The Partial Pelvic Replacement Cup in Severe Acetabular Defects

Steven A. Lietman, MD
Kirankumar Bhavnani, MS, DNB

Severe bone loss resulting in pelvic discontinuity may result in <50% coverage of the socket by native bone. The goal in these cases is to bridge the gap by using bone grafts, methylmethacrylate, or both. The partial pelvis cup helps protect bone grafts during their incorporation and also provides a stable construct to the acetabulum for weight bearing.

Acetabular defects¹ and pelvic discontinuity² have been defined and classified by the American Academy of Orthopaedic Surgeons into five basic types:
- type I—segmental deficiencies (peripheral or central),
- type II—cavitary deficiencies (peripheral or central),
- type III—combined deficiencies,
- type IV—pelvic discontinuity, and
- type V—arthrodisis.³

Extensive defects in the form of pelvic discontinuity (type IV) may result in patients with acetabular tumors, fractures, rheumatoid arthritis, or severe osteolysis following a primary total hip replacement. Many methods have been described for the treatment of defects in the acetabulum.

Smaller defects that involve <30% of the acetabulum may be managed effectively by bone grafting. Larger defects, >30% of the acetabulum, are currently less effectively treated with large structural allografts.⁴ Alternatives to large structural allografts in these defects use the following individually or in combination: large metallic prostheses, percutaneous screws with prostheses, and methylmethacrylate.

All of these techniques are technically demanding and have relatively high complication and failure rates.⁵ ⁶ Thus, there is no consensus as to how large acetabular defects should be treated. This article describes a technique using a partial pelvis prosthesis, that screws proximally into the anterior iliac wing and distally into the posterior column (Figure 1). This procedure has met with early success.

MATERIALS AND METHODS
Between May 1999 and June 2000,
11 patients (6 women and 5 men) underwent the partial pelvis procedure. All patients had either metastatic acetabular disease or severe acetabular osteolysis. Average patient age was 56 years (range: 31-69 years). Average follow-up was 5 months (range: 2-18 months).

The prosthesis was a partial pelvis prosthesis with two superior and one inferior flange made by Link (Figure 2). Large fragment AO cancellous or cortical screws were placed through all holes along the flanges and retained after good screw purchase was obtained.

Preoperative Planning

Preoperative planning included history and physical examination to assess anesthetic risk and anteroposterior (AP) pelvis and AP and lateral radiographs of the entire femur on the involved side to assess the required length of the femoral prosthesis. Detailed templating of acetabular and any femoral defects is essential to gauge the extent of defect and plan the reconstruction. Standard radiographic studies should include an AP and lateral view of the femur in the cancer patient to rule out the presence of a lesion in the femur (Figure 3).

In the presence of a previous implant, it may be difficult to identify pelvic discontinuity on routine radiographs. A visible fracture line through the anterior and posterior columns, medial translation with malrotation of the inferior part of the pelvis in relation to the superior part, and a break in Kohler's line are all indicative of the presence of pelvic discontinuity.

Jadet views of the acetabulum may be helpful; however, preoperative assessment with computed tomography (CT) will show the exact geometry of the bone loss. The "scatter" in the CT images resulting from the presence of hardware due to a previous surgery may obscure certain details. Generally, in metastatic acetabular lesions, and in particular renal cell carcinoma lesions, we prefer to embolize the tumor in our cardiovascular diagnostic lab preoperatively within several days of the index procedure.

Operative Technique

Approach. We prefer a lateral approach to the hip joint with a trochanteric osteotomy. If a cemented stem is present, an extended trochanteric osteotomy is used. The skin incision is centered over the greater trochanter and extends at least 8 cm distally along the anterior border of the femoral shaft and 8 cm proximally. The iliotibial band is split in line with the incision and proximally between the tensor fascia lata and gluteus maximus muscle bellies. The sciatic nerve is palpated prior to performing the trochanteric osteotomy to avoid damage to the nerve. The extended trochanteric osteotomy is used to remove cement from the canal and for maximum acetabular exposure.

The femoral head is then dislocated, and the femoral neck cut is made or in a revision case, the stem is removed. The plane between the tensor fascia lata anteriorly and the gluteus medius posteriorly is developed up to the anterior superior iliac spine. The vascular supply to the gluteal muscles comes from the gluteal arteries posteriorly and therefore the glutei are elevated subperiosteally from anterior to posterior taking care to preserve the superior and inferior gluteal arteries with the elevated muscle mass. The posterior column of the acetabulum is exposed from the posterior ilium to the ischial tuberosity by subperiosteal reflection of the soft tissues, the sciatic nerve is retracted posteriorly, and the hip is kept extended and the knee flexed to avoid tension on the sciatic nerve.

Preparing the Acetabulum. In the case of an existing acetabular cup, we place a screw into the polyethylene and screw the liner out. The cup is removed with flexible osteotomes. The acetabulum is gently curetted to remove all fibrous tissue and cement (as well as the metastasis in the cancer patient). Utmost care should be taken to prevent significant iatrogenic bone loss while preparing the acetabulum. The extent and limit of the acetabular bone deficiency is delineated. Thereafter, the acetabulum is reamed using reamers of
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progressively larger sizes in a standard fashion. The bone defects in the revision hips are filled by allograft bone chips with demineralized bone at this time. If the defect is due to tumor, it is filled with methylmethacrylate after all screws have been placed. Large structural allografts generally are not used if the defect is >30% of the acetabulum as large allografts remodel extremely slowly and incompletely.

Placement of the Partial Pelvis Cap.
The size of the partial pelvis implant is determined by subtracting 2-4 mm from the size of the largest reamer used for the outer diameter size of the partial pelvis implant. The implant is seated in the acetabular cavity in the orientation of the socket to avoid impingement and dislocation. The superior and inferior flanges can be bent to conform to the patient’s anatomy with standard large plate benders.

Fully threaded, 6.5-mm cancellous stainless steel screws are placed in the inferoposterior column through the wide inferior flange of the stainless steel partial pelvis implant. Then, 6.5-mm screws are placed through the two flanges of the proximal portion of the implant into the anterior iliac wing. The superior flanges should be placed as anteriorly as possible, and if this is done, the two superior flanges generally correspond to two areas along the anterior iliac wing that are thicker and allow greater screw purchase. The flanges are somewhat malleable with standard plate benders and can be made to sit firmly on the bone when the screws are tightened.

Hemostasis is achieved to create a dry bed for cementing or bone grafting the defect. In metastatic lesions, defects are cemented with methylmethacrylate and postoperative radiation is begun within 6 weeks postoperatively. With osteolytic defects associated with polyethylene wear, corticocancellous bone chips combined with demineralized bone matrix are used. Based on our laboratory experience, we believe demineralized bone is more effective than mineralized bone graft.10

A polyethylene acetabular liner with an outer diameter that is at least 3 mm smaller than the inner diameter of the partial pelvis is then cemented into the partial pelvis. If the pelvic defect is to be filled with cement, the polyethylene liner and defect can be cemented all at once. A trial reduction with the trial femur is performed. The stability of the hip is confirmed in all planes of motion. The femur is then cemented into place. In the case of the patient with metastatic disease, it is important to obtain preoperative radiographs to delineate any lesions present in the femur. A long stem femoral component should be used to extend at least three times the width of the shaft diameter below the defect.

Closure. The greater trochanter is securely fixed using Dall-Miles cables and a claw. If the osteotomy is extended, additional smooth wires are used. It is important to achieve rigid fixation of the greater trochanter to avoid trochanteric migration, as this can lead to post-
operative instability and abductor weakness. Initially, we were concerned about the trochanteric osteotomy healing in patients with metastatic cancer; however, we have noted no nonunions of the trochanteric osteotomy.

Postoperative Management

The suction drain is not removed until the drainage is <30 cc over 24 hours. Intravenous antibiotics (eg, cefazolin and gentamicin) are administered until the drains and Foley catheter are removed. Due to the high risk of infection, which can severely compromise the results, strict vigilance is maintained in the postoperative period to look for early signs of infection. A wound hematoma or serous collection may need to be drained as an emergency procedure to avoid fulminant infection. With any wound drainage >1 week postoperatively, operative debridement should be considered.

A postoperative abduction brace is used to avoid the position of greatest instability determined intraoperatively and to allow for healing of the trochanteric osteotomy. The patient is asked to maintain strict nonweight bearing on the operated limb until the osteotomy site is at least partially healed, approximately 6 weeks postoperatively.

RESULTS

All 11 patients survived the procedure and were discharged from the hospital ambulating. All patients had decreased or no pain postoperatively. All patients walked postoperatively, most with assistive aids. Specifically, patients usually required a walker (7 patients), but occasionally used only a cane (3 patients); 1 patient required no assistive aids. Complications were one superficial infection that resolved with serial debridements, one deep infection treated with serial debridements and long-term antibiotic suppression, and one partial sciatic nerve palsy.

DISCUSSION

In a series of 175 acetabular revisions reported by Moreland and Bernstein,11 there were 2 failures and both were in cases that had pelvic discontinuity. Crowningshield et al,12 while reporting the stress analysis of acetabular reconstruction in cases of severe acetabular bone loss, stated cortical bone stresses on the medial pelvic wall increase with medial placement of the acetabular component, which will result in early loosening of the "protruded" cup. They also confirmed that a metal backing to the cup helps reduce these stresses. Recently, Berry and Muller13 reported the treatment of pelvic discontinuity and noted a high rate of complications. They recommended an antiprotrusio cage in type IV defects.

Autografts and allografts have been used either as particulate or as structural grafts to bridge these defects. These grafts help build up not only the bone stock but also restore central hip rotation. Structural allografts are not viable at the time of their implantation but serve as an osteoconductive scaffold for subsequent revascularization and osseous in-growth, a process that is probably incomplete even after several years.13 Technical difficulties of large structural allografts include infection, nonunion, dislocation, and aseptic cup loosening. Chandler14 reported an 8% nonunion rate, 26% graft failure rate, and 32% cup loosening rate in cases where structural allografts were used. Jasty and Harris13 reported a 54% failure rate at the end of 8 years with structural allografts. Shinar and Harris4 reported high failure rates with structural allografts in defects >30% of the acetabulum. Stooft et al16 and Morsi et al17 reported improved clinical and radiographic results using allograft bone chips, which play only a minor structural role in reconstituting bone stock in the acetabulum.

In the absence of a bony socket, these grafts are subjected to significant weight-bearing loads, which may prevent their consolidation. Benjamin et al18 studied foam models of acetabuli with voids of varying diameters to check the stability of various components with regard to their abilities to resist migration within the defect. They concluded that a cup with peripheral rim augmentation demonstrated 20%-40% greater stability than a hemispherical cup.

Mayer and Harteil,19 in their series of 21 cases of extensive acetabular bone loss, confirmed the efficiency of screw fixed reinforcement implants for solid fixation of the polyethylene cup. Berry and Muller13 reported a 76% success rate with the Burch-Scheider antiprotrusio cage secured to the ischi- um and ilium in revision hip arthroplasties for massive acetabular bone deficiency when evaluated after 2-11 years (mean: 5 years).

In view of these studies, the prosthetic reconstruct should be highly stable, protect the bone grafts from weight bearing loads, and prevent >50% cup contact with allograft bone. Our experience in using the partial pelvis cup with freeze-dried allograft bone chips to reconstruct severe acetabular bone loss in loosened total hips with osteolysis and with methylmethacrylate in the patient with metastatic acetabular disease has been satisfactory (Figure 4). The partial pelvis lateralizes the hip by no more than several millimeters; however, longer follow-up is required to
more accurately assess the effect of lateralization on the hip center.

CONCLUSION
Use of the partial pelvis cup provides the benefits of a total joint arthroplasty such as pain relief, stability, and good range of motion in addition to protecting bone grafts from weight-bearing loads following reconstruction of severe acetabular bone loss resulting from pelvic discontinuity. It also is a useful salvage procedure in situations of severe medial wall defects with discontinuity between the anterior and posterior columns. The partial pelvis cup also helps "lateralize" the cemented acetabular component and provides a stable metal backing to reduce stresses on the cup, thus preventing early loosening. This implant effectively bypasses the area of bone loss and provides satisfactory function of the hip. We recommend using a partial pelvis cup with three flanges, two fixed over the anterior ilium and one over the inferior posterior column, as this provides maximum stability and fixation.

REFERENCES

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