

Surgical Treatment of Thoracolumbar Fractures



Aims / Objectives

- Fixation
 - Front, Back, Both
 - Does it matter?
- Describe the aims of surgical fixation in the spine
- Explain the rationale and mechanics of different approaches
- Summarise evidence of outcome
(not covering osteoporotic fractures)

AO Principles

- Anatomic Reduction
- Stable Internal Fixation
- Atraumatic Technique
- Early Active Mobilisation

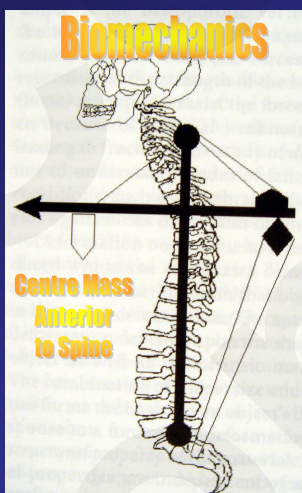
Clinical Instability

The loss of the ability of the spine under physiological loads to maintain its pattern of displacement so that there is no initial or additional neurological deficit, no major deformity and no incapacitating pain



Biomechanics

Anterior
Column
Strut



Posterior
Column
Tension
Band

Experimental Study of Thoracolumbar Burst Fractures

A Radiographic and Biomechanical Analysis of Anterior and Posterior Instrumentation Systems

Yasuhiro Shono, MD,* Paul C. McAfee, MD,† and Bryan W. Cunningham, BS‡

Anterior > Posterior

Biomechanical Evaluation of the Stability of Thoracolumbar Burst Fractures

Kenneth S. James, Karl H. Wenger, John D. Schlegel, and Harold K. Dunn

**Importance of Intact
Posterior Column**

Goals for Surgery

- Realign
- Stabilize
- Decompress
- Prevent Late Pain / Deformity

Neurology

clearance of canal compromise

Biomechanics

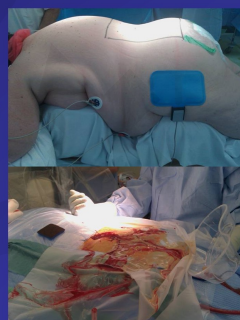
Maintain Function

Prevention of neurological deficit



The Personalities

- Personality of the patient
 - Age
 - Comorbidity
 - Bone stock
 - Energy of injury / other injuries
 - Time since injury



The Personalities

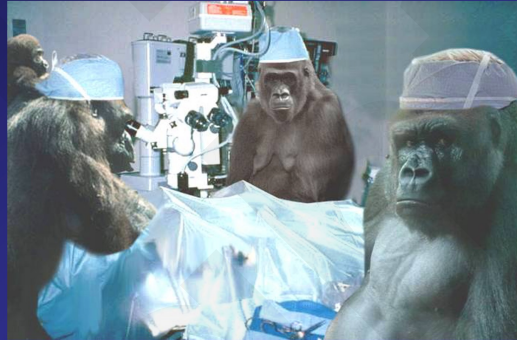
- Personality of the fracture
 - Canal compromise
 - Neurologic compromise
 - Kyphosis
 - Anterior collapse
 - Progression



Munted

The Personalities

- Personality of the surgeon



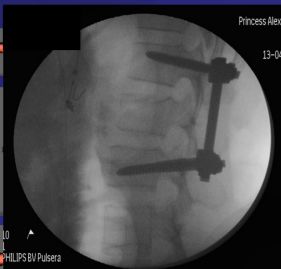
Anterior or posterior surgery

Posterior surgery is mainstay

posterior approach
technically easy
low morbidity

short segment pedicle fixation
reduction of deformity & canal compromise

posterior approach
Important for dislocation / realign



Dural laceration occurring with burst fractures and associated laminar fractures

EP Cammisa, FJ Eismont and BA Green
J Bone Joint Surg Am. 1989;71:1044-1052.

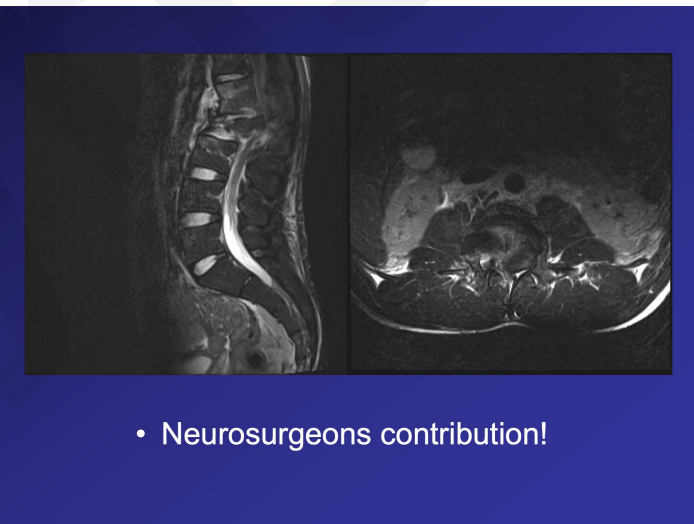
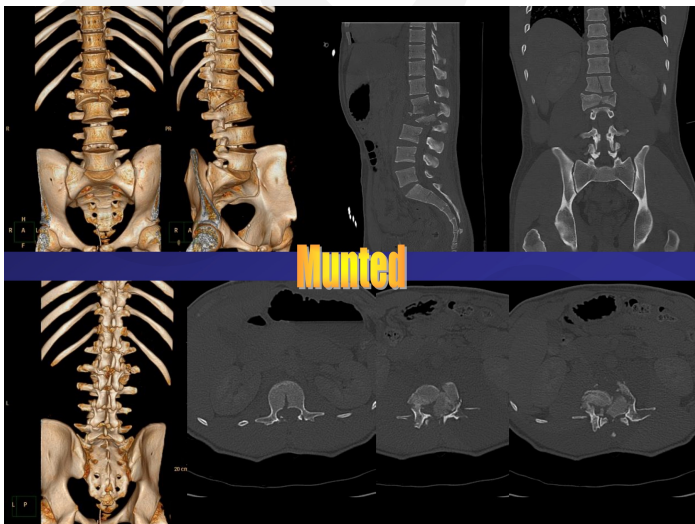
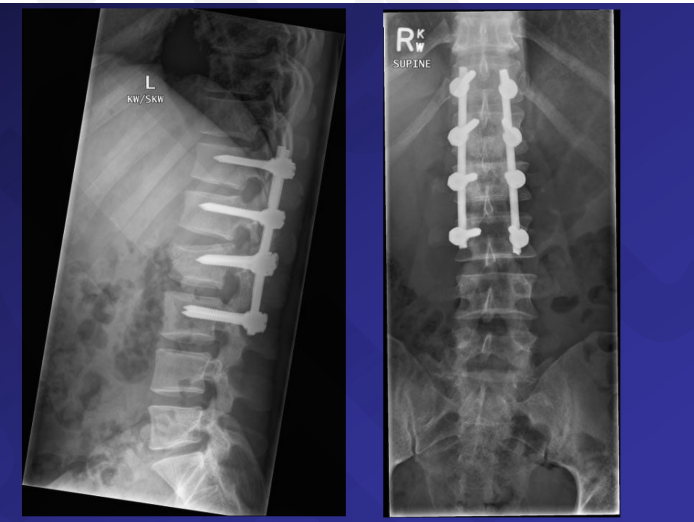
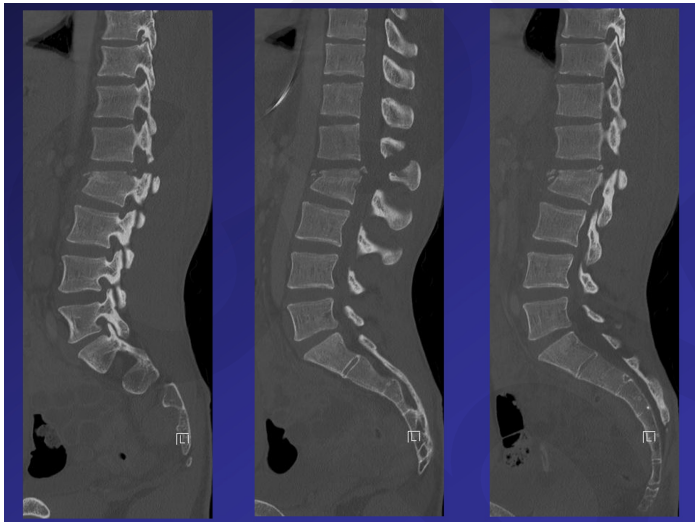
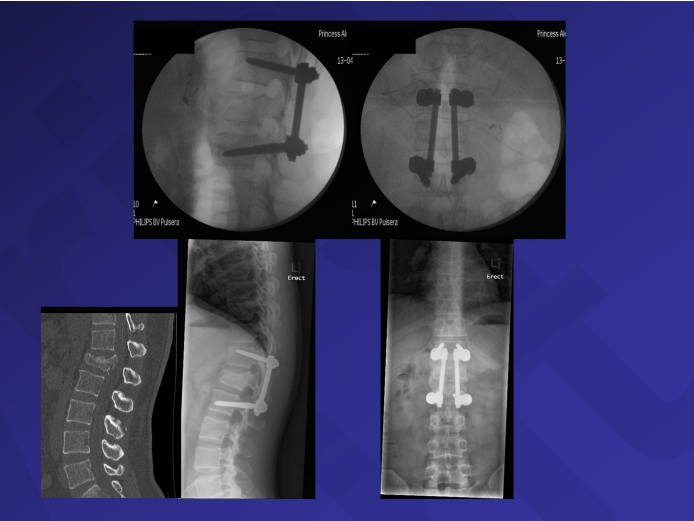
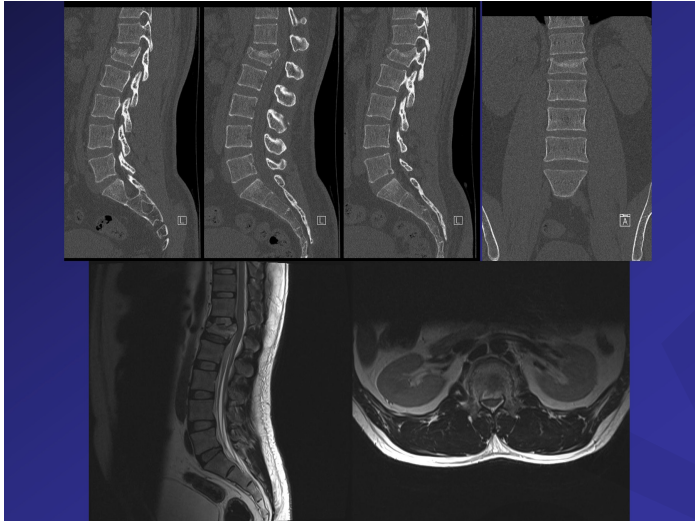
11/30 Dural Lacs

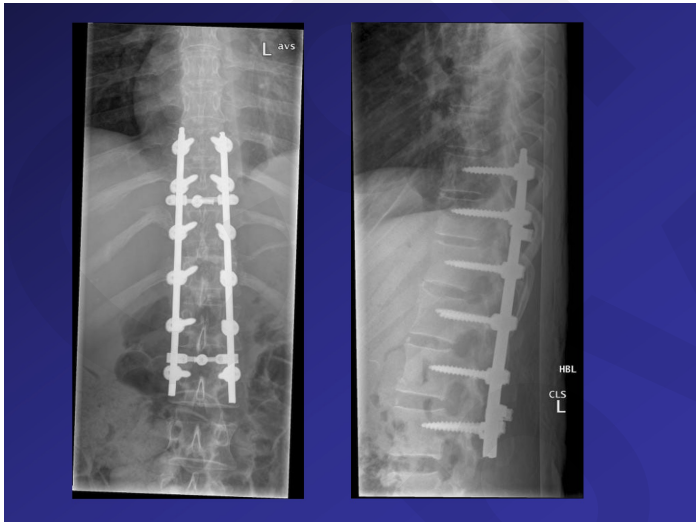
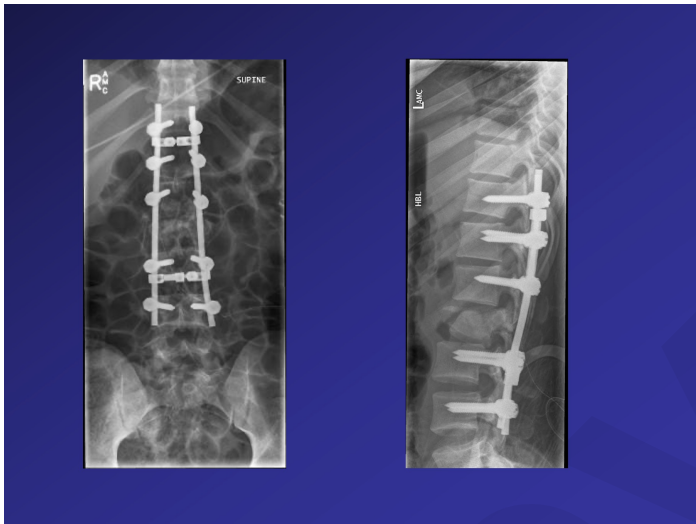
- Exception – facet fracture dislocations
 - i.e. remove posterior compressive fragments from the back

+ Posterior Fix + Decompression =

and destabilised!







Anterior or posterior surgery

Anterior surgery for significant anterior comminution

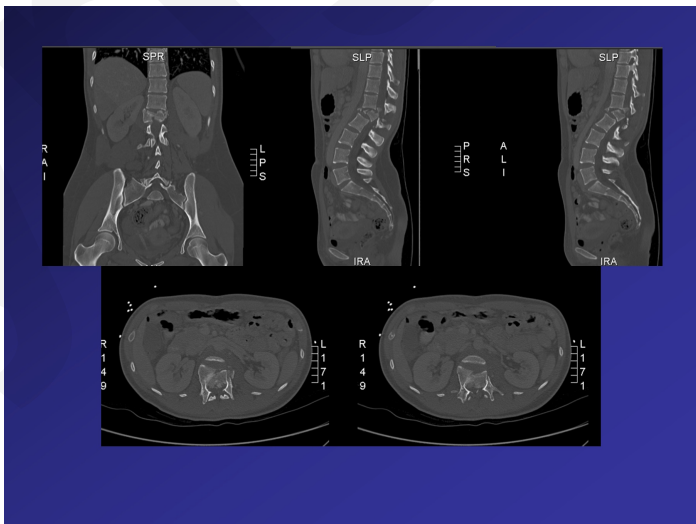
Corpectomy direct cord decompression vs. posterior indirect

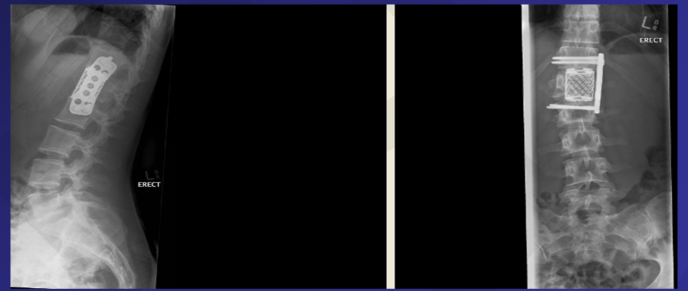
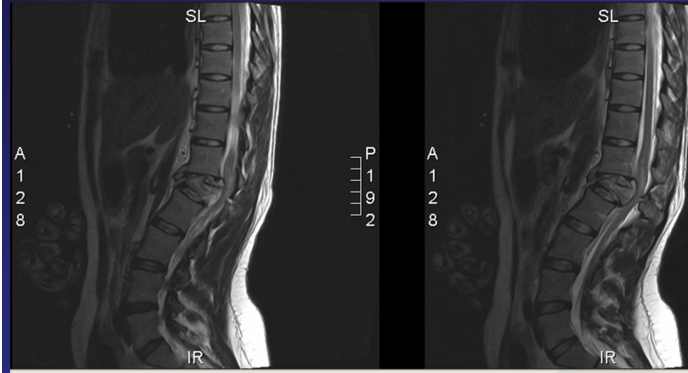
correction of deformity

stabilization of instability

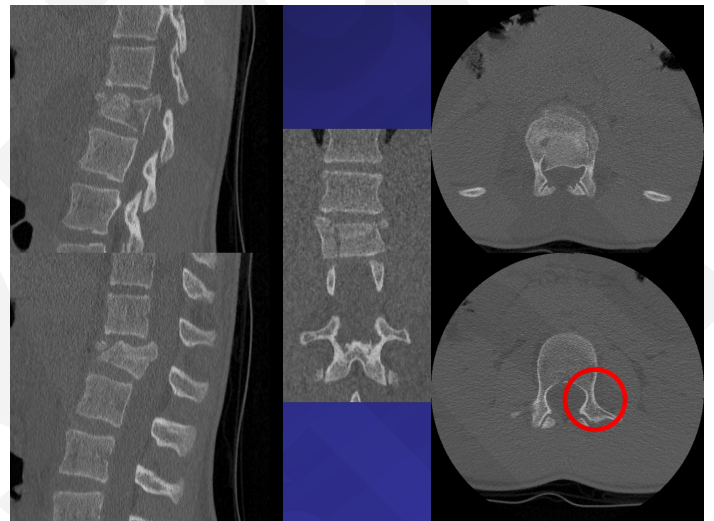
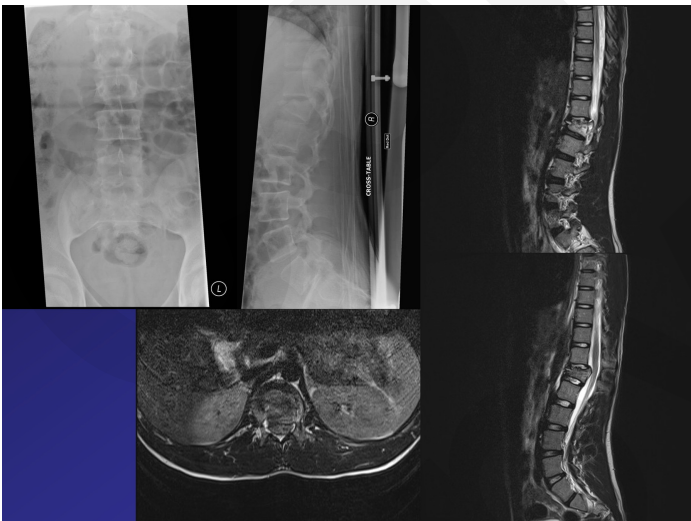
posterior fixation cannot provide anterior column support

Cons: Infrequent Specialist Training

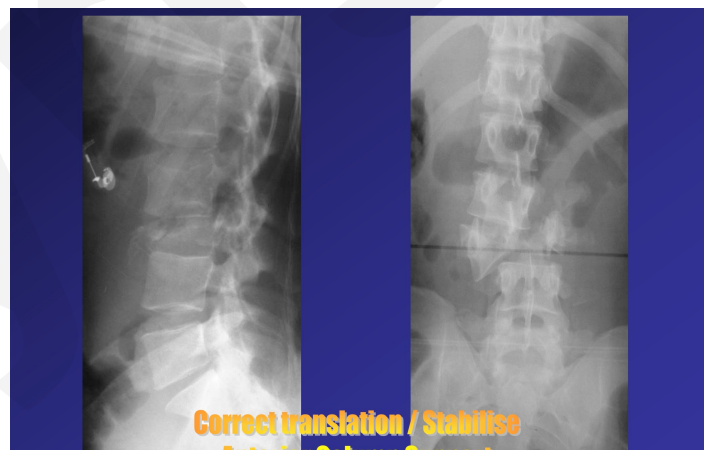




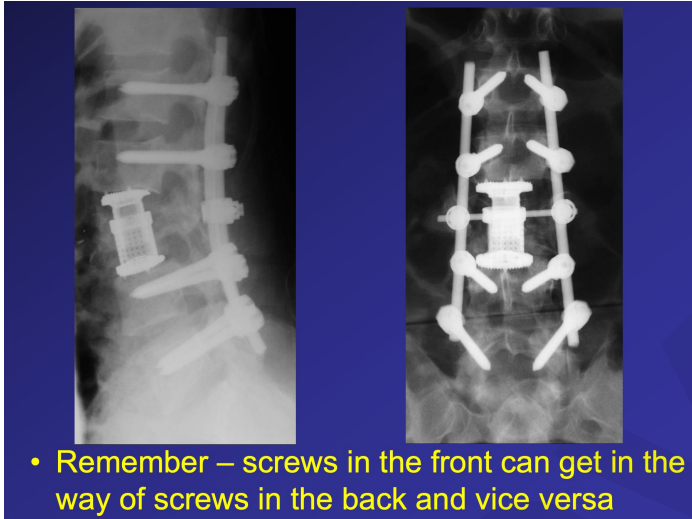
Bicortical screws



Bicortical screws



**Correct translation / Stabilise
Anterior Column Support
Decompress Neural Elements**



- Posterior
 - Realign
 - Restore Tension Band
 - Ligamentotaxis
 - Indirect Canal Decompression
- Anterior
 - Column support
 - Decompression
- Posterior Qs
 - Short or long
 - +/- Fracture screws
 - +/- Cross Links
 - Decompression
 - Fuse
- Anterior Qs
 - Structural Allograft
 - Cage Autograft
 - Expandable Cage
 - Rods or Plate

Aims / Objectives

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- Summarise evidence of outcome

**Realign
Stabilize
Decompress
Prevent Late Pain / Deformity**

Depends on #

Realign, stabilise, decompress

Pick your paper
AO A3 #3 P...

- ## Conclusion
- Fix Early (if you are going to fix!)
 - Realign Posteriorly
 - Make sure the pedicles are big enough to screw
 - Indirect Decompression
 - Do Anterior Surgery Electively



Recent Literature

Load-sharing classification :Cormack, Gaines et al spine 1994) **28 pts**

COMMINUTION	APPOSITION	KYPHOSIS
 1. Little < 30% comminution	 1. Minimal minimal spread	 1. Little < 4° correction
 2. More 30-60% comminution	 2. Spread < 2mm of < 50%	 2. More 4-9° correction
 3. Gross > 60% comminution on sagittal CT	 3. Wide > 2mm of > 50% on axial CT	 3. Most > 9° correction on lateral x-ray - POST OP

score from 3 to 9

≤ 6 = posterior surgery

> 6 = anterior surgery

Old Instrumentation Not Externally Validated

lying vs standing
Prediction of correction

SPINE Volume 35, Number 9S, pp S138-S143
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Does Early Fracture Fixation of Thoracolumbar Spine Fractures Decrease Morbidity or Mortality?

Carlo Bellabarba, MD,* Charles Fisher, MD, MPH,† Jens R. Chapman, MD,* Joseph R. Dettori, MPH, PhD,‡ and Daniel C. Norvell, PhD‡

Aim < 72hrs

Spine
LITERATURE REVIEW

Early Versus Late Stabilization of Spine Injuries

A Systematic Review

Leah Y. Carreon, MD, MSc* and John R. Dimar, MD*†

SPINE Volume 36, Number 11, pp E727-E733
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Eur J Orthop Surg Traumatol (2010) 20:199-204
DOI 10.1007/s00590-009-0546-3

ORIGINAL ARTICLE

Effectiveness of pedicle screw-based ligamentotaxis in reducing preoperative kyphosis in thoracolumbar spinal fractures: a retrospective analytical study based on injury surgery interval

Hitesh N. Modi · Kook Jin Chung · Hoi Soo Yoon · Ji Hyo Hwang · Hong Kyun Kim · Kyu Cheol Noh · Yong Wook Park · Jung Han Yoo

Conclusion Posterior-only pedicle screw fixation in unstable thoracolumbar fractures would correct and maintain the postoperative correction in kyphosis, at least at 3-year follow-up, without increasing implant failure if ISI is less than 2 weeks. While patients operated after 2 weeks of injury would require additional anterior procedure.

Original Article | DOI 10.3349/ymj.2008.53.4.546
pISSN 0537-5986, eISSN 1976-2807 | Yonsei Med J 53(4): 546-554, 2009 | YMJ

Comparison of Surgical Outcomes in Thoracolumbar Fractures Operated with Posterior Constructs Having Varying Fixation Length with Selective Anterior Fusion

Hak Sun Kim, Seung Yup Lee, Ankur Nanda, Ju Young Kim, Jin Oh Park, Seong Hwan Moon, Hwan Mo Lee, Ho Joong Kim, Huan Wei, and Eun Su Moon
Department of Orthopaedic Surgery, Yonsei University College of Medicine, Seoul, Korea

Best Correction at FU

• Fixation randomly decided by surgeon...
• Why 2 above...?

A 28 B 32 C 34

Successful Treatment of Thoracolumbar Fractures With Short-segment Pedicle Instrumentation

Daniel Gelb, MD, Steven Ludwig, MD, Jacqueline E. Karp, BA, Edward H. Chung, MD, Clément Werner, MD, Terrence Kim, MD, and Kornelis Poelstra, MD

Methods: We conducted a retrospective radiographic review of 46 thoracolumbar fractures treated with short-segment posterior instrumentation to determine the rate of correction loss and instrumentation failure in relation to the Load Sharing Classification of Spine Fracture system and the AO Classification of Fractures system. No postoperative bracing was used. Patients with multisystem organ trauma and those with isolated injuries were included.

Results: An average loss of correction of 7.5 degree was observed. Pedicle screw placement into the fractured vertebra seemed to protect against correction loss: 4 of the 7 patients (57%) in the no intermediate fixation group had > 10 degree loss of correction. No relationship was shown between loss of correction and Load Sharing Classification (≤ 6 or ≥ 7 points), loss of correction and AO Classification, or loss of correction and level of injury (thoracolumbar junction vs. lower lumbar).

Conclusions: With modern instrumentation and techniques, short-segment thoracolumbar fracture fixation could be used successfully, despite highly comminuted injuries, without anterior column support or supplemental bracing.

J Spinal Disord Tech • Volume 23, Number 5, July 2010

The Open Orthopaedics Journal, 2010, 4, 7-13

Open Access

Treatment of Unstable Thoracolumbar Burst Fractures by Indirect Reduction and Posterior Stabilization: Short-Segment Versus Long-Segment Stabilization

George Sapkas¹, Konstantinos Kateros², Stamatios A. Papadakis^{3,4}, Emmanouel Brilakis², George Macheras⁵ and Pavlos Katonis⁴

Abstract: In order to compare short-segment stabilization with long-segment stabilization for treating unstable thoracolumbar fractures, we studied fifty patients suffered from unstable thoracolumbar burst fractures. Thirty of them were managed with long-segment posterior transpedicular instrumentation and twenty patients with short-segment stabilization. The mean follow up period was 5.2 years. Pre-operative and post-operative radiological parameters, like the Cobb angle, the kyphotic deformation and the Beck index were evaluated. A statistically significant difference between the two under study groups was noted for the Cobb angle and the kyphotic deformation, while, as far as the Beck index is concerned, no significant difference was noted. In conclusion, either the long-segment or the short-segment stabilization is able for reducing the segmental kyphosis and the vertebral body deformation postoperatively. However, as time goes by, the long-segment stabilization is associated with better results as far as the radiological parameters, the indexes and the patient's satisfaction are concerned.

SPINE Volume 35, Number 3, pp 278-283
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Biomechanical Evaluation of Short-Segment Posterior Instrumentation With and Without Crosslinks in a Human Cadaveric Unstable Thoracolumbar Burst Fracture Model

George M. Wahba, MD,* Nitin Bhatia, MD,* Christopher N. H. Bui, BS,†
Kenneth H. Lee, BS,† and Thay Q. Lee, PhD*†

- Crosslinks, when added to short-segment posterior fixation, improve stiffness in axial rotation, but do not restore baseline stability in this unstable burst fracture model.
- Short-segment posterior instrumentation alone can achieve baseline stability in lateral bending, and crosslinks provide even greater stiffness.
- Short-segment posterior fixation, even with crosslinks, is inadequate in restoring stability in flexion when used to treat a severe anterior and middle column injury. For these severe injuries, anterior reconstruction and/or extension of the posterior construct may be necessary.
- When do I use cross links:
 - Rotationally Unstable Injuries
 - ? Incl. # dislocations in paralysed pts
 - Poor Bone – “Locked plate concept”
 - When in doubt...

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Anterior Decompression and Stabilization with the Kaneda Device for Thoracolumbar Burst Fractures Associated with Neurological Deficits^{††}

BY KIYOSHI KANEDA, M.D.‡, HIROSHI TANEICHI, M.D.‡, KUNIOYOSHI ABUMI, M.D.‡, TOMOYUKI HASHIMOTO, M.D.‡,
SHIGENOBU SATOH, M.D.‡, AND MASANORI FUJII, M.D.‡, SAPPORO, JAPAN

- 150 patients incomplete injuries
- Strut graft plus Kaneda (2 rod construct)
- 142 (95%) improved by 1 grade
- 140 successfully fused
- 56/78 (72%) regained their bladder
- 125/130 returned to work
- Mean 47% to 2% canal compromise on CT

SPINE Volume 34, Number 14, pp 1429-1435
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Anterior-Only Stabilization Using Plating With Bone Structural Autograft Versus Titanium Mesh Cages for Two- or Three-Column Thoracolumbar Burst Fractures

A Prospective Randomized Study

Li-Yang Dai, MD, PhD, Lei-Sheng Jiang, MD, PhD, and Sheng-Dan Jiang, MD, PhD

Key Points

- Sixty-five patients underwent anterior plating for a thoracolumbar burst fracture with a load-sharing score of 7 or more.
- These patients were randomly assigned to fusion with iliac crest autograft or titanium mesh cages with similar distribution of 3-column injuries in each group.
- Solid fusion was documented in all patients in this study, with significant neurologic improvement and no significant correction loss.
- The results showed no significant difference between the 2 treatment groups, nor were significant impacts of 3-column injuries identified.
- The authors recommend the use of anterior-only instrumentation and reconstruction with structural autograft or titanium mesh cages for surgical treatment of thoracolumbar burst fractures with a load-sharing score of ≥ 7 .
- 32 v 33
- Same Instrumentation
- Load Share ≥ 7
- 8 v 9 three column #s
- Randomised
- Unable to blind
- Neuro improved

The Open Orthopaedics Journal, 2010, 4, 93-100

Open Access

Combined Anterior-Posterior Surgery Versus Posterior Surgery for Thoracolumbar Burst Fractures: A Systematic Review of the Literature

Pim P. Oprel*, Wim E. Tuinbreijer, Peter Patka and Dennis den Hartog

- Only 5 observational comparative studies found
- Better Kyphosis and height correction in AP group
 - Probably not clinically important
- AP – higher blood loss, longer ops, longer hospital stay, higher costs and complications
- Bias – worse cases have AP surgery

J Neurosurg Spine 5:117-125, 2006

Comparison of anterolateral and posterior approaches in the management of thoracolumbar burst fractures

PATRICK W. HITCHON, M.D., JAMES TORNER, Ph.D., KURT M. EICHHOLZ, M.D., AND STEPHANIE N. BEELER, B.A.

Departments of Neurosurgery and Preventative Medicine and Environmental Health,
University of Iowa Carver College of Medicine, Iowa City, Iowa

- Retrospective 63 Burst #s
 - 25 post
 - 38 anterolateral
 - Anterior – greater cost
- various techniques

Conclusions: Rigid guidelines for the selection of anterior or posterior approaches are lacking. Evaluation of the authors' results and those of others shows that angular deformity is more successfully corrected and maintained when the anterior approach is used.

Anterior-Only Stabilization of Three-Column Thoracolumbar Injuries

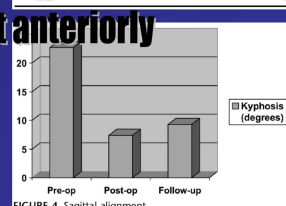
Rick C. Sasso, MD, Natalie M. Best, BS, Thomas M. Reilly, MD, and Robert A. McGuire, Jr., MD

Methods: Between 1992 and 1998, 40 patients underwent anterior decompression and two-segment anteriorly instrumented reconstruction for three-column thoracolumbar fractures. Retrospective review of all available clinical and radiographic data was used to classify these unstable injuries according to the AO classification system, evaluating for neurologic changes, spinal canal compromise, preoperative and postoperative segmental kyphosis, and postoperative segmental kyphosis.

Results: According to the AO classification system, there were 24 (60%) type B1.2, 10 (25%) type C2.1 three-column thoracolumbar burst fractures. The mean preoperative segmental kyphosis averaged 68.5° and vertebral height loss averaged 44.5%. There were no cases of neurologic deterioration, and 30 (91%) patients with incomplete neurologic deficits improved by at least one modified Frankel grade. Mean preoperative segmental kyphosis of 22.7° was improved to an early mean of 7.4° ($P < 0.0001$). At latest follow-up, angulation had increased by an average 2.1° but maintained significant improvement from preoperative measurements ($P < 0.0001$). There was one early construct failure due to technical error. Thirty-seven of the remaining patients (95%) went on to apparently stable arthrodesis.

TABLE 3. Reconstruction Methods and Instrumentation

Anterior Instrumentation	Reconstruction Method	
Z-plate	Structural allograft	2
	Titanium cage/autograft	19
		21
University plate	Structural autograft	10
	Structural allograft	6
		16
	Structural autograft	3
		40



Not C3#s and not most C2#s

J Spinal Disord Tech • Volume 18, Supplement 1, February 2005

Anterior Versus Posterior Treatment of Stable Thoracolumbar Burst Fractures Without Neurologic Deficit

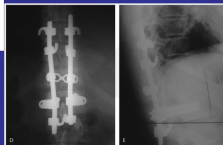
A Prospective, Randomized Study

K. B. Wood, MD,* D. Bohn, MD,† and A. Mehbod, MD†

Results: Of 43 enrolled, 38 completed a minimum of 2-year follow-up (average: 43 months; range: 24–108 months). Eighteen received a posterior spine fusion and 20 an anterior approach. Hospital stay and operating time were similar. Blood loss was higher in the group treated anteriorly; however, the incidence of transfusion was the same. There were 17 “complications” including instrumentation removal for pain in 18 patients treated posteriorly, but only 3 minor complications in 3 patients treated anteriorly. Patient-related functional outcomes were similar for the two groups.

Conclusions: Although patient outcomes are similar, anterior fusion and instrumentation for thoracolumbar burst fractures may present fewer complications or additional surgeries.

- **Posterior**
– 2 above 2
below with
claw above
and 3-4
level fusion



J Spinal Disord Tech • Volume 18, Supplement 1, February 2005

Low lumbar spinal fractures: management options

L3-5

Li-Yang Dai*

Department of Orthopaedic Surgery, Xinhua Hospital, Shanghai Second Medical University,
1665 Kongjiang Road, Shanghai 200092, PR China

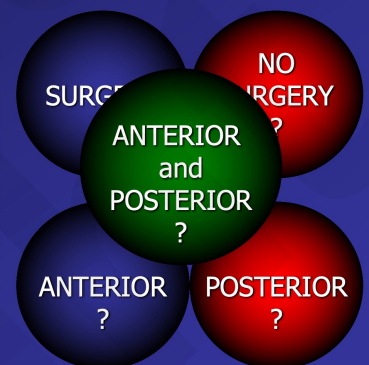
significantly less pain compared to the patients treated non-operatively ($P < 0.01$). Because of the unique anatomy and biomechanics, fractures of the low lumbar spine are different from those in the remaining regions of spine. Most compression fractures are stable, and therefore conservative management is indicated. Surgery should be performed in those with burst fractures or flexion-distraction fractures, with severe spinal stenosis or kyphotic deformity, and fracture-dislocation.

Surgery for thoracolumbar fractures

three questions

controversial topic
• *varied opinions in literature*

guidelines only
• *depends on patient factors*



Summary – A3 Burst # Mx

- McCormack 6 / TLICS 4 = GREY AREA!
- Few absolute indications for surgery - most T-L Burst fractures can be treated nonoperatively
- No significant correlation between residual kyphosis and pain or disability
- Neurological damage occurs at time of injury
- No evidence to support decompression for stable incomplete neurological deficits
- Significant amount of spontaneous canal remodelling has been demonstrated

Neurological Deficit

- no clear evidence that surgery improves neurological deficit
- trend that anterior surgery gives better results
- Kaneda (1997) JBJS
 - 150 patients incomplete injuries
 - 142 (95%) improved by 1 grade
 - 140 successfully fused
 - 56/78 (72%) regained their bladder
 - 125/130 returned to work

Canal clearance

- anterior decompression probably gives the most reliable canal clearance (>65% compromise)
- spontaneous resorption and indirect reduction (posterior) probably effective with less severe compromise

Goals for Surgery

Neurology

No Clear Evidence
any form of Surgery
Improves neurology

Biomechanics

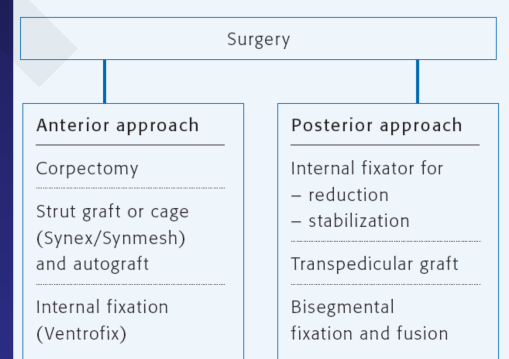
Greatest argument for anterior surgery is biomechanical where early screw breakage is expected ⇒ Anterior reconstruction ? Long Posterior...

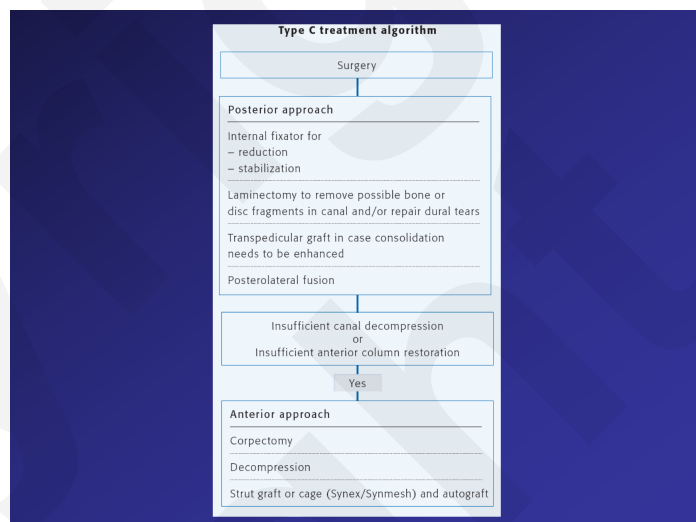
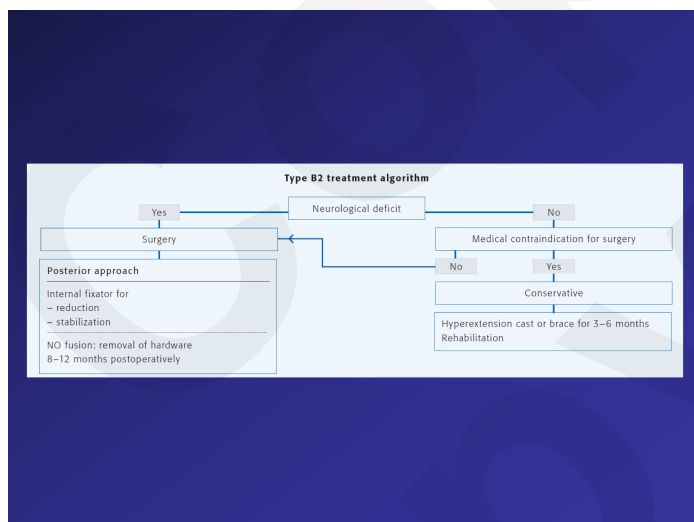
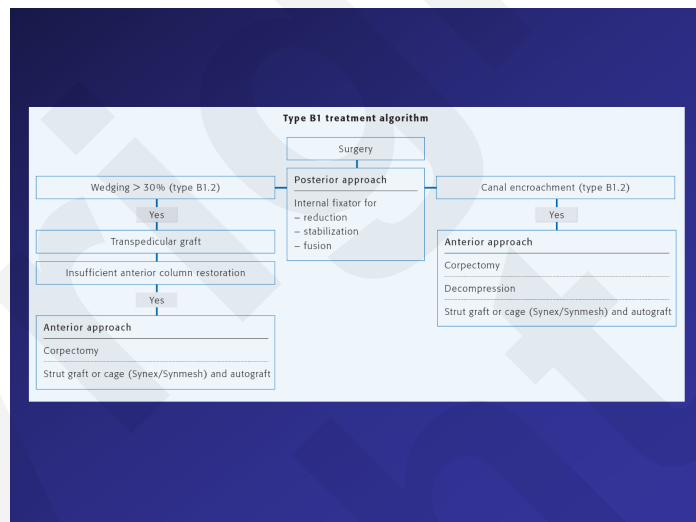
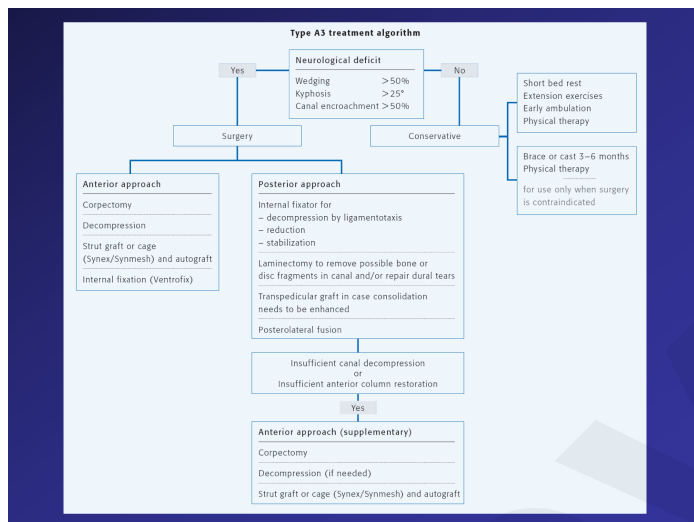
Type A injuries with intact posterior elements are stable in the absence of osteoporosis. They can be treated conservatively in the absence of neurological deficit or if the deformity is moderate (kyphosis less than 25°), if canal encroachment is moderate (less than 50%), or if vertebral body wedging is less than 50%. Surgery for type A injuries can be performed posteriorly relying on ligamentotaxis, or anteriorly with corpectomy and anterior column reconstruction (Table 1.3.2-1 and Table 1.3.2-2).

Type B injuries or flexion-distraction fractures will require posterior fixation because the posterior tension band system has been disrupted. If the type B injury has a burst component, additional anterior surgery may be warranted for further decompression and reconstruction (Table 1.3.2-3). Although type B2 injuries can be successfully managed without surgery, the author recommends treating them surgically if there is no medical contraindication in order to shorten recovery time (Table 1.3.2-4).

Type C injuries are best reduced with posterior surgery because anterior surgery will in most cases fail to achieve adequate reduction. Additional surgery may be necessary depending on the A or B component of the type C injury (Table 1.3.2-5).

Type A2 treatment algorithm





Absolute Indications for Surgery

- Indications for decompression
 - Worsening neurological deficit in the presence of demonstrable neural compression despite attempts at postural reduction
- Indications for stabilisation
 - All cases requiring decompression
 - Complete ligamentous disruption associated with dislocation
- Open Thoracolumbar burst fractures
- Patient with complete neurological deficit
- Multiply injured patient

Relative Indications for Surgery

- Decompression surgery (+ stabilisation)
 - Dynamic neurology
 - Stable incomplete neurology in presence of demonstrable neural compression
- Stabilisation surgery
 - Loss of anterior body height >50%
 - Kyphosis >20-30 degrees
 - Canal stenosis >50%
 - Disruption of posterior ligamentous complex

“Accepted” Indications for Surgery Thoracolumbar Burst Fractures

- Progressive neurologic deficit
- Progressive kyphosis ass. with neurologic deficit
- CT evidence of spinal canal compromise associated with an incomplete neurologic deficit
- Greater than 50% loss of vertebral body height
- Kyphosis greater than 30 degrees at level of #
- Spinal canal compromise greater than 50%

J Spinal Disord. 1990 Mar;3(1):39-46.

Classification Guidance

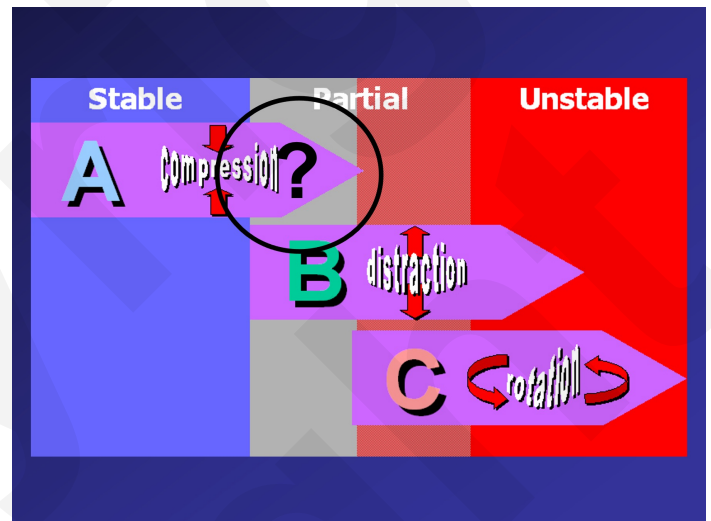
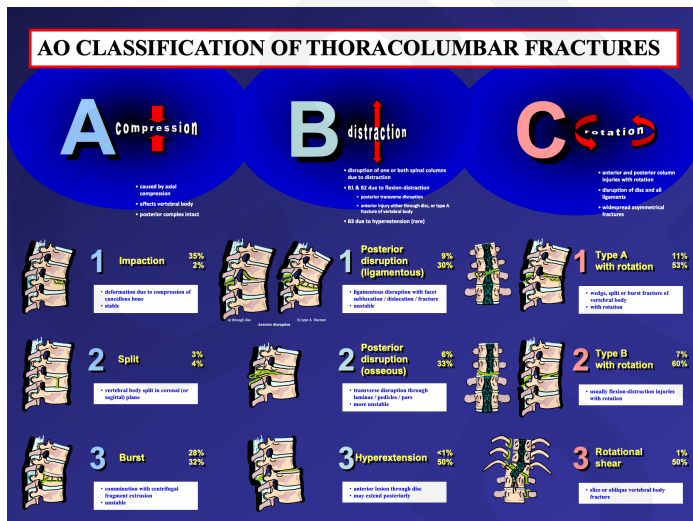


Table 2
Thoracolumbar Injury Classification and Severity Score

Injury Characteristic	Qualifier	Points
Injury morphology		
Compression	—	1
	Burst	+1
Rotation/translation	—	3
Distraction	—	4
Neurologic status		
Intact	—	0
Nerve root	—	2
Spinal cord, conus medullaris	Incomplete	3
	Complete	2
Cauda equina	—	3
Posterior ligamentous complex integrity		
Intact	—	0
Suspected/Indeterminate	—	2
Disrupted	—	3

+ = 1 additional point given to the morphology

≤ 3 = non op
4 = grey
≥ 5 = op