BACKGROUND

- Metastatic tumors of the pelvis may cause pain and a major loss of function due to their potential to invade and destroy surrounding bone and soft tissues. Due to the relatively large size of the pelvic cavity, the elastic nature of the organs it contains, and its surrounding muscles, tumors at that site usually reach considerable size before causing symptoms. While some locations of metastases within the pelvis have no impact on pelvic stability and function (e.g., ilium, pubis), tumors of the posterior ilium may pose a threat to lumbosacral integrity, and tumors of the acetabulum may profoundly impair hip function and the weight-bearing capacity of the lower extremity.
- Both primary sarcomas and metastatic tumors usually present with considerable extension into the soft tissues. Due to their inherent sensitivity to radiation therapy, however, the surgical management of metastatic lesions does not require en bloc resection of overlying muscles, and microscopic residua are treated with adjuvant radiation. The complex anatomy of the pelvic girdle mandates detailed preoperative imaging, planning of exposure and reconstruction technique, and careful and meticulous execution of the surgical procedure.
- Pelvic metastases are treated either with curettage and reconstruction with cemented hardware or by wide resections. These procedures are grouped together and termed pelvic resections, the classification of which is attributed to Enneking. The resected region of the innominate bone is classified as either an extended type I or type IV resection.

ANATOMY

Ilium

- The iliac crest is the attachment site for abdominal wall musculature and quadratus lumborum (Fig. 2).
- The iliacus muscle overlies the inner iliac table, and the femoral nerve lies medial to it in the groove between the iliacus and the psoas muscle.
- Gluteal muscles overlie the outer iliac table.

Acetabulum

- The acetabulum provides the upper-medial mechanical support of the hip joint.
- No muscle attachments connect to the acetabulum.

Pubis

- Hip adductors take their origin from the inferior aspect of the pubis.
- The neurovascular bundle runs along the anterior aspect of the pubis.
- The urinary bladder attaches to its posterior wall.

INDICATIONS

- Pathological fracture of the acetabulum
- Impending pathological fractures of the acetabulum, which are defined as lesions that extend to the acetabular roof and are associated with cortical destruction and considerable pain on weight bearing
- Intractable pain associated with locally progressive disease that has shown inadequate response to narcotics and preoperative radiation therapy
- Solitary bone metastasis, in selected patients

IMAGING AND OTHER STAGING STUDIES (FIG 3)

- Plain radiographs and CT of the pelvis and hip joints are mandatory to evaluate the full extent of bone destruction, soft tissue extension, and integrity of the hip joint. MRI rarely adds additional information; rather, it is indicated in lesions that have diffused intramedullary extension, which is commonly underestimated by CT, such as multiple myeloma.
- Total body bone scintigraphy is done for detecting synchronous metastases elsewhere in the skeleton. At the conclusion of imaging, the surgeon should be able to answer the following questions:
  - What is the full extent of bone destruction and soft tissue extension that are related to the tumor? Is the lesion an impending fracture? If not, it probably should be treated nonsurgically.
  - What incision should be used to obtain optimal exposure?
  - What would be the best technique for resection and reconstruction, if required?
  - Are there additional skeletal metastases and, if so, can they be managed by nonoperative techniques or do they require surgery?
  - Hypervascular lesions (e.g., metastatic renal cell or thyroid carcinomas) can bleed profusely and cause life-threatening blood loss within a few minutes upon tumor exposure and curettage. Preoperative embolization of these tumors is strongly advised to reduce intraoperative blood loss.

SURGICAL MANAGEMENT

Positioning

**Types I through III Resection**

- The patient is placed supine on the operating table with the ipsilateral hip slightly elevated.

**Type IV resection**

- The patient is placed in a true lateral position with the affected side of the pelvic girdle uppermost. The operating table is bent with the breakage point just below the contralateral hip; such a position widens the space between the iliac crest and the lower aspect of the chest wall, allowing a comfortable approach and easier maneuvering at that site (Fig. 4).
Metastatic tumors of the ilium, periacetabular region, pubis, and posterior ilium require types I, II, III, and IV pelvic resections, respectively.

Muscle attachments and relevant structures around the innominate bone.

Plain radiographs and CT scans with coronal reconstruction showing acetabular metastases with their most pronounced cortical destruction at the lateral acetabular wall (A–C) and medial acetabular wall (D–F). Lesions in the former area are exposed after reflection of the glutei from the outer iliac table; those from the latter area are exposed after reflection of the iliacus from the inner iliac table (see Incision and Exposure: Acetabulum).
The most useful approach to pelvic resections is the utilitarian pelvic incision (TECH FIG 1A). All or part of the incision can be used for adequate exploration and resection of pelvic girdle metastases. The incision begins at the posterior inferior iliac spine and extends along the iliac crest to the anterior superior iliac spine. It is then separated into two arms: one extends along the inguinal ligament up to the symphysis pubis, and the other turns distally over the anterior thigh for one-third the length of the thigh and then curves laterally just posterior to the shaft of the femur below the greater trochanter and follows the insertion of the gluteus maximus muscle.

Reflection of the posterior gluteus maximus flap exposes the proximal third of the femur, the sciatic notch, the sacrotuberous and sacrospinous ligaments, the origin of the hamstrings from the ischium, the lateral margin of the sacrum, and the entire buttock. Posteriorly, the incision extends along the posterior iliac crest, posterior-superior iliac spine, and ipsilateral hemisacrum (TECH FIG 1B).

Type I Resection
- The middle component of the utilitarian incision is used to expose the iliac crest. Using electrocautery, the glutei are detached and reflected from the outer iliac table. The iliacus muscle is similarly detached and reflected from the inner table (TECH FIG 2).

Type II Resection
- For lesions with lateral cortical destruction, the middle component of the utilitarian incision, up to the anterior superior iliac spine with a 5-cm extension along the inguinal arm of the incision, is used. Electrocautery is applied to detach and deflect the iliacus from the inner iliac table, exposing the medial wall of the acetabulum (TECH FIG 4).

Type III Resection
- For lesions with medial cortical destruction, the middle component of the utilitarian incision, up to the anterior superior iliac spine with a 5-cm extension along the lateral thigh arm of the incision, is used. Electrocautery is applied to detach and reflect the glutei from the outer iliac table, exposing the lateral wall of the acetabulum (TECH FIG 3).

The inguinal component of the utilitarian incision, from the anterior superior iliac spine to 2 cm across the
symphysis pubis, is used for type III resection. The neurovascular bundle is isolated, marked with vessel loops, and mobilized. The retropubic space is exposed, and a pad is inserted between the urinary bladder and the pubis. Muscle attachments are then detached from the inferior aspect of the pubis (TECH FIG 5).

**Type IV Resection**

- The posterior component of the utilitarian incision is used for type IV resections. Electrocautery is applied to detach the glutei from their origin at the posterior iliac crest and to reflect them (TECH FIG 6).

TECH FIG 2 • A,B. Metastatic sarcoma of the ilium. C. The tumor is exposed after detachment and reflection of the glutei and iliaca from the outer and inner iliac tables, respectively. D. Exposed ilium after reflection of the glutei and iliaca muscles.
Chapter 20 SURGICAL MANAGEMENT OF METASTATIC BONE DISEASE: PELVIC LESIONS

TECH FIG 3 * A. Exposure of an acetabular metastasis that has caused lateral cortical destruction is accomplished using the middle component of the utilitarian incision up to the anterior superior iliac spine, with a 5-cm extension along the lateral thigh arm of the incision. B, C. Using electrocautery, the glutei are detached and reflected from the outer iliac table, exposing the lateral wall of the acetabulum.

TECH FIG 4 * A. Exposure of an acetabular metastasis with medial cortical destruction is achieved by using the middle component of the utilitarian incision up to the anterior superior iliac spine, with a 5-cm extension along the inguinal arm of the incision. B, C. Using electrocautery, the iliacus is detached and reflected from the inner iliac table, exposing the medial wall of the acetabulum.
TECH FIG 5  •  A. Exposure of a pubic metastasis is accomplished with the inguinal component of the utilitarian incision, from the anterior superior iliac spine to 2 cm across the symphysis pubis.  B. The affected bone is reached after isolation and mobilization of the neurovascular bundle from the anterior aspect of the pubis, reflection of the urinary bladder from its posterior aspect, and detachment and reflection of the adductors origin from its inferior aspect.

TECH FIG 6  •  A, B. Exposure of a metastasis at the posterior ilium is achieved by using the posterior component of the utilitarian incision.  C. The glutei are detached from their origin from the posterior iliac crest and outer table.  D. Reflection exposes the outer iliac table.
TUMOR REMOVAL

Type I Resection
- Type I resections involve an osteotomy of the ilium around the lesion. Margins of 1 to 2 cm are sufficient for resection of metastases at that site (TECH FIG 7). Tumor curettage is neither feasible nor justified at that site, because a resection of the ilium that does not impair acetabular or sacroiliac joint integrity rarely has an impact on function.

Type II Resection
- A wide cortical window is made above the lesion (TECH FIG 8A). Gross tumor is removed with hand curettes (TECH FIG 8B,C). Curettage should be meticulous and leave only microscopic disease in the tumor cavity. It is
followed by high-speed burr drilling of the tumor cavity walls (TECH FIG 8D,E).

When the entire acetabulum is destroyed and no cortices are left to contain an internal fixation device and cement, a formal resection is done in the same manner as for primary sarcomas of bone (see Chapters ON-17 and ON-18). The incision is extended along the upper thigh, the joint capsule is opened, the femur is dislocated, and an acetabular osteotomy and resection are carried out.

TECH FIG 9 • A. Plain radiograph showing metastatic carcinoma of the superior pubic ramus. B. Curettage of the tumor cavity. The femoral vessels and nerve are marked with red and yellow vessel loops, respectively. C. Curettage is followed by high-speed burr drilling.

TECH FIG 10 • Plain radiograph (A), CT scan (B), and MRI scan (C) showing metastatic carcinoma of the right posterior ilium. D. Gross tumor at the posterior ilium is meticulously removed with hand curettes, leaving only microscopic disease. E. Curettage is followed by high-speed burr drilling of the tumor cavity.
**Type III Resection**
- A longitudinal cortical window with oval edges is made above the lesion, and tumor curettage and high-speed burr drilling are done in the same manner as in a type II resection (TECH FIG 9).
- When the pubis is destroyed and no cortices are left to allow curettage and burr-drilling, the incision is extended to exposed intact cortices from both sides of the lesion, followed by formal resection of the pubic segment.

**Type IV Resection**
- A longitudinal cortical window with oval edges is made above the lesion, and tumor curettage and high-speed burr drilling are done in the same manner as in a type II resection (TECH FIG 10).
- When the posterior ilium is destroyed and no cortices are left to allow curettage and burr-drilling, wide resection of the posterior iliac segment is carried out. These resections commonly require the en bloc removal of the adjacent component of the sacroiliac joint and potentially can impair stability of the posterior pelvic girdle.

---

**MECHANICAL RECONSTRUCTION**

**Type I and II Resection**
- Type I resections require no reconstruction.
- After completion of tumor removal with burr-drilling, the tumor cavity is reconstructed with cemented Steinmann pins, which are introduced through the iliac crest. Following placement of the pins tips against the subchondral bone, the tumor cavity is filled with cement (TECH FIG 11A–C).
Acetabular metastases may destroy the subchondral bone and dissociate the articular cartilage. In such cases, reconstruction of the articulating surface of the acetabulum can be done with a prosthetic polyethylene insert that has been shaped with a high-speed burr to match the convexity of the femoral head (TECH FIG 11D).

Two courses are available following resection of the acetabulum: (1) reconstruction with a saddle prosthesis; or (2) no reconstruction, leaving a flail extremity.

**Type III Resection**

Following curettage, the tumor cavity is filled with cement, which does not contribute to pelvic stability but allows easier determination of tumor extent on the postoperative imaging studies and subsequent planning of radiation fields, as well as early detection of local tumor recurrence at the cement-bone interface. No reconstruction is required if resection of a pubic segment had been performed.

**Type IV Resection**

Following curettage, the tumor cavity is filled with cement, the purpose of which is similar to cementation of a pubic defect.

Small defects of the sacroiliac joints do not require reinforcement. Medium-sized defects, however, require such reinforcement with a plate to prevent dissociation of the joint. Complete resection of the sacroiliac joint compromises stability of the posterior pelvic girdle.

Gradual upward migration of the ilium on weight-bearing as well as limb-length discrepancy is likely to occur (TECH FIG 12). Traction of the lower extremity followed by a protected weight-bearing protocol is implemented to reduce the extent of limb-shortening.

The glutei and iliacus are sutured over the innominate bone, and both are then sutured to the abdominal wall musculature (TECH FIG 13). These three muscle groups must be attached properly: correct restoration of muscle origin attachment allows function of the glutei and iliacus muscles; and restoration of abdominal wall continuity prevents herniation of the pelvic viscera to the flank.

The surgical wound is closed over suction drains, and an abduction pillow is used to enable wound healing with minimal stress at the muscle suture line. In the case of a complete resection of the sacroiliac joint and loss of posterior pelvic continuity, skin traction is used to pull the extremity and avoid limb shortening.
TECH FIG 13 • Plain radiograph (A) and CT scan (B) showing metastatic carcinoma of the left ilium. 
C. Intraoperative photograph showing the remaining iliac stump following osteotomy (the femoral nerve is lifted with a vessel loop and a clamp is passed through the sciatic notch). D. The glutei are sutured to the iliacus muscle to cover the iliac stump, and both are sutured to the abdominal wall musculature to avoid herniation of the pelvic viscera into the flank.

PEARLS AND PITFALLS
- Detailed preoperative imaging and anatomic tumor classification
- Choice of resection type and extent (curettage vs. resection) and technique of reconstruction, if required
- Preoperative embolization of hypervascular lesions
- Use of the appropriate component of the utilitarian incision for wide tumor exposure
- Tumor removal by curettage and high-speed burr drilling; resection when curettage is not feasible
- Reconstruction with cemented hardware
- Functional reconstruction of muscle groups
- Early ambulation with unrestricted weight bearing, except for patients who had complete resection of their sacroiliac joint
- Postoperative radiation therapy

POSTOPERATIVE CARE
- Continuous suction is required for 3 to 5 days, and perioperative intravenous antibiotics are continued until the drainage tubes are removed. Rehabilitation should include early ambulation with unrestricted weight bearing as well as passive and active range-of-motion of the hip joint.
- In complete resections of the sacroiliac joint, skin traction is applied for the first 10 postoperative days, and weight bearing is allowed only after 3 weeks postsurgically have passed. This protocol allows the formation of scar tissue around the sacroiliac defect, which may decrease the extent of iliac migration.
- Once the wound has healed, usually 3 to 4 weeks after surgery, patients are referred to adjuvant radiation therapy.

OUTCOMES
- Most patients who undergo resection of pelvic metastases experience a substantial relief of pain and are able to ambulate with full weight bearing. Most of them do not, however, reach their full functional capability because of a relatively slow recovery and muscle weakness due to their progressing oncologic disease and general wasting.
- Hardware failures rarely are seen if internal fixation devices have been chosen correctly, used properly, and reinforced with
cement. Local recurrence rates are less than 10% as long as there has been adequate tumor removal and if postoperative radiation was administered.2,3

COMPLICATIONS
- Deep infection
- Wound dehiscence due to poor nutritional and catabolic states
- Deep vein thrombosis
- Sacroiliac dissociation and upward migration and shortening of lower extremity on weight bearing
- Herniation of pelvic viscera to the flank
- Local tumor recurrence

REFERENCES