

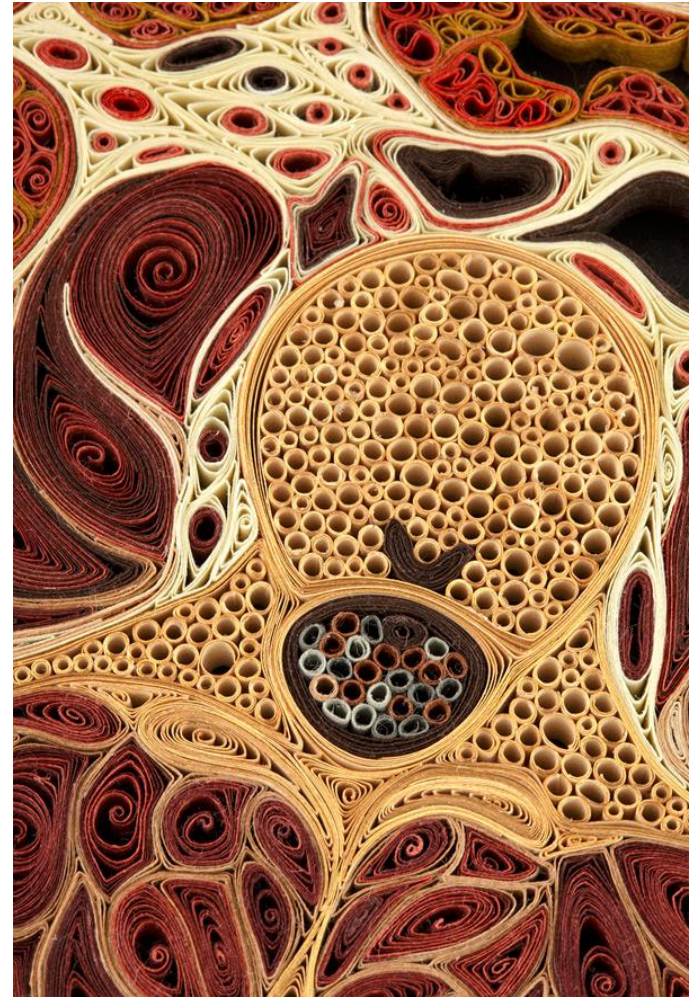
MISS in Thoracolumbar Fractures

Guillem Saló Bru, MD, PhD

Spine Unit. Orthopaedic Department.

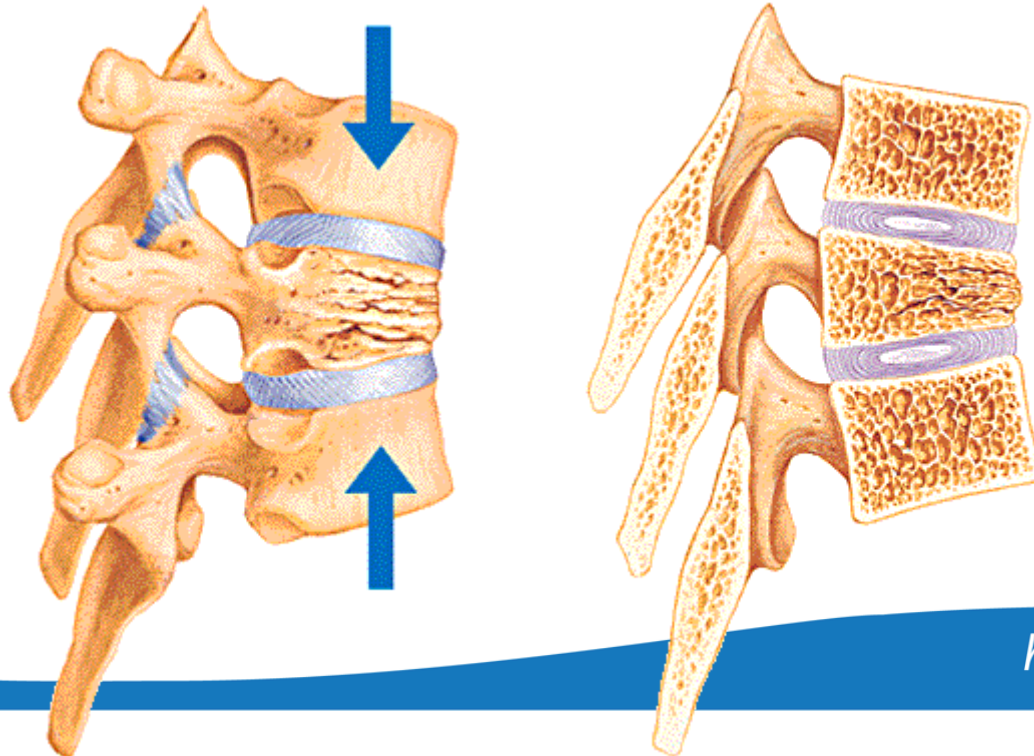
Hospital del Mar. Barcelona.

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Introduction.

- The application of MIS techniques to TL trauma has to adhere to the basic principles of surgical spinal trauma management (i.e., decompression, reduction/realignment, anterior column support, restoration of the posterior tension band when necessary, and fusion).
- The mainstay of treatment is percutaneous transpedicular fixation.
- Non fusion technique.
- An augmentation technique can be added.
- Eventually an anterior support is needed (ALIF / XLIF).



Introduction.

Advantages of percutaneous fixation in fractures

- **Muscle preservation:**
 - Low rate of injury of multifidus motor nerve (20% PF/80% open). Regev et al, Spine 2009;34:1239-42
 - Lower muscle enzyme levels on the first and seventh day postoperatively and less muscle atrophy visible on MRI. Kim et al, Spine 2005; 30:123-9. Lehmann et al, Spine 2008;17:857-63
 - Significant improvement in extensor muscle strenght compared to open. Kim et al, Spine 2005; 30:123-9
- **Minor Blood loss.** Wild et al, Arch Orthop Trauma Surg 2007;127(5), Merom et al, Orthopaedics 2009;32:273-8.
- **Shorter Operative Duration.** Merom et al, Orthopaedics 2009;32:273-8. Ni et al, J Spinal Disord Tech 2010;23:530-7. McAnany et al. Global Spine J 2016;6:186-94.
- **Infection Rate.**
- **Hospital Stays.**
- **Less Pain.**
- **Smaller scar.**

Table 1 Comparison of published results describing intraoperative bleeding, operative time, infection rate and length of hospital stay.

	Intraoperative bleeding ^a		Operative time ^a		Infection rate		Length of hospital stay	
	Percutaneous	Open	Percutaneous	Open	Percutaneous	Open	Percutaneous	Open
Wild et al. [15], n=21	194 mL (100–300)	380 mL (100–800)	87 min (63–120)	81 min (59–118)	0	0	NR	NR
Merom et al. [17], n=20	50 mL	200–500 mL	73–85 min	78–102 min	0	1 (superficial)	1–2 days	3–4 days
Ni et al. [18], n=36	75 mL	NR	70 min	NR	1 (superficial)	NR	5 days	NR
Schmidt et al. [16], n=76	1 transfusion after add. ant. procedure	NR	47 min	NR	0	NR	NR	NR
Verlaan et al. [19]		1000 mL				3.1% to 10%		
Palmisani et al. [20], n=64	NR	NA	120 min (60–240)	NA	1 (deep, instrumentation removed)	NA	NR	NA
Pelegri et al. [21], n=15	NR	NA	108 min (40–180)	NA	0	NA	NR	NA

N: number of patients; min: minutes; mL: millilitres; NR: not reported; NA: not applicable; add. ant: additional anterior.
^a Short-segment fixation.

Introduction.

Disadvantages of percutaneous fixation in fractures

- It is a technically demanding surgery: steep learning curve.
- Requires recognition of anatomy with fewer landmarks.
- Hand-eye coordination: Lack of tactile feedback.
- Difficulty in reduction of severe displaced fractures.
- Difficulty in placement of graft.
- Increase of radiation.
- Increases of Cost of procedures owing to tecnification.



Surgical MISS options. For Thoracolumbar Fractures

1. Augmentation technique alone (vertebroplasty or kyphoplasty).
2. Percutaneous Posterior fixation alone.
3. Percutaneous Posterior fixation and fusion.
4. Posterior fixation and augmentation technique.
5. Anterior structural support (minimally invasive ALIF or XLIF) with or without posterior percutaneous fixation (one-staged or two-staged surgery).

Table 1. Current MIS Techniques Used in TL Trauma

MIS Technique(s)	Indications
Anterior endoscopic decompression and stabilization	Anterior decompression
Posterior percutaneous segmental pedicle screw fixation	Anterior column reconstruction Restoration of posterior tension band Indirect augmentation of anterior column Augmentation of anterior fixation Substitution for when direct anterior fixation is not feasible
Percutaneous vertebral body balloon-assisted endplate reduction and augmentation	Endplate reduction and vertebral height restoration
Temporary percutaneous posterior fixation	Augmentation of anterior column Temporary stabilization to facilitate mobilization or prevention of secondary injury in an unstable injury when definitive fixation is unsafe
Combinations of the above	

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■ Use of Minimally Invasive Surgical Techniques in the Management of Thoracolumbar Trauma

Current Concepts

Y. Raja Rampersaud, MD,* Neel Annand, MD,† and Mark B. Dekutoski, MD‡

Vertebral augmentation techniques

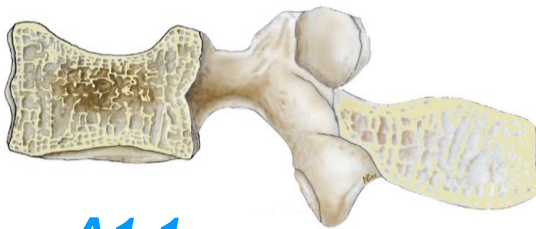
Indications.

Vertebroplasty and Kyphoplasty.

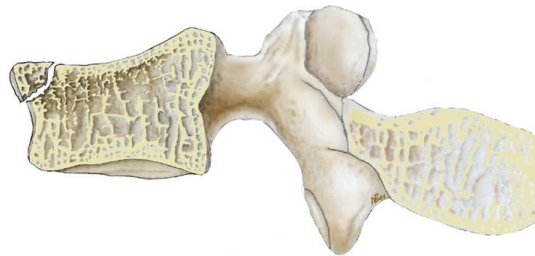
Fractures in osteoporotic patients.

The fractures thereby suitable for augmentation are:

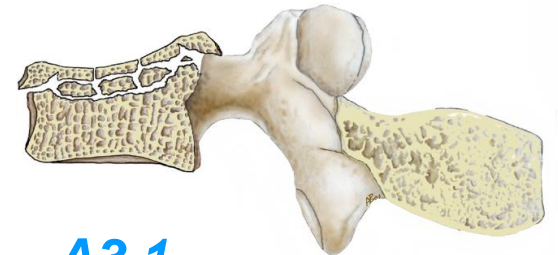
- A1.1 (end-plate impression),
- A1.2 (wedge fracture)
- A1.3 (vertebral collapse)
- A3.1 (incomplete burst fracture) types..



A1.1



A1.2

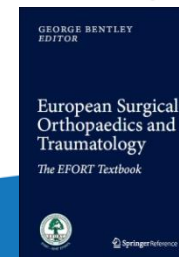
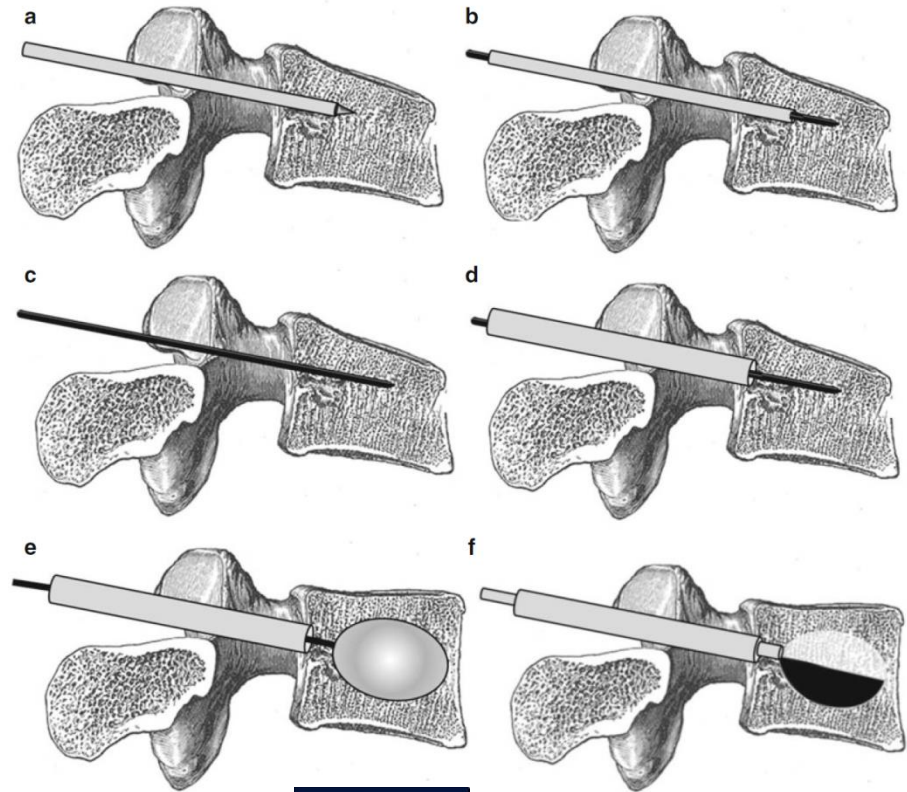


A3.1

Vertebral augmentation techniques

Technique.

- A. Placing the biopsy needle at the pedicle entry site at the angle between the upper articular process and the transverse process.
- B. Kirschner wire fed through the biopsy needle and acting as a guide.
- C. The biopsy needle is removed.
- D. Introduction of the cannulated trocar via guide-wire.
- E. Positioning the kyphoplasty balloon in the drilled channel in the fracture zone. Pressure-controlled inflation of the kyphoplasty balloon and the simultaneous gain in height of the vertebral body.
- F. The cavity that remains after the kyphoplasty balloon has been removed is filled with high-viscosity augmentation material through the cannula.



**Kyphoplasty - the Current Treatment
for Osteoporotic Vertebral Fractures**

Guillem Saló

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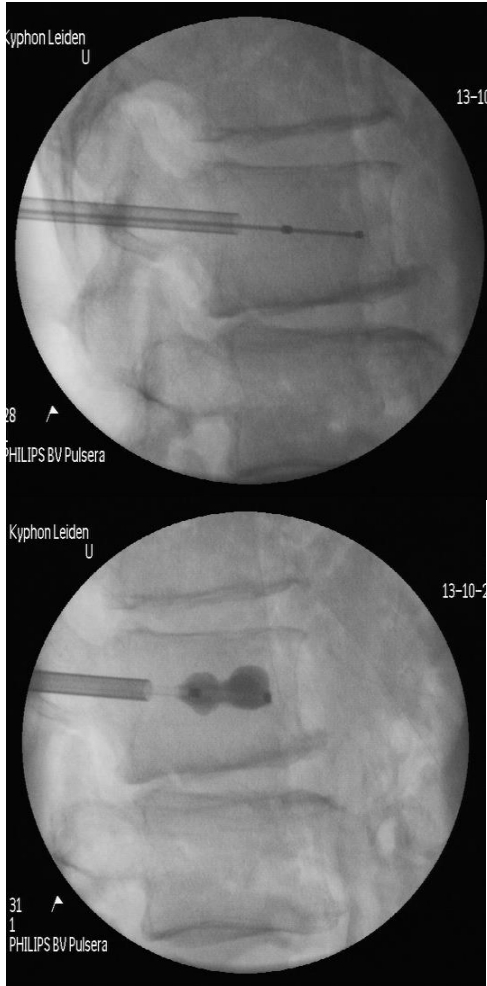
Vertebral augmentation techniques

Technique.



Vertebral augmentation techniques

Technique.



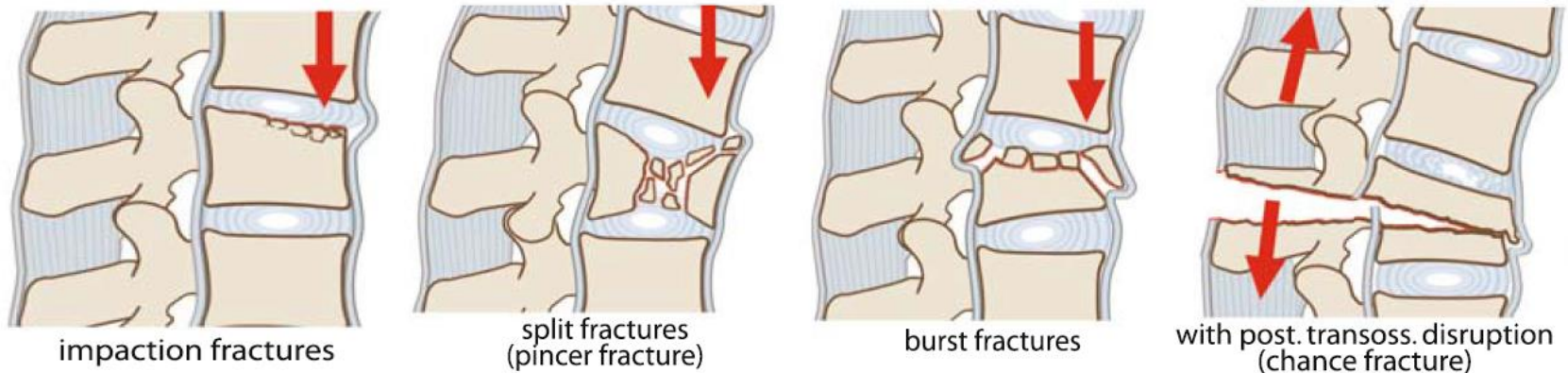
Percutaneous Transpedicular Fixation

Indications.

Type A:

- It seems that percutaneous fixation without grafting can be used to treat minimally displaced Type A1, A2 fractures and some Type A3 fractures(not A3.3).
- In type A3.3 fractures, use of the load sharing classification (LSC) to determine if anterior spine reconstruction is needed (<7)

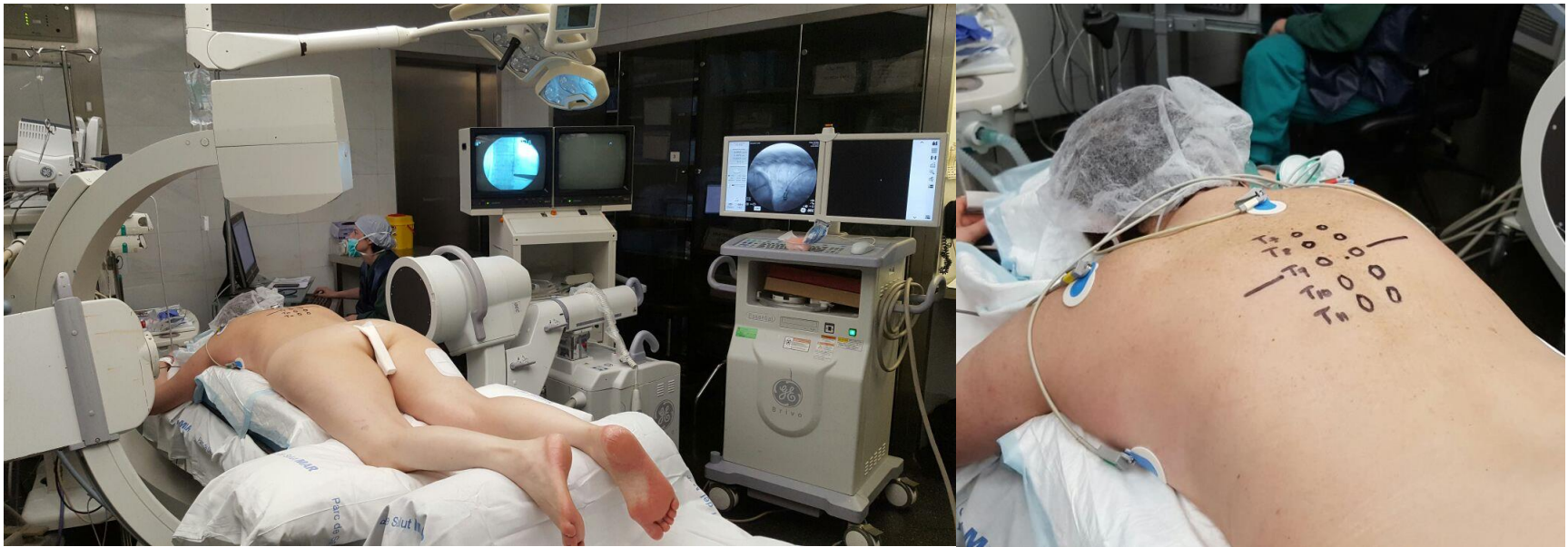
Type B. B2 fractures are an excellent indication for percutaneous fixation alone.



Percutaneous Transpedicular Fixation

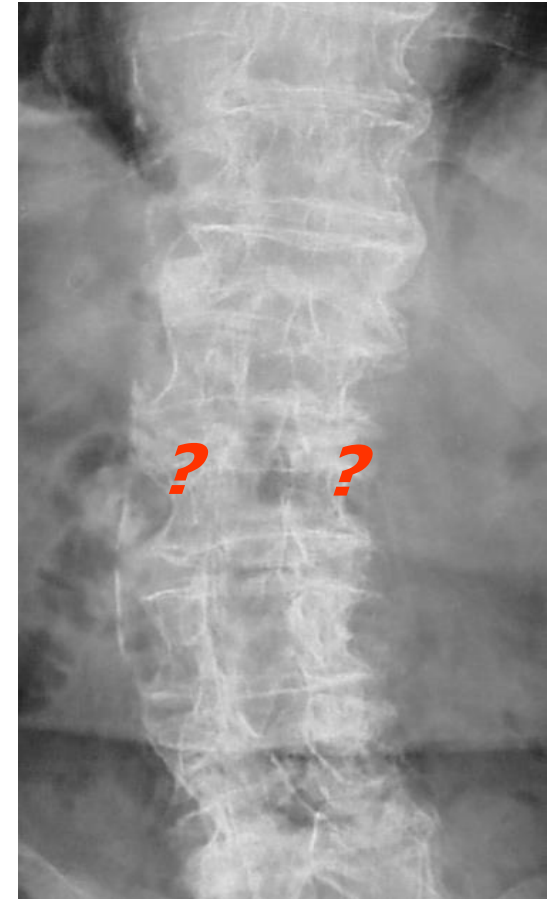
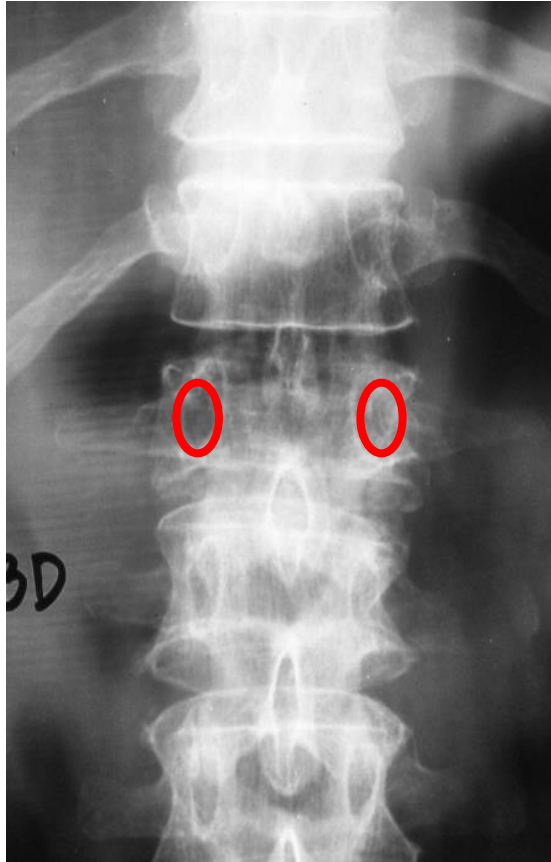
Surgical technique. Patient positioning.

- Patients were placed in the prone position on a radiolucent operating table with the chest and pelvis supported to gain lordosis.
- Reduction of the fracture.
- Intraoperative setting with image intensifier simultaneously in two planes to obtain an anteroposterior and a lateral view of the pedicles.



Percutaneous Transpedicular Fixation

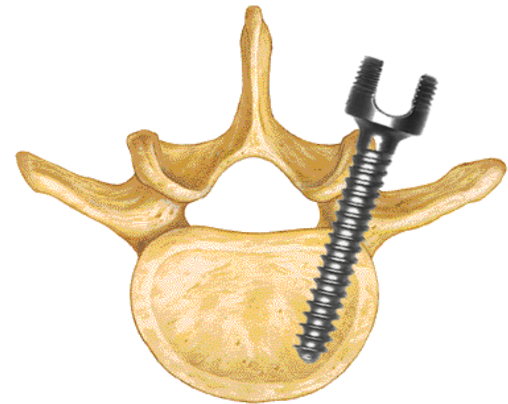
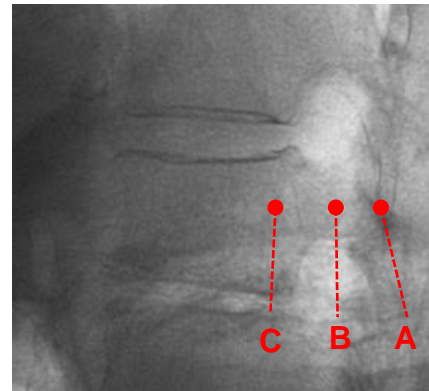
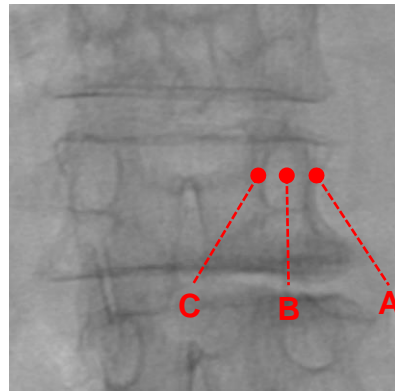
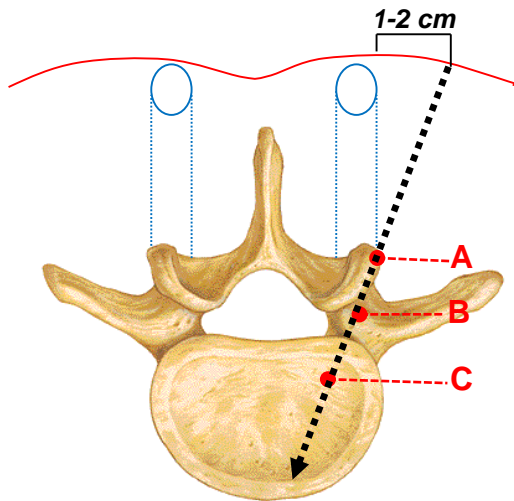
Surgical technique. Patient positioning.



Percutaneous Transpedicular Fixation

Surgical technique.

- The skin incision should be made 1–2 cm laterally so that the Jamshidi needle can be angled appropriately when inserting it into the pedicle.
- While the Jamshidi needle is advanced into the pedicle, a.p. and lateral fluoroscopy should be used intermittently as needed to confirm the direction, making sure that the needle remains lateral to the medial pedicle wall.
- Be carefully when the pedicle is broken.



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ORIGINAL ARTICLE

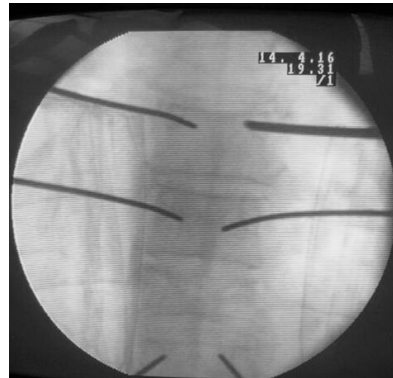
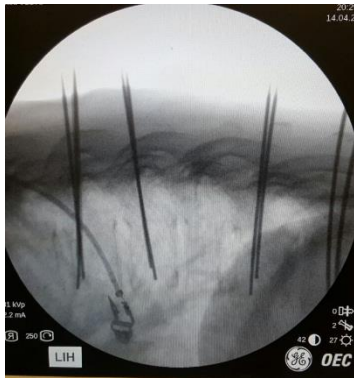
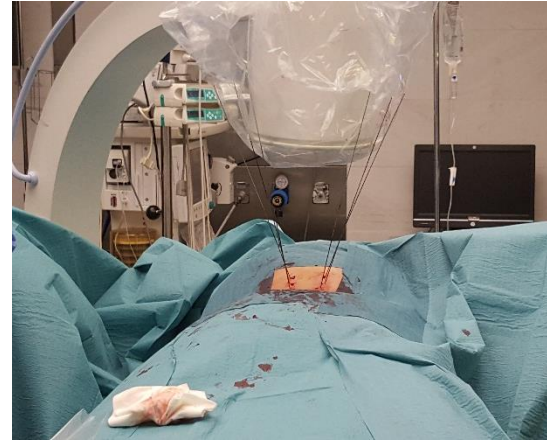
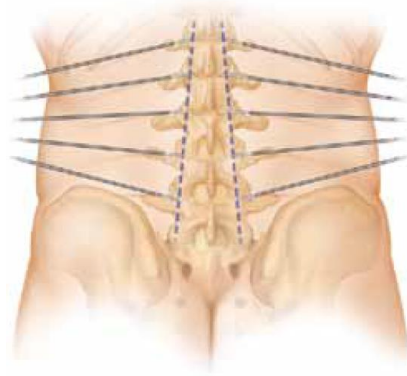
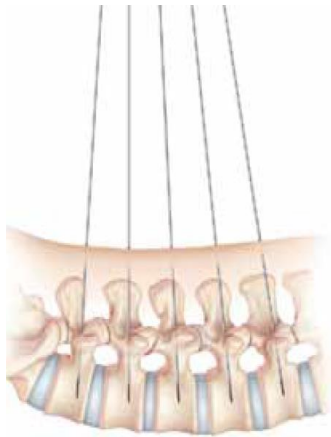
Accuracy of percutaneous pedicle screws for thoracic and lumbar spine fractures: a prospective trial

Timo Michael Heintel · Andreas Berglehner ·
Rainer Meffert

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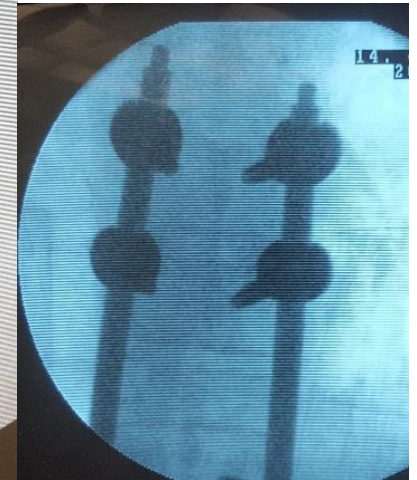
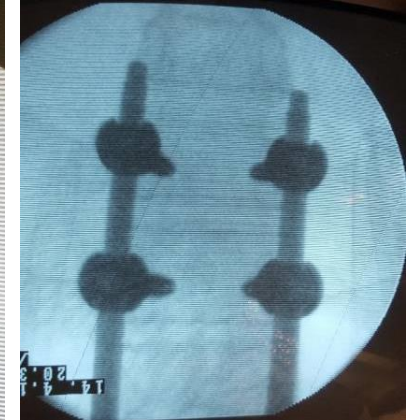
Percutaneous Transpedicular Fixation

Surgical technique.



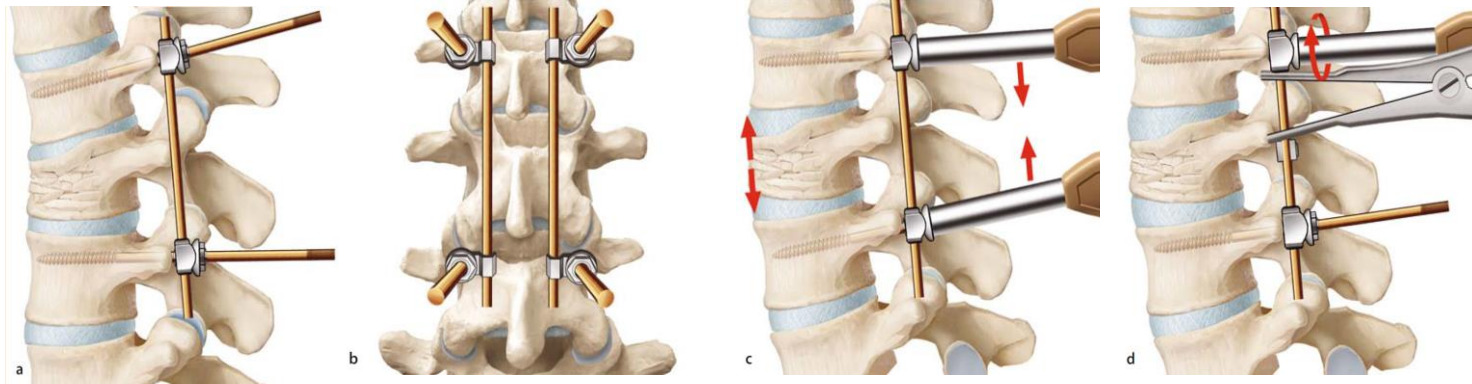
Percutaneous Transpedicular Fixation

Surgical technique.

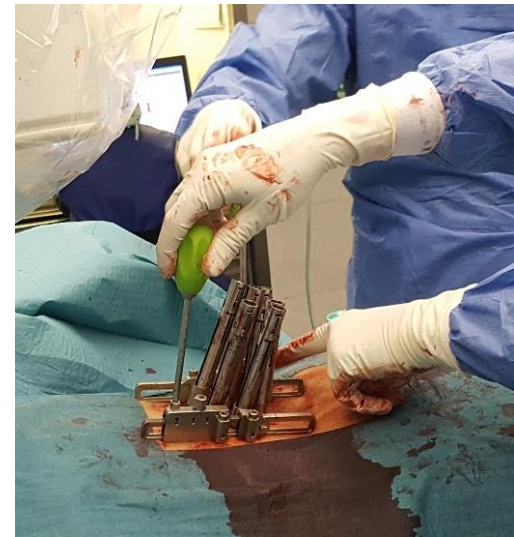
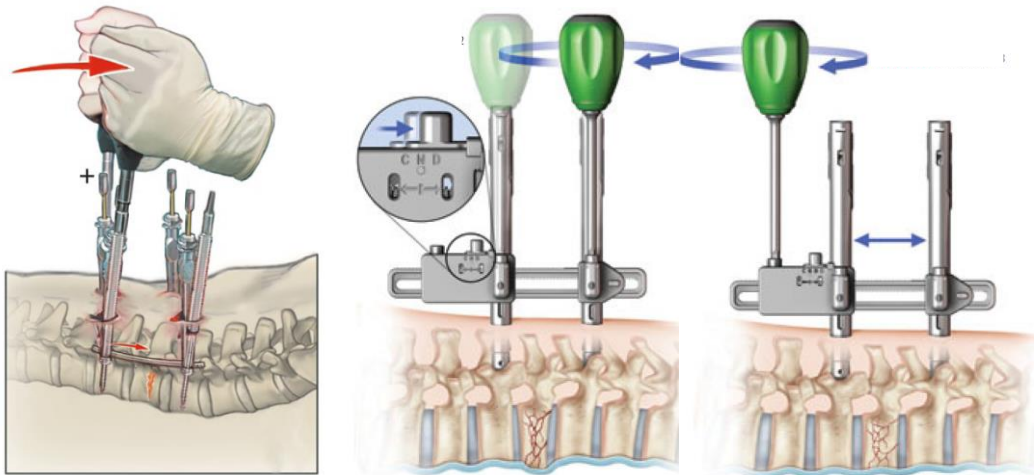


Percutaneous Transpedicular Fixation

Surgical technique. Fracture Reduction.

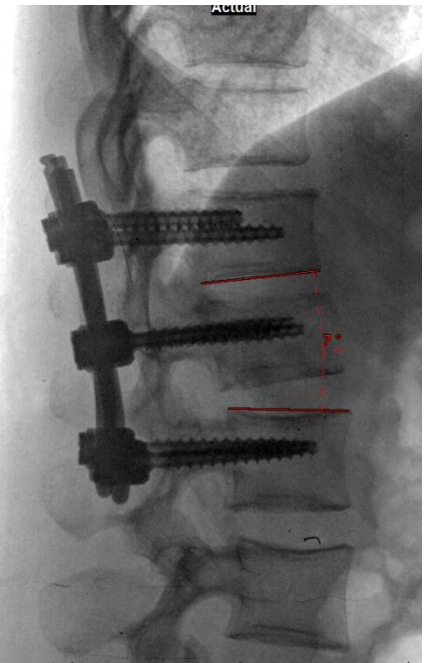
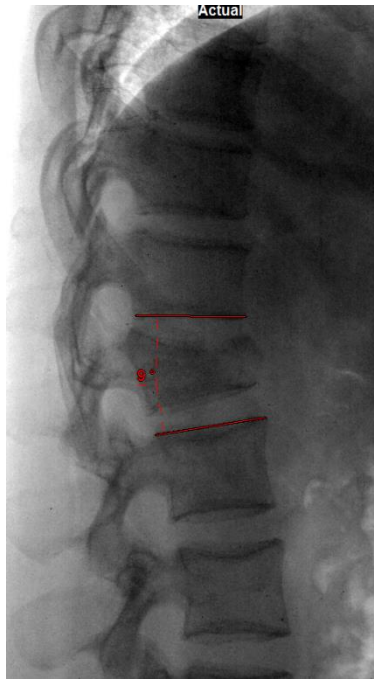


Ligamentotaxis



Percutaneous Transpedicular Fixation

Surgical technique. Fracture Reduction.

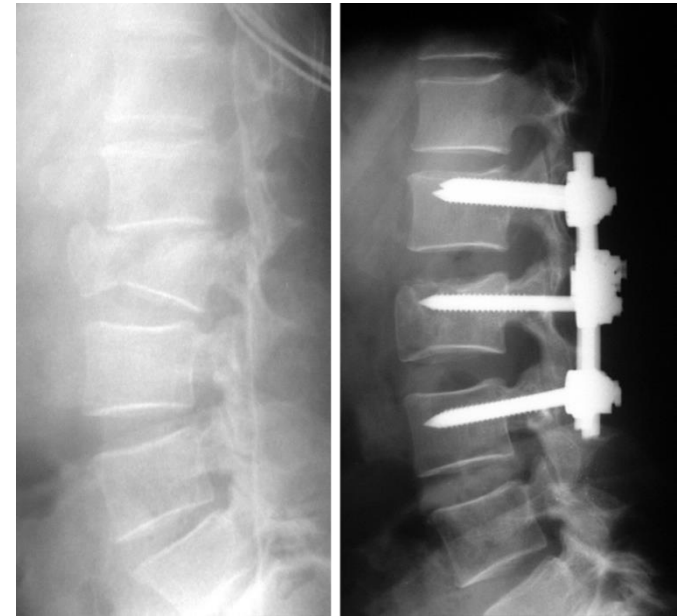


Percutaneous Transpedicular Fixation

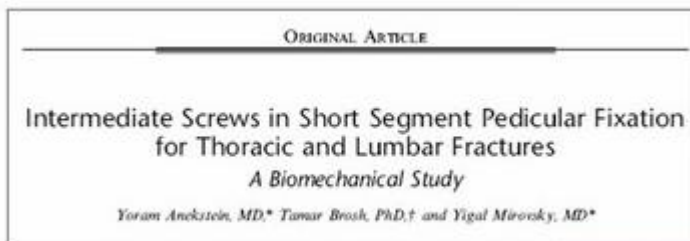
Use of screw at the fracture level in the treatment of thoracolumbar fractures.

Short segment including fracture

- Biomechanically stronger (3-point fixation)
- Better kyphosis correction (6% loss of correction)
- Fracture level screws increase stiffness of the constructs by 30%. (Norton et al, Spine J 2014).
- Fewer instrument failures.
- Comparable clinical and functional outcome.
- Shields fractured body from anterior loads



Mahar A, Kim C, Wedemeyer M, Mitsunaga L, Odell T, Johnson B, Garfin S. Short- segment fixation of lumbar burst fractures using pedicle fixation at the level of the fracture. Spine 2007, 32 (14). 1503-7.



Percutaneous Transpedicular Fixation

Short versus long constructs.

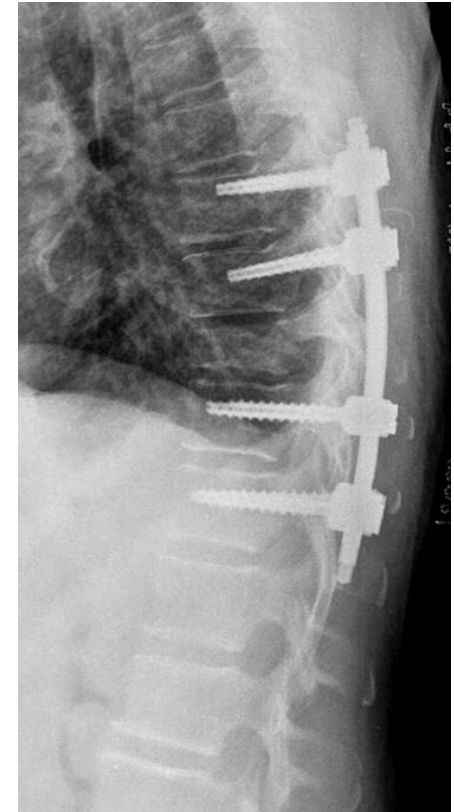
Indications of long segment fixations:

- Fracture-dislocations (injuries with translation), PCL injury.
- Severely comminuted vertebral bodies (LSC).
- Osteoporotic spine
- Patient Factors: Past psychological disturbances, drug abuse, alcoholics or non compliance patients or co-morbidities.

Advantages:

- Stronger: lesser chances of implant failure (multiple fixation points)
- Better alignment of sagittal balance.

Disadvantages: more surgery, more levels fused...



Eur Spine J (2009) 18 (Suppl 1):S75–S81
DOI 10.1007/s00586-009-0995-8

ORIGINAL ARTICLE

Minimally invasive spine stabilisation with long implants

Carlo Ambrogio Logroscino · Luca Proietti ·
Francesco Ciro Tamburrelli

ORIGINAL ARTICLE

Posterior Fixation of Thoracolumbar Burst Fracture
Short-Segment Pedicle Fixation Versus Long-Segment Instrumentation

Gunduz Tezeren, MD* and Ilhami Kuru, MD†

Percutaneous Transpedicular Fixation

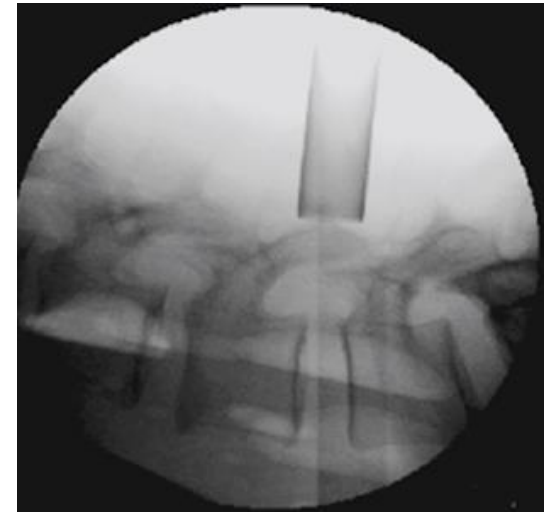
Short versus long constructs.

Guven O et al, J Spinal Disord Tech 2009; 22:417-21. Compared short versus long fixations for treatment of thoracolumbar fractures. 72 patients randomised into 4 groups:

1. Posterior instrumentation 2 levels above and below.
 2. Posterior instrumentation 2 levels above and below and screws at fractured level.
 3. Posterior instrumentation 1 level above and below
 4. Posterior instrumentation 1 level above and below and screws at fractured level.
- Follow up 26-82 m.
 - Intraoperative kyphosis angle correction achieved lowest and greatest loss of correction on follow up in group 3.
 - In all other groups, no differences.
 - Comparing with long fixations, a short segment fusion with screws at fractured level is adequate for intraoperative correction and for the maintenance of correction on follow up .

Percutaneous Transpedicular Fixation And Fusion.

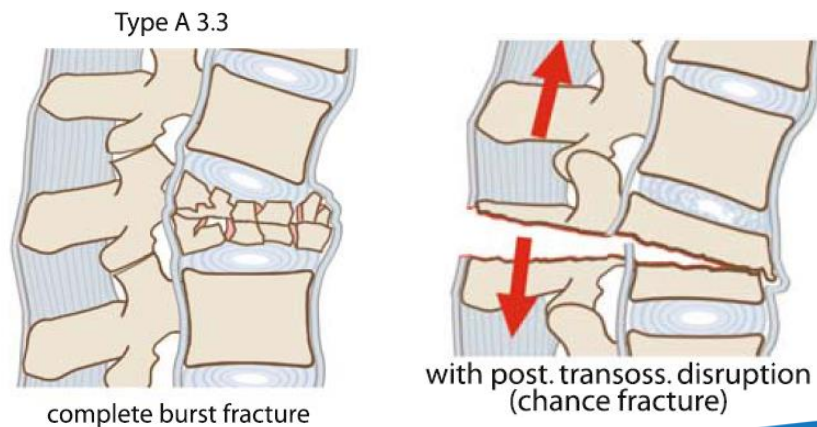
- The need for always using a bone graft during surgical treatment of spinal fractures is highly debated and no consensus exists.
- Type B1 fractures with ligament involvement, are not an indication for percutaneous fixation alone in our opinion, since a bone graft must be added to obtain fusion and make up for the ligament injuries.
- Minimally invasive procedures for the fusion have a place here in combination with percutaneous fixation.



Posterior fixation with reconstruction technique.

Indications.

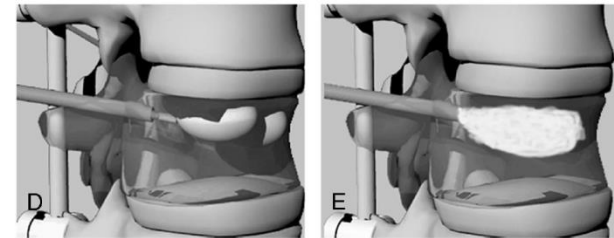
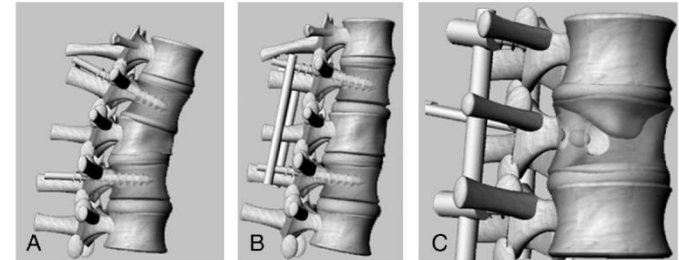
- Combination of percutaneous fixation with percutaneous anterior spinal reconstruction techniques
- A balloon kyphoplasty procedure in combination with posterior short-segment fixation helps not only to correct angular and vertebral body height losses, but to maintain this correction over time.
- This combination applies to fractures not needing a graft, but where fixation alone is not mechanically sufficient ($LSC > 6$) and requires anterior spinal reconstruction.
- Fractures meeting these criteria included Type B2 bone fractures and Type A3.3 fractures, which have significant vertebral compression leading to loss of vertebral body height and an anterior bone void.



Posterior fixation with reconstruction technique.

Technique.

- Percutaneous screw insertion of one vertebra cranial and one vertebra caudal to the fracture.
- Fracture reduction.
- Introduction of balloons under the central depression
- Reduction of the central endplate with the balloons
- Injection of CPC after removal of the balloons
- Augmentation or not of the pedicle screws with PMMA.



■ Cement Augmentation Techniques in Traumatic Thoracolumbar Spine Fractures

F. Cumhuri Oner, MD, PhD, Jorrit-Jan Verlaan, MD, PhD, Abraham J. Verbout, MD, PhD, and Wouter J. A. Dhert, MD, PhD

SPINE Volume 31, Number 11 Suppl, pp S89-S95
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■ Minimal Invasive Short Posterior Instrumentation Plus Balloon Kyphoplasty With Calcium Phosphate for Burst and Severe Compression Lumbar Fractures

Panagiotis Korovessis, MD, PhD, Alexander Hadjipavlou, PhD, and Thomas Repantis, MD

SPINE Volume 33, Number 6, pp 658-667
©2008, Lippincott Williams & Wilkins

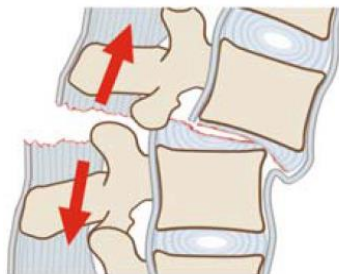
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Anterior Structural Support.

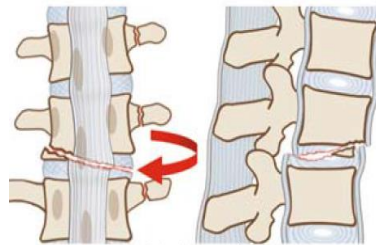
Indications.

Percutaneous fixation with anterior structural support (minimally or open)

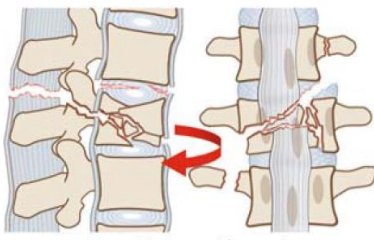
- Type B1 fractures and even Type C fractures, if the posterior structures are not dislocated or greatly laterally displaced, which would require an open posterior reduction.
- In type A3.3 fractures, use of the Load Sharing Classification (LSC) to determine if anterior spine reconstruction is needed (McCormack 1994)
- These fractures requires an intersomatic graft to avoid angular loss of the disc space.



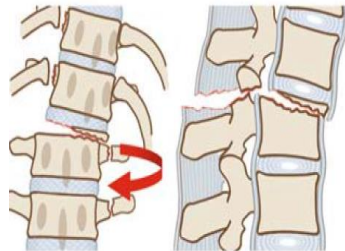
with post. lig. disruption



Type B injury with rotation

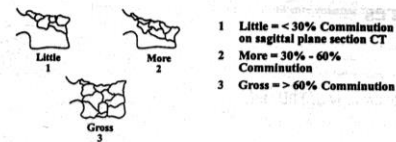


Type A injury with rotation



rotation/shear injuries

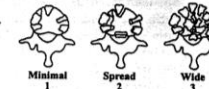
Comminution/Involvement



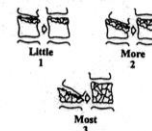
- 1 Little = < 30% Comminution on sagittal plane section CT
- 2 More = 30% - 60% Comminution
- 3 Gross = > 60% Comminution

Apposition of Fragments

- 1 Minimal = Minimal displacement on axial CT cut.
- 2 Spread = At least 2mm displacement of < 50% cross section of body.
- 3 Wide = At least 2mm displacement of > 50% cross section of body.



Deformity Correction



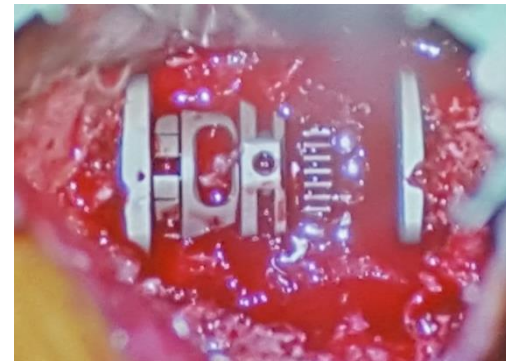
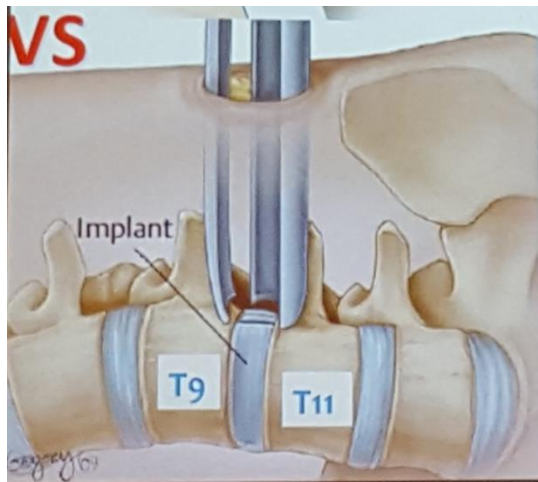
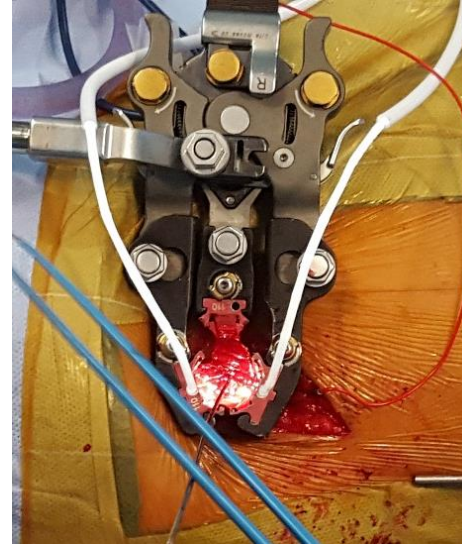
- 1 Little = Kyphotic correction $\leq 3^\circ$ on lateral plain films.
- 2 More = Kyphotic correction $4^\circ - 9^\circ$.
- 3 Most = Kyphotic correction $\geq 10^\circ$.

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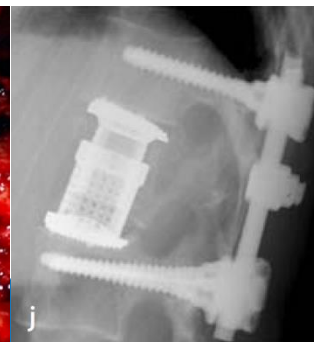
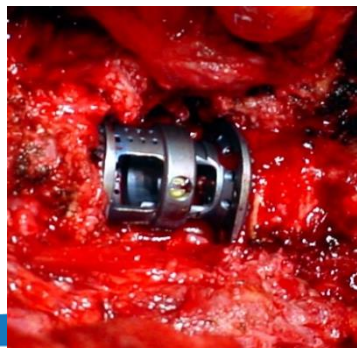
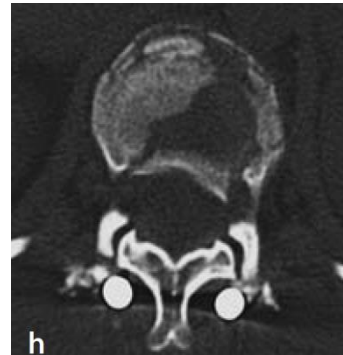
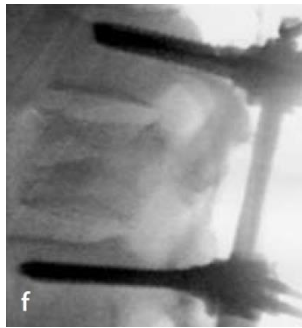
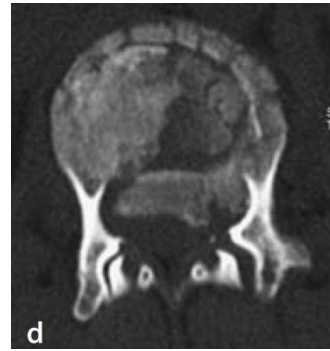
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Anterior Structural Support. Technique.

- Anterior approach.
- Minimally or open
- XLIF or ALIF
- One or two-staged surgery.
- Special retractors.
- Thoracoscopic or laparoscopic approach



Anterior Structural Support. Technique.



Outcomes of MISS in ThL Fractures.

Positioning of pedicle screws placed
percutaneous under fluoroscopy control

Author	Year	Number of screws	% misplacement	N revision
Weisner et al.	2000	408	6,6%	2
Ringle et al.	2006	488	3%	9
Pelegriet al.	2008	50	3,8%	1
Ni et al.	2010	104	6,7%	0
Korovessis et al	2008	180	2,7%	0
Heintel et al.	2013	502	2%	1

- Percutaneous pedicle screw targeting with fluoroscopy guidance, when using proper technique, leads to fewer pedicle wall violations than when performed open.

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DOI 10.1007/s00586-012-2476-8

ORIGINAL ARTICLE

Accuracy of percutaneous pedicle screws for thoracic and lumbar spine fractures: a prospective trial

Timo Michael Heintel · Andreas Berglehner ·
Rainer Meffert

Eur Spine J (2007) 16:613–617
DOI 10.1007/s00586-006-0221-x

ORIGINAL ARTICLE

Computer tomography assessment of pedicle screw insertion in percutaneous posterior transpedicular stabilization

Constantin Schizas · Jacky Michel ·
Victor Kosmopoulos · Nicolas Theumann

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Outcomes of MISS in ThL Fractures.

Review Article

GLOBAL SPINE JOURNAL



Open Versus Minimally Invasive Fixation Techniques for Thoracolumbar Trauma: A Meta-Analysis

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- 6 studies selected (2016)
- Short segment pedicle screw fixation without fusion.
- MISS superior in terms of less blood loss and shorter operative duration.
- No difference in terms of vertebral body height, kyphosis angle and postoperative pain.
- At minimum, percutaneous fixation of thoracolumbar fractures results in equivalent biomechanics and clinical outcomes compared to the open group.

Outcomes of MISS in ThL Fractures.

43–49

Percutaneous minimally invasive versus open spine surgery in the treatment of fractures of the thoracolumbar junction: a comparative effectiveness review

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- Percutaneous MIS can provide a safe and effective treatment for thoracolumbar junction fractures.
- A significant reduction in blood loss, postoperative pain, surgical time, and hospital stay are the main advantages associated with these new minimally invasive techniques.
- These favorable outcomes are particularly important in specific subgroups of patients, including elderly people and patients with important comorbidities, and could make the percutaneous minimally invasive techniques the preferable surgical treatment

Limitations of percutaneous fixation in thoracolumbar fractures

1. Exposure to X-Rays

- Proper percutaneous screw placement requires a precise technique and high-quality fluoroscopy
- will be exposed to ionizing radiation.
- Screw placement requires 9.3 seconds of exposure to X-rays
- These data confirm the increased irradiation for the surgical team and the patient during percutaneous fixation.
- Navigation systems aim to reduce exposure to X-rays while also improving screw placement.

Table 3 Duration of X-ray exposure during percutaneous or open screw fixation.

Duration of X-ray exposure	Percutaneous screw fixation	Open screw fixation
Rampersaud et al. [25], Cadaver study, 96 screws	9.3 s exposure for one screw Dose received Hands: 58.2 mrem/min Radioprotective gloves worn 39.3 mrem/min Thyroid: 8.2 mrem/min Chest: 53.3 mrem/min	
Lehmann et al. [14], Sheep study	3.2 ± 1.4 min/screw	1.88 ± 0.66 min/screw
Schmidt et al. [16]	5.9 ± 3.5 min/screw	
Wild et al. [15]	5.7 min/screw	3.7 min/screw

Min: minute.

Limitations of percutaneous fixation in thoracolumbar fractures

2. Reduction of fracture.

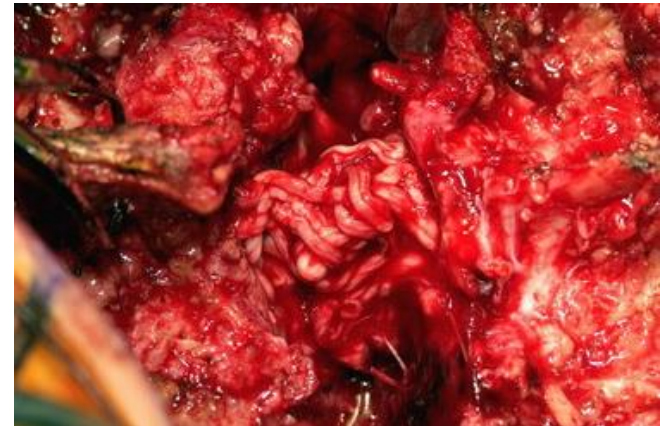
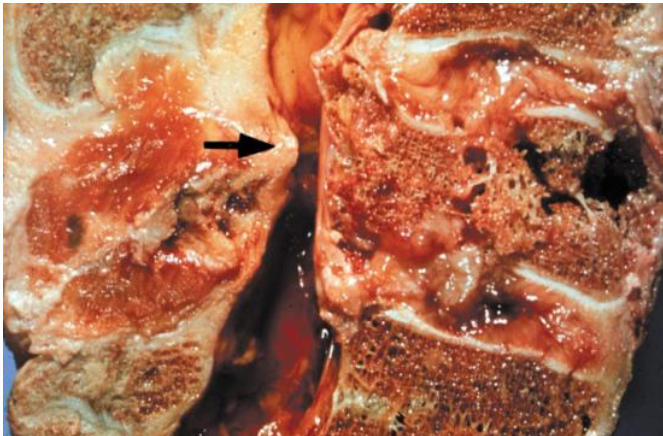
- Displaced fractures.
- Patients who needs a great reduction of fracture are in principle a contraindication to percutaneous fixation, since complete reduction cannot be performed.
- Specially type C (fractures dislocation) or comminuted burst fracture.



Limitations of percutaneous fixation in thoracolumbar fractures

3. Neurological decompression.

- Fractures that are complicated by neurological problems are in principle a contraindication to percutaneous fixation, since decompression cannot be performed.
- However, percutaneous fixation can be combined with a limited posterior midline approach to perform the required decompression.



Conclusions.

- The role of percutaneous spinal fixation and posterior minimally-invasive surgery is becoming clearer.
- They do not replace the other open techniques, but add to treatment options.
- The advantage of these techniques in reducing surgical morbidity, simplifying the immediate postoperative recovery and improving the medium-term functional results is well known.
- Percutaneous fixation is not always performed alone; it can be combined with additional anterior or minimally-invasive posterior routes.
- Screw at fractured level and indirect reduction by ligamentotaxis.
- Anterior support in comminuted fractures
- Long constructs in type C fractures or >7 points in LSC.



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