Metastatic Disease of the Hip: Evaluation and Treatment

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Abstract

Lesions in the area of the hip secondary to metastatic disease present challenging problems for the orthopaedic surgeon. With the advent of improved medical therapies for many types of cancer have come not only an increase in life expectancy but also an increased likelihood that symptomatic metastatic bone lesions will appear. Advances in internal fixation have enabled the orthopaedic surgeon to provide an increased level of comfort and mobility to many patients with metastatic disease.

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Pathologic fractures or impending pathologic fractures in the region of the hip are problems that all orthopaedic surgeons encounter. It is in this anatomic region that the treatment of metastatic lesions has progressed over the past 60 years from benign neglect to aggressive internal fixation.

In the late 19th and early 20th centuries, pathologic fractures were viewed as terminal events, unamenable to treatment by orthopaedic surgeons. In reviewing the literature from 1886 to 1904, Grunert stated, “in the true carcinomatous metastasis, union of the fragments can never occur. . . . there has never been a reported case of such a recovery.”[1]

By the early 1930s, reports had begun to appear in the literature that offered a somewhat more optimistic prognosis, with some clinical investigators stating that as many as 40% of pathologic fractures could heal with treatment.[2] The treatment alternatives then included disarticulation, immobilization with traction, spica casting, and caliper bracing combined with radiation.[3]

Reports of tumor resection and replacement with large bulk allografts first appeared in the literature over 40 years ago. By the 1960s greater efforts were being made not only to alleviate pain but also to restore function in patients with metastatic disease. More recently, advances in orthopaedic management, especially for patients whose tumors are amenable to chemotherapy and radiation therapy, have dramatically improved the outlook.

Epidemiology

Johnston[4] reported that 32.5% of 653 patients with malignant conditions had skeletal metastases at autopsy. Approximately 10% of metastatic lesions are located in the hip.[5] Metastasis to bone most frequently arises from breast, prostate, lung, renal, and thyroid carcinomas.[6] The tumor that metastasizes to the hip with the greatest frequency is carcinoma of the breast; 5% to 75% of metastatic lesions have been found to have originated at that site.[5-9] Ten percent of patients with disseminated breast cancer and 1.4% of all breast cancer patients will ultimately sustain a pathologic fracture of the hip.[10] It is estimated that 40% of patients with pathologic fractures survive for at least 6 months after their fracture, and 30% survive for more than 1 year.[11]

Pathophysiology

Bone metastasis leads to pathologic fracture due to the destruction of normal osseous architecture and

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the replacement of bone with either tumor or necrotic debris. Defects in bone have been divided into two broad categories depending on their size: those smaller than the diameter of the bone and those larger than the diameter of the bone. Defects of the former type are considered to be stress risers, reducing the strength of the bone by causing an uneven distribution of stresses during load bearing, which in torsion can decrease bone strength by 60%.[12] The forces generated by normal activities can then exceed the lowered strength threshold, resulting in fracture.

The pathophysiology of metastatic bone destruction is mediated by osteoclasts, which appear to be activated, perhaps indirectly, through osteoblasts, by tumor products that are not yet fully understood. Various substances of tumoral origin have been proposed as mediators for this osteoclast activation, such as transforming growth factors, prostaglandins, cytokines, and parathyroid hormone–related peptide.[13] It is thought that tumor cells directly destroy bone only in the last stages of the metastatic process.

Evaluation

The preoperative evaluation begins with a history and physical examination. The patient should be questioned about the severity, location, and characteristics of pain and which activities increase the level of discomfort. Pain at rest may signal an expanding osseous lesion.

It is important to identify the primary tumor. If the primary site is unknown, a more extensive evaluation needs to be conducted, usually in cooperation with the primary-care physician and a medical oncologist. A full description of the evaluation of the patient with an unknown primary neoplasm is beyond the scope of this article, but may include chest radiography, mammography, breast examination in female patients, prostate examination in male patients, renal ultrasound, and serologic and other diagnostic tests as indicated. Serologic tests should at a minimum include serum calcium, phosphorus, and electrolyte determinations and a complete blood cell count.

Most pathologic fractures or impending fractures present with a known primary malignant neoplasm. It is the responsibility of the treating orthopaedic surgeon to confirm the diagnosis and in some cases to initiate an evaluation to rule out a concurrent primary bone tumor. The need for assistive devices, such as a cane or walker, and the distance the patient can walk before having to rest should be established.

The radiographic evaluation should include plain radiographs that visualize the hip, pelvis, and femur (Fig. 1). A current bone scan is needed to assess other areas in the skeleton that may also be at risk for pathologic fractures. A bone scan that shows multiple lesions is also evidence that the tumor in the hip is metastatic and not a new primary neoplasm. It also should be recognized that in patients with multiple myeloma, the bone scan may not reveal lesions associated with skeletal destruction. If the patient is too uncomfortable to tolerate lying supine in the nuclear medicine suite while bone scanning is being performed, a skeletal survey may be more useful. Additional diagnostic studies, such as computed tomography (CT) and magnetic resonance imaging, may be required to evaluate the amount of bone destruction, particularly if acetabular lesions are present.

A patient who presents with a single lesion in the hip and a known primary tumor but no other evidence of metastatic disease should be evaluated with caution. Many primary bone tumors, such as chondrosarcoma, also typically present in the hip area. It is not uncommon for patients initially assumed to have a metastatic lesion to undergo hip replacement or insertion of an intramedullary device, only to have the pathologist subsequently report that the tumor was not metastatic but rather a primary bone sarcoma. For this reason, it is recommended that a tissue diagnosis be obtained before definitive internal stabilization in a patient with a solitary lesion about the hip and a known primary tumor but no other evidence of metastatic disease. For lesions of the acetabulum, this can often be achieved with CT-guided needle biopsy. For other lesions about the hip, CT-guided needle biopsy, an open biopsy as a separate procedure, or an open biopsy and a frozen section may be appropriate. The important point is that the diagnosis should be confirmed before definitive treatment and stabilization.

Indications for Surgery

In 1970, Parrish and Murray[7] proposed the following guidelines for selecting patients for operative intervention: (1) The patient's general condition must be sufficiently good and life expectancy sufficiently long (more than 6 weeks) to justify the procedure. (2) The surgeon must be convinced that the operation will be more beneficial than closed treatment. (3) The quality of the bone both proximal and distal to the fracture site must be adequate for stable fixation. (4) The procedure must expedite mobilization of the patient or facilitate general care.

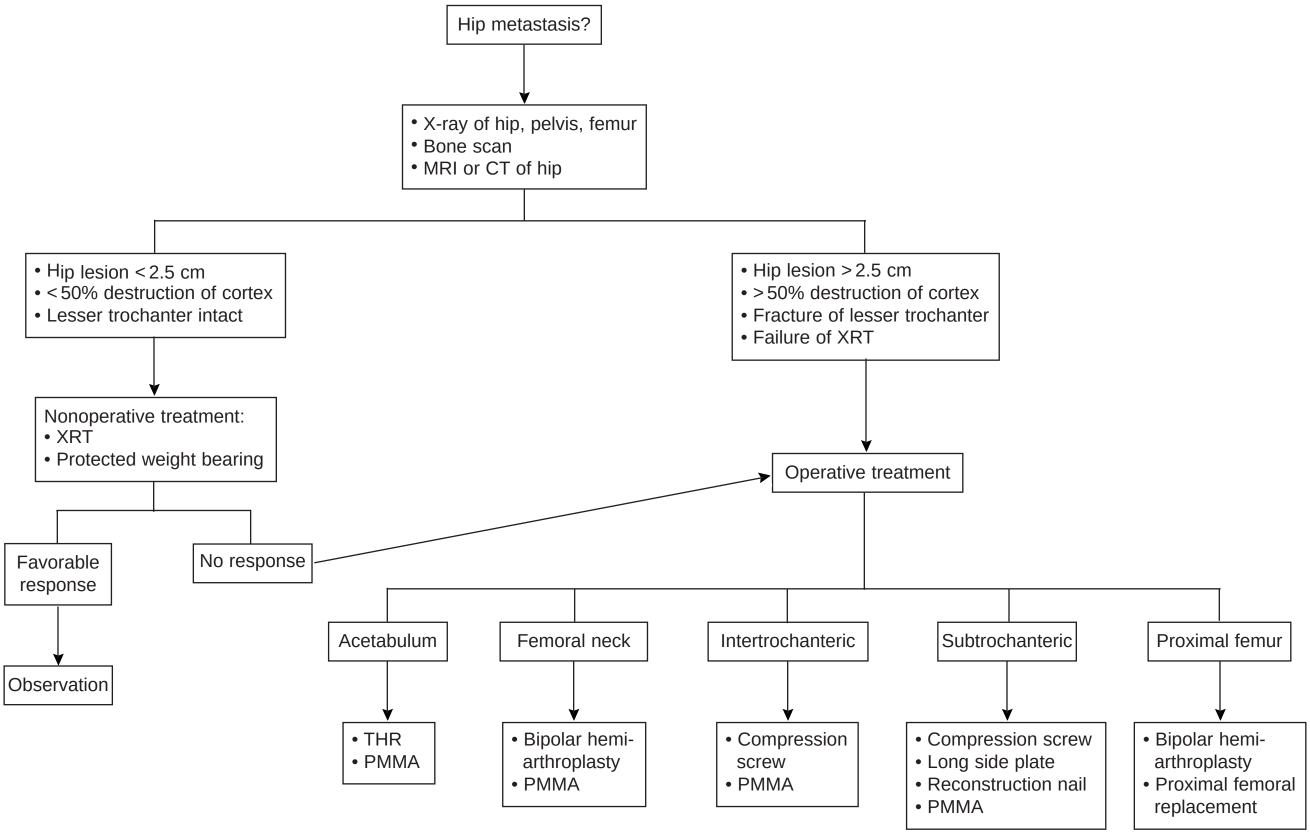

Fig. 1 Algorithm for evaluation and treatment of metastatic disease to the hip. CT = computed tomography; MRI = magnetic resonance imaging; PMMA = polymethylmethacrylate; THR = total hip replacement; XRT = radiation therapy.

In 1976, Harrington et al[14] proposed additional guidelines based on evaluation of plain radiographs. They considered lesions at risk for causing a pathologic fracture to be those that (1) were greater than 2.5 cm in diameter, (2) destroyed 50% of the cortex, or (3) were painful despite treatment with radiation. An avulsion fracture of the lesser trochanter is also a risk factor.

In 1989, Mirels[15] proposed a scoring system for diagnosing impending pathologic fractures in long bones. This system considers the site of the lesion (i.e., upper or lower extremity). It also takes into account the presence and severity of pain; whether the lesion is blastic, lytic, or mixed; and the size of the lesion. The higher the score, the greater the likelihood that the patient will sustain a pathologic fracture if left untreated.

In 1995, Hipp et al[16] also reported on developing a framework for identifying patients with bone defects secondary to metastatic disease that would require prophylactic stabilization. Their work applied engineering principles to analysis of CT studies to estimate the load-bearing capacity, which, when compared with the load-bearing requirements, can be used to calculate a factor of risk. Their findings have yet to be validated for areas other than the spine but do suggest that the current clinical guidelines of a 2.5-cm defect or 50% cortical destruction are associated with large errors in estimating the load-bearing capacity of bone.

Patients who present with lesions that do not meet the criteria for internal fixation should be referred to a radiation oncologist for consideration of radiation therapy. Lesions that are small and minimally symptomatic can often be treated with radiation therapy (if the tumor is radiosensitive) and protected weight bearing with careful observation. Follow-up by the orthopaedic surgeon during and after the radiation treatments is imperative. If the amount of bone destruction increases or if the lesion remains or becomes symptomatic, operative intervention may be indicated. In addition, the weight-bearing status of the patient must be monitored. In most cases, partial weight bearing for at least 6 weeks is advisable, usually until there is evidence that the lesions have undergone healing.

If a patient sustains a fracture through a lesion during radiation therapy, the treatment is internal fixation or prosthetic replacement, similar to the treatment used for impending fractures. If the fracture occurs through a lesion that has been irradiated and the patient has a relatively long projected survival, strong consideration should be given to prosthetic replacement, because of the risk of nonunion and ultimate failure of internal fixation. However, it is always preferable to fix impending fractures prophylactically, so the patient can avoid the discomfort and morbidity associated with a pathologic fracture. A recent study by Algan and Horowitz[17] demonstrated that the results of internal fixation for lesions about the hip were similar to those for the same operative procedure performed for nonmetastatic conditions.

Treatment

Historical Review

The management of hip metastasis has progressed considerably over the past 60 years. At the turn of the century, the most common form of therapy was the use of light traction. The healing rate was poor, with only 20% of patients showing evidence of fracture healing.[1] Emphasis was then placed on identifying and treating symptomatic lesions before fracture. For example, Coley and Higinbotham[18] reported that fractures could be prevented by the use of caliper splints to decrease the load on the affected bone.

By 1950 reports had appeared in the literature supporting tumor resection and replacement with a large bulk allograft. However, the most favorable report of use of this modality, by Higinbotham and Coley,[19] concerned patients whose tumors involved the upper extremity or a minimal weight-bearing bone, such as the fibula. At this time, internal fixation of impending or actual fractures also became popular. In pathologic femoral neck fractures, the internal fixation nails often lost fixation in the weakened femoral head. This led Francis et al,[20] in 1962, to advocate resection of the femoral head and neck as a primary treatment for lesions involving those structures. They believed that resection of the head and neck, especially in patients with early lesions, who had the greatest life expectancy, would provide rapid relief of pain and adequate ambulation, as well as reduce the complications of surgery to a minimum. In their series, all 19 patients had satisfactory results as measured by relief of pain, but only 5 of the patients were able to partially bear weight on the surgically treated side within 3 weeks of surgery. Of the 4 who survived for 2 years, only 2 could fully bear weight without discomfort.

By 1976, Harrington had begun advocating the use of polymethylmethacrylate (PMMA) cement as an adjunct to internal fixation in patients in whom a large amount of bone had been lost as a result of metastatic disease. In 375 patients, Harrington et al[14] excised the lesion and all inadequate bone stock and then performed internal fixation or prosthetic replacement and reinforcement with PMMA. A 94% ambulation rate was achieved. The presence of the PMMA did not seem to interfere with bone union or radiation therapy.

Also in 1976, Zickel and Mouradian[8] reported on the use of an intramedullary fixation device they had devised for fractures in the subtrochanteric region that did not require the use of PMMA. Thirty-five pathologic fractures and 11 impending fractures were treated solely with the device; no attempt was made to excise the tumor. The authors found that those patients with an impending fracture ambulated sooner and survived longer than those who presented with a complete fracture. Operating time and blood loss were not different between groups. They further stated that the criteria for operative intervention should not be limited to only those with 6 or more weeks to live.

In 1980, Lane et al[10] reported on the use of an endoprosthetic replacement or a total hip prosthesis for pathologic fractures or impending fractures of the hip. They considered that the combination of an impending fracture (defined on the basis of the size of the lesion and the amount of pain experienced by the patient) and a life expectancy of more than 1 month was an indication for surgical intervention. Good to excellent results with regard to relief of pain were obtained in all of the patients treated with either an Austin-Moore endoprosthesis (cemented or uncemented) or a total hip replacement.

In 1981, Harrington[21] reported on the use of total hip prostheses in patients with acetabular lesions. A number of their patients had lost so much acetabular bone that conventional prostheses would not provide sufficient support. Harrington designed a larger acetabular component that would distribute the mechanical load to areas of less involved bone.

Current Techniques

After a complete preoperative evaluation, a surgical plan must be carefully designed. Patients who have a highly vascular lesion, such as metastatic renal carcinoma, should be treated with arterial embolization before surgery to decrease intraoperative blood loss.

Acetabulum

It is recommended that patients with a pathologic fracture or impending fracture of the acetabulum be evaluated with magnetic resonance imaging or CT so that the extent of bone destruction can be accurately assessed.[22] Patients with relatively small to moderate amounts of bone destruction frequently can be treated with a protrusio ring, either alone or in combination with an acetabular cup (Fig. 2).

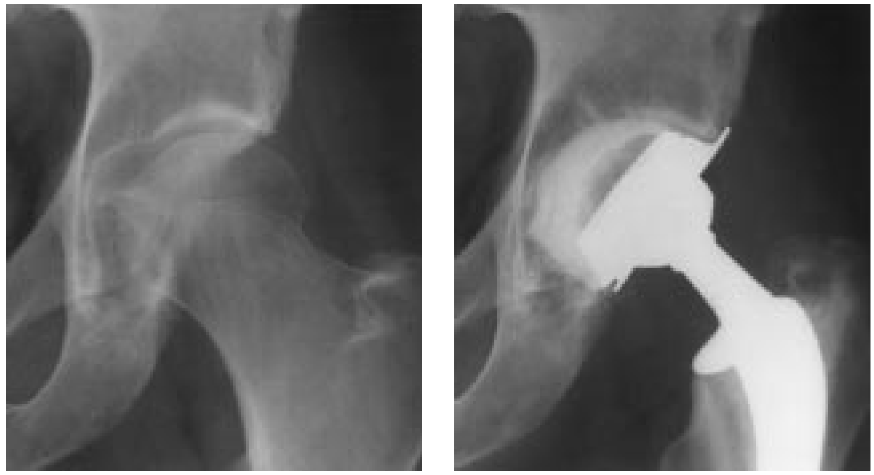

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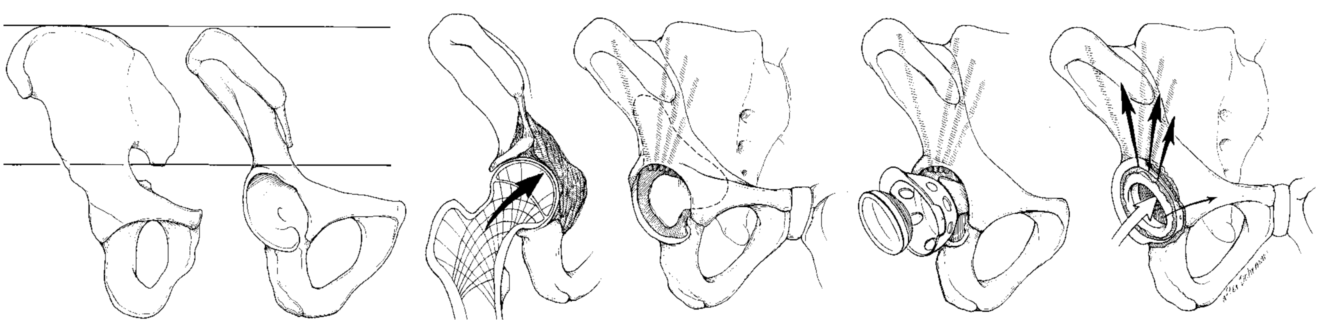
Fig. 2 **A,** Renal cell carcinoma metastatic to the acetabulum. **B,** Protrusio ring and acetabular cup in place.

Harrington[21] subdivided patients with acetabular involvement into four groups on the basis of the location of the lesion, the extent of involvement, and the technique required to accomplish the acetabular reconstruction. In class I, the lateral cortices and the superior and medial portions of the acetabulum were structurally intact. Patients with class I lesions were treated by conventional total hip arthroplasty, frequently with placement of mesh along the medial portion of the acetabular wall for reinforcement. In class II, the medial portion of the wall was deficient. Patients with class II lesions were treated with a protrusio ring. In class III, the lateral cortices and the superior portion of the wall were deficient. Patients with class III lesions were treated with Steinmann pins directed along the medullary canal of the ilium in addition to the protrusio ring and acetabular prosthetic component (Fig. 3). Patients with class IV lesions had only a solitary metastasis in the acetabular area and underwent an en bloc resection.



A B C D E F

Fig. 3 Treatment of class III acetabular metastatic involvement. Anteroposterior **(A)** and anterolateral **(B)** views of the pelvis demonstrate the thinness of the ilium superior to the acetabulum, making that site unfavorable for attempting to anchor an acetabular prosthetic component. **C,** Tumor has destroyed the superior and medial portions of the acetabular bone, leaving only minimal intact cortex for fixation of the acetabular component. **D,** Resection of tumor tissue leaves a large cavity as well as destruction of the acetabular roof, the medial portion of the wall, and most of the rim. Steinmann pins can be drilled into structurally sound bone of the superior part of the ilium and across the sacroiliac joint. **E,** The acetabular component positioned in the protrusio acetabuli shell. **F,** The combination of acetabular cup, protrusio acetabuli shell, and Steinmann pins incorporated into methylmethacrylate effectively transmits weight-bearing stresses into the strong bone of the iliac wing and sacrum.

In patients who undergo hip replacement with a protrusio cup, postoperative care is similar to that after a hip replacement for nonmetastatic disease. This involves dislocation precautions and partial weight bearing for 6 weeks postoperatively. In cases of very extensive bone loss, some consideration should be given to treating the patient nonoperatively or with a Girdlestone procedure, because of the unreliability of internal fixation.

Femoral Head and Neck

We treat impending and complete fractures of the femoral head and neck by cemented bipolar hemiarthroplasty because progression of these lesions may result in failure of internal fixation (Fig. 4). A common error in patients with pathologic fractures in the femoral head and neck is failure to appreciate distal lesions. This may result in unrecognized perforation while preparing the femoral canal; the stem of the prosthesis often goes through this perforation. In addition, a stem that ends just proximal to a missed distal lesion may cause a stress riser, leading to later fracture. Therefore, it is recommended that radiographs be taken of the entire femur before this procedure. In patients who have only proximal disease, a long-stem component will often bypass the lesion. If there is a large lesion in the supracondylar area, it may be necessary to place a fixation device, such as a supracondylar screw and side plate, to avoid a stress riser and possibly a fracture about the tip of the prosthesis.

Postoperatively, patients who undergo bipolar hemiarthroplasty for metastatic disease are treated in much the same way as patients who undergo this procedure for other conditions. This involves dislocation precautions and partial weight bearing for 6 weeks after surgery.

Intertrochanteric Fractures

Impending or complete fractures in the intertrochanteric area with a minimal amount of bone destruction can usually be treated with a screw and side plate. Adjunctive bone cement is often needed to assist in fixation of the lag screw or proximal screw in the plate. This type of fixation is especially advantageous in patients who present with a solitary lesion in the intertrochanteric area that is suspected of being a metastasis but who have no known primary tumor and no other lesions identified by bone scanning. The lesion can be partially excised, usually with the direct lateral approach, to obtain a biopsy specimen for tissue diagnosis. If a sarcoma is encountered on the frozen section, the surgical procedure should be stopped unless this possibility had been considered preoperatively and an en bloc resection had been planned. A biopsy specimen should be obtained as a separate procedure from any lesion strongly considered to be a sarcoma.

The disadvantage of using the screw and side plate for these fractures is that stress is placed on the device during ambulation, which may cause it to eventually fail if the patient becomes a long-term survivor. Progression of the tumor may also compromise fixation, especially if it is relatively radioresistant. In addition, in patients who have received radiation therapy in this area and survive for a relatively long period of time, the end of the plate may cause a stress riser on bone that is weakened from the radiation and may eventually cause a fracture at the distal aspect of the plate.

For patients with extensive destruction in the intertrochanteric area and a complete or impending fracture, use of a long-stem hip prosthesis or a proximal femoral replacement is recommended (Fig. 5). The femoral component is usually combined with a bipolar head.

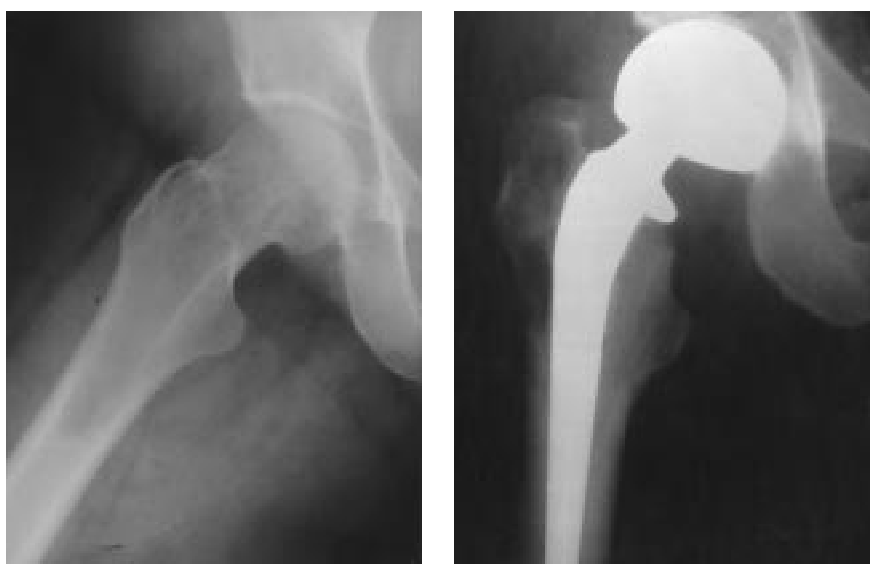


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Fig. 4 **A,** Metastatic lesion involving the femoral head and neck. **B,** After treatment with bipolar hemiarthroplasty.

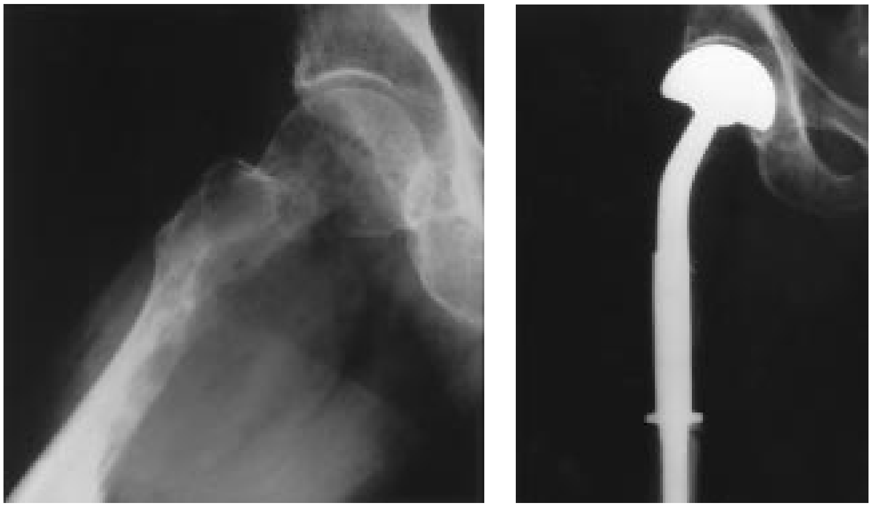

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Fig. 5 **A,** Extensive metastatic disease involving the femoral neck and intertrochanteric areas of the hip. **B,** After proximal femoral replacement.

Postoperatively, patients who are treated with a compression screw progress at a rate depending on the extent of bone loss and the stability of fixation. Patients who undergo proximal femoral replacement are maintained in a hip abduction brace with a knee-foot-ankle orthosis extension for 6 to 8 weeks postoperatively to decrease the risk of dislocation.

Subtrochanteric Fractures

In patients with obvious metastatic disease, we recommend intramedullary fixation with screws placed along the femoral neck. This is biomechanically superior to the screw and side plate, and its use is believed to be associated with a lower probability of mechanical failure. In the past, the Zickel nail (Howmedica, Rutherford, NJ) was the primary implant used for this type of fixation. Currently, most of the manufacturers who produce trauma instrumentation have "reconstruction" nails that can be used for this purpose. In most of these devices, two screws are directed up the femoral neck, and the nail can be locked distally. Recently, Synthes (Paoli, Pa) introduced an unreamed femoral nail that utilizes a spiral blade rather than screw fixation in the femoral head and neck. The potential advantage of this device is that it can be inserted without reaming, which makes the surgical procedure faster. In addition, the angle of the blade to the nail can be changed, which gives the surgeon more flexibility.

In most cases, we recommend locking the rod both proximally and distally because of the low risk of complications associated with placing the distal screws and the potential for loss of stability if they are not used. We use only bone cement when loss of bone makes the screw fixation tenuous. In those instances, a ¼-inch drill bit is used to make portals in the bone both proximal and distal to the screws. The area is first irrigated with saline, and the PMMA is then inserted with a syringe so that it flows around the rod and the screws.

Postoperatively, patients do not require dislocation precautions. Their weight-bearing status is progressed depending on the extent of bone loss and the stability of fixation. For most patients, full weight bearing or ambulation with a cane is possible 6 to 12 weeks postoperatively.

Radiation Therapy

In patients who have not received radiation preoperatively, radiation in the postoperative period may be helpful in slowing progression of a lesion that may ultimately lead to disruption of the internal fixation. Townsend et al[23] demonstrated that the combination of postoperative radiation therapy and surgery led to a better outcome than surgery alone, with a five times greater probability of attaining maximal use of the extremity and a decreased need for a second surgical procedure. We favor postoperative rather than preoperative radiation therapy whenever it is likely that internal fixation will be needed. This is in part because of concern about impeded fracture healing when preoperative radiation therapy is used.

Summary

The outlook for patients with metastatic disease about the hip has improved dramatically, particularly for patients whose tumors are amenable to chemotherapy and/or radiation therapy. Advances in orthopaedic management for patients with impending or occult fractures may result in an increased level of comfort and mobility.

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