Induction and Maintenance of Lordosis in MultiLevel ACDF Using Allograft

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Purpose

• Is lordosis induced by multilevel cortical allograft ACDF placed on intact endplates maintained at 2 year follow-up

• With this technique, does graft-endplate fusion correlate with clinical result
Lordosis
Maintained by Distraction
Allograft Under compression
Methods

- Retrospective series
  - 40 patients
  - 89 levels
- Single surgeon
- Standardized technique
  - Right neck approach

<table>
<thead>
<tr>
<th>Distribution of Cases</th>
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<tbody>
<tr>
<td>Two level</td>
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<tr>
<td>Three level</td>
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<tr>
<td>Four level</td>
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Distribution of Cases:
- Two level: 80%
- Three level: 15%
- Four level: 5%
Demographics

• 19 Males / 21 Females
• 24 Month Average follow-up
  – Range 10-44 months
Indications

• Radiculopathy

• Myeloradiculopathy

• None for axial neck pain
Indications -2
Technique Details

- X-ray localization
- Caspar pin
Technique Details-2

• Maximum distraction
  – Intervertebral spreader

Bony end plates preserved
Technique Details-3

- Oversize graft
- Cornerstone brand
  - Fibular pre-milled allograft
- Average size 8mm (range 7-10mm)
- Packed with local bone
Technique - 5
Technique -4

- Codman plate
Induction and Maintenance of Lordosis

• Grafting on intact endplates
• Oversize grafts & distraction
• ➔ compression on graft
Three Level
Odom’s Criteria

- **Excellent**
  - All preoperative symptoms relieved; abnormal findings improved

- **Good**
  - Minimal persistence of preoperative symptoms; abnormal findings unchanged or improved

- **Fair**
  - Definite relief of some preoperative symptoms; other symptoms unchanged or slightly improved

- **Poor**
  - Symptoms and signs unchanged or exacerbated

Radiographic Pseudarthrosis

1. Absence of bridging, osseous, trabecular bone from the vertebral bodies to the graft
2. Motion on dynamic radiographs
3. the presence of a lucent line at the graft–vertebral body junction
Lucency
Results

Clinical
• All patients had ‘excellent’ or good outcomes as defined by Odom’s criteria

Radiographic
• Lordosis improved an average of 14.3 degrees (range 5-35 degrees)
• 35 of 40 (87%) fused by radiographic criteria
Complications

• Posterior cervical pain ceased on POD#3 on average
• Mild transient dysphagia & hoarseness which resolved by POD#7
• One patient (2.5%) had dysphagia lasting 2 months
Complications -2

- One patient (2.5%) had Horner’s syndrome ipsilateral to the approach
  - resolved at 3 months post-op
- No hardware removal
- No infections
- No same level revisions
Why?
Junctional Problems After Fusion
Adjacent Segment at Risk

- Fusion produces stress riser (ergo the enthusiasm for artificial discs)
- Hypolordosis increases shear across the adjacent disc space
- Hypolordotic alignment increased flexion-extension at the adjacent segment
Adjacent Segment (Lumbar)

- Hypolordosis produces increased posterior element loading in adjacent segments (compensatory hyperlordosis)

The Biomechanical Effect of Postoperative Hypolordosis in Instrumented Lumbar Fusion on Instrumented and Adjacent Spinal Segments

Umehara, SPINE Volume 25, Number 13, pp 1617–1624
Correlation between sagittal plane changes and adjacent segment degeneration following lumbar spine fusion


- 83 patients followed for 5 years following lumbar fusion
- spondylolytic spondylolisthesis and degenerative scoliosis were not included
- Those with a normal c7 plumb line and normal sacral inclination had a significantly decreased incidence of adjacent level degeneration
Comparison of axial and flexural stresses in **lordosis** and three buckled configurations of the **cervical** spine

- Mathematical modeling of cervical vertebral shear stress in lordosis vs. kyphosis
- In lordosis, stresses at the anterior and posterior body are balanced and minimal
- In Kyposis, the anterior body experiences tension opposite the normal compression vector ➔ osteophytes ➔ degeneration
Biomechanical Studies

• Stresses from C5 to T1 are reversed when the spine is not in lordosis

• Intra-discal pressure was significantly increased especially in flexion at c4/5 and c6/7 after plating at c5/6
Clinical Adjacent Level Disease

• 42 patients with myelopathy 9.8 year follow-up
• 50% (21) had adjacent level degenerative change
• 8 of the 21 had neurologic compromise secondary to the degeneration
• 77% of those with kyphosis had adjacent level degeneration (significant difference)
Radiculopathy and myelopathy at segments adjacent to the site of a previous anterior cervical arthrodesis

• Symptomatic adjacent segment 2.9% annual incidence of degeneration
• Survivorship modeling suggests 25.6% new disease in ten years
• No comment on the relationship of lordosis and symptomatic adjacent segment degeneration
Clinical Implications

• Most current series do not emphasize Induction and Maintenance Lordosis

Exception

• Non-plated single level ACDF lordosis decreased by 4.2° while it was maintained in the plated group

Discussion

Is lordosis necessary?

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<tr>
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<th>Collapse (mm)</th>
<th>Kyphosis (°)</th>
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<tbody>
<tr>
<td>Plate + fused</td>
<td>0.3</td>
<td>0.4</td>
</tr>
<tr>
<td>No plate + fused</td>
<td>0.3</td>
<td>0.5</td>
</tr>
<tr>
<td>No plate + pseudarthrosis</td>
<td>1.4</td>
<td>4.9</td>
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The difference between the patient with no plate and a pseudarthrosis and all the other groups is statistically significant for both collapse and kyphosis.
Increased Fusion Rates With Cervical Plating for Three-Level Anterior Cervical Discectomy and Fusion

• Wang, et al SPINE Volume 26, Number 6, pp 643–647
• The average amount of kyphotic deformity of the fused segment was 0.4° (range, 0–2°) for patients with cervical plates,
• The actual significance of preserving the normal contour of the cervical spine is not known. A kyphotic posture of the cervical spine may lead to the development of adjacent segment degeneration. However, a longer follow-up period is needed to confirm a relationship.
• **A,** Immediate postoperative radiograph of a two-level anterior cervical discectomy and fusion without plate fixation, showing initial preservation of anatomic alignment.

**B,** The same patient after the development of a pseudarthrosis at the lower fusion level. Note the collapse of the graft and the resultant kyphotic deformity at the level of the nonunion.

**C,** Radiograph taken after posterior fusion, demonstrating healing of the pseudarthrosis. Note the residual collapse and kyphosis even after successful fusion.

Induction of Lordosis

6°

12°
Room to Improve

- Retrospective
- Relatively short follow up
- CT scan to better assess fusion
Conclusions

1. Multiple level ACDF does not require autograft if supplemented with instrumentation
2. End plates do not need to be removed
3. It is our opinion that the recreation of physiologic sagittal plane alignment will lessen adjacent level degeneration