Periprosthetic Acetabular Fractures

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Learning outcomes

➢ Epidemiology / Aetiology

➢ Identification & Classification

➢ Management Algorithm
Epidemiology & Aetiology

- Periprosthetic fractures of the acetabulum are a rare but potentially disastrous complication of THA.

- Less common than periprosthetic fractures of the femur.

Perioperative Complications

- Loss of structural integrity of bone supporting the prosthesis.
Epidemiology & Aetiology

- In a large series including 23,850 (THA),
- 0.07% (1: 1490) in predominantly uncemented components.
- Due to the high impaction force during insertion.
- In cemented components are exceedingly rare.

(Peterson et al, JBJS-Am 1996)
In a large series, Haidukewych et al. showed a prevalence of 0.4 % in uncemented components, whereas intra-operative fractures with cemented sockets have not been observed.

Severe osteoporosis in elderly patients.

Revision THA
Epidemiology & Aetiology

- **Different cup designs.**
- Impaction of uncemented *Elliptical cups* >> *Hemispherical cups* reamed in a line-to-line manner.  
  (Peripheral diameter of elliptical shells is greater than a standard hemispherical shell)
Epidemiology & Aetiology

- **Threaded** acetabular cup systems.
- **Under reamed** cup
  - Smaller size acetabulum - higher chance of introp fx
  - Large size acetabulum - rim fx
  - Small size acetabulum - column fx

- **Pelvic discontinuity** reported upon excessive reaming
- **Osteoporosis / Revision surgery**
- **Paget’s (2-5%) / Radiation / Dysplasia**
Classification
### Modified Peterson and Lewallen classification of the acetabulum [20]

<table>
<thead>
<tr>
<th>Fracture type</th>
<th>Appearance on x-ray</th>
<th>Pain level</th>
<th>Treatment options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Radiographically stable, with no evidence of component loosening or migration</td>
<td>Minimal pain with hip motion</td>
<td>Nonsurgical treatment</td>
</tr>
<tr>
<td>2</td>
<td>Obvious radiographic migration or loosening</td>
<td>Painful hip motion</td>
<td>Surgical treatment with open reduction internal fixation and acetabular component revision</td>
</tr>
</tbody>
</table>
A more comprehensive classification system for periprosthetic acetabular fractures was proposed by Della Valle et al.

<table>
<thead>
<tr>
<th>Fracture type</th>
<th>Definition of fracture type</th>
<th>Fracture subtype</th>
<th>Definition of fracture subtype</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Intraoperative fractures secondary to acetabular component insertion</td>
<td>IA</td>
<td>Fracture of an acetabular wall recognized intraoperatively; fracture nondisplaced and component stable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IB</td>
<td>Fracture recognized intraoperatively and displaced; acetabular column or component unstable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IC</td>
<td>Fracture not recognized intraoperatively</td>
</tr>
<tr>
<td>II</td>
<td>Intraoperative fractures secondary to acetabular component removal</td>
<td>IIA</td>
<td>Associated with loss of &lt; 50% of acetabular bone stock</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IIB</td>
<td>Associated with loss of &gt; 50% of acetabular bone stock</td>
</tr>
<tr>
<td>III</td>
<td>Traumatic fracture</td>
<td>IIIA</td>
<td>Component stable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IIIB</td>
<td>Component unstable</td>
</tr>
<tr>
<td>IV</td>
<td>Spontaneous fractures</td>
<td>IVA</td>
<td>Associated with loss of &lt; 50% of acetabular bone stock</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IVB</td>
<td>Associated with loss of &gt; 50% of acetabular bone stock</td>
</tr>
<tr>
<td>V</td>
<td>Pelvic discontinuity</td>
<td>VA</td>
<td>Associated with loss of &lt; 50% of acetabular bone stock</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VB</td>
<td>Associated with loss of &gt; 50% of acetabular bone stock</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VC</td>
<td>Associated with prior pelvic irradiation</td>
</tr>
</tbody>
</table>
Unified Classification System (UCS)
Treatment algorithm of acetabular periprosthetic fractures

Paul Simon¹ · Philipp von Roth¹ · Carsten Perka¹
I. Intra-operative

II. Post-operative fractures

A. Acute: Traumatic; extremely rare

B. Chronic:

Osteolysis / Pelvic Discontinuity: Increasing problem in revision THA.
Diagnosis
Diagnostics & Assessment of the stability

➢ Identification & Classification / Stability of the fracture.

➢ Stability of the acetabular component

➢ May be difficult to identify at surgery.

➢ Maintain high degree of vigilance
I. Intra-operative fractures

- **Full clinical and radiographic assessment** of the pelvis.

- **Careful stress testing** of the pelvis and the component.

- **Intra-operative fluoroscopy**

- **Component should be removed**, if there is still concern
II. Post-operative fractures

➢ **AP and lateral views** of the pelvis & hip.

➢ **Judet view** (Acetabular columns)

➢ **CT scan**
(Most cases, parts of the acetabulum are **masked** by the implant)

➢ In particular, after high energy traumas, **additional injuries** have to be excluded.
Radiographic Assessment

CT scans

new algorithms that help differentiate metal from bone can often help provide additional information
Radiographic Assessment

CT angio

(vascular injuries & adjacency)

Where there is an intrapelvic component CT angiography is recommended for preoperative planning.

(reported cases of death due to hemorrhage)
B. Chronic periprosthetic fractures

Signs for possible or definite loosening:

➢ **Continuous radiolucent** line of any width,

➢ **Migration** of the component, or

➢ Change in the **position** of the component.

➢ **Osteolysis** around the acetabular components, if present, is a sign for **instability** of the cup.
Management
Management

I. **Intra-operative**

I. **Post-operative**

➢ Traumatic

➢ Osteolytic / Pelvic Discontinuity
Algorithm of Management

➢ Fracture pattern & Displacement

➢ Component stability

➢ Patient-related factors

➢ The different underlying pathologies, require a specific treatment of the corresponding causes
Treatment Goals in Revision Surgery

➢ **Rigid fracture fixation** for bony union

➢ **Stable integration** of acetabular component

➢ Restoring or maintaining **acetabular bone stock**

➢ Re-establishing: **CoR**, **offset** & **limb length**.
Approach

➢ Depends on the specific fracture patterns.

➢ Posterior approach

• And/or Ilioinguinal / anterior approaches
Operative management

➢ **Rigid fixation**

→ fracture healing

→ stable bone/implant interface.

➢ A less-than-optimal reduction of # is less critical.

➢ **Screws in as many planes as possible**

➢ Persisting gaps → **bone grafting**
Variety of different implants & Techniques

➢ Impaction bone grafting,
➢ Plating & column screws
➢ Cup screw augmentation,
➢ Highly-porous metal cups,
➢ Antiprotrusio cages
➢ Jumbo cups
➢ Cup/cage constructs
Operative management

• Simultaneous assessment of the stability of the femoral component is obligatory.

• The change of the femoral head size, offset and length might be necessary.
Algorithm of Management

Acetabular Periprosthetic Fractures

- Perioperative
  - Stable: screw fixation of cup
  - Unstable: posterior column plating, revision cup

- Traumatic
  - Protected weight: fracture consolidation
  - Fracture non-consolidated
    - Stable: secondary loosening of cup
  - Osteosynthesis, revision cup

- Osteolytic
  - Good bone quality: compression by posterior column plating or protrusion ring
  - Small, contained defect: allogeneic bone graft, revision cup
  - Large, non-contained defect: bone graft or wedges, triflange implants, highly porous metal cups
  - Poor bone quality: wedges, triflange implants, highly porous metal cups, cup cage constructs, socket cups or distraction by triflange implants or jumbo cup
Intra-operative Periprosthetic Fractures
I. Intra-operative fractures

➢ Most cases of intra-operative fractures are

➢ Stable fractures

➢ With stable implants and

➢ Can be treated conservatively.
Non-displaced Fractures, Stable Acetabular Component

➢ Require no further treatment.

➢ If there is concern stability of fracture site,

→ Recommended additional screw fixation of the component into the ileum.

→ Protected weight bearing postoperatively.
Displaced Fractures, Unstable Acetabular Component

- Major motion / substantial displacement,
- Fracture has to be **reduced and stabilized**
- By **plating** of the posterior column.
- +/- Bone grafting or metal augments
- **Cup with multiple screws**
- +/- Protrusion cage / Jumbo cups
Post-operative X-ray after synthesis with plate and screws.
Revision with trabecular titanium shell and screws.
perioperative

stable

- screw fixation of cup

unstable

- posterior column plating, revision cup
Traumatic Periprosthetic Fractures
Non-displaced Fractures, Stable Acetabular Component

- Non-operative treatment
- Protected weight bearing for 6 – 8 weeks.
- Healed fractures in 80%
- Regular radiologic follow up for
- 2ry loosening even in fracture union (high rates !!)
67 years old F
1 year

Posterior column plate fixation and revision of the acetabular component with a non-modular porous tantalum revision cup and a cemented liner.
Displaced Fractures, Unstable Acetabular Component

- Acute displaced fractures, which caused
- loosening of the acetabular component,
- Should be managed with ORIF of the fracture (Posterior or Bicolumnar)
- With Revision of the acetabular component.
Highly porous metal cup was placed with excellent press-fit.

If a reliable press-fit cannot be achieved, additional screw fixation of the cup or antiprotrusio cage is recommended.
traumatic

stable

protected weight

fracture consolidation

stable

secondary loosing of cup

revision cup

fracture non-consolidated

osteosynthesis, revision cup

unstable

posterior or bi-columnar plating, protrusion rings, highly porous metal cups, screw fixation
Osteolysis / Pelvic discontinuity
Periprosthetic Fractures
Pelvic discontinuity due to Osteolysis

➢ It requires management of the **bone defect**.

➢ Depends on the **remaining host bone**, the potential for healing of the discontinuity &

➢ Potential for **biologic ingrowth** of acetabular components.
Small Bone Defects, Good Bone Quality

- Small, contained defects with **sufficient**
- Anterior & posterior acetabular **rim**,

→ Compression by a **posterior column plate**,  
→ **Bone grafting &**  
→ **Revision cup**
Large Defects, Good Bone Quality

- **Highly porous tantalum shells** allow better initial stability and bone ingrowth.

- Additionally, **plating of the posterior column** might be necessary.

- Biomechanically, the most stable fixation can be achieved using a **bicolumnar construct**.

- Alternatively, a **protrusion ring** with **bone allografting** can be used for sufficient stability.
pelvic discontinuity caused by severe osteolysis after cemented acetabular liner breakage.
antiprotrusion cage with impaction bone grafting and a cranial highly-porous metal augment
Large Defects, Poor Bone Quality

➢ A *cup-cage construct* augment construct stability.

➢ A *reconstruction ring*, into a highly porous cup, bridges the fracture.

➢ Then a *PE cup* can be *cemented* into the reconstruction cage.
2 stage Technique for Pelvic Discontuity

- Potential alternative in poor quality bone with whenever sufficiently rigid acetabular construct not achievable.

- 1st stage: achieving pelvic stability by ORIF & reconstructing any bone loss with BG

- 2nd Stage: THA implantation after fracture union (X ray & CT check)
Take Home Message

➢ Periprosthetic acetabular fractures are a rare but severe complication in THA.

➢ The surgical management can be challenging.

➢ Best management is Prevention

➢ The assessment of stability of the fracture & implant stability is crucial.
Take Home Message

➢ **Conservative** therapy is only justified in **non-displaced** fracture with a stable implant fixation.

➢ Regular Follow up is **mandatory**.

➢ **Unstable** fractures & **loose** components have to undergo **ORIF** and acetabular **cup revision**,

➢ **Revision surgeon well versed in acetabular fractures fixation**