Metastatic Disease to the Hip and Pelvis: Surgical Management

Robert H. Quinn, M.D.

Summary: Metastatic disease to the pelvis and lower extremity is a significant contributor to morbidity in patients with metastatic cancer. When indicated, surgical prevention of pathologic fractures and treatment of established fractures can preserve patient mobility, dramatically increase pain control, and prevent associated co-morbidities. Forty percent of bony metastases occur in the pelvis and 25% in the femur. Because of the limited life expectancy and debilitated nature of patients undergoing palliative surgery for metastatic disease, the surgical construct should allow immediate unrestricted weight bearing. All areas of the bone should be imaged and all significantly involved portions of the bone should be addressed with the reconstruction. Postoperative radiation therapy should be considered. With appropriate technique and implant selection, outcomes of surgical management are generally very good. Key Words: Metastatic disease—Surgical reconstruction—Tumors of femur—Tumors of hip—Tumors of pelvis.

Metastatic disease to the pelvis and lower extremity is significant not only in the frequency of occurrence, but also in the magnitude of impact on quality of life. Forty percent of bony metastases occur in the pelvis and 25% in the femur. Although the spine is the most frequent bony site of metastatic disease, the incidence of serious clinical problems, and therefore the need for surgical intervention, is far higher in the pelvis and femur.

High physiologic stresses placed on the hip and proximal femur during activities of daily living make pain in these areas more debilitating, pathologic fracture more common, response to radiation therapy less predictable, and nonsurgical treatment of impending and completed pathologic fractures more difficult.

The goals of palliative care are to minimize pain and to maintain function and mobility. These goals are extremely difficult to realize with a pathologic fracture of the pelvis or femur. In moribund patients or those with very limited life expectancy an untreated pathologic fracture will hasten their demise by greatly increasing the requirement for narcotic analgesics, and also increasing the risk of pneumonia, deep venous thrombosis, and hypercalcemia. Confined to bed rest, these patients present a difficult challenge to nursing care with increased risk of decubitus ulcers and urinary tract infections. Fortunately, operative intervention with contemporary reconstructive techniques, although not without significant risks, results in a high and durable rate of pain control and maintenance or restoration of ambulation. Therefore, surgical management is generally indicated in patients with impending or completed pathologic fractures of the femur who have a life expectancy of greater than 1 month, and those with impending or completed pathologic fractures of the periacetabular pelvis who have a life expectancy of greater than 2 to 3 months. Because of the limited life expectancy and debilitated nature of patients undergoing palliative surgery for metastatic disease, the surgical construct should allow immediate full weight bearing and not require bracing or casting.

Perioperative morbidity and mortality is higher in patients with metastatic bony disease than in the general population. Management of these patients is best coordinated with a medical oncologist who can assist with the multiple potential medical complications associated with this debilitating disease. Blood loss can be excessive, particularly with metastatic renal cell carcinoma, thyroid carcinoma, and multiple myeloma. Preoperative angiographic embolization of these tumors should be considered, particularly when the lesions involve the pelvis.

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Serum calcium levels should be checked and normalized in the perioperative period.

Adjuvant use of radiation therapy provides appropriate local control for most tumors and has been shown to improve function after surgical reconstruction and result in a lower rate of revision surgery. For long bones, the entire bone should be included in the radiation field. Initiation of radiation therapy is generally delayed 2 weeks after surgery or until there has been adequate incisional healing. Although dosing regimens vary considerably, the most common schedule involves delivery of 30 Gy in 10 fractions. Dosing of a single 8 Gy fraction has demonstrated efficacy approaching that of multiple dosing.

Bisphosphonates are now commonly used adjunctively in the treatment and palliation of metastatic bone disease. These agents are useful in the treatment of hypercalcemia of malignancy, in the prevention of skeletal-related events, and in relieving pain and improving function and quality of life. Bisphosphonates inhibit osteoclast-mediated bone resorption, cause osteoclast and tumor cell apoptosis, and may reduce cell adhesion and invasion.

IMAGING

Plain orthogonal radiographs provide the most reliable information in the analyses of metastatic bone disease. Decision-making parameters for operative intervention are based on plain radiographic findings. Bone scan or skeletal survey is helpful for evaluating the extent of bony disease. Computerized tomography (CT) is helpful for three-dimensional imaging and preoperative planning, particularly with the pelvis. Magnetic resonance imaging (MRI) is rarely helpful and typically overestimates the extent of disease requiring treatment.

Pelvis

The complex anatomy of the pelvis makes visualization of metastatic involvement difficult and reconstruction challenging. Appropriate imaging is required for adequate appreciation of the extent and location of metastatic involvement, and CT is recommended in this regard. Surgical reconstruction of the pelvis and acetabulum is associated with higher morbidity and perioperative mortality than treatment of extremity lesions thereby requiring careful preoperative planning, patient assessment, and adequate communication with the patient and family members. Perioperative planning should include measures to address the possibilities of excessive blood loss, rapid shifts in intravascular volume, cardiovascular compromise secondary to reaming of the intramedullary canal of the femur and the use of polymethylmethacrylate (PMMA), and postoperative venous thrombosis and pneumonia.

Periacetabular Lesions

The goal of reconstruction of periacetabular defects is to restore the integrity of the hip joint and associated deficient bone so that effective transference of weight to the sacrum and spine can be restored. This generally will require a total hip arthroplasty along with some combination of pelvic or acetalabular hardware and PMMA or a construct that effectively bypasses the acetabulum, such as a saddle prosthesis. A variety of protrusio-type acetabular cups and cages are currently available to augment acetabular reconstruction in both the setting of metastatic bone disease and revision total hip arthroplasty (Fig. 1). Cemented components are generally preferred in the context of metastatic bone disease as the associated use of radiation therapy will severely limit the degree of bony apposition and ingrowth with uncemented prostheses. Resection arthroplasty may be considered in patients thought to be too great a risk for surgery although this procedure generally will preclude return to ambulation in this frail population and pain relief is variable. Reconstruction options that require bone healing for stability such as arthrodesis or bone grafting for structural defects rarely have a role in patients with metastatic disease given the need for immediate weight bearing and the ubiquitous use of radiation therapy.

In most cases, the posterolateral surgical approach is preferred, and generally affords adequate visualization of the acetabulum, lateral ilium, and ischium for most reconstructions. Trochanteric osteotomy is rarely required and adds morbidity associated with trochanteric reattachment hardware and increased nonunion with radiation. An additional ilioinguinal exposure is rarely necessary to enhance reconstruction of the anterior column.

Acetabular defects have been classified by several systems. Acetabular cups and cages are currently available to augment acetabular reconstruction in both the setting of metastatic bone disease and revision total hip arthroplasty (Fig. 1). The American Academy of Orthopaedic Surgeons system was developed primarily for deficiencies encountered in revision total hip arthroplasty. Levy and associates have published a classification system in which the degree of acetabular destruction was described as minor, major, or massive. The classic system introduced by Harrington describes specific anatomic defects with suggestions for reconstruction of each type. In this system class I defects demonstrate intact lateral cortices and structurally intact superior and medial walls and are typically managed with a standard, conventional cemented total hip arthroplasty. Class II defects have a deficient medial wall but the remainder of the acetabulum and supra-acetabular ilium are intact. These defects...
are managed with a protrusio cup and cemented total hip arthroplasty. Class III lesions are those in which both the superior and lateral cortices of the acetabulum are deficient. For these defects, Harrington has advocated a combination of long threaded Steinman pin-reinforced PMMA and a protrusio cup. This technique is technically challenging and requires extensive exposure, including retroperitoneal dissection, to reduce the risks of pin perforation. With the availability of contemporary implants, the use of long threaded Steinman pins and the additional associated risk of complications can generally be avoided. Class IV lesions represent lesions that, by Harrington’s definition, require resection for cure. Lesions that are associated with extensive periacetabular destruction requiring a saddle type of prosthesis would also be appropriate for this category. A more contemporary adaptation of the classic Harrington classification is shown in Table 1.

Type I defects are treated with a standard cemented total hip arthroplasty (Fig. 2). Any standard surgical approach is appropriate. Dislocation rate should be no higher than following conventional arthroplasty. Full weight bearing is initiated on the first postoperative day. Radiation therapy is initiated 2 weeks after surgery if no wound healing complications exist.

Type II lesions are curetted to remove as much tumor and soft bone as possible. The medial wall defect is reconstructed with PMMA and a protrusio cup to distribute weight bearing stress away from the medial wall (Fig. 3). Mesh can be used medially to prevent extrusion of cement into the pelvis. Any standard surgical approach will provide adequate access to the acetabulum, however, a posterolateral approach is preferred in case the defect becomes a type III defect after curettage. This approach provides far better exposure of the lateral ilium and ischium. Postoperative management is the same as that for type I defects.

Reconstruction of type III defects requires reinforcement of the PMMA with screws. Multiple screws can be placed from within the acetabulum before placement of a protrusio cup, obviating the need for Steinman pins placed through a separate incision (Fig. 4). PMMA is packed around the screws and a protrusio cup cemented into place. A standard total hip arthroplasty is then performed. A posterolateral surgical ap-
An approach is used. Depending on the degree of soft tissue detachment required for exposure, a constrained acetabular component may be considered. Postoperative management is the same as that for type I defects.

Type intravenously lesions demonstrate pelvic discontinuity. Reconstruction of these defects requires an approach similar to type III lesions; however, a protrusio cage is used that allows fixation to the ischium (Fig. 5). When inserted, these cages typically occupy a more vertical position than the normal acetabulum; care must be taken to orient the acetabular cup component in relation to the anatomic hip position rather than in relation to the position of the cage.

A type V acetabular defect is one in which the major portion of the acetabulum has been resected during a curative type of operation (i.e., with wide surgical margins) or destroyed by tumor. The type of reconstruction performed will depend on a wider variety of factors, such as the prospect of curability along with the age and activity level of the patient. Options for reconstruction include bypassing the defect with a saddle prosthesis, reconstructing the acetabulum with an allograft or custom type of prosthesis, or arthrodesis of the hip. Resection arthroplasty without reconstruction is also an option. The major complication rate associated with reconstruction of massive pelvic defects with bulk allografts and prosthetic components can be higher than 50%.

In Harrington’s original series6 the mean patient survival was 19 months. Sixty-seven percent of patients had good or excellent pain relief for at least 6 months and 43% for 2 years; 80% were ambulatory at 6 months and 45% at 2 years. Subsequent studies have revealed median survival times of 8 to 15 months, with satisfactory pain relief and function in 70% to 75%. The complication rate has approached 25% to 30% in several series and perioperative mortality 2% to 28%.7,8,14,17,19,26

### Table 1. Contemporary Adaptation of the Classic Harrington Classification

<table>
<thead>
<tr>
<th>Acetabular Defect Type</th>
<th>Anatomic Description</th>
<th>Method of Reconstruction</th>
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<tr>
<td>I</td>
<td>Lateral cortices and superior and medial parts of wall are structurally intact</td>
<td>Conventional cemented total hip arthroplasty</td>
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<tr>
<td>II</td>
<td>Medial wall is deficient</td>
<td>Reconstruction of defect with PMMA* and protrusio cup with cemented total hip arthroplasty</td>
</tr>
<tr>
<td>III</td>
<td>Superior and lateral walls are deficient</td>
<td>Reconstruction of defect with PMMA reinforced with screws, protrusio cup, and cemented total hip arthroplasty</td>
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<tr>
<td>IV</td>
<td>Pelvic discontinuity</td>
<td>Reconstruction of defect with PMMA reinforced with screws, protrusio cage with ischial fixation, and cemented total hip arthroplasty</td>
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<tr>
<td>V</td>
<td>Total acetabular destruction or resection for cure</td>
<td>Saddle prosthesis or durable reconstruction (structural allograft, custom prosthesis) if cure potential is high</td>
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*Polymethylmethacrylate.

fractures that do heal often require much longer periods of time than nonpathologic fractures.

**Femoral Head and Neck**

Arthroplasty is the treatment of choice for impending and actual pathologic fractures of the femoral neck. Internal fixation is associated with a high-failure rate in this location. Preoperatively, radiographs of the entire femur should be obtained. Any more distal lesion visible radiographically should be addressed utilizing a stem length that bypasses the lesion by at least two bone diameters. Controversy exists regarding the routine use of long stem femoral components. Canal preparation and cement use is associated with an increased risk of embolization with long stem components and their routine use is probably not warranted in the absence of radiographically visible disease.¹

Controversy also exists regarding the routine use of total hip arthroplasty versus hemiarthroplasty.²,¹²,²⁴ Proponents of total hip arthroplasty cite evidence that metastatic disease has been identified in 83% of acetabula determined radiographically to be uninvolved. Additionally, pain relief is felt to be more predictable because of the possible deleterious effects of radiation on the hip joint. Advocates of hemiarthroplasty suggest that microscopic involvement of the acetabulum has not been associated with a higher failure rate and total hip arthroplasty is associated with higher risks, most notably dislocation. Total hip arthroplasty is certainly indicated when structurally significant involvement of the acetabulum is present or in the presence of significant pre-existing arthritis (Fig. 2).

It is not uncommon to encounter structurally significant lesions in the proximal femur for which the diagnosis is unknown, but metastatic disease is suspected. In these situations, it is often appropriate to proceed with curettage, cementation, and internal fixation through a limited lateral approach. Although the failure rate is higher with this approach, the hip joint is not contaminated precluding future curative surgery if indicated, and the construct often will prove adequate should the patient indeed have metastatic disease.

**Intertrochanteric Region**

Pathologic or impending fractures of the intertrochanteric region can generally be treated with internal fixation and PMMA used to reconstruct the area of bone loss, particularly the posteromedial cortex. Internal fixation can be performed with a nail plate or intramedullary device. Lesions associated with extensive bone loss and revisions of prior failed reconstruction (Fig. 6) may require prosthetic replacement with either a calcar re-
placement component or proximal femoral replacement. If the greater trochanter and lateral cortex are relatively uninvolved than a calcar replacement component will usually suffice. If there is extensive destruction of the proximal femur, including the greater trochanter, then proximal femoral replacement will often provide more predictable pain relief although this procedure results in loss of the abductor attachment and an associated Trendelenberg gait. Tenodesis of the abductor tendon to the iliotibial band under moderate tension with the hip in neutral abduction minimizes the degree of Trendelenberg weakness and does not require a brace postoperatively; the patient is instructed to perform no active abduction exercises for 6 weeks after surgery.

Subtrochanteric Region

Compressive forces in the subtrochanteric region of the femur can exceed six times body weight. This load is primarily resisted by the proximal posteromedial cortex. Demands placed on any reconstruction in this area are therefore quite high. Favorable reconstruction techniques include utilization of devices that minimize the moment arm effect and reconstitute any substantial cortical defect with PMMA. Intramedullary nail devices are therefore preferred over nail plate devices that have demonstrated a high-failure rate because of the higher stresses placed on these tension-band constructs. Cortical bone defects substantially reduce bone strength, particularly in torsion. Defects less than the bone diameter are termed stress risers; larger areas are referred to as open section defects. Stress risers as small as a drill hole can reduce energy storage capacity by 70%; open section defects can reduce this capacity by greater than 90%. Large stress risers and open section defects in the subtrochanteric femur and femoral shaft therefore benefit substantially from debulking of the tumor by curettage and re-establishing cortical integrity with the use of PMMA.

Second and third generation reconstruction nails allow static locking that prevents telescoping of the nail through areas of circumferential cortical loss. These nails allow fixation in the proximal femur via bolts, large diameter screws, or spiral blades, and distal fixation with bolts or screws. Substantial bone loss in the proximal femur will preclude adequate fixation with intramedullary nail devices. In this situation, or in the presence of significant acetabular involvement, long-stem calcar replacement hemiarthroplasty with PMMA reconstruction of the defective cortex is often necessary. Often the greater trochanter will require reattachment or reinforcement with wires or cables. Alternatively, proximal femoral replacement may be performed (Fig. 7A–C). Because these implants are extraordinarily expensive and the complications associated with proximal femoral resection are significantly greater, their use is rarely indicated in this patient population with severely limited life expectancy. Proximal femoral replacement should be reserved for those patients with such extensive proximal bone loss that a long stem traditional or calcar replacement component com-

FIG. 3. Radiograph (A) and CT (B) of a type II acetabular defect. (C) Postoperative radiograph after reconstruction with a cemented total hip arthroplasty and protrusio cup. (Quinn RH, Metastatic disease to the lower extremities: surgical management, In: Schwartz H. Orthopaedic Knowledge Update: Musculoskeletal Tumors 2, in press. Reprinted with permission.)
FIG. 4. (A) Type III acetabular defect after placement of stabilizing screws. (B) Final reconstruction utilizing PMMA and protrusio cup. (Quinn RH, Metastatic disease to the lower extremities: surgical management, In: Schwartz H. Orthopaedic Knowledge Update: Musculoskeletal Tumors 2, in press. Reprinted with permission.)

FIG. 5. (A) Type intravenously acetabular defect demonstrating pelvic discontinuity. (B) Reconstruction utilizing PMMA and protrusio cage. (Quinn RH, Metastatic disease to the lower extremities: surgical management, In: Schwartz H. Orthopaedic Knowledge Update: Musculoskeletal Tumors 2, in press. Reprinted with permission.)
combined with PMMA reconstitution of the cortex would likely fail to allow immediate weight bearing or satisfactory pain relief, or in the presence of catastrophic failure of a prior reconstruction.

**Femoral Shaft**

Most lesions of the femoral shaft are adequately treated with an intramedullary nail (Fig. 7A, D). The largest diameter nail possible should be used and should be statically locked. Closed intramedullary nailing may be performed with small lesions, particularly with radiosensitive tumors.

Larger defects should be treated with open curettage and PMMA reconstruction.

Whether to use a second or third generation nail in the absence of radiographically evident lesions in the proximal femur remains controversial. Few patients with metastatic disease will develop clinically significant lesions during their short life expectancy if there is no radiographic or bone scan evidence of an existing lesion. Therefore, the routine use of these devices, which are more costly and complicated to insert, is probably not warranted in most patients. Greater consideration may be

![Image of lesions and treatments](image-url)
given to patients with a longer life expectancy such as with the more indolent forms of breast carcinoma and lymphoma.

CONCLUSION

In patients with metastatic disease involving the pelvis, lower extremities, or both, operative intervention can make a significant impact on quality of life remaining with palliative care. Keeping patients ambulatory and functional decreases morbidity associated with bed rest, improves pain control, and helps maintain the patient’s dignity. Although surgery in these patients is associated with higher risk than in many other orthopaedic procedures, the success rate is high, and many of the techniques, particularly those utilizing PMMA, have survived decades with minor refinement.

REFERENCES


AUTHOR QUERIES

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