TIPS TO TREAT POST-TRAUMATIC KYPHOSIS WITH & WITHOUT NEUROLOGIC INJURY

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**Medtronic:** Consulting, Speaking, Royalties

**Norton Hospital:** Speaking, Research Funding

**DePuy:** Consultant, Speaker

**Scoliosis Research Society:** Board Member

**FOSA:** Board Member

**Publication:** Reviewer for JAAOS, Spine, Spinal Deformity Journal, & the Global Spine Journal
Post-traumatic Kyphosis*

Definition:
“A Painful Kyphotic Angulation That Can Occur Anywhere in the Posttraumatic spine”

Consensus Cause:
“Untreated or Inappropriately Treated Flexion/Distraction Injuries or Severe Burst Injuries”

Preferred Treatment:
“Posterior Based Osteotomies Most Popular Surgical Treatment Method”

How do We Predict the Development Of Post-traumatic Kyphosis*

4 Important Predictive Factors

- Bone Mineral Density (BMD)
- Severe Comminution
- Preservation of Posterior Wall
- Thoracolumbar Junction Location

*Progression
Study Design:
- 28 Patients: Single Level Pedicular Fixation for Burst Injuries
- Utilizes Point System to Grade to Severity of Comminution
- All Patients Underwent Short Segment PSF with Instrumentation
- 10/28 Failed – 36%
- Comminution of the Vertebrae Affects Post – Injury Stability
Radiological Prediction of Posttraumatic Kyphosis After Thoracolumbar Fracture

Study Design:

➢ Retrospective Analysis of 63 Patients
  - AO Classification A1 → A3 Fractures
  - Thoracolumbar Fracture T10-L5
  - Radiographic Parameters Measured
  - Standard Demographics

➢ Risk of Progression:
  - > 50 Years Old
  - Localized T12 or L1
  - A3 Fractures Had Higher Progression
  - 30-50% Had Cephalad Endplate Angle >20°
1. Progressive **Neurological Loss** Needs Repair
2. Progressive/*Painful Deformities* Generally Need Correction
3. Trauma Required to Cause a Kyphotic Deformity is **Variable**
4. Always Look for **Underlying Pathology**: Tumor & Infection
5. Lumbar Kyphosis is More **Poorly Tolerated** Than TL
6. Approach the Deformity with **Techniques You Know**
7. **Fuse Long** With Posteriorly Based Osteotomies
8. **Never Stop at the Apex** of the Thoracic Spine
9. Consider **Anterior Support** When the Body is Incompetent
10. Identify & **Stabilize Early** to Avoid the Whole Problem*

* Current Trends are More Aggressive
Surgical Treatment of Post Traumatic Kyphosis in the Thoracolumbar Spine: Indications & Technical Aspects


Everard Munting

Indications:

➢ Pros:
  ▪ Neurological Deficit
  ▪ Pain
  ▪ Angulation > 20°
  ▪ Non-union
  ▪ Instability

➢ Cons:
  ➢ Old Age
  ➢ Osteoporosis
  ➢ Workman’s Compensation
  ➢ Litigation

Surgical Planning:

➢ Acute/Subacute ➔ PSF + Late AIBF
➢ Pathological ➔ Biopsy + Cultures + AIBF + PSF
➢ Late (6 Weeks) ➔ PSF + AIBF
➢ Fixed Kyphosis ➔ AIBF + PSF
➢ Previous Surgery ➔ Posterior Decomp. ± AIB

Surgical Planning Critical; Expect 50 – 70% Correction; 10% Major Complications
Minimum 5 Year Follow-up Surgical Results of Post-Traumatic Thoracic & Lumbar Kyphosis Treated With Anterior Instrumentation

Spine, Volume 32, Number 9, pp 986-994, 2007
I Benli, A Kaya, V Uruc, S Akalin

Retrospective Review:
- 40 Patients/ 2 Year FU
- Anterior Vertebrectomy
  - AIBF + 3 Level Instrumentation
- ½ Plate/Screw & ½ Double Rod
- Evaluated by PFA & SRS-22
- 51.4° → 7° Av. Correction
- 92% of Patient Had Complete Pain Reduction
- 24 Patient With Neurologic Symptoms Improved
Modified Closing-Wedge Osteotomy for the Treatment of Sagittal Malalignment in Thoracolumbar Fracture Malunion

A Bourghli, L Boissiere, JM Vital, I Obeid, et. al.

Retrospective Review:

- 10 Patients/ 2 Year FU
- All Rx’d with **MCOWO**:
  - All Post Traumatic
  - 36’ Radiographs
  - T12 or L1
  - Trapezoidal Wedge Removal
  - Angulation Improved
    - From $52^\circ \rightarrow 7.1^\circ$
  - Cord Shortened 1.2 cm
Floating Spine After Pedicle Subtraction Osteotomy for Post-Traumatic Kyphosis

H Shigematsu, M Koisumi, J Iida, E Iwata, Y Tanaka
Eur Spine J (2014) 23 (Suppl 2) : S278 – S284

Important Case Review:
- 50 Year Old Male
- T12 Compression Fx
- Rx’d With Brace
- Developed 43° Painful
- Kyphosis 1 Year Later

Powerful Tool But:
- No Posterior Fusion Surface
- High Stress Zone – TL Junction
- Poor Anterior Column Support
- Questionable Anterior Blood Supply
- Salvage with an AIBF + Instrumentation

PSO + PSF + Instrumentation

Avoid Wide Laminectomy, Improved Grafting, Never Remove Intact Instrumentation
Comparison Between Pedicle Subtraction Osteotomy & Anterior Corpectomy & Plating for Correcting Post-Traumatic Kyphosis: A Multicenter Study

MM El-Sharkawi, WMT Koptan, YH El-Miligi, GZ Said

Retrospective Review:

- 43 PSO vs. 37 Ant. Corpectomy + AIBF + 3 Level Instrumentation

Changes in Mean Kyphotic Angle of Groups

Pre-op Post-op 2 Years
PSO: 29.8° → 22° (P = 0.001)
ACP: 22°

VAS & ODI Available for PSO

Retrospective Review:

Complications:

- PSO: 2 Transient Neurologic Injuries
  - Instrumentation Failure
  - 3 with Graft Site Pain
  - 1 with Incisional Hernia
- ACP: 1 Aortic Injury
  - 3 with Graft Site Pain
  - 1 with Incisional Hernia

PSO Equally Safe But More Effective for the Treatment of Post-Traumatic Kyphosis

- Satisfaction:
  - 93% in PSO
  - 73% in ACP
Pre-op Bone Health Evaluation:

- Get a Thorough History
  - Family History of Osteoporosis
  - Smoker
  - Early Hysterectomy
  - Previous Fragility Fracture
- CT SCAN
- Labs
  - Vitamin 25-Hydroxy D > 30ng/ml
  - Testosterone
  - PTH
  - Calcium

Pre & Post-op Medical Rx

**Bisphosphonates:** Stomach Ulcers, Jaw Osteolysis
- Fosamax™ (alendronate) - Prototypical Drug
- Boniva™ (ibandronate) - Oral, IV & Not in ♀
- Actonel™ (risedronate - Oral
- Reclast™ (zolendronic acid) - IV Only & Not in ♂

**Calcitonin:** Weaker, Nasal Irritation
- Miacalcin™ (synthetic calcitonin)
- Fortical™ (synthetic calcitonin)

**Estrogen & Hormonal Treatment:** Women Only
- Evista™ (raloxifene) - SERM only in
  Selective Estrogen Receptor Modulator
  = Less Side Effects
- Estrogen – Estrogen (ET) & Estrogen/Progesterone (HT)

**Denosumab** (Prolia™) RANKL Inhibitor Immunoglobulin

**Teriparatides** (Forteo™): Theoretical Cancer Risk
- Parathyroid Synthetic Analog
- Both Men & Women
- Stimulates New Bone Growth
- SQ Injection
- 2 Year Treatment Regime
- 25% Increase in Bone Mass
- Long Term Effects Unknown
Evidence for Use of Teriparatide in Spinal Fusion in Osteoporotic Patients

World Neurosurgery 100: 551-556, April 2017
N Chaudhary, J Lee, J Wu, S Tharin

Review of the Literature:

➢ Pub Med Review of Osteoporotic Patients Using Teriparatide

➢ 7 Pre-clinical Studies Show Teriparatide Improved Fusions 50C → 89% vs. Controls 14% → 56%

➢ 1 Clinical Study Showed Teriparatide Improved Fusions 68 → 82%

➢ 1 Clinical Study Showed Teriparatide Decreased Pedicle Screw Loosening 13% vs. 25%

➢ 1 Clinical Study that Insertional Torque Significantly Increased in Teriparatide Group 1.28 vs. 1.08 Nm
Role of Weekly Teriparatide Administration in Osseous Union Enhancement within 6 Months After Posterior or Transforaminal Interbody Fusion for Osteoporosis Associated Lumbar Degenerative Disorders

Prospective Randomized Study:
- > 50 Years Old
- BMD < 80% Young Adult Mean
- Previous Comp. Fx, Femur Fx, + DDD
- Randomly Receive Teriparatide 6 Months
- Modified Intent to Treat
- CT Assessment for Bone Density
- Evaluated with JOA-BPEQ & ODI
  - 66 Patients Completed Study
  - Bone Fusion Rate & CT Density Significantly Higher with Teriparatide (P=.013 & P<0.035)
  - Promotes Fusion & Decreases Bone Loss

Age Adjusted Per Protocol Analysis

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<th>Months</th>
<th>Teriparatide</th>
<th>Placebo</th>
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* Where Non-fusion is Graded 3

A Significant Difference

P=0.035
P=0.059
P=0.669

Fusion Adjuncts
Post-Traumatic Kyphosis Cases
41 Year Old Male Involved in a Severe MVA. Transported to ER Where He Was Found to Be Neurologically Intact. Following Medical Stabilization the Radiologic Workup Revealed a Right Distal Femur Fracture, A Talus Fracture, and Meta-Carpal Fractures. Spine Radiographs Showed a L2 Burst Injury with Severe Canal Obliteration. Exam Revealed Weak Lower Extremity Function (2/5 Distally), Decreased Sensation (Including the Perineum). His Past Medical History is Non-contributory and Is a Smoker.

Physical Exam

- Severe Lower Back Pain
- Motor Strength → 4/5 Quads, 1/5 EHL, 2/5 Plantar Flexion
- Sensory → Diffuse Decrease
- Pain With Percussion → No Significant Lumbar Kyphotic Deformity
- Intact Bowel/Bladder Function but Perineal Sensation Decreased

ASIA B
46 Year Old Male MVA with Poly-Trauma Suffered an L2 Fracture/Burst With Paraplegia (ASIA A)

Nov. 6, 2014
Treatment Options

1. Electrical Stimulation X 1 Year + Brace
2. PSF + Instrumentation
3. PSF + PCO (Ponte’s)
4. PSF + CTV
5. Anterior Vertebrectomy (AIBF) + Instrumentation
6. AIBF (Vert.) + PSF + PCOs

Optimization

A. Stop Smoking
B. Endocrinology Consult
C. Vitamin C & D + Calcium Citrate
D. Bisphosphonates
E. Teriparatides
Instrumentation Failure
Nov 29, 2015

AVN + Kyphosis
Treatment Options

Treatment

1. PSF
2. PSF + PCO (Ponte’s)
3. PSF + CTV
4. Anterior Vertebrectomy (AIBF) + Instrumentation
5. AIBF (Vert.) + PSF

Optimization

A. Stop Smoking
B. Endocrinology Consult
C. Vitamin C & D + Calcium Citrate
D. Bisphosphonates
E. Teriparatides
There is a Critical Need To Sequentially Resect the Body to Decompress the Spinal Canal & to Restore the Integrity of the Anterior Column
Fracture Reduction

**Anterior Reduction**

May Be Combined With Anterior Instrumentation or Posterior Stabilization

**Benefits:**
1. Direct Decompression of Neural Elements
2. Loosening of Anterior Soft Tissue & Bony Elements to Aid in Reduction
3. Wide Array of Potential Vertebra Replacements
4. Superior Anterior Column Support
5. Large Amount of Autograft
44 Year Old Female with a Prior History of a Gastric Bypass 10 Years Ago with >200# Weight Loss. Reports 1 Year History of Severe Upper Thoracic Back Pain Following a Fall Without Neurologic Symptoms. Has Noted Concurrent Increasing Round-back Deformity. Referred Following the Identification of a T5-6 Fracture By Her Family Physician.

**History**

**Physical Exam**

- Severe Thoracic Back Pain
- Motor Strength → Intact
- Sensory → Sensory Intact
- Severe Thoracic Pain With Percussion → + Thoracic Kyphotic Deformity
- Intact Bowel/Bladder Function
June 9th, 2017
June 9\textsuperscript{th}, 2017
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<th>Parameter</th>
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<td>TP – 6.6</td>
<td>L</td>
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<td>Alb – 3.2</td>
<td>L</td>
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**DX:**

Osteoporosis + Osteomalacia
**Treatment Options**

1. Traction
2. PSF
3. PSF + PCO (Ponte’s)
4. PSF + CTV
5. Anterior Vertebrectomy (AIBF) + Instrumentation
6. AIBF (Vert.) + PSF + PCOs

**Optimization**

A. Stop Smoking
B. Endocrinology Consult
C. Vitamin C & D + Calcium Citrate
D. Bisphosphonates
E. Teriparatides
Lordosis by Smith Peterson Osteotomy (Ponte)

Anterior Disc Pivot Point

Compression
Halo – Gravity Traction
Sept 17th, 2017
Pathology Shows Osteomalacia/Osteoporosis & Necrotic Bone
Following 4 PCOs (Ponte) + PSF + Reduction + Bone Grafting
June 25th, 2017
70 Year Old Male Presented with TL Pain Since a Fall 2 Years Ago. He was Originally Evaluated in the ER and Placed in a TLSO. Pain has Worsened over the Past Year & He has Noticed He Has Trouble Standing Up. Lab Values are Normal & He is Neurologically Intact. Pain Centered at the Thoracolumbar Junction on Exam.

**Physical Exam**

- Severe Mid TL Back Pain
- Motor Strength → 5/5 Lower Extremities
- Sensory → Normal
- Severe TL Junctional Pain With Percussion → + TL Kyphotic Deformity
- Intact Bowel/Bladder Function

**ASIA E**
Treatment Options

1. PSF
2. PSF + PCO (Ponte’s)
3. PSF + CTV
4. VCR + PSF
5. Anterior Vertebrectomy (AIBF) + Instrumentation
6. AIBF (Vert.) + PSF + PCOs

Optimization

A. Stop Smoking
B. Endocrinology Consult
C. Vitamin C & D + Calcium Citrate
D. Bisphosphonates
E. Teriparatides
Vertebral Column Resection (VCR)

Multiplane – Sagittal & Coronal Correction

- Vertebrectomy
- Discectomies
- Cage Placement
- Shorten
- Amputate Intercostal Nerve Root
73 Year Old Female Presented with LBP, Seen In Terra Haute In, & had a Vertebroplasty, Pain became so Severe She has been bedridden over the past two months, now staying in southern Kentucky with Daughter. Saw a local NES, Called Our NES & Patient transferred after Studies Have Been interpreted as Probable Osteomyelitis. WBC is WNL, Sed Rate is 38, CRP is 2.1

History

Physical Exam

- Severe Lower Back Pain
- Motor Strength → Diffuse Weakness
- Sensory → Diffuse Numbness
- Severe LBP with Pain With Percussion → + Lumbar Kyphotic Deformity
- Intact Bowel/Bladder Function but Perineal Sensation Decreased

ASIA D
Bone Scan Showing Increased Uptake
Results Summary:

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<th>Region</th>
<th>Area [cm²]</th>
<th>BMC [g]</th>
<th>BMD [g/cm²]</th>
<th>T-Score</th>
<th>PR (Peak Reference)</th>
<th>Z-Score</th>
<th>AM (Age Matched)</th>
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Total BMD CV 1.0%, ACF = 1.007, BCF = 0.981

Results History:

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<td>24.3%*</td>
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Treatment Options

1. Traction
2. PSF
3. PSF + PCO (Ponte’s)
4. PSF + CTV
5. Anterior Vertebrectomy (AIBF) + PSF + Instrumentation
6. AIBF (Vert.) + PSF + PCOs

Optimization

A. Stop Smoking
B. Endocrinology Consult
C. Vitamin C & D + Calcium Citrate
D. Bisphosphonates
E. Teriparatides
Interoperative Anterior Reconstruction
Removal of 1st (Left) Cement Fragment
Anterior Reconstruction with Cage
Soft Tissue & Bone Cultures Negative
Posterior Instrumentation + Teriparatide
67 Year Old Male Involved in a MVA. Seen in the ER 6 Months Ago Complaining of Severe Pain in the Middle of the Back. Treated With a Brace but Continues to Have Severer TL Pain.

ASIA E

[Two images of X-rays showing spinal surgery and hardware, dated September, 2007]
4 Months Following Injury

Dec. 9th, 2013
4 Months Following Injury

Dec. 9th, 2013
Follow-up MRI

July 9th, 2014
Follow-up Thoracic CT

July 21st, 2014
Follow-up Lumbar CT

July 21st, 2014

Dx: Burst Fracture + Probable AVN (Kummel’s Disease) Treated With Costo-transversectomy + Instrumented Spinal Fusion
### Treatment Options

1. Traction
2. PSF
3. PSF + PCO (Ponte’s)
4. PSF + CTV
5. Anterior Vertebrectomy (AIBF) + Instrumentation
6. AIBF (Vert.) + PSF + PCOs

### Optimization

A. Stop Smoking
B. Endocrinology Consult
C. Vitamin C & D + Calcium Citrate
D. Bisphosphonates
E. Teriparatidies
Costotransversectomy
Costotransversectomy

T8-9 Costotransversectomy for Kyphosis 2º to Osteomyelitis

Amputate the Intercostal Nerve Root
Intra-operative
(Pedicle Probe in Fx)
Intra-operative
(Costo-transversectomy & Expandable Cage Placement)
10-16-16

**History**

82 Year Old Female with no History of Illness Fell One month ago suffering a L2 “Compression” Fracture and a Left 3-Part Humeral fracture. Severe low back pain, unable to stand. She has severe bilateral Anterior Thigh Pain and Lower Extremity Weakness.

**Physical Exam**

- Severe Lower Back Pain
- Motor Strength → Diffuse Weakness
- Sensory → Diffuse Numbness
- Severe LBP with Pain With Percussion → + Lumbar Kyphotic Deformity
- Intact Bowel/Bladder Function but Perineal Sensation Decreased

ASIA D
Presentation Plain Radiographs in Brace & Bed

LEFT SEMI ERECT IN Brace

BED/IN BRACE

Loesay

Loesey
Cleft Sign
Indicative of AVN

MRI Scan Showing ITO Cleft Sign: Kummel’S
**DEXA Scan**

**Results Summary:**

<table>
<thead>
<tr>
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<th>BMC [g]</th>
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Total BMD CV 1.0%, ACF = 1.013, BCF = 1.013

Fracture Risk: High, WHO Classification: Osteoporosis
Shoulder XR
Treatment Options

1. Traction
2. PSF
3. PSF + PCO (Ponte’s)
4. PSF + CTV
5. Anterior Vertebrectomy (AIBF) + Instrumentation
6. AIBF (Vert.) + PSF + PCOs

Optimization

A. Stop Smoking
B. Endocrinology Consult
C. Vitamin C & D + Calcium Citrate
D. Bisphosphonates
E. Teriparatides
F. TLSO*  

* For a 3 Month Period
Inter-op Radiographs

Stage I

Stage II
Remember the Top Ten Important Factors with Traumatic Fractures

Questions?