RADIOLOGICAL EVALUATION & CLASSIFICATION IN PELVIC FRACTURES

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Disclosures

No conflicts of interest

Pelvis is a ring: % 96.8 post lesion (Scheyerer MJ 2012)
Pelvic Injuries

AP pelvic radiogram is diagnostic in 90% of patients

- Anterior pelvic lesions
- Associated acetabular fracture
- Posterior pelvic lesions
- Deformities
  - rotational
  - vertical

AP Pelvic Radiogram

Gap < 5 mm

Gap < 4 mm
• Promontorium should overlap anterior border of S1
  • Posterior displacement
  • Rotational deformities
  • Subtle S1 joint injuries
    • Sacral ala

• Upper border of pubic symphysis should be on the level of S2 body
  • Vertical displacement
  • Sacral foramina
  • Flexion deformities
Computerized Tomography

- More detailed information from posterior lesions
- Sacral foramina
- Subtle sacral impactions
- Rotation of hemipelvis, comminution
- Associated lesions

Radiological Instability Criteria
Radiological Instability Criteria

- Posterior displacement > 5 mm
- Vertical displacement > 5 mm
- Displacement instead of impaction in posterior pelvis
Radiological Instability Criteria

- Symphyseal diastasis > 2.5 cm

Radiological Instability Criteria

- Avulsion fxs:
  - L5 transverse process
  - Ischiadic spine
  - Lateral border of sacrum

Attention!

- Stationary pelvic radiograms do not always reflect true pathology
- All apparently stable patients should get EUA
Floroscopic Imaging

Classification
Young & Burgess Classification

<table>
<thead>
<tr>
<th>LATERAL COMPRESSION</th>
<th>ANTEROPOSTERIOR COMPRESSION</th>
<th>VERTICAL SHEAR</th>
<th>COMBINED MECHANISM</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Lateral Compression" /></td>
<td><img src="image2.png" alt="Anteroposterior Compression" /></td>
<td><img src="image3.png" alt="Vertical Shear" /></td>
<td><img src="image4.png" alt="Combined Mechanism" /></td>
</tr>
</tbody>
</table>

Young & Burgess Classification

- Mechanism of injury
- Severity of the injury
- Associated injuries
- Hemodynamic instability
- Mechanical instability

Lateral Compression Injury

- Internal rotation
- Anterior SI, SS & ST ligaments shorten, but not torn
- Posterior neurovascular injury seldom
- Pathognomonic: Transverse pubic rami fx (inlet)
- Unilateral, contralateral or bilateral
- If bilateral, one set of rami will always have a transverse fx pattern
Lateral Compression Type I Injury

- Most common LC type
- Transverse rami fxs + sacral impaction
- Mostly mechanically and hemodynamically stable

Lateral Compression Type II Injury

- Posterior iliac wing fx
- Fx line may go into SI joint (crescent fx)
- Mechanically unstable
- Posttraumatic arthritis risk (crescent)
- Vascular injury 8%
Lateral Compression Type II Injury

Day Classification of Crescent Fxs:
- Type I: Fx enters ant 1/3 of SI joint
- Type II: Fx enters middle 1/3
- Type III: Fx enters post 1/3

Lateral Compression Type III Injury

- Rolled – over pelvis (wind swept)
- LC on trauma side APC on the other side
- Neurovascular injury: 23%

AP Compression Injury

- External rotation force
- Neurovascular structures stretched
- Symphyseal diastasis or vertical rami fx (inlet)

AP Compression Type I

- Symphyseal diastasis < 2 cm
- Min widening in ant SI joint
- Ligaments are stretched, but not torn, no ER instability
• Symphyseal diastasis >2.5 cm, also posterior diastasis
• Ant SI, ST & SS ligaments are torn, post SI lig intact
• SS or lateral sacral border avulsion in inlet view
• Neurovascular stretch
• Vascular injury 10%

AP Compression Type II

AP Compression Type III

• All ligaments are torn
• No superior displacement in initial film
• Severe blood loss
• Pelvic vascular injury 22%
• Visceral injury common
• Laparotomy: 20%
• Mortality: 20%

• Superior displacement (outlet view) & posterior displacement (inlet view)
• Associated injuries common
• Pelvic vascular injury 10%

Vertical Shear Injury
Combined Injury

Thank You
**SICOT presents Pelvic Fractures**

**Damage Control after Pelvic Fractures in Polytrauma**

T. Pohlemann
Klinik für Unfall-, Hand- und Wiederherstellungschirurgie
Universitätskliniken des Saarlandes, Homburg/Saar

"Polytrauma Management"?

Primary Emergency Room treatment is only one, but essential part of a „chain of resuscitation, treatment and rehabilitation“!

Surgical strategy?

Patient stable: Early Total Care

Patient unstable: Damage Control Surgery
What is special in polytrauma patients with severe, concomitant pelvic injuries?

- Letality up to 70%!
- No surgical control of retroperitoneal haematomas!
- Patients in extremis!

Pelvic Classification:
AO/OTA 1996: Combination MECHANISMUS & RESID. STAB

<table>
<thead>
<tr>
<th>Incidence:</th>
<th>A</th>
<th>B</th>
<th>C</th>
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<tbody>
<tr>
<td>50-70%</td>
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<tr>
<td>15-30%</td>
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<tr>
<td>10-20%</td>
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</tbody>
</table>

AP Becken I (n=1722) & AG Becken II (n=2550) & AG Becken III (n=1939)
MHH Unfallchirurgie 1972-1999 (n=2576)

Incidence:
appr. 8900 patients!

The Need For Clear Definitions!
Present Definitions:

"plain" oder "uncomplicated" pelvic injury
peripelvic soft tissue injury neglectable

Goal: Osteoligamentous Reconstruction

Present Definitions:

"Complex" Pelvic Injury
Significant peripelvic soft tissue injury
(urogenital, holovisceral, muscle, nerves/vessels)

Peripelvic soft tissues
Unstable circulation (blood loss > 2000 ml) (neurovasc. dissociation)
Hemipelvectomy

Exsanguination, shock

Pelvic injuries: frequency vs. lethality

AG Becken I DGU & AO (1991-1993, 10 Zentren, n =1722)
Treatment options: literature

- "self tamponade"  ☑ effective
- MAST  ☑ effective, compl.
- pelvic girdle, binders  positiv
- ligature Aa. iliacae  ☑ effective
- pass. aortal occlusion  short term effect
- angiography  effective
- mech. stab. + tamponade  effective
- definitive ORIF  effective

Interpretation of literature: clear definitions missing!

<table>
<thead>
<tr>
<th>Severity of hemorrh.?</th>
<th>methods?</th>
<th>management?</th>
</tr>
</thead>
</table>

clear criteria for inclusion
simple decisions
reproducible, universal treatment

Inclusion criteria:
"Life threatening pelvic injury present/non exclusable"

clinically unstable pelvis
primary Hb below 8 g/%

Frequency?

- MHH Unfallchirurgie 1972-95 n=2002 cases: ca.2%
- Beckenkungruppe DGU/AO I 1991-93 n=1722 cases
- Beckenkungruppe DGU/AO II n=2500 cases

Pelvic fractures in Germany: ca. 20.000 p.a

ca.400 p.a
Anatomical basis: sources of bleeding

10-20% arterial
(Arteries of the true pelvis)

80-90% venous
➢ praesacral vein plexus
➢ perivesical vein plexus
➢ fracture surfaces

Angiography:

Pro’s:
➢ retroperitoneum closed
➢ no surgical intervention
➢ success rate 40-80%?

Con’s:
➢ only art. haemorrhage accessible (10-20%)
➢ qualified specialist required
➢ time issue?
➢ high lethality reported

Our treatment algorithm pelvis:

1. decision (0-5 min)
Mass bleeding?  Overroll trauma

No
Polytrauma Algorithm
extended shock therapy
radiographs chest, pelvis
sonography abdomen

OR, surg. haemostasis
2. decision (10-15 min)
circulation & pelvic ring-unstable

Polytrauma Algorithm
extended diagnostics

Mechanical stabilization of the pelvic ring?

C-clamp
External fix.
Pelvic girdle
Sling

Indication:
Pelvic clamps

C-type injury (Sacrum fracture, SI-dislocations)
beware: overcompression sacrum
beware: transiliacale fx-dislocation, ilium fracture)

Pelvis is the most possible source of haemorrhage!
Technique of pelvic tamponade:
The source of hemorrhage is within the true pelvis and can therefore be accessed without laparotomy!

Technique of pelvic tamponade:
infraumbilical medial incision underneath fascia no further dissection necessary!
Summary:

- Successful polytrauma management is based on standardized, rapid evaluation and treatment. Apply reliable protocols (e.g., ATLS™)!

- Sequence of interventions?
  - Stable conditions: „Early total care“
  - Unstable conditions: „Damage control“

- Module for pelvic fractures?
  - Mechanical pelvis stabilization & Surgical haemostases (tamponade)
VuMedi Iliosacral
ML Chip Routt Jr MD

Iliosacral Function
• Stability
• Ilium to Sacrum
• Reduction
• Percutaneous
• A&P
• SI-Sacral-Combo

The Posterior Pelvis – Door Hinges
• Pelvic Ring Injury
• Broken Door(s)
Iliosacral

Why Do We Need It?
- Closed
- Casting
- Traction
- Neglect
- Others

Why Do We Need It?
- Operative Tx
- Bleeding
- Exposures
- Wounds
- Complications
Why Do We Need It?

- Operative Tx
- Newer Gear
- Techniques
- O(R)IF
- Experience
- Education
- Confused

Osseus Fixation Pathways (OFP)
Accurate Reduction

• Improves Stability
• Unloads Implants
• Optimal Space
• Safer Implants
• More Implants
• Improves Union
• Avoids Deformity

Reductions

• Open
• Traction
• Frames
• CPAS
• Anterior ORIF
• Others – Simple/Smart

Reduction - Skeletal Traction

• Distal Femoral
• 10-15#
• Simple
Treatment?

- ORIF Symphysis Pubis
- Supine
- I&D/ORIF Posterior Pelvis
- Prone

Construct

- Symphysis Plate
- Iliosacral
Reduction – Clinical Decision

Clinical Course
Reduction - Stability

• Closed
• Open
• Screw

Iliosacral Details

• Dependant
• SI – Sacral -Others
• Start Point
• Aim
• Length
• Level S1/S2
Supine > Prone
• Airway
• Face
• Access
• Anterior Ring
• Abdomen
• GU
• Vascular
• Chest
• Extremities

Prone
• Direct
• Open
• “Manipulators”
• Outrigger Frames
• No Anterior Ring
• Gravity Deformation
• Screw-in-situ

Sacral “Style”
• Sacral - Others
• Start Point
• Aim
• Length
• Balance
• Level S1/S2
Is It “Normal” or “Dysmorphic”?

• Segmentation-Upper-Narrowed Alar-Oblique

Normal - Dysmorphic

• Outlet
• Features
“Normal”
- Axial CT
- Options
- Oblique
- Linear

“Dysmorphic”
- Axial CT
- Upper
- Second
- OFPs

Lock the Door
Fix the Hinge
Osseus Fixation Pathways

- Edges
- Shapes
- Areas
- OFPs

Imaging

- Preop
- Planning
- Sagittal
- Mid
- NonO

Imaging

- Variety
- Adjusted
- Tilt
Iliosacral Summary

- Early
- Small Wounds
- Blood Loss
- Reduction
- Osteology-OFPs
- Stability
- Variety Options
Anterior and posterior pelvic plate fixation

Indications

Decisions

MARTIN BIRCHER ST. GEORGE’S HOSPITAL LONDON

General principles

You cannot consider the anterior and posterior injury in isolation

Beware the pelvic binder

The soft tissues may govern the management

The time since injury - open or closed techniques

Your system and experience

Anterior plate fixation of the pelvis
Anterior injuries

Symphysis disruption – options
Plate or external fixation

Rami fractures – options
Plate, screw or external fixation

Combination injuries – tilts
Plates only

Symphysis pubis separation
The plate rules!

Decisions
The soft tissues?
Bladder or urethral injury?
Urgency of the situation?
1 or 2 plates?
4 hole or 6 hole?
3.5,4.5 recon, Matta or DCP?

Symphysis pubis separation
The plate rules!

The soft tissues?
Bladder or urethra
Symphysis pubis separation
The plate rules!

**THE POSTERIOR INJURY**
**THE SIZE OF THE PATIENT**
**BEWARE THE APC 2 INJURY**

Pubic rami fractures
Most fractures do not need reduction or fixation

Is the periosteal sleeve violated?

---

18 year old 120 mph motorcycle accident
Bladder tear
Soft tissue injury posterior laterally
Splenectomy a little
The tilt fracture
Uni-lateral(LC) or bilateral(APC)

The tilt fracture
Bilateral(APC)
Posterior plating of the pelvis

Posterior injuries
Sacroiliac dislocation – SI screws or plates
Crescent and iliac fractures – usually plates
Sacral fractures – screws or plates
U and H fractures – usually plates
Combinations
Double plating of the S.I. Joint

Key points – Relaxation of psoas, lumbosacral nerve, screw direction and length

18 year old multiple injuries
Right posterior degloving

Iliac blade fractures
Posterior plates

Decisions
As for anterior plating........and
Is there evidence of nerve compression?
Front or back first ?
One or two positions?

Posterior plating

The state of the skin
Open SIJ and posterior surgery

14 year old 12 foot fall from tree
Summary
Anterior and posterior pelvic plating
  Strong biomechanical fixation solutions
  Soft tissues must be quiet
Must consider both the front and the back lesion
  Surgery as soon as possible
  Watch the binder
  Beware of the APC 2’s

THANK YOU
Geriatric Pelvis Fracture care

Amir Matityahu, MD
Director of Pelvic and Acetabular Trauma and Reconstruction
UCSF Department of Orthopaedic Surgery
Orthopaedic Trauma Institute
San Francisco General Hospital

Outline
- Epidemiology
- Pelvis Fractures
  - Misconceptions
  - Morbidity and mortality
  - Fracture repair options
  - Outcomes from fracture repair

Anticipated Growth in the US Elderly Population >65 yrs

<table>
<thead>
<tr>
<th>Year</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>28 million</td>
</tr>
<tr>
<td>2020</td>
<td>52 million</td>
</tr>
<tr>
<td>2040</td>
<td>68 million</td>
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</table>

JH Lonner et al CORR, 318:136; 1995
Elderly population growing in size
- MVA survival greater
- Elderly are surviving with more complex chronic illnesses
- Elderly more active

Epidemiology
- In 2005, osteoporosis-related fractures = $19 billion in costs.
- By 2025, costs = $25.3 billion.

Osteoporosis was responsible for more than 2 million fractures in 2005, including:
- 135,000 pelvic fractures
- 297,000 hip fractures
- 547,000 vertebral fractures
- 397,000 wrist fractures
- 675,000 fractures at other sites
Epidemiology of Pelvis Fractures

5% of all fractures in Octogenarians
But, 23% of admissions to level I trauma centers


The severity may be frequently missed

Retrospective study, N = 37, age 85
All had anterior ring fractures

60% had posterior ring fractures
- 24% had LC-2 fractures with iliac wing component

81% were treated conservatively
Still need the x-ray and CT scan to help in diagnosis

J Orthop Surg (Hong Kong). 2010 Aug;18(2):153–7. Occult posterior pelvic ring fractures in elderly patients with osteoporotic pubic rami fractures. Leung F., Department of Orthopaedics and Traumatology, Queen Mary Hospital, Hong Kong

Study to evaluate elderly patients with pelvis fractures

- National Trauma Databank – 2002-2006
- 900 Trauma Centers in the USA
- 2.7 million patients total
- 45,000 had pelvis fractures included in the study

Amir Matityahu, Joshua Elson, Saam Morshed, and Meir Marmor
Survivorship and Severe Complications Are Worse for Osteoporotic and Elderly Patients with Pelvis Fractures as Compared to Adults: Data from the National Trauma Data Bank, Journal of Osteoporosis Volume 2012.
Who are these patients? NTDB 2002-2006

<table>
<thead>
<tr>
<th>Age Group</th>
<th>N</th>
<th>65-79</th>
<th>&gt;79</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;65</td>
<td>32,660</td>
<td>6,408</td>
<td>5,647</td>
</tr>
<tr>
<td>65-79</td>
<td>61%</td>
<td>41%</td>
<td>24%</td>
</tr>
<tr>
<td>Mechanism</td>
<td>High Velocity</td>
<td>63%</td>
<td>45%</td>
</tr>
<tr>
<td></td>
<td>Low Velocity</td>
<td>6%</td>
<td>32%</td>
</tr>
<tr>
<td>GCS &lt;16</td>
<td>46%</td>
<td>62%</td>
<td>77%</td>
</tr>
<tr>
<td>Open fracture</td>
<td>4.5%</td>
<td>1.7%</td>
<td>0.7%</td>
</tr>
</tbody>
</table>

Lower Energy

Who are these patients? NTDB 2002-2006

<table>
<thead>
<tr>
<th>Systolic BP&lt;90</th>
<th>&lt;65</th>
<th>65-79</th>
<th>&gt;79</th>
</tr>
</thead>
<tbody>
<tr>
<td>17%</td>
<td>17%</td>
<td>17%</td>
<td></td>
</tr>
<tr>
<td>Severe Complications</td>
<td>11%</td>
<td>16%</td>
<td>15%</td>
</tr>
<tr>
<td>Died</td>
<td>8.8%</td>
<td>13%</td>
<td>13%</td>
</tr>
<tr>
<td>Surgical Intervention</td>
<td>18%</td>
<td>8%</td>
<td>2%</td>
</tr>
<tr>
<td>Died</td>
<td>8.8%</td>
<td>13%</td>
<td>13%</td>
</tr>
<tr>
<td>Open fracture</td>
<td>4.5%</td>
<td>1.7%</td>
<td>0.7%</td>
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Lower Energy

Logistic Regression NTDB 2002-2006

Multivariate logistic regression analysis for the entire population of closed pelvic fractures using predictors upon arrival to the emergency department with the outcomes death and severe complication (odds ratios).

<table>
<thead>
<tr>
<th>Model Predictors</th>
<th>Death</th>
<th>Severe Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-64 years old</td>
<td>Referent</td>
<td>Referent</td>
</tr>
<tr>
<td>65-79 years old</td>
<td>2.35</td>
<td>2.19</td>
</tr>
<tr>
<td>&gt;79 years old</td>
<td>3.60</td>
<td>2.87</td>
</tr>
<tr>
<td>Head Injury</td>
<td>1.62</td>
<td>1.59</td>
</tr>
<tr>
<td>ISS &gt;= 16</td>
<td>10.4</td>
<td>9.6</td>
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</tbody>
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Lower Energy
Severe Pelvis Injury
NTDB 2002-2006
Multivariate logistic regression analysis for the entire population of closed pelvic fractures using predictors upon arrival to the emergency department with the outcomes death and severe complication (odds ratios).

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<td>Referent</td>
<td>Referent</td>
</tr>
<tr>
<td>65-79 years old</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>&gt;79 years old</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Head Injury</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>ISS &gt;= 16</td>
<td>15</td>
<td>18</td>
</tr>
</tbody>
</table>

Lower Energy

Death increases 1% per 10 years
18 years old – 7.5%
88 years old – 14.5%

Treatment of insufficiency fractures

Traditional
- Analgesics
- Early Ambulation
  - Complications with bed rest
    - Pneumonia and PE
Proposed Surgical Treatments
- Early fixation of the sacrum and/or rami
- Sacroplasty
(1) significant increase in average motion after fracture creation, (2) significant reduction in average motion after fixation, and (3) nonsignificant increase in average motion across the SI joint relative to intact SI motion. There were no significant differences among treatments.

Pelvis fracture suspected on clinical exam or pubic rami fractures seen on x-ray

- Perform CT Scan
- Iliac wing or Sacral Fracture
- No Posterior ring fracture
- Stable
- Unstable
- Not Sure
- Conservative management
- Surgical Stabilization
- Exam Under Anesthesia
- Early Mobilization and Analgesics
- Trans-sacral screws, ilium screws, and plates
Summary
Less Energy
Higher mortality rate
Higher Complications
Early Mobilization
Or Early fixation then mobilization