Perioperative Morbidity and Mortality After Reconstruction for Metastatic Tumors of the Proximal Femur and Acetabulum

Robert H. Quinn, MD, and Jessica Drenga, APRN*

Abstract: An observational cohort study was performed on 90 hip arthroplasties performed in 84 patients for metastatic disease of the hip. Significant improvement was noted with both 3-month and 6-month function scores vs preoperative function scores ($P < .001$). Complications included 1 intraoperative femur fracture, 2 cases of deep venous thrombosis, 1 peroneal nerve palsy, 1 deep infection, and 5 dislocations. Eight (8.8% of 90 procedures, 9.4% of 84 patients) patients died during the initial hospital stay. Although the risk of mortality after hip arthroplasty for metastatic diseases is perhaps higher than previously expected, improvement in postoperative function scores in surviving patients was significant and perioperative morbidity in this complex patient population was acceptably low. Key words: hip arthroplasty, metastatic, morbidity, mortality, complications.

More than 1.3 million new cases of cancer are currently diagnosed annually in the United States [1]. Fifty percent of these new cases develop in organs with a propensity for bone metastasis (breast, prostate, lung, kidney, and thyroid). Fifty percent of all patients diagnosed with cancer will develop bony metastases, making bone the third leading metastatic site after the lung and liver. From 1972 to 1999, the annual age-adjusted incidence for prostate cancer approximately doubled, whereas that for breast cancer increased approximately 20%. During the same period, 5-year relative survival increased from 67% to 97% for prostate cancer and from 75% to 86% for breast cancer [1]. This progressive trend of increased incidence of cancer combined with increased survival leads to a greater probability that these patients will experience bony metastatic disease requiring treatment.

The hip is commonly involved in metastatic disease to the skeleton. The pelvis is the most common location for bony metastatic disease after the spine. The proximal end of the femur is the most common long bone involved. Because of the anatomy of the hip joint and the associated physiological stresses distributed across it, destructive lesions in this area are more likely to cause symptoms and pathological fracture than in other areas of the body.

The treatment of metastatic disease involving the hip with arthroplasty or hemiarthroplasty has been well described. Many articles have supported the success of these procedures in providing predictable and durable palliation [2-11]. However, very little attention has been paid in the literature to the perioperative morbidity and mortality associated...
with these procedures. We have prospectively analyzed a consecutive series of our patients to determine the incidence of significant complications related to the surgical treatment of metastatic disease about the hip.

**Materials and Methods**

We prospectively reviewed a consecutive series of 90 operative procedures in 84 patients with metastatic disease involving the hip. All were treated by a single surgeon between January 1995 and September 2002.

The underlying diagnosis was breast cancer in 36 hips (30 patients), prostate cancer in 10 hips, multiple myeloma in 8, lung cancer in 20, renal cell carcinoma in 7, lymphoma in 2, bladder carcinoma in 1, squamous cell carcinoma in 1, locally infiltrative cervical cancer in 1, and unknown primary in 4. There were 56 women, which accounted for 62 hips, and 28 men. The average age at the time of the arthroplasty procedure was 61 years.

Thirty-eight procedures were performed for pathological fractures of the femoral neck and proximal femur. Three operations were performed for pathological fractures of the acetabulum. Thirty-two procedures were performed for an impending pathological fracture, defined as an intramedullary lesion equal to or greater than 50% of the cross-sectional diameter of the bone or involving a length of cortex equal to or greater than 2.5 cm in diameter. Sixteen procedures were performed for painful lesion not relieved with radiation therapy. One procedure was performed for nonunion of a pathological fracture treated with intramedullary rodding. Average Mirel score was 10.6 (range, 8-12).

Thirteen hips were treated with unipolar hemiarthroplasty and 77 hips with total hip arthroplasty. For patients in which the major lesion involved the proximal femur, total hip arthroplasty was more likely to be performed with radiographic evidence of tumor involvement of the acetabulum and in those patients with predicted life expectancy of greater than 3 months. Fourteen patients required acetabular reconstruction with a roof reinforcement ring and one with a bulk allograft. Twenty-one patients underwent proximal femoral resection and replacement with either a proximal femoral allograft-prosthetic composite (5 hips) or a modular oncology replacement (16 hips, Howmedica Modular Replacement System, Rutherford, NJ). Proximal femoral replacement was performed when bone was severely involved by tumor and/or fracture and it was felt that retention of existing bone would lead to suboptimal palliation. All proximal femoral allografts were procured with abductor tendons attached, allowing direct reattachment of the host abductor tendon. The allografts were prepared with a transverse osteotomy. A long-stem femoral component was cemented in both the allograft and host femur. Allografts were more likely to be used early in the series and modular oncology replacement later as part of the surgeon’s overall transition away from the use of the former in favor of the latter. Eleven patients (all 5 with an allograft-prosthetic composite and 6 with extensive femoral disease) received a long-stem femoral component 250 to 300 mm in length. Ten patients received a long-stem femoral component 200 to 225 mm in length. All femoral stems were cemented in place. Cement plugs were used with all stems except those exceeding 250 mm in length. No venting of the femur was performed. The cement was centrifuged and inserted without pressurization.

Tripolar constrained acetabular components (Osteonics, Allendale, NJ) were implanted in 32 patients. Patients with significant loss of soft tissue attachments due to tumor, resection, or reconstruction were felt to be at increased risk for instability and were more likely to receive constrained components. Polymethylmethacrylate (PMMA) was used for acetabular cup fixation in all cases.

Mean operative time, including anesthesia, was 180 minutes (range, 115-310 minutes). Mean estimated blood loss was 700.8 mL (range, 75-6000 mL). General anesthesia was performed in 64 cases. Regional anesthesia (epidural, spinal, or combined) was performed in 26 cases. Mean preoperative hematocrit was 33.05 (range, 24.5-50).

Mean inpatient stay was 6.47 days (range, 2-25 days).

All patients were followed up to death or until the end of the follow-up period. Average follow-up was 10.8 months (range, 0-84 months). Sixty-three patients died before completion of the follow-up period.

**Results**

Functional score was evaluated using the Musculoskeletal Tumor Society lower extremity rating scale [12]. Preoperative functional score averaged 18 points (range, 0-30). The functional score for the 65 patients who were available for follow-up examination at 3 months postoperatively averaged 78 points (range, 30-100). At 6 months postoperatively, the average functional score was 90 (range,
60-100) for the 42 patients available for follow-up examination.

There were significant differences between both 3-month and 6-month function scores vs preoperative function scores (\( P < .001 \), Wilcoxon signed rank test). Of 65 procedures, 63 (97%) with paired function scores showed improvement at 3 months, whereas 100% of the 42 paired procedures showed improvement at 6 months.

Complications included one intraoperative femur fracture requiring cable fixation. Two patients were treated for deep venous thrombosis. One patient had a peroneal nerve palsy that persisted throughout the follow-up period. One patient had a deep wound infection treated with suppressive antibiotics until death occurred 2 months postoperatively. Five patients with a total hip arthroplasty had a dislocation, two of these occurred with constrained acetabular components. Two patients without a constrained prosthesis were treated successfully with closed reduction and bracing, whereas one required revision of the acetabular component. The other two patients required open reduction of the constrained components. One of these was found to have associated loosening of the acetabular component that was revised.

Eight (8.8% of 90 procedures, 9.4% of 84 patients) patients died in the acute postoperative period. Two patients became hypotensive intraoperatively, one shortly after injection of PMMA and the other after femoral reaming and then again after injection of PMMA. Both had cardiac arrest. One died intraoperatively and the other was successfully resuscitated, but postoperative cranial computed tomographic scan demonstrated extensive ischemic damage, and support was withdrawn. Two patients tolerated the surgery without adverse event but had bronchospasm, one immediately upon extubation and the second 6 hours postoperatively. Both required reintubation. One subsequently developed signs of fat embolism syndrome. She improved over a 7-day course and was extubated then developed worsening respiratory compromise and died on postoperative day 13 after refusing reintubation. The second patient was believed to have lymphangitic spread of her lung carcinoma combined with right ventricular dysfunction and died on postoperative day 1. A fifth patient had a minor drop in blood pressure and oxygen saturation after PMMA injection but was stable until she developed an episode of oxygen desaturation on the first postoperative day. Respiratory status then slowly deteriorated until she died 2 days later. Another patient had oxygen desaturation shortly after PMMA injection and again during wound closure but was extubated successfully. He developed sudden respiratory distress on the morning of postoperative day 2 and had cardiac arrest. After successful resuscitation, support was withdrawn 7 days later after he demonstrated inability to be weaned from the ventilator. One patient tolerated surgery well but developed oxygen desaturation in the recovery room; workup revealed lymphangitic spread of his lung carcinoma. He refused intubation and died 8 days later from respiratory failure. A final patient developed respiratory insufficiency 3 days postoperatively, refused further treatment, and died 7 days later.

Seventy-six patients were discharged from the hospital, including all 6 who had bilateral procedures. Four of these died within 1 month of discharge, 5 between 1 and 2 months of discharge and 7 between 2 and 3 months of discharge.

A logistic regression model was constructed to determine which, if any, variables played a significant role in the identification of cases of acute death. The following variables were analyzed: age, sex, diagnosis, preoperative presence of a pathological fracture, total hip arthroplasty vs hemiarthroplasty, acetabular reconstruction more than cup and PMMA, femoral resection vs retention, femoral stem length, operative time, preoperative hematocrit, American Society of Anesthesiologists class, type of anesthesia (regional vs general), estimated blood loss, and use of preoperative chemotherapy. Among all variables included in the models, only occurrence of fracture played a role in predicting the cases of acute death and bordered on significance at \( P = .055 \) (odds ratio, 8.37; 95% confidence interval, 0.96-73.3).

**Discussion**

The beneficial effect of hemiarthroplasty and total hip arthroplasty in providing pain relief and functional improvement in the presence of metastatic bone disease without pathological fracture has been well documented in the literature [2-11]. Mortality after hip arthroplasty, with emphasis on the potentially deleterious effects of PMMA use, particularly for fixation of long-stem femoral components, has also been well described [13-20]. Few studies, however, have focused on the acute morbidity and mortality of these patients in an attempt to identify particular risk factors to predict adverse events.

This study demonstrated significant functional benefit to patients after hip reconstructive surgery for metastatic disease. Virtually all surviving
patients demonstrated significant functional improvement at 3 and 6 months after surgery.

Mortality after elective hip arthroplasty appears to be in the range of 0.15% to 0.8% in the 30-day to 60-day postoperative period [17-19]. Intraoperative cardiac arrest, with or without associated mortality, with cemented long-stem components has been reported to occur in 0.6% to 10% of patients [15,16]. Significant adverse clinical events including hypotension, hypoxemia, coma, and cardiac arrest have been reported to occur in 62% of patients undergoing cemented long-stem femoral arthroplasty [13].


To our knowledge, this is the first series of patients with metastatic disease of the hip treated with hemiarthroplasty or total hip arthroplasty that has focused specifically on perioperative morbidity and mortality. The mortality rate in this cohort was 8.8%. Although the presence of pathological fracture did approximate significance in predicting a higher likelihood of mortality, no identifiable factor proved to predict mortality with statistical significance. In particular, stem length and American Society of Anesthesiologists class failed to predict mortality. This would imply that there may be specific individual factors that predispose certain patients to the adverse effects of PMMA injection, which are less clearly related to stem length and overall health.

Elevations in intramedullary pressure that occur during femoral canal preparation and cementation have shown in vivo and in vitro increases in circulating marrow [21-27]. This fat embolism syndrome is thought to account for many of the episodes of circulatory collapse, respiratory distress, and cerebrovascular insult that occur during arthroplasty and intramedullary nailing procedures. Techniques have been described to decrease the elevation in intramedullary pressure, which occurs during canal preparation and cement insertion, including the use of a cement plug [24], venting of the femoral canal [21-25,27], and not pressurizing the cement. These in vivo studies have demonstrated reductions in intramedullary pressure generation and circulating marrow, but no studies have yet demonstrated that any of these techniques decrease clinical fat embolism syndrome. Femoral venting has been shown to increase tumor disbursement [21] and can cause ectopic bone formation at the site [28]. In this study, canal plugs were used in all cases where possible (ie, stem length <250 mm) and cement was not pressurized in any case. Femoral vent holes were not used in any case.

Dislocation occurs more commonly in this patient population because of functional loss of normal soft tissue constraints either by tumor itself, because of surgical resection and reconstruction (particularly when acetabular reconstruction beyond placement of an acetabular component is required), or by muscle weakness caused by debilitation. In addition, these patients spend more time in bed and in chairs and often require transfer assistance, which can lead to increased episodes of placing the hip in “at-risk” positions. In an effort to decrease the risk of dislocation, constrained acetabular components were used frequently in this series. The tripolar constrained acetabular components (Osteonics) used in this series are a semi-constrained type that allow greater range of motion than more constrained components. It is felt that the enhanced range of motion and semiconstrained nature lowers the incidence of dislocation without leading to a higher incidence of acetabular failure. In patients without significant acetabular...
involvement, hemiarthroplasty can be performed with a much lower risk of dislocation. In patients with supra-acetabular tumor that is likely to be sensitive to radiation and or the use of bisphosphonate therapy such as breast or prostate tumors, hemiarthroplasty is also probably adequate. In those patients with significant acetabular involvement with tumors less sensitive to adjuvant therapy such as lung or renal carcinomas, consideration should be given to the possibility that the tumor will cause progressive destruction, and in this population, total hip arthroplasty will potentially provide more complete and durable palliation.

The mortality rate reported in this series appears to be higher than that culled from prior studies. This mortality rate may well continue to increase as the population of patients with bony metastatic disease increases, and survival is prolonged with the implication that patients will be increasingly compromised at the time of surgery.

Improvement in postoperative function scores in surviving patients was significant and perioperative morbidity in this complex patient population was acceptably low. Therefore, although the risk of mortality is perhaps higher than previously expected, the outcome in surviving patients is predictably good and a satisfying functional outcome is fairly rapidly achieved. Physicians and patients involved in this intervention need to be aware of the significant potential for mortality.

References


