with low back pain
What happens if non-operative treatment fails?
The Role of Surgery
- Short answer -

Neck / back pain

Radiculopathy
= pain going down the leg

Myelopathy / Cauda equina
= Spinal cord or nerve injury
The Role of Surgery
- Short answer -

- Factors that favor Surgery
  - Clinical findings and MRI findings fit
  - Failure of non-operative treatment
  - Severe Pain
  - Neurological deficit
    - Weakness
    - Bowel / bladder incontinence
  - Leg or arm pain or weakness
What is Evidence Based Medicine?

The use of clinical methods and decision making that have been thoroughly tested by properly controlled peer-reviewed medical research.
Evidence Based Medicine

Class I
- Prospective, Randomized, Controlled Trials

Class II
- Non-Randomized, Prospective Controlled Trials
- Observational Studies

Class III
- Case Series
- Case Reports
- Expert Opinion
Evidence Based Medicine

Level 1 Recommendation
  – Class I Evidence

Level 2 Recommendation
  – Class II Evidence

Level 3 Recommendation
  – Class III Evidence
Diagram demonstrating the basic design of a **RANDOMIZED CONTROLLED TRIAL**. The study sample is randomized to different treatments, and the outcomes are prospectively determined.


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Diagram demonstrating the basic design of an **OBSERVATIONAL COHORT STUDY**. The treatment is chosen by the patient and physician rather than through randomization. The study groups are defined by treatment and outcomes are compared. Cohort studies can be prospective or retrospective.

*The Importance of Study Design in the Spine Literature, Pearson A. et.al.*  
Evidence Based Medicine: Spine

- Lumbar HNP (3)
- Lumbar stenosis (3)
- Degenerative spondylolisthesis (5)
- Axial LBP (4)
- Artificial disc (3)
LUMBAR HERNIATED NUCLEUS PULPOPOSUS
Case example: Herniated Lumbar Disk

- 43 y/o male with 2 months of pain radiating into right foot
- No relieve by physical therapy and medication
- No back pain, weakness or urinary incontinence
- No "red flags"
EBM-Spine: Lumbar HNP

Peul WC et al NEJM 2007

**Design**
Multicenter RCT with ITT Analysis

**Patients**
141 Patients- early surgery (median: 1.9 weeks)  
142 Patients- non-operative management

**Results**
Early surgery resulted in faster recovery  
No difference in outcomes in 1 year

**Limitations**
High cross-over rates  
11% of surgery → conservative  
39% of conservative → surgery  
Blinding not possible  
Follow-up only 1 year
EBM Spine: Lumbar HNP

Atllas SJ, et. al. Spine 2005 (Maine Lumbar Spine Study)

Design
Prospective Cohort Study (observational)

Patients
235 Surgery
272 Conservative

Results
Surgery: Improved in pain, function and satisfaction outcomes at 1, 5 and 10 years.
No difference in work status, surgery vs. conservative.
Benefit of surgery narrowed between the two groups over time but still statistically different at 10 years.

Limitations
Imaging not required
Mail in questionnaire rather than actual clinical exam.
EBM Spine: Lumbar HNP

Spine Patient Outcomes Trial (SPORT)

Design
2 Combined Trials (Due to protocol non-adherence)
   RCT- 501 Patients
   Observational Cohort- 743

Patients
   1244 total

Results
Surgery resulted in greater improvement compared with non-operative treatment at 4 years.

Limitations
Cross over (40% of surgery group, 45% of non-operative). This precluded meaningful analysis of the data on an ITT basis because the 2 groups were very similar in treatment received at 2 years.
LUMBAR STENOSIS
EBM Spine:  Stenosis
The Finnish Spinal Stenosis Study

**Design**
RCT with ITT Analysis

**Patients**
94 Patients,  (50 Surgical, 44 Non-surgical)

**Results**
Surgery better in ODI, leg and back pain. Greater difference at 1 year than at 2 years
Crossover rate 10% (low) in either direction.
Level I evidence favoring surgery but not in walking ability

**Limitations**
Small number of patients
20% of surgery group had instrumented fusion (variation in surgical management)
EBM Spinal: Stenosis
Maine Lumbar Study Atlas SJ et al, Spine 2005

**Design**
Prospective observational Cohort
10 year follow-up

**Patients**
148 Patients- (81 Surgical, 67 Nonsurgical)

**Results**
Level 2 evidence that decompression *MAY* provide better outcomes over nonsurgical treatment.

**Limitations**
Cross over to surgery 39%
Non-randomized: more severe patients to surgery.
Few patients with mild symptoms were treated with surgery
EBM Spine: Stenosis
Sport Trial for Lumbar Spinal Stenosis
Weinstein J, et. al., NEJM  2008, Spine 2010

Design
   RCT with prospective observational Cohort

Patients
   654 Patients (289 RCT, 365 Observational)

Results
   Level 2 evidence to suggest that surgery results in better outcome at 2 years and maintained at 4 years.

Limitations
   High cross over
   - 33% of surgery group to non-surgery group
   - 43% from non-surgery group had surgery

Surgical treatment variable (11% had a fusion)
Non-surgical treatment not specified
DEGENERATIVE SPONDYLOLISTHESIS
**Surgical vs. Nonsurgical Treatment for Lumbar Degenerative Spondylolisthesis**

Weinstein J. et. al. NEJM 2007, JBJS 2009

**Design**
- RCT with prospective observational cohort
  - (304 RCT, 303 Observational Cohort)

**Patients**
- **521 Patients** Follow-up, (372 Surgery, 149 No-surgery)

**Results**
- Surgery patients (laminectomy with 1 level fusion) had substantially greater pain relief and improvement in function at 4 years.

**Limitations**
- High level of cross over, difficult to interpret ITT analysis
  - 36% of surgery group, 49% of non-operative group
- Non-operative treatment not standardized
- Surgical treatment not standardized
  - (fusion posteriorly or circumferentially with or without instrumentation)
EBM: Degenerative Spondylolisthesis
The Surgical Management of Degenerative Lumbar Spondylolisthesis: A Systemic Review.
Martin CR et al. Spine 2007

Design
Literature Review: RCT and comparative observational studies in English, German and French (1966-2005)

Patients
13 Studies of 578 patients

Results
Fusion is more effective than laminectomy in achieving a satisfactory outcome
Instrumentation increased fusion rate
Decompression only had the least satisfactory outcome

Limitations
Some studies included non-consecutive patients
Some had undefined follow-up
No standardized outcome measure was used consistently

Strengths
Comprehensive review on degenerative spondylolisthesis
**EBM: Degenerative Spondylolisthesis**
"Degenerative Lumbar Spondylolisthesis with Spinal Stenosis" Kornblum, et.al. *Spine* 2008

**Design**
A Prospective Long Term Study “Comparing Fusion and Pseudoarthrosis”

**Patients**
58 Patients with laminectomy and non-instrumented fusion

**Results**
Good or excellent outcome in
- 86% fusion
- 56% non-union
- 25/47 (53%) developed non-union

**Strengths**
Follow-up was long (5-14 years)

**Limitations**
Small number
Non-standardized outcome measure
19% (11 patients) lost to follow-up
Single center, secondary analysis
Surgical Treatment of Spinal Stenosis with Spondylolisthesis: Cost Effectiveness after 2 years
Tosteson AN et al, Ann Internal Medicine 2008

**Design**
Prospective Cohort Study

**Patients**
601 Patients (randomized and observational cohort)
- 368 Surgery (fusion in 93% / 78% instrumentation)
- 233 Non-surgery

**Results**
A trend toward improved cost effectiveness with circumferential instrumented fusion
Surgery results in better improvement of health

**Strengths**
- Multicenter study
- Large number of patients
- RCT and observational patients
- Validated outcome measure used

**Limitations**
- Non-operative care not specified
- Costs relied upon self-reported utilization data
- Follow-up limited to 2 years
AXIAL LOW BACK PAIN
Design
Multicenter RCT with 2 year follow, ITT Analysis

Patients
292 (Fusion 222, Non-operative 72)

Results
Fusion may lead to better outcome

Strengths
Multicenter RCT small dropout (5 patients)

Limitations
No standardization in either group
Industry funding
Asymmetry of group sizes 75 (due to design as multiple fusion arms)
Design
Multi-centre RCT with 2 year follow-up

Patients
349 Patients (179 Surgery, 170 Rehab)

Results
Improvement above rehabilitation in ODI (4.1) with surgery (barely statistically significant)

Strengths
Multicenter RCT
Multiple outcome measures (ODI, walking test, SF36, work status)

Limitations
High crossover (28% non-operative to rehabilitation)
Included redo’s and spondylolisthesis
Flexible stabilizations included as fusion
EBM: Axial Low Back Pain
Randomized Clinical Trial of Lumbar Instrumented Fusion and Cognitive Intervention in Patients with Chronic Low Back Pain and Disc Degeneration. Brox et al Spine 2003

**Design**
RCT with 1 year follow-up

**Patients**
64 patients

**Results**
Both groups improved significantly and equally

**Strengths**
Blinding of physical therapy evaluator
Standardized nonsurgical treatment

**Limitations**
Short follow-up
Small numbers
Lack of no treatment arm
Failure of treatment in assigned group (4/37 of the surgery group and 2/27 in non-surgical)
EBM Spine: Axial LBP

Lumbar Instrumented Fusion Compared with Cognitive Intervention and Exercises in Patients with Chronic Low Back Pain After Previous Surgery for Disc Herniation: A Prospective Randomized Controlled Study. Brox et al Pain 2006

**Design**

Nationwide (Norway) RCT with 1 year follow-up and ITT Analysis

**Patients**

60 Patients

**Results**

No Difference

**Strengths**

RCT
Validated outcome measures
Blinding of PT evaluator

**Limitations**

Short follow-up (1 year)
Small numbers
Lack of no treatment arm
7/29 Did not have surgery, 2/31 Did not have non-surgical
ARTIFICIAL DISC
EBM: Artificial Disc

Results of Prospective, Randomized, Multicenter Food & Drug Administration Investigational Device Exemption Study of Pro Disc-L Total Disc Replacement vs. Circumferential Fusion for the Treatment of 1 Level Degenerative Disc Disease Zigler et al Spine, 2007

Design
Multicenter randomized controlled non-inferiority trial with 2 year follow-up

Patients
161 pro-disc patients, 75 fusion patients

Results
Study suggests that short-term outcomes of artificial disc replacements are similar to or marginally better than fusion

Strengths
RCT

Limitations
Industry funding
About 10% lost to follow-up in each group
FDA revision of success criteria
**EBM: Artificial Disc**


**Design**
Multicenter RCT non-inferiority trial with 2 year follow-up

**Patients**
304 Patients. (205 Artificial Disc, 99 Anterior lumbar (BAK cage and autograft))

**Results**
Suggest that short term outcomes are similar or slightly better with artificial disc

**Strengths**
Multicenter RCT

**Limitations**
Large loss to follow-up (44 in disc group, 33 in fusion group)
Industry funding
72% of the disc replacement group and 86% of fusion group in the clinically “successful” results were still on narcotics at 2 years.
Design
Prospective randomized multicenter trials evaluating implants
2 year follow-up 605 study/561 control

Patients
Prestige- 276 study/265 control
Bryan- 242 study/221 control
ProDisc- 163 study/106 control

Results
Secondary surgery
3.1% study group vs. 8.2% control (fusion)

Strengths
Large multicenter RCT

Limitations
Industry supported
Short follow-up
Conclusions from these Studies

**Lumbar HNP**
- Early surgery, faster recovery
- Surgery, greater improvement

**Lumbar Stenosis**
- Surgery

**Degenerative Spondylolisthesis**
- Surgery – fusion with instrumentation
Conclusions from these Studies

Axial LBP
Conservative vs Surgery: No difference

Artificial Disc
Verdict not in NONE are really Class I evidence
For Axial LBP

Studies to compare:
• fusion and structured post-op rehab
• to structured rehab only
• to a non-structured non-operative arm

For Axial LBP

studies examining the longevity and long term complication of artificial disc
Studies in the Future

For lumbar stenosis
studies use validated outcomes (SSS/Zurich claudication questionnaire)

For degenerative spondylolisthesis
There is no randomized controlled trial with long term follow-up comparing the various fusion techniques

Future studies will need to be:
Not just effective but **cost effective**
Other questions remain....

Timing of the surgery?

Specific surgical technique?  
(e.g. various fusion approaches)

The place for new technology  
disc arthroplasty?  
dynamic stabilization?  
BMP?
Alternatives to EBM based on Randomized Control Trial (RCT)

- Observational cohort study
- Best evidence & good judgment
- Personalized medical treatments
EBM – Spine: Observational Studies for Providing the Best Answers to Some Questions

“RCT & Observational study design typically yield the same answer”

Cancato et al. *NEJM* 2000

**OBSERVATIONAL STUDY**
- Lower costs
- Easier patient recruitment

**RCT**
- Extremely Expensive And Work Intensive
- 3 SPORT Studies - $12 million
- Difficult to obtain long term follow-up (SPORT IDH 35% lost to follow-up at 4 years).
BEST EVIDENCE AND GOOD JUDGMENT
EBM in Spine Practice

“Evidence-based medicine is the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual practice.”

“EBM is not restricted to randomized trials and meta analysis.”

_Evidence Medicine: Which is it and which is not_ Sackett, et al BMJ 1996
“It involves integrating individual clinical expertise with best available external clinical evidence from systemic research.”

Individual Clinical Expertise: Clinician experience and practice

External Clinical Evidence: Clinically relevant research