Evolving Treatment of Traumatic Spine Fractures

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Introduction

Anatomical Overview
- Cervical Spine
- Thoracic Spine
- Lumbar Spine

Multiple classification schemes exist with regards to spine fractures. They all attempt to answer the same basic questions:
- How unstable is the spine?
- What is the optimal treatment?
- How much intervention should be performed?

White and Punjabi

Attempt to define clinical stability
- The ability of the spine under physiologic loads to limit displacement so as to prevent injury or irritation of the spinal cord and nerve roots and, to prevent incapacitating deformity or pain due to structural changes.

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**Classification Scheme**

**Stable Fracture**
- Should be treatable with immobilization alone
- Minor compression fractures
- Minor fracture through non-load bearing portion of spine
- Most common type of fracture

**Stable fractures need only temporary bracing/immobilization to allow proper healing**
- Not much to improve upon here

**Unstable Spine fracture**
- Inability of spine to bear load
- Compression of spinal cord or nerve roots
- Dislocation of normal anatomy

**Unstable fractures need to be stabilized and the spinal cord needs to be decompressed**
- This is where there is much debate and room for improvement
  - Who should have surgery?
  - When should surgery be performed?
  - What type and what extent of stabilization?
Treatment of Spine Fractures

- AO/ASIF – Arbeitsgemeinschaft fuer Osteosynthesefragen
- Association for the Study of Internal Fixation
  - Attempts to delineate optimal balance of stabilization and preservation of motion/function

Evolving Treatment of Traumatic Spine Fractures

- “In Wilderness is the preservation of the world”
  - Henry David Thoreau

Spinal Anatomy

- Skull
- 7 Cervical Vertebrae
- 12 Thoracic Vertebrae
- 5 Lumbar Vertebrae
- Sacrum
- Coccyx

Evolving Treatment of Traumatic Spine Fractures

- “In motion is the preservation of the spine”
  - Daniel Kueter
Cervical Spine

- Most motion of any spinal region
- Smallest bony structures of any spinal region
- Large stress forces from supporting the weight of the cranium
- Housing of delicate spinal cord and nerves
- Very little “wiggle room”

Pediatric vs. Adult

- Spinal cord injury is uncommon in children
- Head injuries outnumber spine injuries 30:1
- Only 5% of all spinal cord injuries occur in children
- National Emergency X-Radiography Utilization Study (NEXUS) attempts to establish an algorithm for what type of imaging is necessary in children and adults

Pediatric Spine Injuries

- Diagnosis
- C-spine X-rays not indicated in children who are awake, alert, neurologically intact, and no focal cervical tenderness
- With clinical signs/symptoms, then AP/Lateral C-spine films, Odontoid views, CT, MRI
- In the age group <10 years, 67% of cervical spine injuries occur in the upper 3 segments of the cervical spine
  - Diagnosis and treatment can be difficult

Cervical Spine

- We’ve all seen the pictures of this
- Now what do we do?
Initial management of spinal cord injury
- Major causes of death in spinal cord injury are aspiration and shock
- Appropriate survey and treatment under ATLS protocol
- Spinal immobilization
- The emphasis here is to define the spinal injury and take steps to prevent further cord injury and loss of function and minimize or reverse the present deficit

Management in the Field
- Immobilization of the affected area
- CPR takes precedence over spinal immobilization
- Maintain adequate blood pressure
  - Goal SBP > 90
  - Some benefit to mean arterial pressure > 85 for first 7 days after severe spinal cord injury
- Maintain adequate oxygenation
  - Injured spinal cord very susceptible to hypoxic changes

Tertiary Treatment
- Evaluation by Neurosurgeon
- Medical treatment to minimize spinal cord injury
- Surgical treatment to minimize spinal cord injury

Methylprednisolone (Solumedrol) Protocol
- Still highly controversial even among experts
- The evidence suggesting harmful side effects is more consistent than any demonstrated clinical benefit
- Solumedrol Protocol
  - 30mg/kg bolus of solumedrol over 15 minutes, followed by 45-minute pause, followed by maintenance infusion of 5.4mg/kg/hr for 23-47 hours
  - Must be started within 8 hours of injury
  - Therapy initiated within 3 hours of injury = 23 hour infusion
  - Therapy initiated 3-8 hours of injury = 47 hour infusion

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Methylprednisolone (Solumedrol) Protocol

- Not indicated for
  - Cauda equina syndrome (Compression of the spinal nerves, not the spinal cord itself)
  - Gunshot wound to the spine
  - Life threatening morbidity (Morbid obesity, fragile diabetic)
  - Pregnancy
  - Narcotic Addiction
  - Age <13 years
  - Patient on routine maintenance steroids (Rheumatoid arthritis, endocrine insufficiency)

In summary, the potential for benefit is questionable at best

The potential risk is known and is significant

The current trend among neurosurgeons is to withhold Solumedrol protocol

Informal polling at most neurosurgical meetings results in 2/3 of neurosurgeons reporting that they have abandoned the protocol

So, if Solumedrol doesn’t help much, what is on the horizon???

Early Decompression of Cervical Spinal Cord Injury

- Journal of Neurosurgery December 1975 Volume 43, Number 6
- Management of cervical spinal cord trauma in Southern California

Acute cervical spinal cord injuries were reviewed in 151 patients treated by the neurosurgical community in Southern California. Neurological recovery was compared preoperatively and postoperatively to determine the effect of early surgical decompression on neurological recovery. No neurological improvement was found in any patient with a complete lesion who underwent early surgical decompression. In those with incomplete lesions the effect of early decompression on neurological recovery could not be determined. Patients with some degree of sensory preservation had a similar incidence of motor recovery after early surgical decompression.

With complete sensory preservation, anterior cervical fusion within the first week of injury was associated with improved neurological recovery.
Early Decompression of Cervical Spinal Cord Injury

Spine, 15 November 1997 - Volume 22 - Issue 22 - pp 2609-2613

Neurologic Outcome of Early Versus Late Surgery for Cervical Spinal Cord Injury

Vaccara, Alexander R. MD, et al

Conclusions. The results of this study reveal no significant neurologic benefit when cervical spinal cord decompression after trauma is performed less than 72 hours after injury (mean, 1.8 days) as opposed to waiting longer than 5 days (mean, 16.8 days).

Immediate Spinal Cord Decompression for Cervical Spinal Cord Injury: Feasibility and Outcome

Papadopoulos, Stephen M. MD, et al

Methods : 91 consecutive patients with acute, traumatic cervical spinal cord injury (1990-1997) were prospectively studied. Sixty-six patients (protocol group) underwent emergency magnetic resonance imaging (MRI) to determine the presence of persistent spinal cord compression followed, if indicated, by immediate operative decompression and stabilization. Twenty-five patients were managed outside the treatment protocol.

Results : Fifty percent of protocol patients, compared with only 24% of reference patients, improved from their admitting Frankel grade. Eight protocol patients (12%), but no reference patients, improved from complete motor quadriplegia (Frankel grade A or B) to independent ambulation (Frankel grade D or E). Protocol patients required shorter intensive care unit stays, and shorter total hospital stays than reference patients.

Conclusion : We conclude that immediate spinal column stabilization and spinal cord decompression, based on magnetic resonance imaging, may significantly improve neurologic outcome. The feasibility of such a treatment protocol in a tertiary treatment center is well demonstrated.

Injury, Volumme 36, Issue 2, Supplement 1, July 2005, Pages S13-S26

Surgery in Spinal Trauma

The role and timing of early decompression for cervical spinal cord injury. Update with a review of recent clinical evidence

Michael G. Fehlings and Richard G. Perrin, Division of Neurosurgery, Toronto Western Hospital, Toronto, Ontario, Canada

Animal studies consistently show that neurological recovery is enhanced by early decompression.

One randomized controlled trial showed no benefit to early (<72 h) decompression, however, several recent prospective series suggest that early decompression (<12 h) can be performed safely and may improve neurologic outcomes.

A recent meta-analysis showed that early decompression (<24 h) resulted in statistically better outcomes compared to both delayed decompression and conservative management.

Currently, there are no standards regarding the role and timing of decompression in acute spinal cord injury.

Urgent decompression in acute cervical spinal cord injury remains a reasonable practice option and can be performed safely.
Early Decompression of Cervical Spinal Cord Injury

- STASCIS: Surgical Treatment of Acute Spinal Cord Injury Study
- Presented at the American Association of Neurological Surgeons (AANS) 76th Annual Meeting, 2008.
- Preliminary, 1-year results from the Surgical Treatment of Acute Spinal Cord Injury Study (STASCIS) showed 24% of patients who received decompressive surgery within 24 hours of their injury experienced a 2-grade or greater improvement on the American Spinal Injury Association (ASIA) scale, compared with 4% of those in the delayed-treatment group.
- Final results expected to be published in 2011.

Minimally invasive treatment of Cervical Spine fractures

- C2 Odontoid fracture

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Thoracic and Lumbar Spine
- Anatomically similar
- Surgical fixation techniques similar

Thoracic Spine
- Least mobile of the major spine segments
- Most resistant to injury
- Most likely to be treatable with bracing

Thoracic Spine
- If bracing is not adequate, the thoracic spine is the most forgiving for long section instrumentation and fusion

Evolving Treatment of Traumatic Thoracolumbar Spine Fractures
Shorter Segment Constructs
Shorter Segment Construct

- Historical data for unstable burst fractures “3 above, 2 below”
- Stabilize broken bone by permanently fusing it to the bones above and below
- Evolution of robust materials, pedicle fixation, and enhanced materials for biologics enables shorter segment constructs

Shorter Segment Construct

- 55F with L2 unstable burst fracture
- T11-L4 fusion in 2004
- Fusion and hardware failure at L3-4, foot drop due to disc incompetence at L4-5
- Final outcome T11-S1 fusion in 2008...for single level burst fracture

Shorter Segment Construct

- How short can you go?
- Two levels above and one level below pedicle screw fixation for the treatment of unstable thoracolumbar fracture with partial or intact neurology
- Hitesh N Modi, et al
- Conclusion
- Two levels above and one level below pedicle screw fixation in unstable thoracolumbar burst fracture is useful to prevent progressive kyphosis and preserves one motion segment distally.

Shorter Segment Constructs

- Since arrival in Chattanooga, I have only once done a construct longer than 2 above, 1 below. No failures to this point.
- Most of my constructs are 1 above and 1 below.
  - I almost always place screws in the fractured body to provide additional stability points.
  - If I cannot place instrumentation in fractured bone, then I will extend construct either superior or inferior for a total of 3 fixation points bilaterally.
  - I almost always go bicortical with my screw placement
Short Segment Constructs

- Parker JW, Lane JR, Karaikovic EE, Gaines RW.
- Department of Orthopaedic Surgery, University of Missouri, Columbia, Missouri 65212, USA.
- 46 of 51 complex spine fractures managed with instrumentation one level above and one level below the fracture site.
- Mean follow up 5.5 years.
- No patients lost to follow up.
- 45 of these 46 patients healed appropriately without complication = 97% success rate.

Short Segment Constructs

- 19 yo female s/p fall from rope swing
- Bowel, Bladder dysfunction; Painful dysesthesias; Leg weakness

Short Segment Constructs

- 44 yo female s/p MVA
- Bowel, Bladder dysfunction; Painful dysesthesias; Leg weakness

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Short Segment Construct

Evolving Treatment of Traumatic Thoracolumbar Spine Fractures

Expanding role of Kyphoplasty

- Traditional indication for osteoporotic compression fracture with posterior vertebral body wall intact
- I have expanded this to include a multitude of traumatic burst and compression fractures
- My initial algorithm:
  - Can it be treated with kyphoplasty?
  - If not, what is the shortest construct I can make to achieve stability
  - If the patient has any symptomatology, I will almost always choose kyphoplasty over bracing

Kyphoplasty is probably our most successful procedure
- Patients do exceedingly well
- Kyphoplasty kit = $3000
- Custom TLSO Hardshell brace = $2000
  - To my estimation, 99% of patients are non-compliant with bracing
  - If they get up and walk around even once without their brace, they are exposing themselves to risk
  - Kyphoplasty provides permanent correction of deformity and prevention of long term sequelae
  - Patient pain relief after Kyphoplasty is almost instantaneous
Expanding role of Kyphoplasty

- 18 M s/p Jet Ski accident
- Just graduated high school
- Scheduled for 14 day graduation trip to Hawaii in 1 week
- Scheduled for international church trip to Africa in 1 month
- L1 burst fracture
- Significant back pain
- Primary concern is quality of life over next several months

Expanding Role of Kyphoplasty

- 67 F s/p fall while hiking in Costa Rica
- Airlifted to Chattanooga for “Higher level of care”
- Braced by one of my partners
- Hurt to breathe or walk

Expanding Role of Kyphoplasty

- Discharged home pain free the next morning
- On a 12 hour plane trip to Hawaii 6 days later
- Currently in Africa doing mission work

Expanding Role of Kyphoplasty

- Home the next morning
- At the “Cotton Ball” social gala the following night
Expanding role of Kyphoplasty

- 44M s/p fall over waterfall
- Painful to even breathe

Expanding role of Kyphoplasty

- Discharged home 16 hours later, pain free, no brace

Expanding Role of Kyphoplasty

Emerging Techniques in Spine

Instrumented Reduction of Fracture without Fusion
Instrumented Reduction of Fracture without Fusion

- 9 yo boy s/p MVA
- Exp Lap with repair of multiple mesenteric bleeders, partial bowel resection
- L3-4 Chance fracture
- Option of brace vs. Instrumentation without fusion vs. Instrumentation/Fusion
- No anterior tension band due to exp lap

Opted for instrumentation without fusion
- Patient is riding his bike and swimming 2 weeks after surgery
- He is, of course, non-compliant with his brace
- Hardware removed 3 months after placement
- Patient has healed in correct anatomic alignment with permanent full range of motion
- Patient’s spine will be able to grow in height as he matures

2010 Erlanger Trauma Symposium

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In Summary

- Appropriate Initial assessment, immobilization, and resuscitation
  - No Changes here
- Early Decompression and stabilization
  - Studies likely will show statistical benefit to early decompression
- Preservation of as many motion segments as possible while safely protecting the spine
  - Minimize length of instrumentation constructs
  - Exploration of newer, less invasive technologies, such as kyphoplasty
  - Temporary internal instrumentation may be safer and offer better healing than external braces