The Case for Posterior Foraminotomy

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Disclosure

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Spinicity
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Today's Case

C4/5
Thanks Sheeraz!

This is a perfect case for a posterior foraminotomy:
1. Young patient
2. Unilateral symptoms
3. Single level
4. Minimal neck pain
5. No abnormal alignment
6. No abnormal motion

<table>
<thead>
<tr>
<th>Pro</th>
<th>Con</th>
</tr>
</thead>
<tbody>
<tr>
<td>No approach problems</td>
<td>Possibility of recurrence</td>
</tr>
<tr>
<td>No need to stabilize</td>
<td>No treatment of instability</td>
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<tr>
<td>Decreased adjacent level disease</td>
<td>Unilateral treatment</td>
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<td></td>
<td>Interrupts neck musculature</td>
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</table>

Is it Effective?
• 44 patients followed for 6 or more years (mean 8.8 years)
• 98% of patients experienced symptomatic relief
• No index level reoperations
• Two cases of adjacent level disease

Does it Work for Two Levels?
35 patients
1. 99 minutes
2. 55 g Blood loss
3. 88% had relief at 3 months
4. 97% had relief at final F/U

What About MIS?

What About the Posterior Approach?

Standard open techniques require extensive disruption of dorsal musculoligamentous resulting in:
- Incision-related pain
- Devitalization of neck musculature
- Poor esthetics
- Interruption of the posterior “dynamic tension band”

Minimal access approaches attempt to overcome these drawbacks of conventional open surgery.
Tubular Dilator Retractors

1. Utilizes serial expansion of muscles over a guide wire
2. Spreads muscles instead of cutting them
3. Final dilation to 16 mm to 24 mm in diameter
4. Serves essentially as an access port

“Mom...look what I did through the Tube!”

Minimally invasive techniques are being used for:
1. Odontoid screw fixation
2. Transarticular screw placement
3. C1-2 Harms techniques
4. Tumor removal
5. Laminectomy
6. Trans-facet fixation

Cervical Foraminotomy

- 100 consecutive patients undergoing minimally invasive cervical foraminotomy
- 97 patients reported as "good" or "excellent" results
- Typical discharge home in 3 hours
- 60 patients able to return to work within one week.
- Two dural tears
- One wound infection
What is the Rate of Reoperation or Adjacent Disease?

- 178 patient followed a mean of 31.7 months
- 9 (5%) of patients underwent reoperation at index level
- Associated factors: young, thin, anxious patients
70 patients:
1. No secondary intervention
2. 5 patients had ACDF
3. ACDF was a mean of 44 months later
4. 1.1% per year same level
5. 0.9% per year adjacent level surgery

Biomechanical Effects in vivo

Cost Utility Analysis
Alvin, et al (JSDT)

The Cleveland Clinic experience w/ foraminotomy:
- 45 ACDF vs 25 foraminotomy patients
- Assessed with VAS, NDL EQ-5D & PHQ-9
- Both groups showed improved outcomes and MCID
- At one year, foraminotomy was more cost effective

ACDF $131,951 / QALY
Foraminotomy $79,856 / QALY
Military Experience

Foraminotomy has been around for over 50 years, so what does the future hold?

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Foraminotomy has been around for over 50 years, so what does the future hold?
Central Canal Decompression

Minimally Invasive Fusion

! Thank You !
Cervical Radiculopathy: Case Based Debate

CERVICAL TDR

Pierce D. Nunley MD
Director, Spine Institute of Louisiana
Assistant Professor, Louisiana State University

Disclosures
 Research Funding
  • LDR Spine

 Speaker’s Bureau
  • LDR Spine
  • K2M

History
Smith and Robinson introduced anterior cervical discectomy and arthrodesis in 1958 as a surgical option for the management of cervical disc disorders.


ACDF has gained acceptance as standard of care for patients with persistent radicular and/or myelopathic symptoms that have failed to improve with conservative treatments.

ASP – Adjacent Segment Pathology

As longer term results became available, the outcome studies increasingly focused on the adverse effects of this procedure.

20-32% of patients undergoing ACDF would develop ASP during the next 10 years.

The concern that spinal fusion may be a contributing factor to accelerated ASP led to increased interest in “motion preservation”.

Similar stress profiles were recorded from intact specimens and those with the artificial joint inserted.

The artificial joint resulted in reduced stresses in the annulus compared with spines with a simulated fusion.

Rationale

- This immediately led the scientists and surgeons to focus their attention towards developing alternative procedures to ACDF.
- The concept of “motion preservation technology” was thus born and subsequently led to the development of cervical total disc replacement (c-TDR).
- Since then several total disc arthroplasty implants have been used for treating cervical degenerative disc disease and the clinical outcomes have been published in the literature.
A review of the published literature raises the following basic questions:

1. Are the short or long term clinical outcomes better in patients with disc replacement as compared to ACFD?

2. Is there a significant difference in the incidence of Clinical adjacent segment pathology (CASP) after the two procedures?

3. Is there a strong, evidence-based rationale to perform total disc replacement instead of ACFD?

4. Are there specific patient subsets in which either of the procedures may provide better longer term outcomes (index level or adjacent segment disease)?
Primary Outcome Comparisons

Problems
1. The longest published follow-up period for total disc replacement is about 8 years.
2. Most of the published data for total disc replacement consists of patients with one or two level disease.
3. The data for total disc replacement is usually gathered from the patients who have participated in the randomized controlled trials (RCT) for particular implants. (Such trials have very stringent inclusion/exclusion criteria for selecting patients and are often criticized as not representing the general patient population.)

ACDF Outcomes

Problems
1. Most published results of the ACDF procedure are retrospective and/or anecdotal from experience of a single surgeon or institution, (class III studies at best.)
2. The outcome instruments used and success criteria used for the ACDF studies have varied according to the different authors’ judgment and tools available at the time of data acquisition.

Bottom Line
- Comparable success rates for both procedures at the average follow-up of 2–4 years
- Clearly established the non-inferiority of the TDR procedure to the ACDF
- Questionable rationale for utilizing TDR as an alternative to the fusion procedure**.

Adjacent Segment Pathology (CASP)

Hilibrand’s follow-up study: Admitted that the scientific literature was unclear whether the ASP is a result of the spinal fusion with iatrogenic motion restriction or whether it represented a progression of the natural history of degeneration.


The primary end points of TDR clinical trials are focused on improvements in patient’s symptoms attributable to the index-level. The published results are mostly focused on the outcomes at 24-month follow-up, the period being too short to assess ASD.

Our Experience

Total disc arthroplasty is equivalent to ACDF for providing relief from symptoms. The risk of developing adjacent segment degeneration is equivalent after both procedures but is significantly higher in patients with concurrent DDD in lumbar spine.

At a projected follow-up of up to 54 months, the risk of developing symptomatic adjacent segment disease (CASP) does not significantly vary between patients receiving total disc arthroplasty or anterior fusion.

Other factors including bone mineral density and presence of concurrent lumbar degeneration have a more significant effect in the incidence of adjacent segment degeneration.
Comparison of artificial cervical arthroplasty versus anterior cervical discectomy and fusion for one-level cervical degenerative disc disease: a meta-analysis of randomized controlled trials.

- 13 RCT’s, 24 month f/u
- Statistical significant improvement TDR over ACDF in
  - Neurological Success
  - Secondary Surgical Procedures
  - VAS – Neck & Arm
  - NDI – Statistically similar

Artificial cervical disc arthroplasty versus anterior cervical discectomy and fusion: a systematic review

"Level I evidence suggests that artificial cervical disc arthroplasty has relatively low complication, reoperation, and heterotopic ossification rates and that quality of life measures such as Neck Disability Index, visual analogue scale, and Short Form 36 (SF36) significantly improved ….”

Two-level Total Disc Replacement with Mobi-C® Cervical Artificial Disc versus Anterior Discectomy and Fusion: A Prospective, Randomized, Controlled Multicenter Clinical Trial with 4 Year Follow-up Results

N=389 f/u 4-7 years
Patients receiving treatment with TDR at TWO LEVELS had statistically significantly greater improvement than ACDF for:
  - NDI
  - SF-12 PCS
  - Patient Satisfaction
  - Overall Success
  - Revision Surgeries
  - Radiographic ASP
Cervical TDR vs Foraminotomy

- Patient Symptoms
  - Radiculopathy vs Neck Pain
  - Myelopathy?

- Radiological Considerations
  - Central vs Peripheral
  - Soft vs Hard
  - Adjacent Segments

- Long Term Consequences
  - Bridge Burning?

Long-term patient outcomes after posterior cervical foraminotomy: an analysis of 151 cases

- n=151, f/u 4 to 15 years
- Reoperation Rates:
  - 18.3% f/u > 2 years
  - 24.3% f/u > 10 years

- “Patients with no preoperative neck pain had the lowest rates of revision surgery after PCF.”

Mroz, et al  Neurosurgery 2014

- N=790, f/u 2 – 6 years
- Reoperation rate at the index level was:
  - 4.8% for the ACDF
  - 6.4% for the PCF group (p = 0.7),
Cervical arthroplasty after previous surgery: results of treating 24 discs in 15 patients.

“provided encouraging early clinical results, although patients with preoperative hypermobility should be treated with caution. Issues such as accelerated device-related wear and the use of arthroplasty after aggressive facetectomy resection will need further study.”

The Effect of Posterior Decompressive Procedures on Segmental Range of Motion Following Cervical Total Disc Arthroplasty.
Patwardhan AG, et al. – SPINE June 2014

- Human Cadaver Biomechanical Study
- Unilateral Hemilaminotomy MAY be safe, but warned against cyclic loading in In-Vivo state
- Bilateral Hemi and Laminectomy UNSTABLE

By performing Hemilaminotomy, what FUTURE are we relegating our patients to?

Debate Case
Conclusions

- c-TDR is a safe and efficacious procedure for the indications of cervical myeloradiculopathy in appropriately selected patients
- c-TDR at two levels has shown superiority over 2 level ACDF (Class I Evidence)
- PCF may lead to as many or more revision surgeries as well as prevent conversion to c-TDR
- THEREFORE: c-TDR is the best choice

Thank You!
For Single Level Disease With Radiculopathy, ACDF is the Best Option

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DISCLOSURES
INDUSTRY
(a) DePuy, Sintor; (b) Vertech, In Vivo, Therapeutics, Paradigm Spine, Biomerix,
Brookhaven Imaging, ConMed, Intuity, Pioneer, Ortho, ASIP, PMIG; (c) Facetlink

• a) Research or institutional support received;
• b) Miscellaneous non-income support (e.g., equipment or services),
  conventionally (indeed) received, or other non-research related funding (e.g., paid travel);
• c) Royalties;
• d) Stock or stock options held;
• e) Employee or Consultant; (n) Nothing of value received

EXTERNAL ADVISORY ROLE
SIC HSS
MAH – United Healthcare
CSRS – Past President
SRS – BDG
IMAST – Past Chair
ADO – Chair Development Committee

Agenda
• ACDF Has a Long Track Record of Outstanding Outcome
• CDA Data Cannot Be Trusted
• Laminoforaminotomy Not Ideal
ACDF

Pathophysiology of Cervical Spondylosis

- Disc dehydration
- Altered biomechanics
- Annular disruption
- Herniated disc
- Spondylotic compression

ACDF for Radiculopathy

Good Solution For All Possible Causes of Radiculopathy

- Direct nerve root compression
  - soft disc herniation
  - spondylosis (osteophyte formation)
- Foraminal stenosis (disc degeneration)
- Dynamic nerve root compression

ACDF for Radiculopathy

Logic of Anterior Surgery

- Direct decompression
- Excellent visualization
- No manipulation of neural elements

“Where the pathology is!”
ACDF for Radiculopathy

Benefits of Procedure

- Directly remove pathology
- Distraction → indirect decompression
- Eliminates motion = ↓ root irritation (ACDF only)

ACDF for Radiculopathy

Arrests Progression of Cervical Spondylosis

CRITICAL DISTINCTION

- Eliminates motion
- Removes arthritic stimulus
- Regression of osteophytes

Adjacent Segment Disease

Reoperation Rate Lowest In Patients With Most Fusion Levels

- Contradicts Theory That Fusion → ASD

- Length of fusion
  - single level = 18%
  - multilevel = 12%

Hilibrand et al., (Am), 1999 JBJS
ACDF Effective, Safe, Procedure

Proven Outcome
Comparable to Hip/Knee Replacement

Anderson Spine 2009

ACDF Improves Sagittal Balance

- ACDF Corrects Kyphosis
  - Uchida JNS 2009
  - Song JBJS Br 2010
  - Shamji Spine 2013

- Important Factor Anterior Reconstruction
  - Kyphosis → Poor Outcome
    - Ferch JNS Spine 2004
    - Kawakami JSDT 1999
    - Villavicencio Neurosurgery 2011
    - Gum AOJ 2012
  - Kyphosis → Increased Incidence of ASD
    - Faldini CORR 2011
    - Hansen Spine 2013
    - Park MS Spine 2014

- Sagittal Balance Associated with Myelopathy
  - Smith Spine 2013

Agenda

- ACDF Has a Long Track Record of Outstanding Outcome
- CDA Data Cannot Be Trusted
- Laminoforaminotomy Not Ideal
My Opponent Will Cite Data Supporting CDA

• Try To Create **Mass Confusion** With Charts, Tables, and Meta Analyses
  - ProDisc C 5 Year Results
  - Zigler JE Spine 2013
  - Prestige 7 Year Results
  - Burkus JNS 2014

DON’T BELIEVE IT
REOPERATION RATES SUSPECT
UNDERREPORTING COMPLICATIONS
NOT ALL CDAs Do Well

---

**Reoperation Data Is Unreliable**

• Reoperation Rates at the same institution different for ACDF patients in the control arm of an IDE study (9%) versus outside of IDE study (2.1%)

---

**CDA Patients Highly Selected**

• Only 43% percentage of patients are candidates for CDA
  – Auerbach Spine 2008
• Cannot extrapolate CDA results to general population
Reports of CDA Complications Increasing

- Early
  - Dislocation
- Late
  - Osteolysis
  - Subsidence

Where Are These Complications In IDE Study Data?

Other Late Complications

- Wear Osteolysis
- Ossification

Where Are These Complications In IDE Study Data?

ASD Occurs After CDA

9/72 Adjacent Segment Degeneration (12.5%)

Bryan
No Industry Funding

Yi Surg Neurol 2009
Same Segment Disease After CDA

Where Are These Complications In IDE Study Data?

Yi Surg Neurol 2009

Not All CDAs Do Well

- Review of Discover Data
- Decreased Disk Height → Poor Outcome
- Excessive Lordosis → Poor Outcome

Rihn JSDT 2014

Laminoforaminotomy

- High Neurological Injury
- High Reoperation Rate
- Kyphosing
Laminoforaminotomy

- Neurological Injury
  - 2.3% Palsy
    - Choi World Neurosurgery 2013
  - 2.1% Palsy
  - But if you are part of that 2%, it's a big deal
    - Jagannathan JNS 2009

High Reoperation After Laminoforaminotomy

- N=790, Cleveland Clinic, n=627 ACDF, 163 PCF
- 2 year reop rate (p=0.7)
  - ACDF 4.8%
  - PCF 6.4%

Laminoforaminotomy Kyphosing Procedure

- N=162, UVA, Postop Kyphosis 20% of Patients at 5 Years
  - Jagannathan JNS 2009
Progressive Kyphosis After Laminoforaminotomy

- Described Even In Paper Favorable to Laminoforaminotomy
- Had to Be Rescued with ACDF

Summary

- ACDF Great, Safe, Effective Durable Procedure
- Need More Independent Verification of CDA Data
- Laminoforaminotomy Potential To Be Cost Effective

Conclusion

- Need Better Understanding of the Drivers of Outcome of Cervical Surgery
  - Sagittal Balance?
  - Fusion Rate?
  - Motion?
  - Reoperation Rate?
Thank You
Current Surgical Strategies for Cervical Radiculopathy

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Disclosures

1. Committee Appointments
   1. AAOS Evaluations Committee
   2. CSRS Research Committee
   3. NASS Evidence-Based Guidelines Committee
   4. CSRS Survey Committee
   5. NASS Value Committee

2. Journals
   1. Spine Journal (Reviewer)
   2. Spine (Reviewer)
   3. CORR (Reviewer)
   4. Global Spine Journal Reviewer

3. Royalties
   1. Zimmer

4. Consulting
   1. Medtronic
   2. Stryker
   3. Zimmer
   4. Orthofix

5. Teaching
   1. Medtronic
   2. Stryker
   3. Globus

6. Advisory Boards
   1. Zimmer Scientific Advisory Board
   2. Orthofix Scientific Advisory Board
   3. MTF Medical Board of Directors
   4. Axiomed Data Safety Monitoring Board

Increasingly Common Problem

Table 1. Total Procedure Counts, Demographics, and Outcomes of Cervical Spine Surgery from 2002–2009

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<thead>
<tr>
<th>Cervical Procedures (Weighted)</th>
<th>1,323,979</th>
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<tbody>
<tr>
<td>Total Count (Unweighted)</td>
<td>273,396</td>
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<tr>
<td>ACF</td>
<td>219,444</td>
</tr>
<tr>
<td>PCF</td>
<td>23,321</td>
</tr>
<tr>
<td>PCD</td>
<td>30,631</td>
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</tbody>
</table>
Economic Crisis

• Spine surgery outcomes
  - Technical concepts
    • Fusion Rates
    • Complications

What is Value?

• "Goalposts around which we define outcomes"

The Past …
The Past …

- Goal of surgery
  - Technically successful procedure

Outcomes Measures

Review Article

Patient-reported Outcome Measures in Spine Surgery

Abstract

The ultimate goals of intervention for spinal pathology are to improve the patient's quality of life, restore function, and relieve pain. Traditional clinician-based assessments typically fall short of

The Surgeon’s Task

- Choose the procedure that results in the best possible outcome for the patient
**Emphasis**

- Cost
- Cost Effectiveness
- Value

**How is Value Defined**

- Value
  - Quality of an intervention divided by the cost measured over time
- Key factors
  - Quality
  - Cost
  - Time

**Obligation**

- Goal of healthcare is NOT simply to achieve lowest cost treatment for given pathology
What’s the CHEAPEST treatment?

- NSAIDs
- Tylenol
- PT
- Home exercise program
- Injections

Case

1. 37 year old right hand dominant attorney with 4 week history of right upper extremity pain, numbness, and mild weakness
2. Attempted oral steroid with minimal relief only and currently doing PT
3. Physical exam confirms positive Spurling’s on the right, with 4+/5 weakness of deltoid and biceps
4. No physical exam findings of spinal cord irritation
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What Would You Do?

1. ACDF
2. CDR
3. PCF