Acetabular Reconstruction for Metastatic Bone Disease

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November 15th, 2006
Introduction

- Continuous improvements in quality and quantity of life for individuals living with invasive cancer
- 50% of the 1,228,600 new cases of invasive CA / year will metastasize to bone (U.S.)
- The pelvis is the second most common site of metastasis (secondary to the spine)
- Treatment options for metastatic bone disease involving the acetabulum
- Technological advances this past decade have simplified the surgical treatment of pelvic metastases

Protrusio ring devices, +/- flanges, obturator hook etc...

Chemotherapy
Bisphosphonates
Hormonal treatment
Local radiation

??? Surgery ???
Patient Work-Up

• Consultation with a medical oncologist
  - refractory to conservative management
  - expected to survive surgical recovery time
  - Nutritional status
  - PmHx

• What are the patient’s complaints?
  → location of pain, ambulation, independence

• Symptomatic appendicular involvement
  Extremity stability above pelvic stability

• Will the reconstruction improve the patient’s quality of life?

Goal:

→ Full WB post-op
→ Durable construct to last expected lifetime of patient
Eastern Cooperative Oncology Group (ECOG) Scale

- Means of evaluating preoperative functional status
- Helps to predict survival in cancer patients
- Helps to determine eligibility for clinical trials

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Normal activity</td>
</tr>
<tr>
<td>1</td>
<td>Symptoms, but nearly full ability to walk</td>
</tr>
<tr>
<td>2</td>
<td>Some bed time, but needs to be in bed &lt;50 percent of time</td>
</tr>
<tr>
<td>3</td>
<td>Bedridden ≥50 percent of daytime</td>
</tr>
<tr>
<td>4</td>
<td>Totally bedridden</td>
</tr>
</tbody>
</table>
Metastatic Work-up

Evaluation of Local Disease

• Plain radiographs - pelvis and ipsilateral femur
  *Judet views*: acetabular bony destruction
  *Internal oblique (obturator) view*: posterior column, ischium
  *External Oblique (iliac) view*: anterior column, sciatic notch and ilium

• CT pelvis: to assess quality of trabecular bone in the dome and ilium

• +/- MRI of pelvis (Satcher et al., 2003)

Evaluation of Systemic Disease

• Blood work: Ca, Alb, LFT, INR, PTT, CBC, ESR, SPEP, UPEP, Alk P

• Bone Scan (technetium-99): r/o asymptomatic disease

• CT - Chest, Abdomen and Pelvis +/-Brain

• +/- Angiogram (renal cell carcinoma, myeloma and thyroid)
  * with possible embolization*

*
Classification of Pathological Metastatic Lesions of the Acetabulum

1) **Levy** - Minor, major or massive  
2) **Harrington** - Class I, II or III  
3) **American Academy of Orthopaedic Surgeons**  
   - applies to lesions resulting from all etiologies  
   - not effective as a guide for treatment of metastatic defects  
   - 5 point classification system  
   -- beneficial for study comparison  

* 4) **Modified AAOS Classification of Acetabular Bone Defects**  
   - anatomic classification system that helps determine the minimum amount of reconstruction needed for the patient
Harrington Classification of Acetabular Bony Defect

Harrington, KD. The management of acetabular insufficiency secondary to metastatic malignant disease (JBJS, 1981)

- Landmark paper
- Classified the relationship of acetabular bony defects to extent of disease
- Described the use of cement, wires and THA implants for reconstruction in 58 patients
- 52% survival 2 years post-op

**Class I**
- Contained cavitary defects
  - Lateral cortices, superior walls and medial walls are intact

**Class II**
- Medial wall and dome involved
  - Peripheral acetabulum / rim intact

**Class III**
- Defects in both lateral wall and the superior cortices
AAOS Classification of Acetabular Deficiencies

**Type I:** Segmental deficiencies
- Peripheral
- Superior
- Anterior
- Posterior
- Central (medial wall absent)

**Type II:** Cavitary deficiencies
- Peripheral
- Superior
- Anterior
- Posterior
- Central (medial wall intact)

**Type III:** Combined deficiencies

**Type IV:** Pelvic discontinuity

**Type V:** Arthrodesis

# Modified AAOS Classification

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I</td>
<td>• Segmental / cavitary defects</td>
</tr>
<tr>
<td></td>
<td>• intact dome</td>
</tr>
<tr>
<td></td>
<td>• intact Ant &amp; Post. column</td>
</tr>
<tr>
<td>Type II</td>
<td>• Medial wall defects</td>
</tr>
<tr>
<td></td>
<td>• intact columns</td>
</tr>
<tr>
<td>Type III</td>
<td>• Combined dome &amp; column</td>
</tr>
<tr>
<td></td>
<td>• Intact posterior column</td>
</tr>
<tr>
<td>Type IV</td>
<td>• Pelvic discontinuity</td>
</tr>
<tr>
<td></td>
<td>• Posterior column integrity disrupted</td>
</tr>
</tbody>
</table>

Michelle Ghert, Khalid Alsaleh, Forough Farrokyar and Nigel Colterjohn
Surgical Principles

“Extensive pre-operative planning is involved in reconstructing the acetabulum 2° to metastatic disease”

1) Remove as much tumor as possible

2) Reconstruct the defect left by bone destruction
   • Cement supplemented by Steinmann pins
   • Bone graft

3) Bypass the mechanical defect with fixation across the defect
   • Potential or real mechanical instability is bypassed with threaded Steinmann pins and a standard or flanged reconstruction ring

* Most require roof ring reconstruction of the acetabulum b/c:
  1) Creates a new mechanically stable acetabulum anchored to prox. ilium
  2) Provides stability against central migration of the hip (as it contacts the residual bone in the anterior and posterior columns and proximal ilium
Surgical Approach

Standard surgical approach for metastatic reconstruction:
  • Lateral transgluteal approach (+/- ilioinguinal approach)
  • Posterior approach

Extensive capsulectomy and soft tissue release
  • Obturator externus
  • Psoas tendon
    → Reconstruction ring with ischial flange

Protect the superior gluteal nerve

Wunder et al., Clin Orth 2003
Operative Treatment

Class I Defects:
(Cavitary defects, lateral cortices, superior walls and medial walls are intact)
• Prosthetic replacement favoured over internal fixation
• Conventional placement of an acetabular component with cement
• Methylmethacrylate strongly recommended

Class II Defect:  Risk for central acetabular fracture-dislocation
(Medial wall and dome involved, peripheral acetabulum / rim intact)
• Medial wire mesh to contain the methylmethacrylate
• Protrusio ring to distribute the stresses to the intact rim
• ‘Oh-Harris’ ring is the prototypical ring initially described

Class III Defect:
(Defects in both lateral wall and the superior cortices)
• Resection Arthroplasty or complex reconstruction
Class II Defect:

Class II # through a large aneurysmal met that has destroyed the medial wall of the acetabulum.

Oh-Harris protrusio cup, distributes the stresses to the intact rim.

*escape of cement into pelvis (requires a medial wire mesh)

Orthopedic Surgical management of Skeletal Complications of Malignancy. Harrington, Cancer (1997)
Class II Defect:
Class III Defect: Resection Arthroplasty or complex reconstruction

A-P made after excision of involved bone segment and reconstruction with a saddle prosthesis

Damron and Sim, JBJS (ICL) 2000
Class III acetabular fracture 2 to breast CA

Medial wall, superior dome and much of the acetabular rim have been destroyed (Preserved femoral head)

Orthopedic Surgical management of Skeletal Complications of Malignancy. Harrington, Cancer (1997)
1) Drill 3 large threaded Steinmann pins retrograde (acetabular dome into the superomedial ilium and across the SI joint)

2) Retrograde pins were cut off within the resected tumor bed

3) Drill 3 large Steinmann pins antegrade through the ilium into the acetabular cavity

6 pins = scaffold of support for the protrusio shell

Orthopedic Surgical management of Skeletal Complications of Malignancy. Harrington, Cancer (1997)
Post-op radiograph demonstrating the relationship of the protrusio shell, pins, and cement

<table>
<thead>
<tr>
<th>Type I</th>
<th>Description</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Segmental / cavitary</td>
<td>Tumor curettage</td>
</tr>
<tr>
<td></td>
<td>defects</td>
<td>• Cemented acetabular cup with cement</td>
</tr>
<tr>
<td></td>
<td>intact dome</td>
<td>• +/- Bone grafting</td>
</tr>
<tr>
<td></td>
<td>intact Ant &amp; Post.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>column</td>
<td></td>
</tr>
<tr>
<td>Type II</td>
<td>Medial wall defects</td>
<td>Anti-protrusio cage</td>
</tr>
<tr>
<td></td>
<td>intact columns</td>
<td>• Cement of medial wall</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• +/- Bone graft to medial wall</td>
</tr>
<tr>
<td>Type III</td>
<td>Combined</td>
<td>Anti-protrusio cup (cemented) or</td>
</tr>
<tr>
<td></td>
<td>dome &amp; column</td>
<td>roof-ring stabilized</td>
</tr>
<tr>
<td></td>
<td>Intact posterior</td>
<td>• Stabilization with retrograde screws</td>
</tr>
<tr>
<td></td>
<td>column</td>
<td>into intact iliac wing</td>
</tr>
<tr>
<td>Type IV</td>
<td>Pelvic discontinuity</td>
<td>As Type III + antegrade Steinmann pins via</td>
</tr>
<tr>
<td></td>
<td></td>
<td>iliac wing into ischium and/or the anterior</td>
</tr>
<tr>
<td></td>
<td></td>
<td>column (columns are stabilized first)</td>
</tr>
</tbody>
</table>

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Conceptual illustration showing the typical complex reconstruction of a class-III defect\textsuperscript{23} in the acetabulum with flexible Steinmann pins and an antiprotrusio device. (Reprinted with permission of the Mayo Foundation.)

\textit{Damron and Sim, JBJS (ICL) 2000}
Post-operative Radiation


**Purpose:**
To determine the effectiveness of postoperative radiation therapy following orthopedic stabilization of pathological fractures caused by metastatic disease

**Methods:**
Retrospective chart review, N=60 (64 orthopedic stabilization procedures)
N=35 (S + RT), N=29 (S)
ECOG scale to determine functional status, repeat Sx to same site and post-operative survival

**Results:**
- Only post-operative RT was significantly associated with attaining a ECOG score of 1 or 2 post-operatively
- Decreased second procedure to same site in S+RT group
- Prolonged survival in RT group

*Post-op radiation is fundamental to minimize disease progression and risk of implant failure*
Functional and Oncological Outcome of Acetabular Reconstruction for the Treatment of Metastatic Disease. Rex et al., JBJS (2000)

**Purpose:**
- To evaluate the functional and oncological outcome of acetabular reconstruction for metastases

**Methods:**
- N=55
- Pre-op functional status assessed using the ECOG score
- Presented a method of classifying metastatic acetabular lesions based on Harrington’s classification

**Results:**
- Median post-op survival was 9m (3m if visceral involvement)
- Variation in outcome due to Primary CA
- 5/55 failure rate

**Conclusions:**
- Results of reconstruction validate the role of operative treatment for palliation
- Protrusio acetabular cups help compensate for medial wall defects
- Cement and pin fixation can be used to reconstruct large defects in the acetabular column or dome
- Low rate of fixation failure (recons exceeded the life expectancy of patients)
Outcomes of an anatomically-based approach to metastatic disease of the acetabulum  M. Ghert, K. Alsaleh, F. Farrokhyar and N. Colterjohn

**Purpose:**

i) to determine the surgical and functional outcome of an anatomically based approach to acetabular reconstruction for metastatic bone disease

ii) which patient factors were predictive of improved survival

**Methods:**

- Operative technique depended on anatomical extent of bone loss
- Functional outcome measures were analyzed (ECOG, survival).

**Results:**

- ECOG scores improved from 2.6 to 1.1
- Median survival time of 15 months
- Longer survival with breast CA (21 months vs 9) and without visceral involv.

**Conclusion:**

- This anatomically based approach to acetabular reconstruction 2° to metastatic disease is effective in improving quality of life
Anteroposterior radiograph made after total hip arthroplasty with acetabular reconstruction with a Ganz antiprotrusio ring, screws, and cement.
Anteroposterior radiograph of the pelvis, showing a solitary metastasis from hypernephroma involving the right ischium (arrows) and extending to the acetabulum. (Reproduced, with modification, from Sim, F. H.; Frassica, F. J.; and Chao, E. Y. S.: Orthopaedic management using new devices and prostheses. Clin. Orthop., 312: 163, 1995. Reprinted with permission of the Mayo Foundation.)
Anteroposterior radiograph of the pelvis, showing a class-III defect of the left acetabular dome and the peripheral rim due to metastatic renal cancer.