Fusion Techniques in Degenerative Disc Disease

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Disclosure information

I have no financial relationships with commercial entities that produce health-care related products.
Cervical Disc Disease. Introduction.

✓ Degenerative process.
✓ Natural part of aging process.
✓ Spectrum of clinical sd. associated with:
  ✓ Neck pain.
  ✓ Neurologic dysfunction.
✓ Incidence unknown.
✓ Radiographic degeneration:
  ✓ 90% in patients older than 65 years\(^1\).
  ✓ 76% in patients older than 56 years\(^2\).
✓ Symptomatic degeneration:
  ✓ 9.5% of men and 12.5% of women complained with chronic pain\(^3\).
  ✓ 24% overall frequency of neck pain\(^4\).

Cervical Disc Disease

Cervical degenerative disorders:
1. Spondylotic degeneration with axial pain (neck pain).
2. Disc displacement with radiculopathy (soft disk).
3. Spondylotic radiculopathy (hard disk).
4. Spondylotic myelopathy.
Cervical Disc Disease

1. Spondylotic degeneration with neck pain.

- Desiccation of nucleus pulpos
- Loss of mechanical conditions
- Increased strain on the annulus
- Tears and protrusion
- Excess of motion in zygapophyseal joints
- Increased strain in the supporting ligaments
Cervical Disc Disease

1. Spondylotic degeneration with neck pain.
   - C5-C6 most commonly involved.
   - Primary Pain generator: Intervertebral disc.
   - Facet joints can become painful.
   - Axial neck pain.
   - Loss of motion.
   - Interscapular and upper brachial sclerotomal pain radiation.
   - Pain is mechanical in nature, worst in flexion and extension.
Cervical Disc Disease

2. Cervical disc displacement / prolapse.

- Disc material prolapsed through tears in annulus
- Root impingement / cord impingement.
- Nerve dysfunction (directly and through vascular compromise)
- Sensory or motor dysfunction
2. Cervical disc displacement / prolapse.
   - Younger patients.
   - Exiting root most commonly involved (C6).
   - C5 and C7 are also common.
   - Radiating lacerating pain located on the dermatotoma.
   - Pain may be intensified with maneuvers (Valsalva, rotation and flexion, axial compression).
Cervical Disc Disease

3. Spondylotic radiculopathy (hard disc).

- Mechanical incompetence of the motion segment
- Degeneration of the facets
- Disc collapse
- Osteophytes on the annulus
- Osteophytes on the facet joints
- Compression the nerve root
Cervical Disc Disease

3. Spondylotic radiculopathy.
   - Older patients.
   - Symptoms develop more gradually.
   - More likely to complain multilevel or bilateral radicular symptoms
   - Radiating lacerating pain located on the dermatotoma.
   - Pain may be intensified with maneuvers (Valsalva, rotation and flexion, axial compression).
Cervical Disc Disease

4. Spondyloptic myelopathy.

- Osteophytes compress de central spinal canal
- Vascular insufficiency
- Spinal cord dysfunction

FIG. 52-5. Narrowing of the spinal canal. (Modified from Barnhardt et al., ref 1)
Cervical Disc Disease

4. Spondylotic myelopathy.
   - Older patients.
   - Most common cause of spinal cord dysfunction in patients older than 55 years.
   - Most common at C5-C6 level.
   - Complete symptomatic reversal after treatment is rare.
   - Five categories according neurologic findings:
     1. Transverse lesion sd. (corticospinal and spino-thalamic)
     3. Central cord sd. (central grey mater of cord).
     5. Brachialgia cord sd. (myeloradiculopathy)
Options of surgical treatment.

Options for this 4 types of patients:
• The type of surgical procedure advocated for cervical disc disease is dictated by the location and extent of the pathology.
• There are also situations in which similar pathology can be addressed in several ways, with roughly similar results.
Options of surgical treatment.

**Decompression**
- Corporectomy
- Laminoforaminotomy
- Laminectomy
- Laminoplasty

**Fusion techniques**
- Anterior fusion.
- Posterior fusion.
- Combined fusion

**Total disc replacement.**
Anterior Fusion
Anterior Fusion

- The gold standard for the surgical treatment of cervical radiculopathy. Indications.
  - Radiculopathy responds well to the surgical treatment (success rates of surgical treatment greater than 90%).
  - Myelopathy is generally a clear indication for surgical intervention, especially if the patient develops signs or symptoms of neurological damage. 90% good to excellent results
  - Axial neck pain from degenerative disk disease is a rare indication (success rates of surgical fusion only 60%).
- Most patients will have immediate relief of arm symptoms
- Recovery time: 4-6 weeks for office work, 8-12 weeks for heavy physical work
- Continued neck pain may be troublesome
Anterior Fusion. Historical aspects.

• 1952: Anterior cervical approach: Leroy Abbot, Bailey & Badgley¹
• 1958-61: Anterior discectomy & interbody fusion: Smith & Robinson² (horseshoe graft), Cloward³ (dowel graft).
• 1970: Anterior cervical Plate. Orozco y Llobet⁴
• 1989: Improve of surgical supplies & trapezoidal plate. Caspar⁵
• 1986-90: Unicortical anchoring plates. Morscher⁶
• 2000: Anterior dynamic plates (load-sharing)⁷
• 2000-2014: New plates design and materials. Development of cages⁸

Anterior fusion: Preoperative evaluation.

- Complaint and Physical Exam
  - Neck Pain
  - Arm Pain/Numbness/Tingling
  - (radiculopathy)
  - Myelopathy (cord abnormalities)
    - Balance.
    - Unusual sensations.
    - Slow wide based gait
Anterior fusion. Preoperative evaluation

XRAYs
- Bone structure and quality
- Alignment
- Lordosis
- Instability
- Other diagnosis of neck pain
  (Cancer/Infection/Fracture)

MRI/CT Scan
- Condition of discs
- Spinal stenosis/Disc herniation
- Root impingement
- Myelomalacia
- Other diagnosis of neck pain
  (Cancer/Infection/Fracture)

Translational Instability >3.5 mm / Angular Instability > 11°
Anterior approach (Smith and Robinson\textsuperscript{1}): 

- Patient position: neck in slight extension.
- Arms tucked and placed under light traction.
- Surgical landmarks: carotid tubercle (C6), cricoid cartilage (C5-C6), thyroid cartilage (C4-C5).
- Identify the level by fluoroscopy.
- Transverse skin incision: one or two levels.
- Oblique skin incisions: longer exposure.
- Section of \textit{"platisma colli"} and blunt dissection.
- Right side: better for a right-handed surgeon.
- Left side: theoretically decrease injury rate of laryngeal recurrent nerve\textsuperscript{2}.
- Safe approach to anterior cervical spine.

Cervical Anterior fusion technique
Cervical Anterior fusion technique

- Complete removal of disc.
- Curettage of vertebral endplates
- Posterior osteophytes must be taken down:
  - More immediate and complete relief of neural symptoms.
  - Increases the foraminal decompression.
  - Better identification of extruded disk fragments.
- The posterior ligament can be removed or not\(^1\).
- It’s important to restore the disc height: The graft or cage should be 2 mm oversized\(^2\).

Cervical Anterior fusion technique

• Interbody spacer / fusion device
  – Autograft (Iliac crest, peroneus)
  – Allograft
  – Cage filled with cancellous bone
    • Titanium.
    • PEEK
    • Tantalium
    • Bone

• Anterior plate fixation.
  – Non-locked
  – Locked
  – Dynamic

• Cervical collar Post-op (soft or hard)
Cervical Anterior fusion technique
Anterior fusion. New implants.

Anterior fusion. Role of anterior platting.

• Widely used after 70's
• Increases chance of fusion.
• Recommended specially for more than one level of fusion\(^1\)
• The plate protects the graft against an excessive axial load\(^2\).
• In a one-level fusion, the anterior plate is a mechanic device for distribution of loads. This increases the vertebral fusion rate\(^2\).
• Not demonstrated an increased risk of adjacent disc degeneration
• Good clinical and radiological results

Anterior fusion. Role of anterior platting.

97 patients. Discectomy plus Anterior fusion only with tricortical graft:
- 11% non-fusion rate in one level
- 28% non-fusion rate in two levels
The authors recommended to add a plate.

78 patients. Discectomy and fusion
- 38 only with a interbody cage (79% of fusion, 32,3% of subsidence, 10,5% of revision surgery)
- 40 with a interbody cage and plate.(97,5% of fusion, 9,7% of subsidence, 0% of revision surgery)
Similar clinical results.
Anterior fusion. Role of anterior platting.

- 28 cage alone / 26 cage + plate
- No differences in fusion (96%) or segmental kyphosis.
- Differences in subsidence: 35.71% vs 11.54% (P<0.05).
- Clinical outcomes were similar in the 2 treatment groups.
- Conclusions: The use of cage and plate construct in 2-level ACDF results in a shorter fusion duration and a lower subsidence rate than that of cage alone; however, there is no significant difference in the postoperative global and segmental alignment and clinical outcomes between groups.
Anterior fusion. Role of anterior platting.

**Dynamic Plates**


- Retrospective. 52 patients.
- No clinical differences (84% good/excellent results).
- Non-union rate 16 % with dynamic / 5 % with static plate
- Conclusion: dynamic plate not offers advantages compared with static plates


- 2 level ACDF.
- ACDF/Static Plate/autograft: 87.8% per level
- ACDF/Dynamic Plate/allograft: 89.8% per level
- All pseudarthrosis patients were asymptomatic (10-13 months)

The dynamic plates improved the loads distribution and provides a good resistance against movement.
- It can lead to a segmental kyphosis due the movement between plate and screws.
- It could have a less fusion rate due excessive movement between plate and screws

2 level ACDF.
- ACDF/Static Plate/autograft: 87.8% per level
- ACDF/Dynamic Plate/allograft: 89.8% per level
- All pseudarthrosis patients were asymptomatic (10-13 months)
Anterior fusion. Results.

- Moderate success in reducing neck pain by >50%.
- Excellent success in reducing arm symptoms by >80%.
- Global results good-excellent between 85-95%.
- Fusion rate 95%.
- Complications rate less than 5%.
- Gold standard.


Low-quality evidence was found that iliac crest autograft results in better fusion than a cage (RR: 1.87; 95% CI: 1.10–3.17); but more complications (RR: 0.33; 95% CI: 0.12–0.92). When fusion of the motion segment is considered to be the working mechanism for pain relief and functional improvement, iliac crest autograft appears to be the golden standard. When ignoring fusion rates and looking at complication rates, a cage as a golden standard has a weak evidence base over iliac crest autograft, but not over discectomy.

Fusion rates were 91% for allograft and autograft and 97% for cage. Adverse events were uncommon in all groups. ACDF with allograft, ACDF with autograft, ACDF with cage, and cervical disc arthroplasty show similar improvements in pain, function, and quality of life with correspondingly low adverse event rates. All ACDF procedures result in high fusion rates.
Anterior fusion. Tantalum cage.

- Prospective. Randomized. 28 tantalum cage vs 33 iliac crest + plate in one level.
- At 24 months, equal results for both groups.
- The data reported suggest that using porous tantalum as a stand-alone device is less costly and more effective than autograft and plate in ACDF procedures.

Anterior fusion: Early Complications.

1. Complications related to approach
   - Vascular injury
   - Root injury
   - Cord injury / Dural penetration (0.5%)
   - Recurrent laryngeal nerve palsy (bimodal voice). 3.1%
   - Stellated ganglion injury (Horner’s syndrome) 0.1%
   - Visceral injury (esophageal perforation 0.3%)
   - Cervical Haematoma 5.6%, (surgical intervention only 2.4%)
   - Airway occlusion

Lied B, Sundseth J, Helseth E. Immediate (0-6 h), early (6-72 h) and late (>72 h) complications after anterior cervical discectomy with fusion for cervical disc degeneration; discharge six hours after operation is feasible. Acta Neurichir (Wien). 2008; 150(2):111-8.
2. Donor site complications
   - Pain.
   - Infection
   - Bleeding.
   - Iatrogenic fracture.

3. Other complications
   - Wound infection 0.1%
   - Skin problems (rare)
   - Postoperative dysphagia 9.5%

Mortality rate 0.1%
Overall morbidity rate was 19.3%
Anterior fusion: Late Complications.

1. Hardware complications (1%).
2. Pseudoartroses.
3. Subsidence of the graft / cage.
Anterior fusion: Late Complications.

4. Extrusion of the bone graft or cage: 2%.
5. Kiphotic deformity.
Anterior fusion: Late Complications.

6. Adjacent disk degeneration.

From a meta-analysis of prospective studies, there is no difference in the rate of ASD for ACDF versus TDA. We also report an overall lower rate of follow-up for patients with ACDF than for those with TDR. Future prospective studies should continue to focus on excellent patient follow-up and accurate assessment of patient symptoms that are attributable to an adjacent level as this has been an under-reported finding in prospective studies.

Conclusions CDA may result in better mid- to long-term functional recovery and a lower rate of subsequent surgical procedures than ACDF would. A review of the literature showed that only an insufficient number of studies had investigated adjacent segment disease; therefore, it is mandatory that adequate future research should focus in this direction.

For treating symptomatic cervical disc disease, cervical disc arthroplasty appears to provide better function, a lower incidence of reoperation related to index surgery at 1 to 5 years, and lower major complication rates compared with fusion. However, cervical disc arthroplasty did not reduce the reoperation rate attributable to adjacent segment degeneration than fusion. Further, it is unclear whether these differences in subsequent surgery including arthroplasty revisions will persist beyond 5 years.
Posterior Fusion
Cervical posterior fusion technique

Posterior approach
Cervical posterior fusion technique
Posterior Fusion (C3-C7 Lateral Masses)

<table>
<thead>
<tr>
<th>Journal</th>
<th>Year</th>
<th>Patients</th>
<th>Follow-up (mo)</th>
<th>Root Injury</th>
<th>Vertebral Artery Injury</th>
<th>Fusion (%)</th>
<th>Construct Failures</th>
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<tr>
<td>Ebraheim</td>
<td>1989</td>
<td>13</td>
<td>13.1</td>
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<td>30</td>
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<tr>
<td>Jeanneret</td>
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<td>51</td>
<td>12-54</td>
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<td>Nazarian</td>
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<td>Levine</td>
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<td>221</td>
<td>?</td>
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<td>100</td>
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<td>Roy-Camille</td>
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<td>19</td>
<td>6 (25%)</td>
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<td>Fehlings</td>
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<tr>
<td>Ebraheim</td>
<td>1995</td>
<td>36</td>
<td>17</td>
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<td>97%</td>
<td>1 Hardware failure</td>
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<td>Heller</td>
<td>1995</td>
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<td>24</td>
<td>7 (9%)</td>
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<td>1998</td>
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<td>Horigan</td>
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<tr>
<td>Deen</td>
<td>2003</td>
<td>225</td>
<td>18</td>
<td>5 (2.2%)</td>
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<td>Sekhon</td>
<td>2005</td>
<td>21</td>
<td>12</td>
<td>3 (14.3%)</td>
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<tr>
<td>Wu</td>
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<td>115</td>
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<td>1 (0.7%)*</td>
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**Efficacy:** High fusion success Mostly plates, few rod-screw 0-10% Increased kyphosis,

**Safety:** Rare hardware failure, Root at small risk (1.2%), very low risk for vertebral artery
Posterior fusion.

• High efficacy >97% healing
• Poor study design
• Maintenance of stability good >95% of cases.
• Complications:
  – Vertebral artery injury rare
  – Root injury 0-5%
  – Hardware failure rare except screw back out in plates

Conclusions. Take at Home messages.

• Despite of the interest in cervical motion preservation, fusion still is the gold standard of treatment for disc degeneration disease.
• Fusion rate of bone allograft and plate is over 95%.
• There is no differences in fusion rate between cages and graft.
• In more than one-level fusion is recommended to add a plate.
• Posterior fusion has similar results than anterior fusion in terms of safety and Efficacy.
• The long term results of new implants and matherials (bone cages, tantalum cages, screwed cages) is not known.
Excellence in Spine

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