

# Innovative Techniques in Minimally Invasive Cervical Spine Surgery

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*San Francisco California*



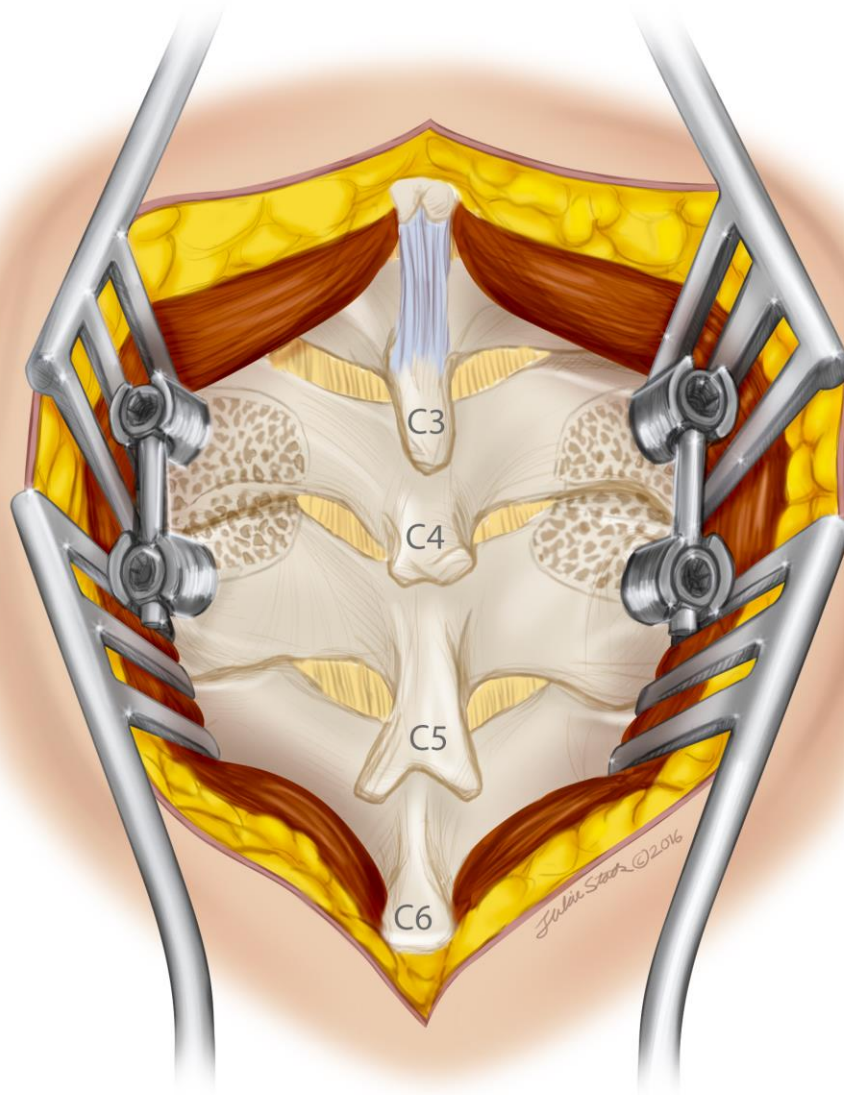
# PCF – Posterior Cervical Fusion

PCF not currently an ambulatory care procedure

Pearl diver – only 14% of all cervical fusions are done from a posterior approach.

- many reasons...
- Increased perioperative morbidity
- Chronic myofascial pain
- Length of stay is 4.5 days

# Posterior Cervical Fusion



# PCF – Posterior Cervical Fusion

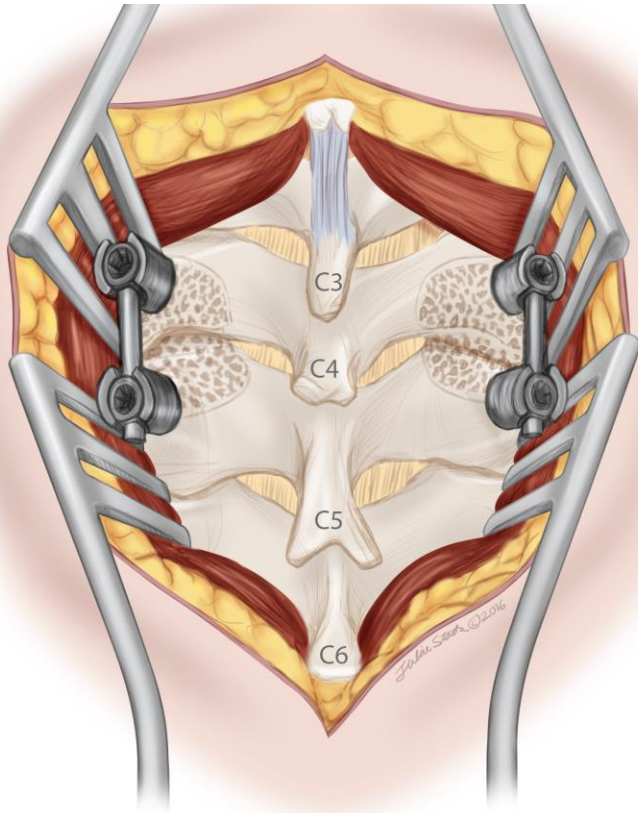
Choy et al 2016

data on 3401 patients with posterior fusion

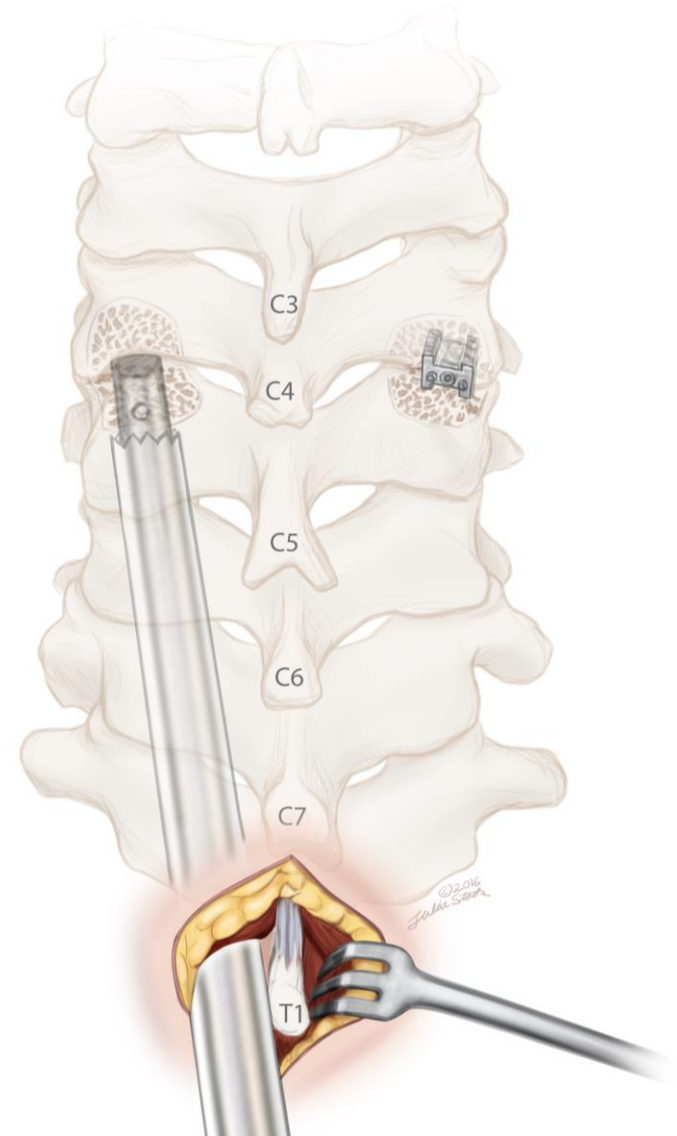
- 30 day readmission rate 6.2%
- of which, 17% infection
- reoperation rate 4.9%

# Tissue-Sparing Technique

Standard open approach for posterior fusion with lateral mass fixation.



Tissue-sparing posterior approach using intervertebral cages in the facet joints



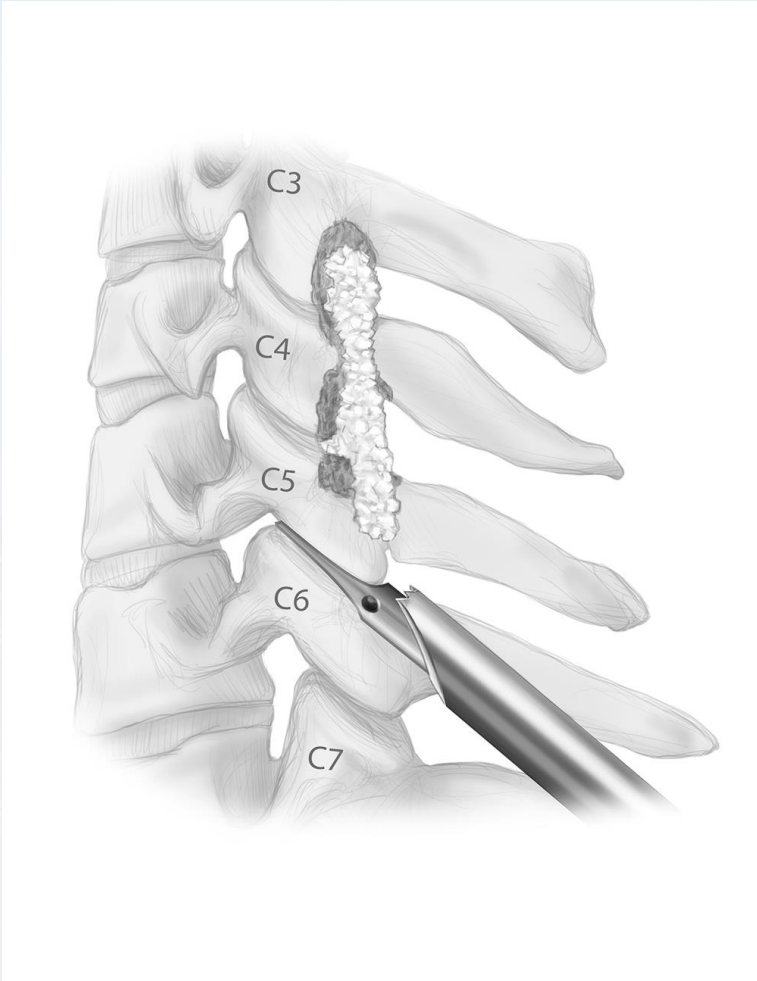
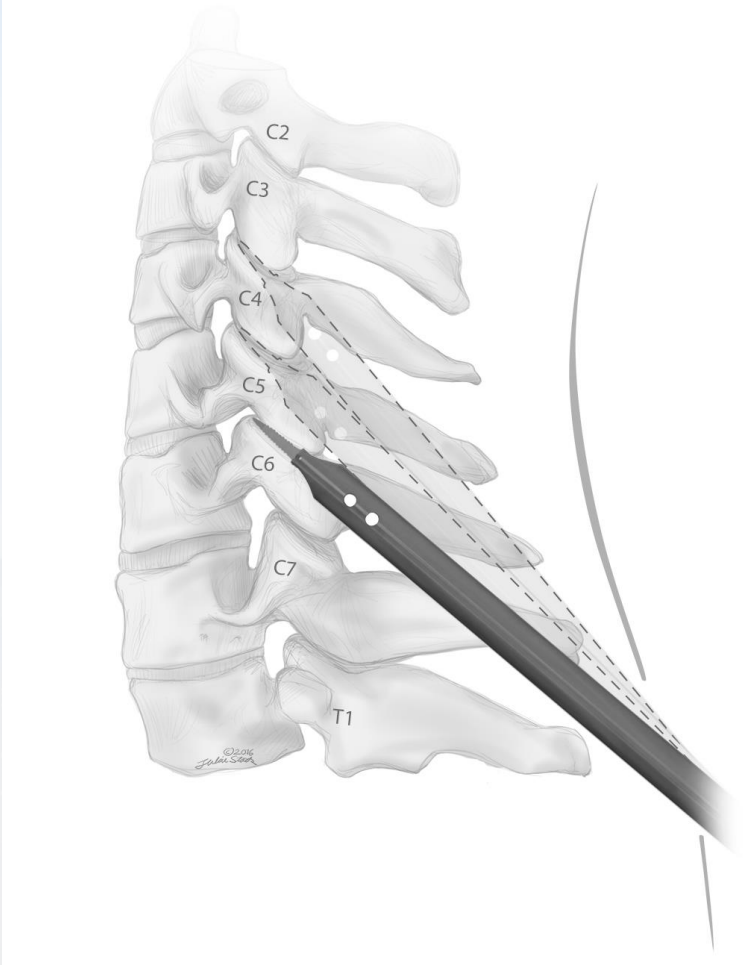
# Minimally Disruptive



Traditional Open Posterior Cervical Fusion



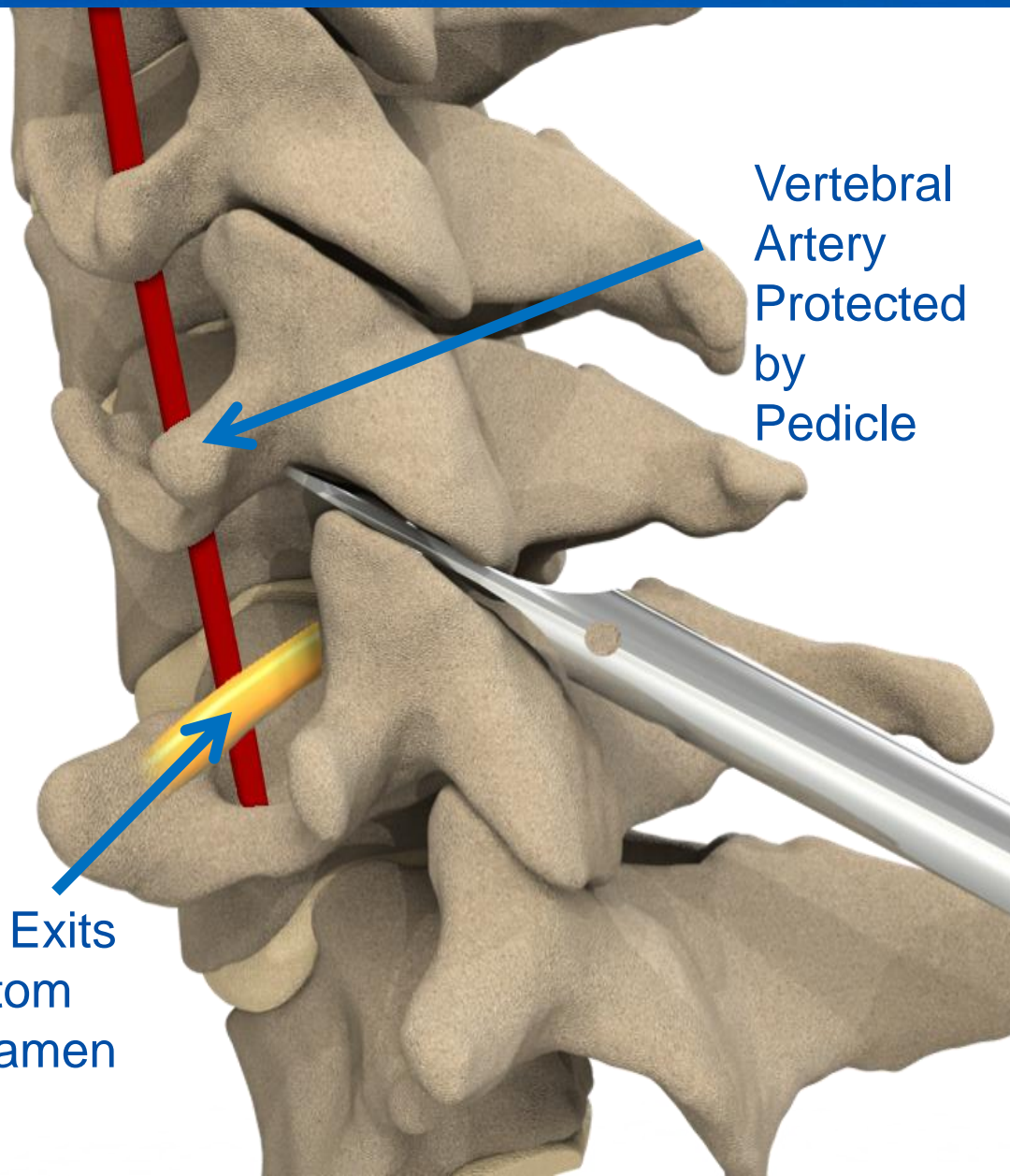
# Minimal Access PCF



# Safety



Medial to Lateral Technique  
Guides Away from Canal



Vertebral  
Artery  
Protected  
by  
Pedicle

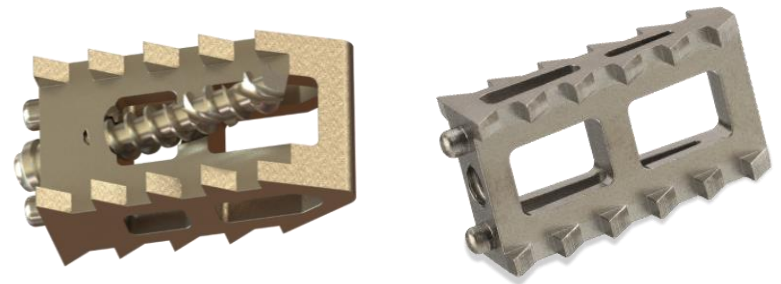
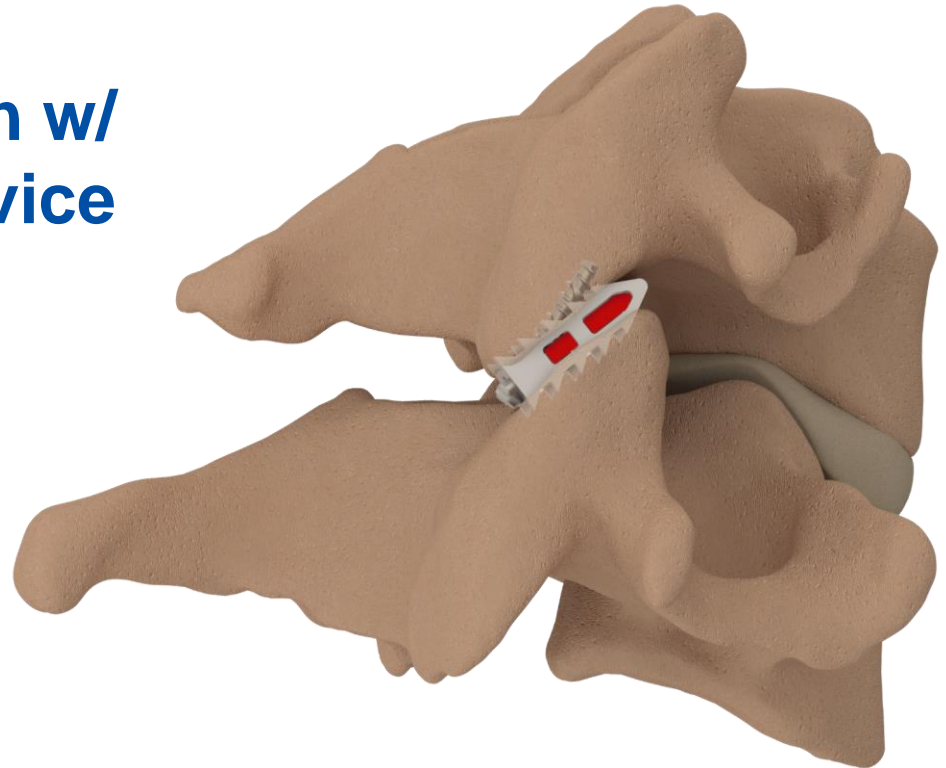
Nerve Exits  
in Bottom  
of Foramen

# Technology Overview

## Posterior Cervical Fusion w/ Intervertebral Fusion Device & Bone Graft

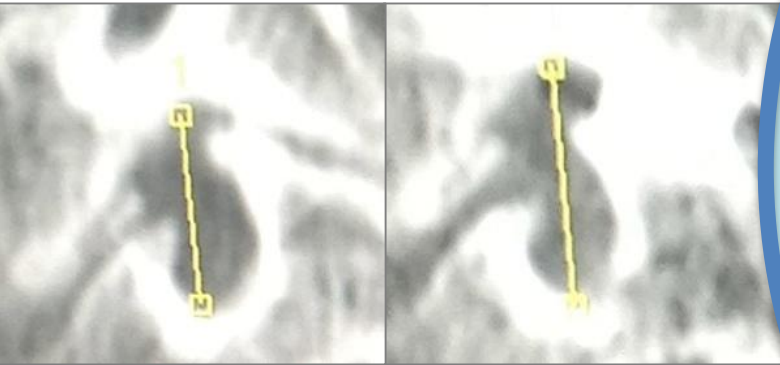
### Unique Approach to Cervical Fusion

- Tissue Sparing Technique
- Indirect Decompression
- Stabilization & Fusion



# Mechanism of Action

## Indirect Decompression

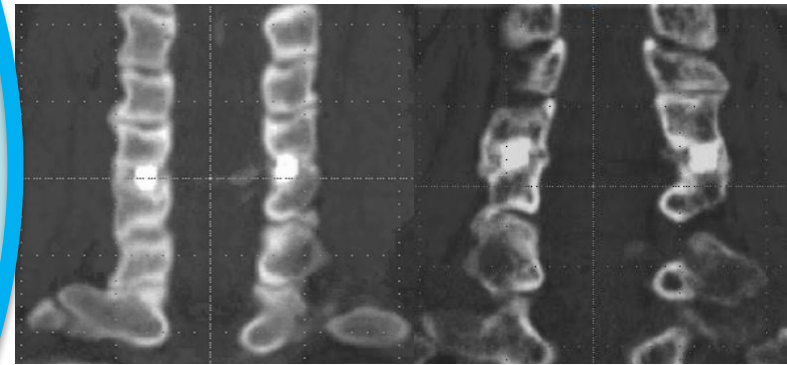


**10.0mm  
Pre-Op**

**13.2mm  
Post-Op**



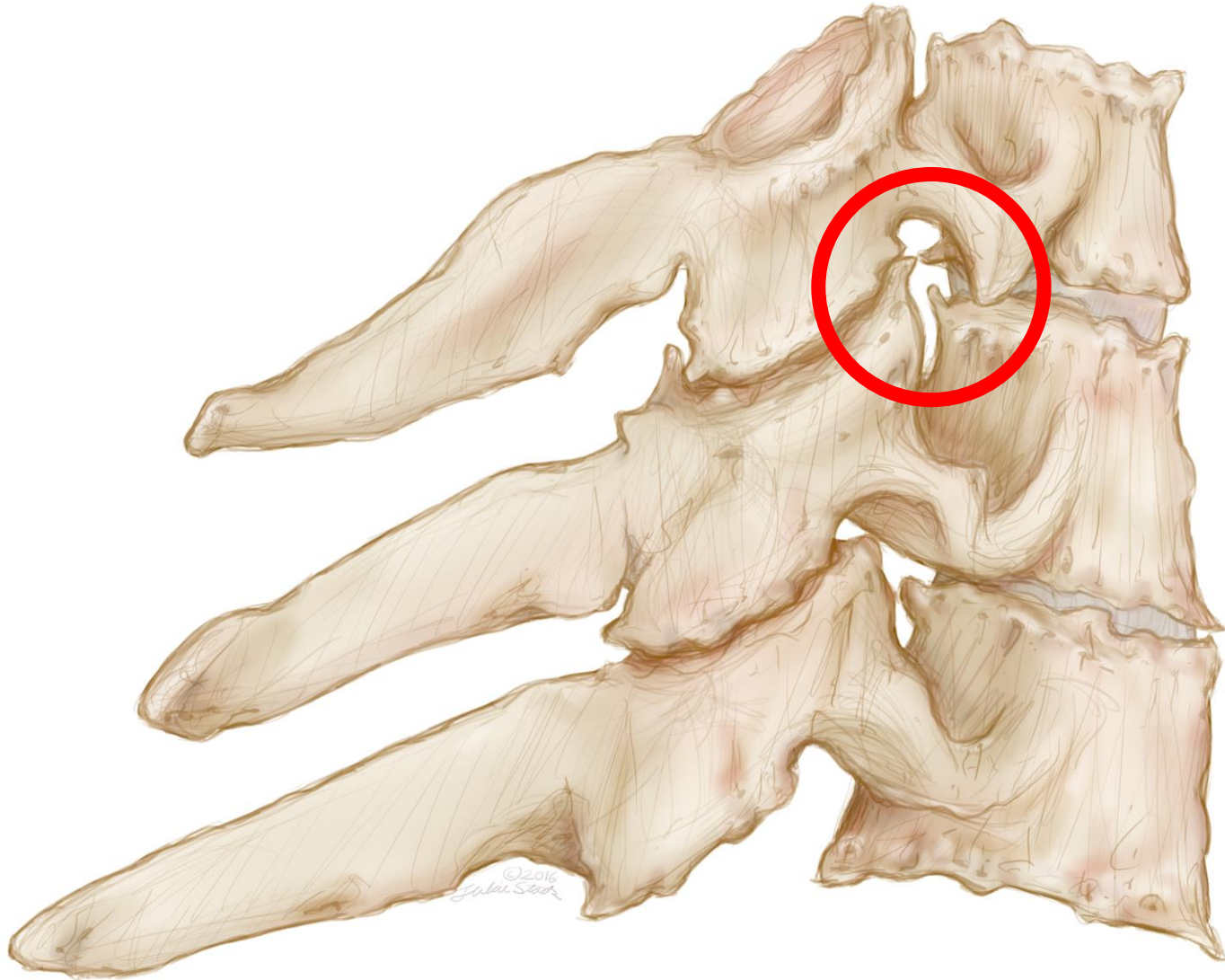
## Rigid Fixation



**93% Fusion Rate @ 1 Year**  
**98% Fusion Rate @ 2 Years**

Implants packed with bone to promote fusion

# Foraminal Stenosis & Osteophytes



# Cervical intervertebral disc space narrowing & size of intervertebral foramina.



Lu J, Ebraheim NA, Huntoon M, Haman SP  
Clin Orthop Relat Res (370):259–264, 2000

Reduction in Intervertebral Disc Space	Reduction in Foraminal Area
1 mm	20%–30%
2 mm	30%–40%
3 mm	35%–45%

*“1-, 2-, and 3-mm narrowing of the intervertebral disc space corresponded to foraminal area reductions of 20%–30%, 30%–40%, and 35%–45%, respectively.”*

“Modest distraction of the facets... ..can increase foraminal height and area and therefore indirectly decompress the exiting nerve roots.”

Effect of machined interfacet allograft spacers on cervical foraminal height and area - Laboratory investigation

*Lee A. Tan, M.D.,<sup>1</sup> Carter S. Gerard, M.D.,<sup>1</sup> Paul A. Anderson, M.D.,<sup>2</sup> and Vincent C. Traynelis, M.D.<sup>1</sup> <sup>1</sup> Department of Neurosurgery, Rush University Medical Center, Chicago, Illinois; and <sup>2</sup> Department of Orthopedics & Rehabilitation, University of Wisconsin, Madison, Wisconsin*

# Fusion

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**93% Bridging Bone at 1 Year**  
**98% Bridging Bone at 2 Years**



# Clinical Outcomes



## ARTICLE

### **Percutaneous posterior cervical fusion with the DTRAX Facet System for single-level radiculopathy: results in 60 patients** Clinical article

**McCormack BM1, Bundoc RC, Ver MR, Ignacio JM, Berven SH, Eyster EF.**

Clinical Faculty, Department of Neurosurgery, University of California San Francisco Medical Center, San Francisco, CA, USA

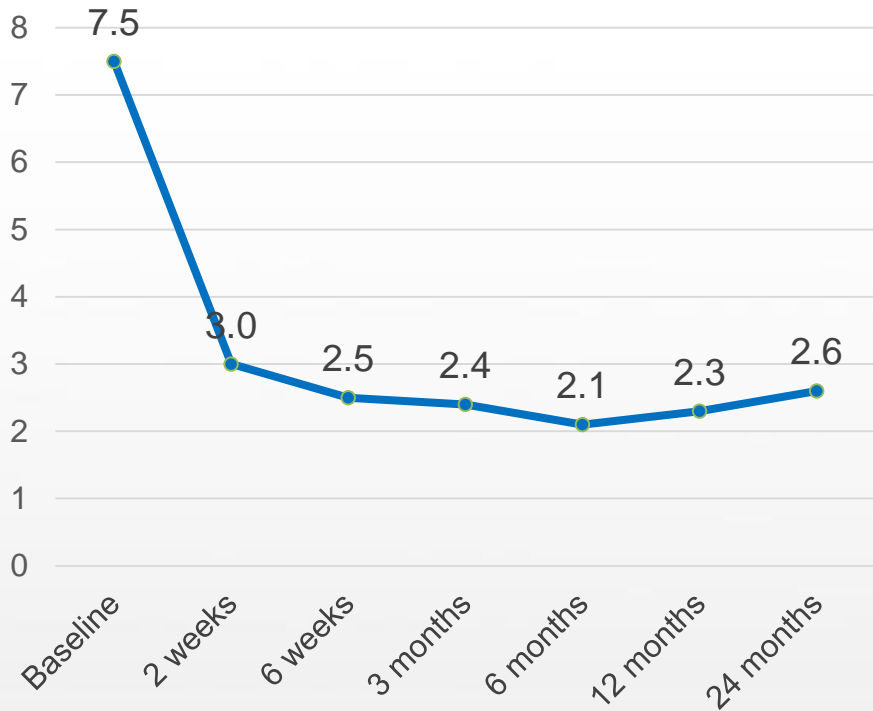
J Neurosurg Spine. 2013 Mar;18(3):245-54. doi: 10.3171/2012.12.SPINE12477. 2013 Jan 18.

# Symptom Improvement

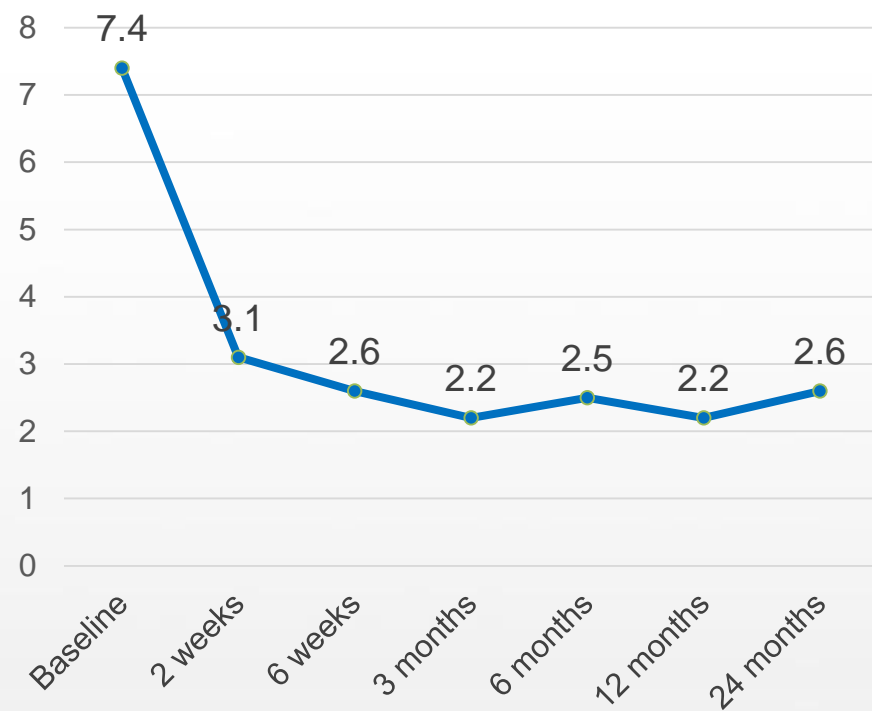
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## Significant Improvement in VAS: Neck & Arm

Visual Analogue Scale (VAS): Neck



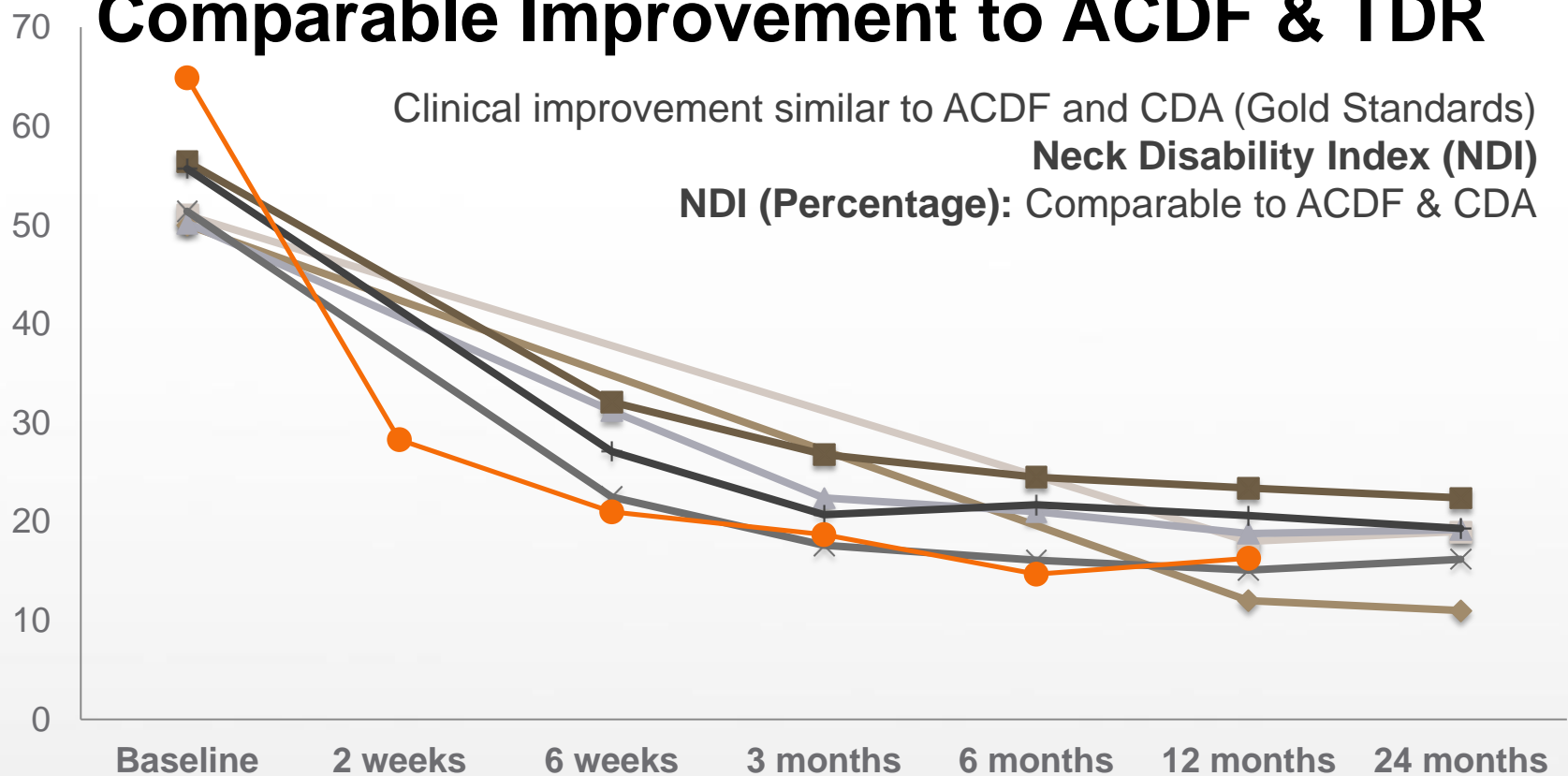
Visual Analogue Scale (VAS): Arm



# Improvement in Function

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## Comparable Improvement to ACDF & TDR



—■— Cheng 2008 ACDF

—◆— Cheng 2008 CDA

—▲— Heller 2009 ACDF

—×— Heller 2009 CDA

—■— Mummaneni 2007 ACDF

—+— Mummaneni 2007 CDA

# Tissue-Sparing Technique



# Use Cases

- **Stand alone for radiculopathy**
- **Posterior fixation for circumferential fusions**
- **Symptomatic non-union after ACDF**
- **Adjacent level disease**
- **Laminectomy & Fusion**

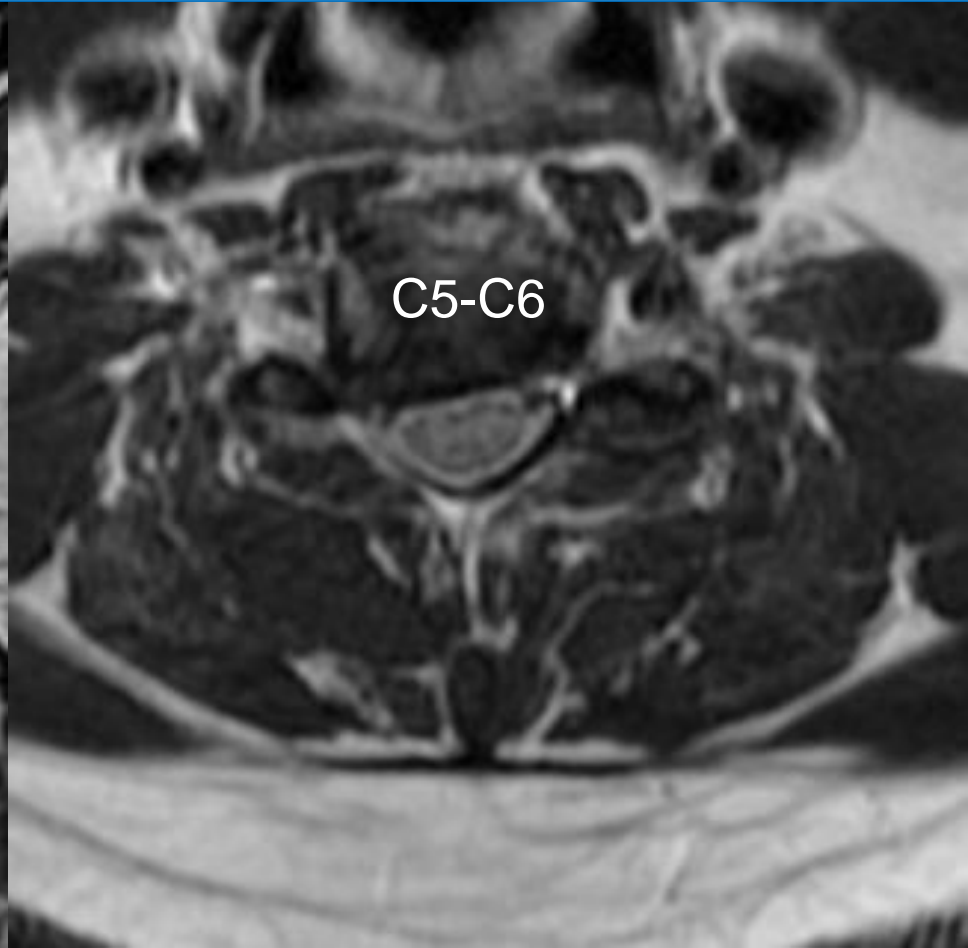
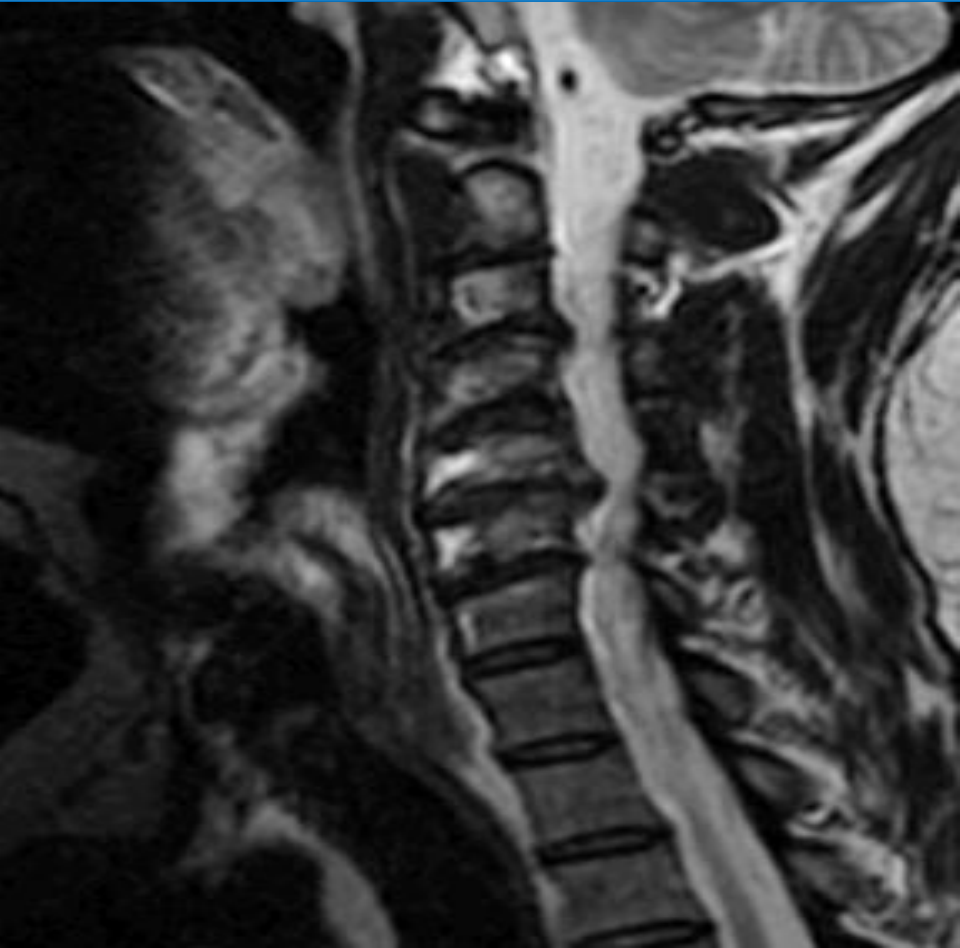
# Patient Selection: Example 1

49 y.o. Male, Radiating Arm Pain, Radio Announcer



# Patient Selection: Example 1

- Positive Spurling Test on Physical Exam
- Positive EMG for C6 radiculopathy.
- MRI showed severe foraminal narrowing from disc-osteophyte complex at C5-6.



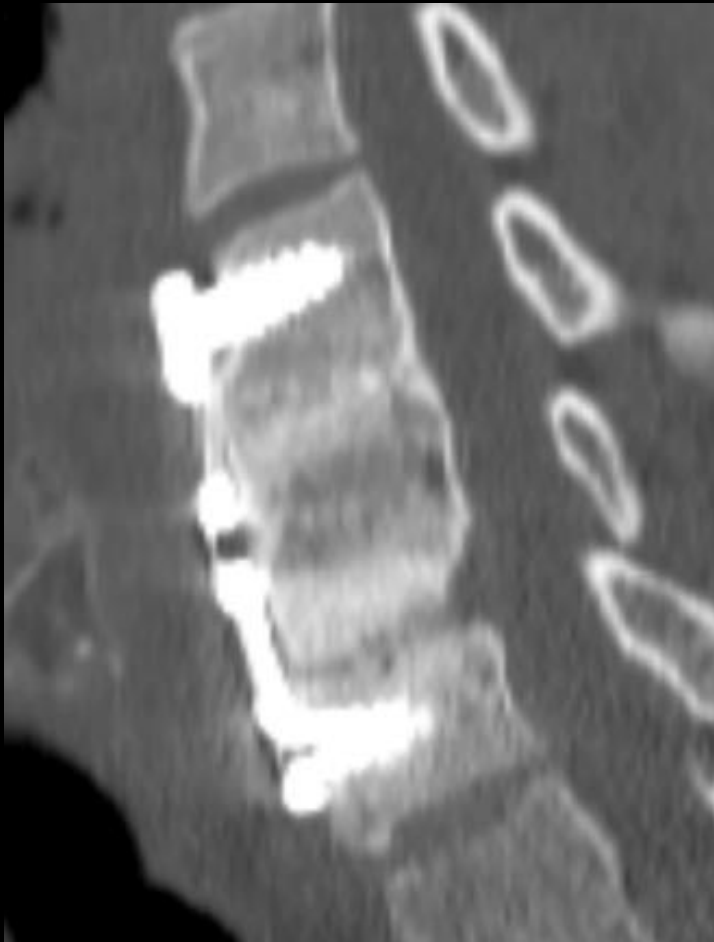
# Patient Selection: Example 1

- Cervical Fusion with DTRAX performed at C5-C6
- 2 week follow up – relief of radicular symptoms.
- At 6 month follow up – no pain medication, pain reported 0-1



# Patient Selection: Example 2

- 35 year old male with 50% numbness, 50% pain
- 2-level ACDF C5-C7 in 2013
- Progressive return of symptoms after 8 months.



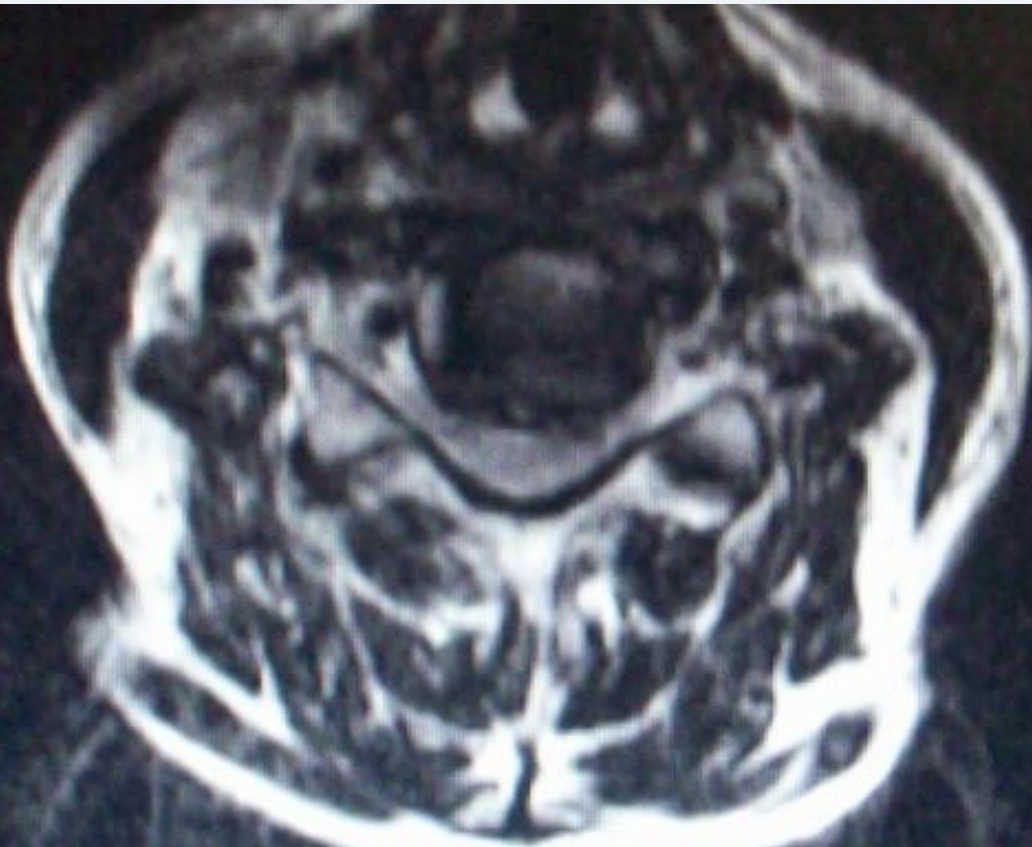
# Patient Selection: Example 2

- Immediate resolution of symptoms and return to work.



# Patient Selection: Example 3

- 58 y.o. female neck and arm pain
- osteoporosis
- Smoker: ½ pack per day (down from 2 ppd)
- Prior non union s/p lumbar fusion



# Patient Selection: Example 3



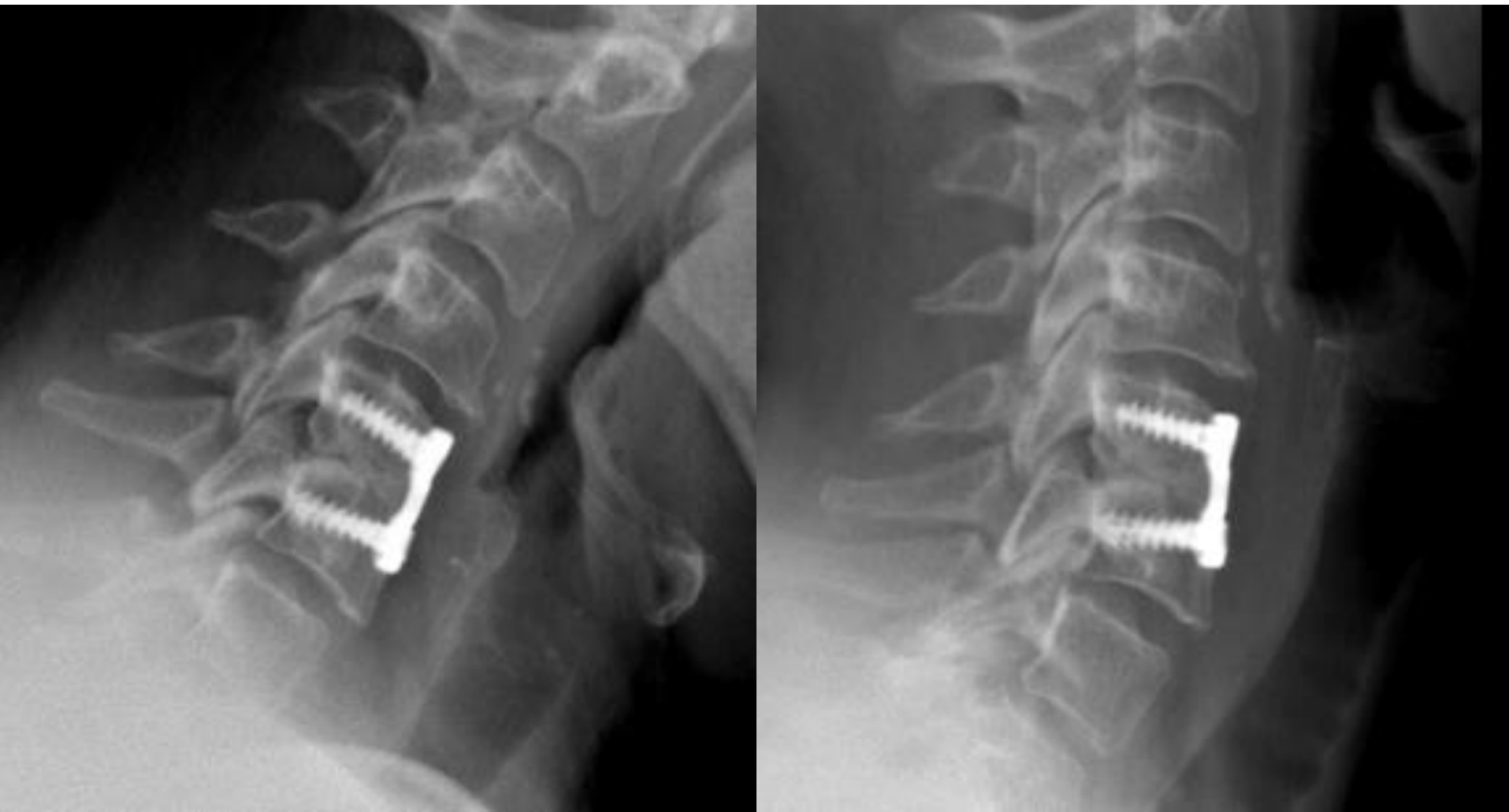
# Adjacent Level Example 4

- 46 yo female 11 years s/p successful C5-6 ACDF
- Neck and radiating right shoulder and arm pain
- Failed 6 months of conservative care



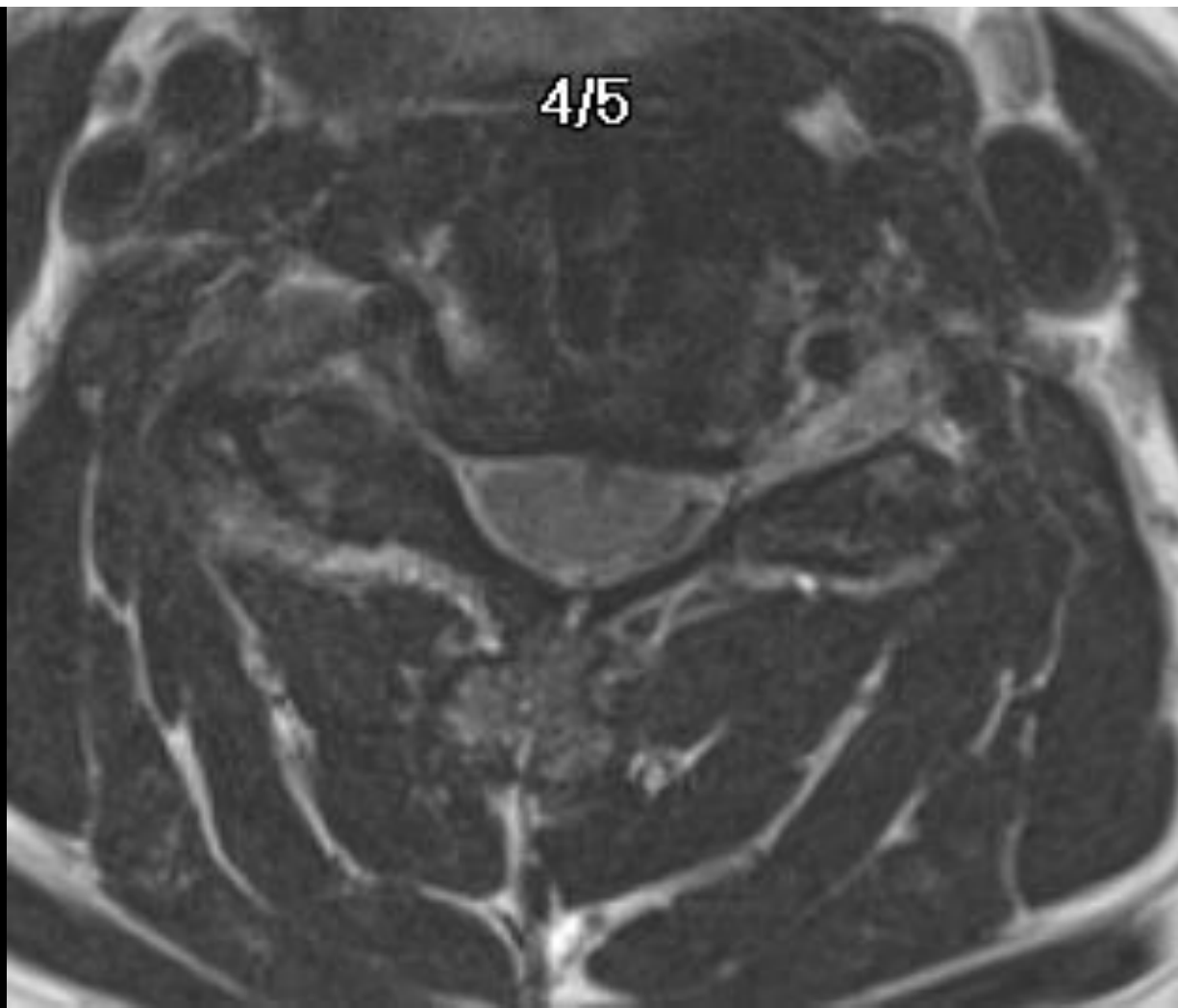
# Adjacent Level Example 4

- No significant instability with flexion/extension



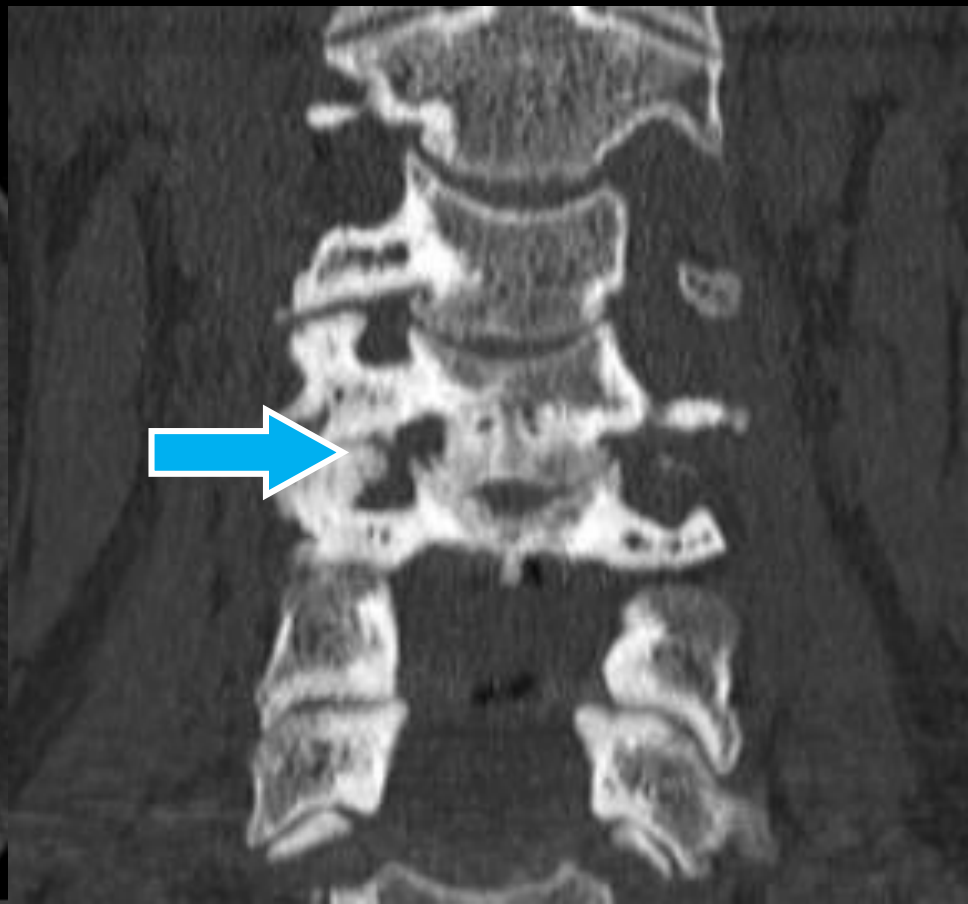
# Adjacent Level Example 4

- MRI shows right C4-5 foraminal stenosis



# Adjacent Level Example 4

- CT shows C4-5 right facet arthritis & foraminal stenosis



# Adjacent Level Example 4

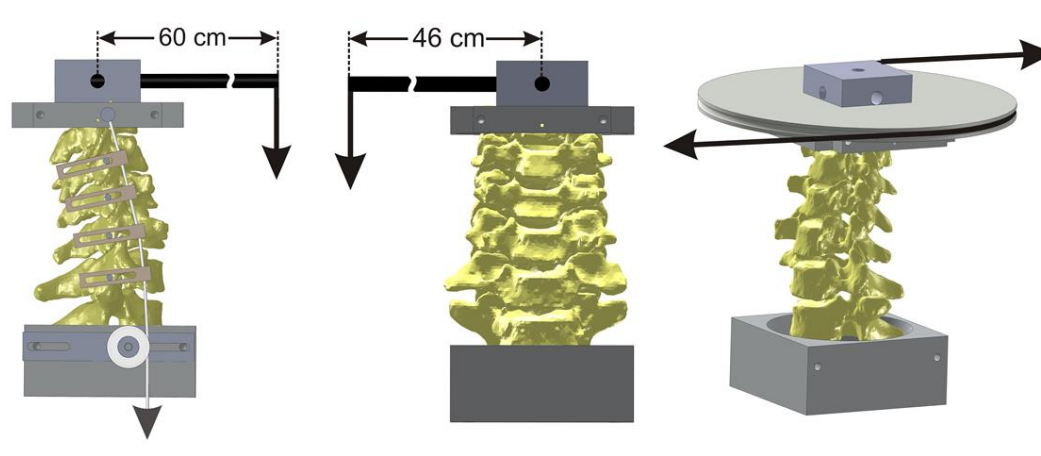
- Post-op AP, lateral X-rays



# Biomechanical Stability vs ACDF

## Original Research

Bilateral posterior cervical cages provide biomechanical stability: assessment of stand-alone single-level fusion and as supplemental fixation for anterior cervical discectomy and fusion.



*Leonard I. Voronov, Krzysztof B. Siemionow, Robert M. Havey, Gerard Carandang, Frank M. Phillips, Avinash G. Patwardhan. Medical Devices: Evidence and Research, June 2016, 10.2147/MDER.S109588.*

# Plated ACDF vs PCF with Cage

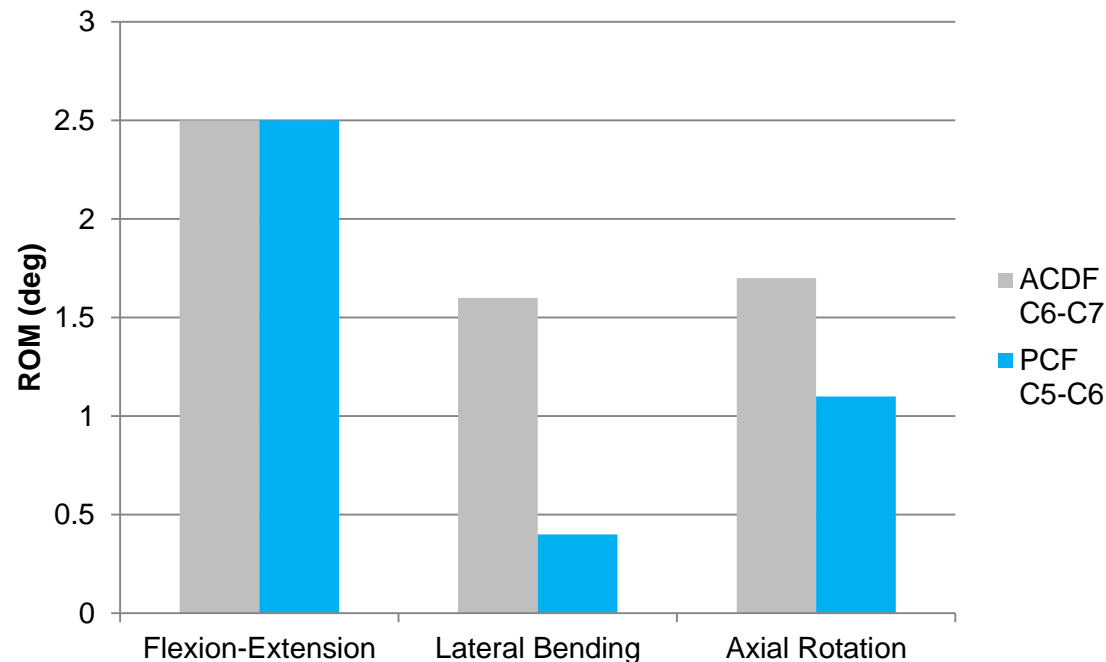
“The biomechanical effectiveness of bilateral posterior cages in limiting cervical segmental motion is **comparable to single-level plated ACDF.**”

ACDF vs PCF with Cage

ROM in Degrees (sd)

	ACDF C6-C7	PCF C5-C6	p-value
Flexion-Extension	2.5 (0.8)	2.5 (1.3)	0.911
Lateral Bending	1.6 (0.7)	0.4 (0.3)	0.000
Axial Rotation	1.7 (0.4)	1.1 (1.7)	0.370

ACDF vs PCF with Cage



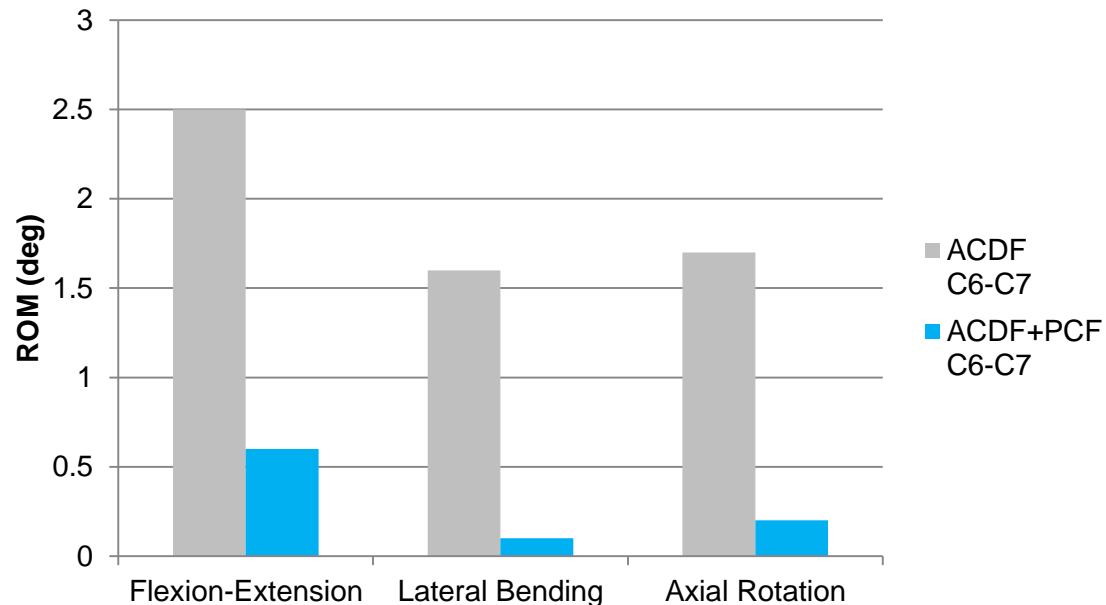
# Plated ACDF vs Plated ACDF + PCF with Cage

Supplementation of single- and multilevel ACDF with posterior cervical cages provided a **significant increase in stability** and therefore may be a potential, minimally disruptive option for supplemental fixation for improving ACDF fusion rates.

ACDF vs ACDF + PCF w/ Cage (1-Level)

	ROM in Degrees (sd)		
	ACDF C6-C7	ACDF + PCF C6-C7	p-value
Flexion-Extension	2.5 (0.8)	0.6 (0.3)	0.002
Lateral Bending	1.6 (0.7)	0.1 (0.4)	0.005
Axial Rotation	1.7 (0.4)	0.2 (0.3)	0.000

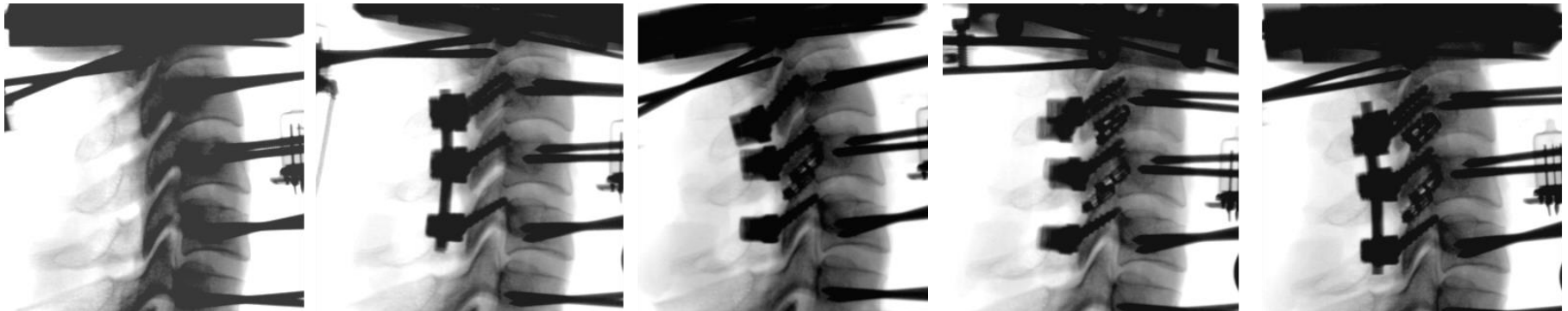
ACDF vs ACDF + PCF with Cage (1-Level)



# Biomechanical Stability vs LMS

Original Research

Biomechanical evaluation of DTRAX® posterior cervical cage stabilization with and without lateral mass fixation



*Leonard I. Voronov, Krzysztof B. Siemionow, Robert M. Havey, Gerard Carandang, Frank M. Phillips, Avinash G. Patwardhan. Medical Devices: Evidence and Research, August 2016, 10.2147/MDER.S111031*

# LMS vs PCF with Cage (1-Level)

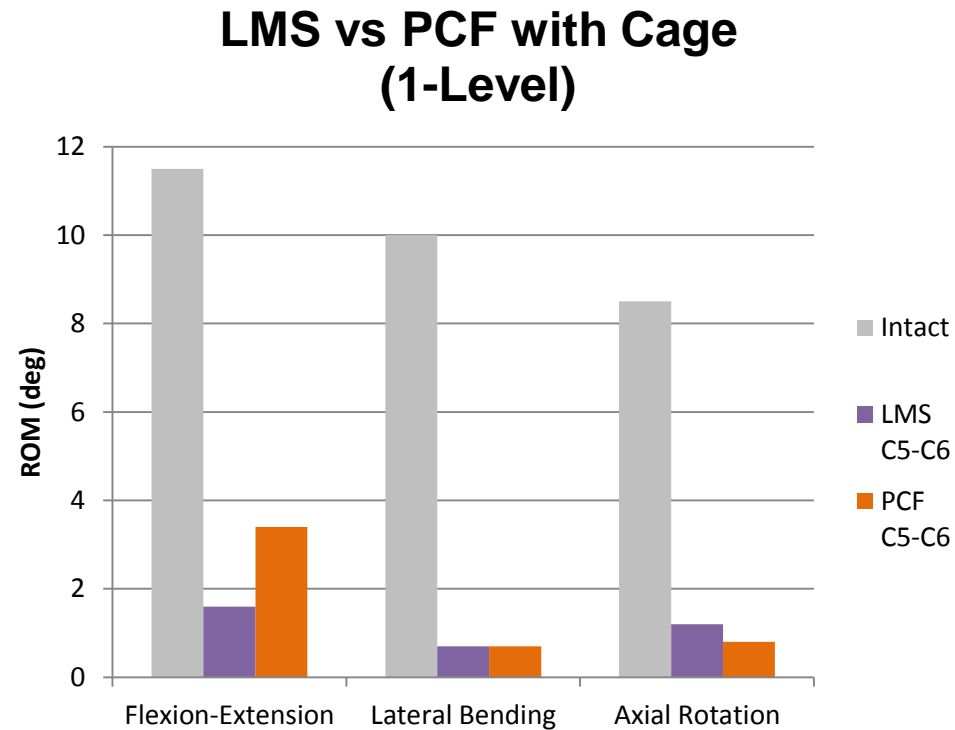
LMS allowed less motion in flexion/extension than PCF with Cage ( $p < 0.05$ )

LMS and PCF with Cage are comparable in lateral bending ( $p > 0.05$ )

PCF with Cage allowed less motion in axial rotation than LMS ( $p < 0.05$ )

LMS vs PCF with Cage (1-Level)				
ROM in Degrees (sd)				
	Intact	LMS C5-C6	PCF C5-C6	p-value
Flexion- Extension	11.5 (3.5)	1.6 (0.7)	3.4 (1.8)†	0.032
Lateral Bending	10.0 (2.1)	0.7 (0.3)	0.7 (0.5)†	1.000
Axial Rotation	8.5 (2.1)	1.2 (0.4)	0.8 (0.5)†	0.020

† Significance from intact at  $p < 0.05$



# Questions?



*Thank You*

