Management of Metastatic Bone Disease of the Acetabulum

Abstract

Metastatic acetabular disease can be severely painful and may result in loss of mobility. Initial management may consist of diphosphonates, narcotic analgesics, radiation therapy, protected weight bearing, cementoplasty, and radiofrequency ablation. Patients with disease affecting large weight-bearing regions of the acetabulum and with impending failure of the hip joint are unlikely to gain much relief from nonsurgical treatment and interventional procedures. The profound osteopenia of the acetabulum, limited healing potential of the fracture, and projected patient life span and function necessitate surgical techniques that provide immediate stable fixation to reduce pain and restore ambulatory function. Current reconstructive procedures, including cemented total hip arthroplasty, the saddle or periacetabular endoprosthesis, and porous tantalum implants, are based on the quality of remaining acetabular bone as well as the patient’s level of function and general health. Well-executed acetabular reconstructions can provide durable hip joints with good pain relief and function.

Metastatic disease of the acetabulum can be very painful and may severely limit function and activities of daily living. Osteolytic destruction caused by the tumor can result in pathologic fracture of the acetabulum and increased pain and inability to ambulate. These fractures have poor healing potential with radiotherapy. Fracture healing may take longer than the patient’s expected life span.

For primary malignant bone tumors, wide resection is performed in an effort to cure the patient. In contrast, metastatic disease requires a more palliative approach. In general, radical or wide resections, including hemipelvectomy, are not indicated for patients with metastatic disease. Diphosphonates, narcotic analgesia, radiation therapy, and protected weight bearing are the first steps in management.

Interventional treatment, including percutaneous cementoplasty and radiofrequency ablation, is indicated for patients who fail nonsurgical treatment but are not candidates for surgery. Large lesions with impending or completed acetabular fractures may require surgery, with the goal of creating a durable hip joint to provide pain relief and enable immediate weight bearing.

Tumor Workup

The acetabular lesion should be evaluated on a standard AP pelvic radiograph to determine the extent of tumor involvement (Figure 1). Judet obturator and iliac oblique views are helpful to assess the integrity of the anterior and posterior columns and walls, roof, and quadrilateral plate.
The entire femur should be imaged, as well, to identify additional disease.

CT of the pelvis and acetabulum is helpful in assessing the degree of bony destruction and deficiency (Figure 2). Three-dimensional CT may help to more accurately define the extent of bony destruction and the quality and amount of bone available for fixation. Thin-slice CT (ie, 0.6 mm) allows for excellent resolution of the fractured acetabulum and can be used to generate a life-size plastic model of the pelvis and areas of pathologic destruction. This can allow for highly accurate estimation of implant position for optimal fixation and screw length.

MRI of the pelvis is less helpful than CT in evaluating metastatic acetabular disease and bony integrity, and MRI may overestimate the degree of bony involvement. Additional imaging studies, including bone scanning and/or skeletal surveys, can help to determine whether the acetabular lesion is a primary bone tumor or a metastatic lesion. Biopsy always should be performed to confirm that the acetabular lesion is a metastatic tumor and not a primary bone tumor, but in some cases it is not necessary to wait for the biopsy result before proceeding with treatment. In a patient with a solitary acetabular lesion and with no history of cancer, biopsy must be performed. In patients aged ≥40 years, a solitary acetabular lesion is likely to be a metastatic lesion, even in the absence of a history of cancer. With a history of cancer, a solitary acetabular tumor is even more likely to be a metastatic lesion; in such cases, biopsy is required. A patient with a history of cancer and with multiple visceral metastases and acetabular lesion does not require biopsy before surgery. During acetabular reconstruction, tissue from the

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**Figure 1**
Standard AP pelvic radiograph demonstrating a pathologic left acetabular fracture with destructive lesions in the acetabulum extending proximally into the ilium and distally into the ischium in a 57-year-old woman who was diagnosed with metastatic breast carcinoma and who presented with increased left hip pain and inability to ambulate.

**Figure 2**
Axial CT scans of the same patient as in Figure 1 demonstrating destructive lesions in the left acetabulum extending from the iliac wing (A), the acetabular dome (B), the posterior wall (C), and the ischial tuberosity (D).
lesion can be sent for pathologic analysis.8

Biopsy may be performed using fine-needle aspiration, core biopsy, or open incisional biopsy techniques. CT-guided fine-needle aspiration and core biopsy reduce the risk of contamination of the biopsy tract. Open incisional biopsy should be performed through a small longitudinal incision in line with the incision; this same incision may ultimately be used in wide excision of the tumor and biopsy tract if the lesion turns out to be a primary bone sarcoma. Meticulous hemostasis should be obtained to prevent hematoma and spread of tumor cells.8,9 In the case of primary bone sarcoma, incorrect biopsy tract placement and hematoma contamination of the site may result in amputation.9

**Surgical Classifications**

In 1981, Harrington10 reported his results on hip reconstruction performed in 58 patients with metastatic acetabular insufficiency and fracture-dislocations. He categorized these lesions into three classes. In class I lesions, the articular surface is disrupted but the walls and columns are intact. Patients with class I lesions were reconstructed with cemented acetabular and femoral components. In class II lesions, the medial wall and quadrilateral plate are deficient, requiring acetabular reconstruction with a flanged cup to transfer weight-bearing forces away from the medial acetabulum and to prevent medial collapse of the reconstruction. In class III lesions, the roof and acetabular rim are deficient and require reconstruction with Steinmann pins in cement and total hip arthroplasty (THA) using a flanged cup or cage (ie, cement-reinforced THA).10,11

The metastatic acetabular classification (MAC) describes lesions in four anatomic zones—the acetabular dome, medial wall, anterior column, and posterior column12,13 (Figure 3). Specific reconstructions were proposed based on the anatomic pattern of destruction. A cavitary lesion in the dome or roof of the acetabulum with intact subchondral bone (ie, type 1) may be managed with cementation of the lesion followed by THA. Patients with insufficient supportive subchondral bone should be treated with THA with reinforced cement using a flanged cup or cage. Medial wall defects with dome defects (ie, type 2) require flanged cups or cages to avoid protrusion or medial collapse of the reconstruction. Defects in either the anterior or the posterior column (ie, type 3) or both columns (ie, type 4) may also be managed with cement-reinforced THA and cage support or a saddle.
prosthesis if there is adequate bone stock in the proximal ilium. For all of these reconstructions, adequate bone stock in the ipsilateral pelvis and ischium or floor of the acetabulum is needed for Steinmann pin and cage-screw fixation.12,13

**Nonsurgical Management**

Patients with painful but small acetabular lesions that do not compromise the weight-bearing posterior column, dome, or medial wall may be treated initially with diphosphonates, narcotic analgesics, radiation therapy, and protected weight bearing.12-15

Diphosphonates may be used to reduce skeletal events related to bone metastases. One study found pamidronate to reduce pain and hypercalcemia in women with bone metastases resulting from breast cancer.16 In a recent meta-analysis of nine randomized controlled trials (2,806 patients with breast cancer with bone metastases), diphosphonates, including intravenous zoledronic acid 4 mg and intravenous pamidronate 90 mg, reduced the risk of skeletal-related events by 15%.17

Administration of narcotics via epidural catheters is an effective approach to manage bone pain in patients in terminal stages of their illness.18,19 Jeon et al19 retrospectively reviewed 96 patients who received 127 epidural catheters to manage pain caused by terminal cancer. The proportion of patients with severe pain decreased from 78.1% to 19.6%. In a meta-analysis of 31 studies, Ballantyne and Carwood18 observed excellent pain relief in 72% of the patients with terminal cancer who received epidural analgesia. There were no major complications.

Radiation therapy is indicated for radiosensitive tumors with low risk for pathologic fractures (eg, breast cancer, lung cancer); however, it also may be used for any metastatic lesion to minimize the need for surgical intervention. An early study on external beam irradiation in 14 patients with metastatic acetabular lesions demonstrated pain relief in all patients.14 The Radiation Therapy Oncology Group performed a randomized trial known as RTOG 9714 comparing 8 Gy in 1 fraction with 30 Gy in 10 fractions in 898 patients with bone metastases from breast or prostate cancer. At 3-month follow-up, both groups demonstrated similar responses, with partial response rates of approximately 50% in both arms; 33% of all patients no longer required narcotic medications.20 Currently, the most commonly used schedule in the United States for managing oncologic bone pain is a regimen of 30 Gy given in 10 treatment fractions over 2 weeks.20,21

**Interventional Procedures**

Surgical intervention may be indicated for patients who have little to no pain relief and severe functional impairment despite adequate nonsurgical treatment. Reconstruction of metastatic acetabular fractures, however, is an extensive surgery with the potential for significant blood loss, large fluid shifts, and a major systemic inflammatory response. Many patients with metastatic disease are incapable of surviving or making a meaningful recovery from such a procedure.12,13 For these patients, less invasive approaches may be considered.

Interventional procedures, including injection of methylmethacrylate into osteolytic lesions (eg, percutaneous cementoplasty) may provide immediate stability and relatively pain-free weight bearing (Figure 4). Anterolateral and posterolateral portals are made under CT-guided imaging to pass two vertebroplasty needles into the acetabular lesion, taking care to avoid injury to the lateral femoral cutaneous nerve, sciatic nerve, and superior gluteal artery.22 The needle is removed, leaving the cannula behind, and a Kirschner wire is inserted into the acetabulum through this cannula. Dilators may be passed over these Kirschner wires, followed by a working cannula through which cement, mixed with a small amount of contrast dye, is injected into the sites under image guidance.

Cotten et al23 injected methylnitromethacrylate into 12 acetabular osteolytic lesions in 11 patients. Nine patients experienced pain relief within 4 days, and all patients experienced improved ambulation within 5 days. Scaramuzzo et al24 retrospectively reviewed 20 patients who underwent polymethyl methacrylate injection into 24 metastatic acetabular lesions. Complete pain relief was achieved in 75% of patients, with a 7.3-month mean duration of pain relief. Smaller, relatively contained lesions are likely to do better with cementoplasty. Larger acetabular lesions that compromise the structural support of the acetabulum, including impending fractures, complete fractures, pelvic discontinuity, and fractures creating medial wall insufficiency, are contraindications to percutaneous cementoplasty.24 Typically, percutaneous cementation is combined with radiation therapy, cryoablation, or radiofrequency ablation to obtain local tumor control in addition to mechanical reinforcement of weakened bone.

Radiofrequency ablation has shown good results in the management of pain from bone metastases. In this technique, an electrode is inserted into the tumor and coagulating tissue. Multitined electrodes are used for larger, metastatic lesions, and the bone–soft-tissue interfaces
are included in treatment.25 Thanos et al26 reported on 30 patients (34 lesions) with painful bone metastases using radiofrequency ablation. There was a marked decrease in scores for pain and for pain interference during daily life 4 and 8 weeks after treatment. In addition, there was a marked decrease in the use of analgesics, with only three patients using oral analgesics at 8 weeks.

**Surgical Reconstruction Procedures**

Surgical reconstruction is indicated in the presence of a large acetabular lesion that compromises hip joint stability, pathologic acetabular fracture, or radioresistant tumor. Patients with persistent debilitating pain for 1 to 3 months despite either nonsurgical management (including narcotic analgesics, protected weight bearing, diphosphonates, and radiation therapy) or interventional procedures may be candidates for reconstructive acetabular surgery.12,13

**Surgical Preparation**

Preoperative embolization is very helpful in reducing intraoperative blood loss, the need for blood transfusion, and surgical time.27,28 Wirbel et al28 reported on 11 patients with pelvic metastases who underwent selective embolization before surgery. There was a significant difference in blood loss and transfusion requirements in the embolized group compared with a nonembolized control group of 10 pelvic metastases (P = 0.05). Although preoperative embolization is considered to be an option in the surgical management of all acetabular metastases, preoperative embolization also should be considered for hypervascular histologies such as renal cell, thyroid, or hepatocellular carcinoma and/or in the presence of a large extraosseous soft-tissue mass. This procedure must be balanced against potential nephrotoxicity in medically frail patients.12

**Setup and Exposure**

The patient should be placed in the lateral decubitus position on a well-padded bean bag and radiolucent table. This allows for intraoperative fluoroscopy to confirm placement of supra-acetabular screws and Steinmann pins. Furthermore, the beanbag can be rapidly deflated and the patient positioned supine should immediate access to the iliac vessels be needed to control hemorrhage. The C-arm may be brought in from the side opposite the operating surgeon, who typically stands posterior to the patient. Surgical management of
most metastatic acetabular defects can be performed through the Kocher-Langenbeck (ie, extensile posterior) approach.29

Total Hip Arthroplasty
Most surgical treatment options for metastatic acetabular lesions involve variants of THA. In the presence of cavitary lesions with intact subchondral bone and medial wall (ie, Harrington class I, MAC type 1), the acetabulum may be managed with curettage and cemented THA10,12,13 (Figure 5). A simple cage is required if the medial wall is deficient (ie, Harrington class II, MAC type 2).12,13

An extensive cage with long flanges provides a larger surface area of contact between the acetabulum and the implant and has been proposed to provide greater stability in the setting of bone destruction involving the acetabular roof (ie, Harrington class III). This type of cage was used to reconstruct the acetabulum in 15 patients with metastatic acetabular defects.1 At an average follow-up of 14 months, the overall failure rate was 27%. Two cages demonstrated significant loosening at 15 and 30 months. Harris hip scores improved from an average of 33 (range, 25 to 39) to 69 (range, 35 to 93). Significant pain relief was reported, and 73% of the patients stated that they would be willing to undergo the operation again. Clayer30 retrospectively reviewed 29 acetabular reconstructions using an anti-protrusio cage for metastatic acetabular disease. At a mean follow-up of 16 months, one patient demonstrated mechanical loosening and five patients dislocated. Twenty-

Figure 5

AP radiograph (A) and coronal CT scan (B) of the left hip in a 59-year-old man with metastatic bronchogenic carcinoma demonstrating supra-acetabular bone destruction with an intact medial wall. C, AP radiograph obtained following total hip arthroplasty using a cemented acetabular component and one Steinmann pin.
seven of 29 patients (93%) were able to ambulate after the procedure.

**Harrington Procedure**

Harrington reported on the results of cemented THA with acetabular reconstruction using Steinmann pins in 58 patients with metastatic acetabular fractures. Harrington class I lesions were treated with a cemented THA, and Harrington class II lesions were reconstructed with a flanged cup. Harrington class III lesions were reconstructed with retrograde placement of 4.8-mm Steinmann pins through the superior acetabulum, into the iliac crest, and across the sacroiliac joint. The medial cavity was then cemented to include the pins, and the flanged cup was inserted into the cement. Thirty-seven patients (64%) had good to excellent pain relief 6 months postoperatively, and 45 patients (78%) were ambulatory 6 months postoperatively. In five cases, the prosthetic reconstruction loosened because of tumor recurrence. None of the patients with class III disease had evidence of prosthetic loosening even though these patients had the greatest degree of bone destruction.

Since the original report by Harrington, multiple groups have demonstrated the strength of the cement-reinforced hip reconstruction technique. Steinmann pins may be placed antegrade through incisions over the iliac crest and directed between the inner and outer tables toward the floor of the acetabulum (Figure 6). We have placed these pins with a free-hand technique, but a triangulation guide may be used, as well. Ho et al performed the procedure using 3.5-mm screws rather than Steinmann pins in 37 patients with class III lesions of the acetabulum. At a mean follow-up of 23.6 months, all patients reported improved pain, mobility, and function. There were six dislocations (16%), which occurred within 2 months of the index surgery. The authors attributed this to the extensive muscle resection performed during tumor debulking. Six patients developed deep infection (16%), with five requiring resection arthroplasty.

Marco et al reported on 55 patients with metastatic acetabular lesions treated with the Harrington technique. Fifty-four reconstructions were performed with an anti-protrusio cup and 1 with a hemipelvis endoprosthesis. Thirty-six patients (65%) had insufficiencies in either the anterior or posterior columns (ie, MAC type 3). Ten patients (18%) had insufficiencies of both the anterior and posterior columns (ie, MAC type 4). At 6-month follow-up, 19 patients had died. Of the 33 patients available for follow-up at 6 months, 76% had pain relief and 19
were able to walk. Fourteen patients had disease progression, and 5 of these patients had fixation failure. Early postoperative complications included deep vein thrombosis in five patients and superficial infection in three.13

The Harrington reconstruction technique has proved to be a durable reconstruction that, in most cases, lasts the lifetime of the patient. However, these are complex reconstructions with high complication rates in very ill patients. Preoperative planning, the presence of an operating room team familiar with the steps in the procedure, and surgeon experience are critical for good outcomes.

**Saddle and Periacetabular Endoprostheses**

For lesions involving the acetabulum and ischium in patients with adequate bone stock in the ilium, reconstruction may be performed using a saddle prosthesis.33,34 The saddle prosthesis has been proposed as an option in cases in which tumor has infiltrated both the anterior and posterior columns with medial wall and dome insufficiency (ie, MAC type 4).12 This prosthesis is a modular device with a proximal U-shaped saddle that articulates with a notch made in the ilium, a femoral prosthesis, and an intervening linking base component that allows for adjustment of soft-tissue tension as well as rotation, abduction, adduction, flexion, and extension. Saddle prostheses are primarily designed for flexion and extension; the other motions are limited. Soft-tissue tension and the balance of the abductors keep the saddle prosthesis in place.35

Aboulafia et al13 reported on 17 patients with malignant periacetabular tumors who underwent acetabular resection and reconstruction using a saddle prosthesis. Eight patients had primary malignant lesions, and nine had metastatic lesions. At an average follow-up of 33.4 months, seven of the nine patients who were still alive had excellent results and the other two had good results.

Kitagawa et al34 reported on 12 patients with sarcoma and 4 with metastasis involving the periacetabular region who were treated with acetabular resection and reconstruction with a saddle prosthesis. At a mean follow-up of 37 months, postoperative functional scores according to the Musculoskeletal Tumor Society–International Symposium on Limb Salvage system and the Toronto Extremity Salvage Score were 53% and 64%, respectively, in patients undergoing wide acetabular resection for sarcoma and 30% and 42%, respectively, in patients undergoing intrallesional excision of the acetabulum for metastatic disease. Complications included deep infection in three patients and dislocation at the constrained acetabular liner or femoral neck Morse taper in 3. Implant survivorship was 84% at 2 years, with no failures at the ilium-saddle interface.

**Porous Tantalum Implants**

Porous tantalum implants have been successfully used in revision hip arthroplasty to reconstruct massive acetabular defects and pelvic disconti-
Porous tantalum implants may play a role in the management of acetabular reconstruction following metastatic disease. Khan et al reported on the use of tantalum implants to reconstruct acetabular bone destruction resulting from metastatic disease, multiple myeloma, lymphoma, and Langerhans cell histiocytosis. Reconstruction was performed using an uncemented tantalum cup with augment if necessary. All cups were fixed with multiple screws. In cases of more substantial bone loss in which cup–host bone contact was inadequate for stable fixation, the cup cage technique was used. Twenty patients with a mean age of 60 years who underwent acetabular reconstruction with the above technique were followed for a mean of 56 months. There were no cases of clinical or radiographic loosening. There was one perioperative death, one case of deep vein thrombosis, and one dislocation. Longer-term follow-up on larger numbers of patients is needed to confirm the durability of this technique in this specific population.

**Resection Arthroplasty**

Resection arthroplasty for metastatic acetabular lesions (ie, Girdlestone procedure) may be indicated in patients with severe pain, extensive pelvic lesions, and disease that spans the hemipelvis. These patients have few, if any, reconstructive options. Resection arthroplasty is also indicated in bedridden patients who experience pain at rest and in patients who are medically unable to tolerate major pelvic reconstructive surgery (Figure 8). This procedure is performed solely to relieve pain in patients who cannot be treated successfully with narcotics. Because of the significant limb-length discrepancy and essentially flail leg, in general this procedure is not done to restore ambulatory function.

**Complications**

The complication rate associated with surgical reconstruction in this patient population is high. Harrington reported two deaths, one related to massive intraoperative blood loss and the second due to myocardial infarction. There were five cases of prosthetic loosening because of tumor recurrence. Major concerns with the saddle prosthesis are infection (with reports as high as 20%) and prosthetic migration. Preoperative planning expedites surgery and minimizes the risk of infection. The patient should have several units of packed red cells available, as well as fresh-frozen plasma and platelets to prevent dilutional anemia secondary to osteolysis.

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**Figure 8**

A, AP pelvic radiograph of a severely ill 67-year-old woman with metastatic breast cancer who presented with severe right hip pain that could not be controlled with narcotic medication. She could not bear any weight. She presented with a pathologic fracture involving the medial and posterior walls with massive posterior column and ischial osteolysis, as well as central dislocation of the femoral head. Her multiple medical comorbidities and poor medical condition precluded prolonged surgical reconstruction. B, AP pelvic radiograph obtained following femoral head resection and intralesional curettage of the metastatic lesion.
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couplopathy with massive transfusion. Preoperative embolization of specific tumor types can help to limit intraoperative blood loss.

Treatment Algorithm

For painful metastatic acetabular lesions that do not compromise acetabular stability, that is, that do not involve large areas of the dome, posterior column, or medial wall, and are not impending fractures, initial management involves the use of narcotic analgesics, protected weight bearing, diphosphonates, and radiation therapy. Patients with a very short life expectancy (<3 months) are candidates for epidural analgesia. Patients who meet these criteria and who have continued pain despite radiation therapy are candidates for interventional techniques, including percutaneous cementoplasty and radiofrequency ablation.

Patients with large metastatic lesions that compromise acetabular stability, as well as those with pathologic acetabular fractures or radioresistant tumors, may be candidates for surgical stabilization provided they are medically able to undergo surgery and have a life span of ≥3 months. A cavitary lesion in the acetabular dome with intact subchondral bone (ie, MAC type 1) may be managed with cementation of the lesion followed by THA. Medial wall defects with dome defects (ie, type 2) can be managed with flanged cups. Defects in the anterior and/or posterior columns (ie, type 3 [single-column involvement], type 4 [both-column involvement]) may be managed with Steinmann pin-cement-reinforced THA and cage support. Column deficiencies with adequate bone stock in the ilium may also be managed with a saddle prosthesis. Porous tantalum cups or cup-cage constructs may provide immediate stability for these difficult reconstructions. Resection arthroplasty may be a final option to provide pain relief in rare cases of severe pain that is unrelieved with narcotic treatment and widespread pelvic disease with no reconstructive options, in bedridden patients with pain at rest, and in patients who are medically unable to tolerate major pelvic reconstructive surgery.

Summary

Management of painful metastatic acetabular lesion is complex and requires assessment of several factors, including tumor size and location, structural stability of the acetabulum, pain relief from narcotics, radiosensitivity of the tumor, and expected life span of the patient. Management may be nonsurgical, interventional, or surgical. Reconstructions of metastatic acetabular lesions and pathologic fractures are complex, high-risk surgeries. When performed well in the appropriate patient, they have the potential to provide significant pain relief and improved function in patients with terminal disease.

References

References printed in bold type are those published within the past 5 years.


