Session I:  
This Paper Will Change Your Practice – It Changed Mine. New Information That You Need to Know

7:30 am – 8:40 am

**Moderators: Michael D. McKee, MD and Mohit Bhandari, MD, PhD, FRCSC**

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A Trial of Fracture Fixation in the Operative Management of Hip Fractures

Fixation using Alternative Implants for the Treatment of Hip fractures (F.A.I.T.H) Investigators*

The Writing Committee members are as follows:


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ABSTRACT

Background
Reoperation rates are high after surgery for hip fractures. We investigated the effect of a sliding hip screw versus cancellous screws on the risk of reoperation and other key outcomes.

Methods
For this international, multicentre, allocation concealed randomised controlled trial, we enrolled patients aged 50 years or older with a low-energy hip fracture requiring fracture fixation from 81 clinical centres in eight countries. Patients were assigned by minimisation with a centralised computer system to receive a single large-diameter screw with a side-plate (sliding hip screw) or the present standard of care, multiple small-diameter cancellous screws. Surgeons and patients were not blinded but the data analyst, while doing the analyses, remained blinded to treatment groups. The primary outcome was hip reoperation within 24 months after initial surgery to promote fracture healing, relieve pain, treat infection, or improve function. Analyses followed the intention-to-treat principle. This study was registered with ClinicalTrials.gov, number NCT00761813.

Findings
Between March 3, 2008, and March 31, 2014, we randomly assigned 1108 patients to receive a sliding hip screw (n=557) or cancellous screws (n=551). Reoperations within 24 months did not differ by type of surgical fixation in those included in the primary analysis: 107 (20%) of 542 patients in the sliding hip screw group versus 117 (22%) of 537 patients in the cancellous screws group (hazard ratio [HR] 0·83, 95% CI 0·63–1·09; p=0·18). Avascular necrosis was more common in the sliding hip screw group than in the cancellous screws group (50 patients [9%] vs 28 patients [5%]; HR 1·91, 1·06–3·44; p=0·03. However, no significant difference was found between the number of medically related adverse events between groups (p=0·82; appendix); these events included pulmonary embolism (two patients [<1%] vs four [1%] patients; p=0·41) and sepsis (seven [1%] vs six [1%]; p=0·79).
**Interpretation**

In terms of reoperation rates the sliding hip screw shows no advantage, but some groups of patients (smokers and those with displaced or base of neck fractures) might do better with a sliding hip screw than with cancellous screws.

**Funding**

National Institutes of Health, Canadian Institutes of Health Research, Stichting NutsOhra, Netherlands Organisation for Health Research and Development, Physicians’ Services Incorporated.
Non-Union Research That Will Impact Your Practice

Donald A Wiss  Cedars-Sinai Medical Center  Los Angeles, California

Non-Union Research That Will Impact Your Practice

Classification
- Hypertrophic
- Oligiotrophic
- Atrophic

Anatomic Site
- Femur, Tibia, Humerus

Location
- Proximal
- Middle
- Distal

Alignment
- Straight
- Angular
- Rotation

Bone Grafts
- Autologous
- BMP
- Substitutes
- Stem Cells, PRP

Other Treatments
- Exchange Nailing
- Dynamization
- Augmentation Plate
- Bone Transport

Other Considerations
- Failed Fixation
- Stiff Joints
- Antibiotic Spacers

Social Issues
- Insurance
- Social Support
- Co-Morbidities

Biology
- Aseptic
- Septic

Basic Science
- Molecular Pathways
- Stem Cells
- Genetics

Clinical Evaluation
- CBC, ESR, CRP
- Metabolic Work-Up
- Imaging

Soft Tissues
- VAC
- Rotational Flaps
- Free Tissue Flaps

Other Considerations
- Failed Fixation
- Stiff Joints
- Antibiotic Spacers

Treatment
- IM Nail
- Plate
- External Fix
- Arthroplasty

Non-Union

Definition
This Paper Will Change Your Practice: Elbow
David Ring MD PhD

- Surgery for stiffness is MORE effective when there is heterotopic ossification restricting motion

- No difference in splints
- Not clear that a splint is better than exercises on your own
- People improved for more than 12 months
- In the absence of HO, ulnar neuropathy, errant implants, malunion, etc. the capsule can be stretched

- Protectiveness creates stiffness
- Not an elusive pathophysiology

- Coaching that stretching helps creates immediate gains in motion

- Selected distal humerus, elbow fracture-dislocations, and olecranon fractures can be treated nonoperatively

- Beware the apparent capitellum fracture. It’s often much more complex
HANDOUT COMING SOON
Zone 2 sacral fractures managed with partially-threaded screws result in low risk of neurologic injury

Amir Herman, Emily Keener, Candice Dubose, Jason A. Lowe

A B S T R A C T

Background: Zone 2 sacral fractures account for 34% of sacral fractures with reported neurological deficit in 21–28% of patients. The purpose of this study was to examine the risk factors for neurological injury in zone 2 sacral fractures. The authors hypothesized that partially thread iliosacral screws did not increase incidence of neurological injury.

Methods: A retrospective review of consecutive patients admitted to a level 1 trauma center with zone 2 sacral fractures requiring surgery from September 2010 to September 2014 was performed. Patients were excluded if no neurologic exam was available after surgery. Fractures were classified according to Denis and presence/absence of comminution through the neural foramen was noted. Fixation schema was recorded (sacral screws or open reduction and internal fixation with posterior tension plate). Any change in post-operative neurological exam was documented as well as exam at last clinic encounter.

Results: 90 patients met inclusion criteria, with zone 2 fractures and post–operative neurological exam. No patient with an intact pre-operative neurologic exam had a neurological deficit after surgery. 86 patients (95.6%) were neurologically intact at their last follow-up examination. Four patients (4.4%) had a neurological deficit at final follow-up, all of them had neurological deficit prior to surgery. 81 patients were treated with partially threaded screws of which 1 (1.2%) had neurological deficit at final follow-up. Fifty-seven fractures (63.3%) were simple fractures and 33 fractures (36.7%) were comminuted. All four patients with neurological deficit had comminuted fractures. The association between neurologic deficit in zone 2 sacral fracture and fracture comminution was found to be statistically significant (p-value = 0.016). No nonunion was observed in this cohort.

Conclusions: The use of partially threaded screws for zone 2 sacral fractures is associated with low risk for neurologic injury, suggesting that compression through the fracture does not cause iatrogenic nerve damage. The low rate of sacral nonunion can be attributed to compression induced by the use of partially threaded compression screws. There is a strong association between zone 2 comminution and neurologic injury.

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Introduction

Sacral fractures occur in 23–45% of all pelvic ring injuries, and when found to be unstable, require operative stabilization [1–3]. Sacral fractures are classified according to Denis: extra foraminal (Zone 1), involving the neural foramina (Zone 2) or involving the neural canal (Zone 3) [3]. Zone 2 sacral fractures are reported to range between 34 and 47.5% of all sacral fractures. Denis originally described the influence of fracture zone on neurological deficit and prognosis, with zone 2 fractures characterized by injury to the L5 through lower sacral nerve roots. Other authors reported the incidence of neurologic damage to be as high as 21–28% of the patients with most patients recovering at least one functional level [4,5].

Several fixation methods for zone 2 sacral fractures have been examined: posterior plating [6,7], triangular fixation using pedicular screws [8] and sacroiliac or trans-sacral screws [9–13]. Percutaneous fixation with trans-sacral or sacral screws has become a popular method of fixation owing to, low complication rates and good clinical outcomes [12,13]. In addition, the
biomechanical properties of the sacral screws show 80–85% return of pelvic biomechanical rigidity after instrumentation [14,15].

One potential concern with partially threaded screws is the potential for compression and narrowing of the neural foramen particularly through comminuted fractures, which may result in iatrogenic neurologic injury [16,17]. Fully threaded screws represent an alternative to partially threaded screws as a means to avoid this potential complication [18,19].

The purpose of this study was to define the incidence of post-operative neurologic injury and identify risk factors for neurologic deficit after zone 2 sacral fractures. The authors hypothesized that partially threaded posterior screws (trans-sacral, sacral) would not result in iatrogenic neurologic injury, and that fracture comminution through the neural foramen would predict injury-related neurologic compromise.

Methods

Following institution IRB approval, a retrospective review of all pelvic ring fractures and fracture dislocations fixed at a single level 1 trauma academic center from September 2010 to September 2014 was performed using CPT and ICD-9 codes. Patient inclusion criteria included: age > 18 years at the time of injury and closed zone 2 sacral fracture according to Denis. Exclusion criteria were: lack of neurological examination after surgery, patients that did not have neurologic examination prior to surgery and had a neurologic deficit after surgery, open fractures, and any patient transferred after fixation to an outside facility.

We extracted patient demographic data including age and gender; as well as injury profiles (mechanism of injury, abbreviated injury score (AIS) and the injury severity score (ISS)). Neurological status at arrival, first available neurologic exam after surgery and last clinical follow-up neurologic examination were obtained from consult, post-operative, in-patient progress, and clinic notes, respectively. Further data collection included: comminuted vs simple fractures, the surgical intervention of open vs closed reduction, and posterior tension band plate fixation versus percutaneous screws, as well as screw type (partially threaded vs fully threaded), and screw number.

Neurologic deficit at final follow up was defined as motor strength of less than five (out of five) of the injured extremity.

Statistical analysis

Statistical analysis was performed by an experienced biostatistician (A.H.) using SPSS © 23.0 (Chicago, IL, USA). Categorical data are presented as count (percent). Continuous data are presented as mean (±standard deviation). The data were divided to patients with intact and deficient neurological examination at final follow-up. All the collected variables were compared between these two study groups. Comparisons between continuous variables were done by the Wilcoxon–Mann–Whitney rank sum test. Comparisons between categorical data were done with chi-square test or the Fisher exact test. The later test was used if expected count was less than five in any cell. All p-values reported are two-sided.

Results

Initial data review included 100 patients with zone 2 sacral fractures. After reviewing the patients’ data, seven patients were excluded because of lack of neurological examination at follow-up. These included one patient that died shortly after admission, five patients that were transferred intubated and followed at another hospital and one patient that had an above knee amputation the same side as the sacral fracture. Three additional patients were excluded because they did not have a neurological examination prior to surgery and had a neurologic deficit after surgery.

The study population included 90 patients, mean age was 39.10 (±15.03). Of the 90 patients, 36 patients (40.0%) were male and 54 patients (60.0%) were female. The most common cause of injury was motor vehicle accident – 52 patients (57.8%) followed by fall from height – 12 patients (13.3%). There was no statistically significant difference in the demographic characteristics between neurologically intact and deficient patients (Table 1).

Of the 90 patients, 86 (95.6%) had no neurological deficit at any time point. Four patients (4.4%) had a neurological deficit at final follow-up. None of the four patients with final neurological deficit had an intact examination at time of admission. These four patients presented with weak but present initial motor exam defined as 2–3/5 motor strength in the tibialis anterior, extensor hallucis longus, flexor hallucis longus or gastrocnemius–soleus complex. No patient presenting with an initially intact neurologic exam developed a neurologic deficit following operative fixation (Table 2).

Table 1

<table>
<thead>
<tr>
<th>Neurologically intact PostOp</th>
<th>Neurologically deficit PostOp</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>39.21 (±15.22)</td>
<td>36.75 (±10.43)</td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
<td>34 (39.5%)</td>
</tr>
<tr>
<td>Gender</td>
<td>Female</td>
<td>50 (60.5%)</td>
</tr>
<tr>
<td>Mechanism of injury</td>
<td>Assault</td>
<td>1 (1.2%)</td>
</tr>
<tr>
<td>Crush Injury</td>
<td>Fall from height</td>
<td>12 (14.0%)</td>
</tr>
<tr>
<td>Fall from horse</td>
<td>MCC</td>
<td>12 (2.3%)</td>
</tr>
<tr>
<td>MVC</td>
<td>Pedestrian vs MV</td>
<td>10 (11.6%)</td>
</tr>
<tr>
<td>Tornado</td>
<td>AIS–Abdomen</td>
<td>2.38 (±0.61)</td>
</tr>
<tr>
<td>AIS–Extremities</td>
<td>AIS–Injury severity score</td>
<td>3.02 (±0.88)</td>
</tr>
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Table 2

<table>
<thead>
<tr>
<th>Neurologically intact PostOp</th>
<th>Neurologically deficit PostOp</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side of zone 2 fracture</td>
<td>Left</td>
<td>42 (48.8%)</td>
</tr>
<tr>
<td>Right</td>
<td>Bilateral</td>
<td>33 (38.4%)</td>
</tr>
<tr>
<td>Fracture pattern</td>
<td>Simple</td>
<td>11 (12.8%)</td>
</tr>
<tr>
<td>Committted</td>
<td>Fixation method</td>
<td>19 (22.3%)</td>
</tr>
<tr>
<td>ORIF and plate</td>
<td>CRPP and screw</td>
<td>5 (6.1%)</td>
</tr>
<tr>
<td>Type of screws</td>
<td>Sacroiliac screws</td>
<td>35 (40.3%)</td>
</tr>
<tr>
<td>Trans-sacral screws</td>
<td>Number of screws</td>
<td>46 (56.8%)</td>
</tr>
<tr>
<td>1 screw</td>
<td>2 screws</td>
<td>48 (59.3%)</td>
</tr>
<tr>
<td>2 screws</td>
<td>3 screws</td>
<td>25 (30.9%)</td>
</tr>
<tr>
<td>3 screws</td>
<td>4 screws</td>
<td>5 (6.2%)</td>
</tr>
<tr>
<td>Type of screw threads</td>
<td>Partially threaded</td>
<td>3 (3.7%)</td>
</tr>
<tr>
<td>Fully threaded</td>
<td>Fully threaded</td>
<td>1 (1.2%)</td>
</tr>
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AIS=Abbreviated Injury Score; MVC=Motor vehicle collision; MCC=Motor cycle collision; MV=Motor vehicle.
Table 3
Neurological examination of patients with neurological deficit.

<table>
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<tr>
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<th>First available examination</th>
<th>Last follow-up examination</th>
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<tbody>
<tr>
<td>Patient 1</td>
<td>TA 3 EHL 4 FHL 4 GS 4</td>
<td>TA 1 EHL 5 FHL 5 GS 5</td>
</tr>
<tr>
<td>Patient 2</td>
<td>2 2 NA NA 2 2 5 5</td>
<td></td>
</tr>
<tr>
<td>Patient 3</td>
<td>3 3 3 3 3 4 4 4</td>
<td></td>
</tr>
<tr>
<td>Patient 4</td>
<td>3 3 3 3 3 4 4 4</td>
<td></td>
</tr>
</tbody>
</table>

NA = Not available. TA = Tibialis anterior, EHL = Extensor hallucis longus, FHL = Flexor hallucis longus, GS = Gastrocnemius-Soleus.

Of the four patients with deficit at final follow-up all had Tibialis Anterior (TA) and extensor hallucis longus (EHL) motor strength of less than five (out of five). Two patients had either flexor hallucis longus or Gastrocnemius-soleus complex with strength of four or less (of five). One patient also experienced a sensory deficit. Most patients had some recovery of their initial examination (see Table 3).

Correlation of associated injuries and neurologic deficit after sacral fracture was performed using the abbreviated injury score (AIS, Table 1). For the entire patient cohort the mean AIS – abdomen was 2.43 (±0.689). The mean ISS for the entire patient cohort was 22.72 (±10.63). There was a statistical trend for higher ISS in neurologically deficient patients (p-value = 0.087).

Fifty seven patients (66.3%) had simple pattern fractures (Fig. 1) and 33 patients (36.7%) had comminuted fractures (Fig. 2). All four patients with neurological deficit had a comminuted fracture pattern. Of the 86 patients without neurological deficit, 29 patients (33.7%) and 57 (66.3%) had comminuted or simple fracture patterns, respectively. The association between comminuted fractures and neurological deficit was found to be statistically significant. (p-value = 0.016, Table 2).

Of patients with comminuted fracture those with neurological deficit were more commonly fixed open reduction and internal plate fixation (two patients 50.0%) than patients that were neurologically intact (five patients, 5.8%). This difference was found to be statistically significant (p-value = 0.001).

Sacral screws alone were used to fix the sacral fractures of 35 patients (42.16%). In 48 patients (58.84%), trans-sacral screws were used for fracture fixation, either combined with sacroiliac screws or as sole fixation. No statistically significant difference was found between these two groups (p-value = 0.506, see Table 2). Percutaneous screw fixation was performed in 83 patients and partially threaded screws were used in 81 (97.6%) of these. Only one (1.2%) of these 81 patients had neurological deficit at final follow-up, but this deficit was present pre-operatively. There were no nonunions recorded in this cohort.

Discussion

The data presented supports a higher incidence of neurologic injury with comminuted zone II fractures than simple fractures. Surgical fixation with partially threaded sacral and trans-sacral screws did not result in iatrogenic neurologic injury even in comminuted fractures.

Previous works described the incidence of neurologic injury after sacral fractures to be as high as 21–28% [2,5]. The most common injury pattern described was a sensory-motor deficit [5]. Zone 2 sacral fractures are mostly associated with sciatic-like nerve injury and drop-foot – injury to the L5-S1 nerve roots. In this series, the incidence of neurologic injury (4.4%) is lower than previously reported.

It has been reported that all patients show improvement of at least one grade of muscle function and 53% have complete...
neurological recovery [5]. In our patient, cohort one patient had neurological recovery and that after he had sacral laminectomy and decompression during his open reduction and internal fixation (Fig. 2).

Vaccaro et al. and Routt et al. have suggested that zone 2 sacral fractures should be fixed using fully threaded sacral screws to avoid neuroforaminal compression generated by partially threaded screws and resultant iatrogenic nerve injury [16,17]. Concise scientific study of this assertion is lacking. Data presented in this cohort does not support these prior concerns as no patient with comminution developed a postoperative neurologic injury. Additionally, this series supports that surgical stabilization with partially threaded sacral and trans-sacral screws yielded 100% union rate.

Min et al. reported on 35 patients with Zone 2 sacral fractures that were treated with partially threaded sacral screws. They did not find any new neurological deficit that could be attributed to the compression screws [20]. They did not study other risk factors such as comminution and they had a small cohort of 35 patients that had Zone 2 sacral fracture.

Our data suggest that neurologic deficit is injury related and that it depends on the comminution of the fracture that is determined at injury. Strengthening this conclusion is the fact that neurologically injured patients had higher scores of abdomen AIS and ISS. This suggests that these were more severely injured patients. We did not recognize a single patient that had an intact neurological examination upon admission and had a neurological deficit after surgery.

Fig. 2. A 39-year-old male that was injured in a motor vehicle collision. (a) an axial CT in which the comminution involves the neural foramina can be seen with a fragment in the foramina. He initially presented with motor function of three out of five in TA, EHL, FHL and GS. He was treated by open reduction, decompression laminectomy and internal fixation by two tension bands. (b) and (c) presents his inlet and outlet pelvis x-ray at 1 year follow-up. He recovered to four out of five in TA, EHL, FHL and GS but remained 0/5 in peroneal strength.

Our study has several drawbacks; the first is that it is a retrospective study based on clinical records some of which some records might be incomplete or biased. Several patients were intubated upon arrival which makes it impossible to determine their neurological status at arrival. However, intubation upon arrival is inherent to a population of severely injured patients at a referral trauma center. These patients cannot be excluded if a true representation of the sacral fracture population is to be considered. Further studies are required to confirm our results. More specifically, we would be interested in a randomized trial comparing the results between partially threaded and fully threaded screws, focusing both on neurologic status and union rate after surgical fixation of zone 2 sacral fractures.

Conflicts of interest

None declared.

References


This Paper Will Change Your Practice, It Changed Mine: New Information That You Need to Know

OTA Specialty Day March

Kenneth A. Egol, M.D.
I (and/or my co-authors) have something to disclose.

Detailed disclosure information is available via:

“My Academy” app;

Printed Final Program; or

AAOS Orthopaedic Disclosure Program on the AAOS website at [http://www(aaos.org/disclosure](http://www.aaos.org/disclosure)
Closed Contact Casting Vs Surgery for Initial Treatment of Unstable Ankle Fractures in Older Adults: A Randomized Clinical Trial

- Randomized Clinical Trial
- Published IN JAMA
- Took place at 24 centers in the UK
Design

• Patients over 60

• Randomized to receive cast or surgery
  • Via telephone 24 hrs a day

• 6 week assessments not blinded all others were

• Min 6 months FU
Intervention

• ORIF
  • Standard Principles
  • Post op care per surgeon

• Close Contact Cast
  • IN OR under anesthesia
  • Specific protocol
  • All had 1 hour training session
Outcomes

• 620 patients randomized
  • Over 300 in each group

• Follow up at 6 weeks and 6 months

• Olerud-Molander Score
• SF-12
• Euro-Quol 5
• Pain from subscales of OM
Outcomes

- Patient reported time to WB
- Timed get up and go test at 6 mos
- Radiographic
  - Union
  - Ankle mortise
- Complications recorded
Results

• Baseline demos demonstrated equivalent groups

• 19% of casted patients were converted to ORIF due to loss of reduction

• 4% re-casted (second anesthetic)
Results

• At 6 months successfully casted and ORIF had equivalent outcomes

• 10% of ORIF patients had a wound problem or infection (1% in cast)
Limitations

- 6 months follow up
- Definition of Older?
- Learning curve to casting
- Ankle fractures are a wide range of injury
- A reduced mortise at healing is the key- not new
So Why is it Important?

• Provides level 1 evidence to what we know

• Provides treating surgeons with information to discuss with patients and families

• Provides cover from malpractice attorneys
Conclusion

• In properly selected older patients with unstable ankle fractures

• Casting with a reduced ankle mortise can be successful 75% of the time

• If this treatment is chosen, patients need close follow up
Thank You
This Paper Will Change Your Practice – It Changed Mine. New Information That You Need to Know:

Basic Science

Theodore Miclau, MD
Department of Orthopaedic Surgery, University of California, San Francisco
UCSF/ZSFG Orthopaedic Trauma Institute, San Francisco, USA

The burden of musculoskeletal disease has surpassed cardiovascular disease as the major health burden in the world, and bone fractures contribute substantially to the overall burden of musculoskeletal disease. In the US, there are over 600,000 fractures per year with a substantial number of these fractures exhibiting delayed healing or non-union. The gold standard to stimulate bone union been autologous bone grafting, which although generally good, remains problematic due to limited graft supply, donor site morbidity, and potential complications. Therefore, understanding mechanisms of normal fracture healing to develop effective therapies to treat patients is imperative.

Generally, fracture repair occurs through two processes: direct bone (intramembranous ossification) and the formation of bone through a cartilage intermediate (endochondral ossification). With the exception of an initial inflammatory process, adult healing is similar to that observed during bone development. Previous work suggested that in adult repair, stem cells in the periosteum and endosteum give rise to chondrocytes that form the soft callus during endochondral ossification, and subsequently, during vascular invasion of the cartilage callus, osteoprogenitor cells are delivered to the fracture site to form new bone.

Recent findings, however, challenge this assumption. This presentation will summarize an article (Hinton et al., 2017) that reviews data suggesting that suggests that a significant number of bone cells are derived directly from the transformation of chondrocytes. They discuss other recent findings that show demonstrate this concept (see other references below).

These finding are potentially paradigm-shifting. Traditionally, strategies for stimulating bone repair seek to stimulate the process of direct bone formation. However, given that the majority of long bone fractures heal with some degree of callus formation (with the exception of those treated with absolute stability) and bone is formed directly through the transformation of chondrocytes, successful fracture repair therapies might target the endochondral rather than intramembranous ossification process. These findings have the potential to affect the way fracture healing, bone incorporation, and bone tissue engineering strategies are developed and employed.

Reference:

Other references: