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Operative Techniques in
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Unusual Acetabular and Proximal Femur Reconstructions: Technical Considerations From The Orthopaedic Oncology Perspective

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The term "proximal femur replacement" deceptively implies that the proximal femur bone is simply replaced with metal. This is an inadequate description. A proximal femur replacement is not merely a large hip arthroplasty, and unusual acetabular reconstructions are among the most challenging in orthopedic surgery. Many principles of orthopedic oncology can be readily applied to the nononcologic setting, and can therefore assist the reconstructive surgeon with helpful techniques to address these difficult clinical problems.
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Introduction

The term "proximal femur replacement" (PFR) is deceptively simple, and implies that the proximal femur bone is simply replaced with metal. This is an inadequate description. A PFR is not merely a large hip arthroplasty, and unusual acetabular reconstructions are among the most challenging in orthopedic surgery. There are several considerations in terms of acetabular reconstruction, abductor management, fixation techniques, and others that must be taken into account before the patient is brought to the operating room. This article reviews some of these considerations, and illustrates the solutions that orthopedic oncologists at our institution have applied. Many of the following principles of orthopedic oncology can be readily applied to the nononcologic setting, and can therefore assist the reconstructive surgeon with helpful techniques to address these difficult clinical problems.

Part 1—Unusual Acetabular Reconstructions

In dealing with acetabular bone deficiency, a number of different techniques can be used. Each has advantages, disadvantages, proponents, and opponents. As is typical in orthopedic surgery, and medicine in general, if there are many ways to solve a problem, none is universally useful, and each may have a role in select circumstances. In discussing these reconstructions, one can proceed from the "most normal" situation, where many different techniques can be used, to the least normal scenario, where acetabular damage has eliminated many of the possibilities, and reconstruction, if technically possible, has become more "exotic" and more complication prone.

In choosing, which reconstruction to perform, it is imperative to identify what acetabular structures remain. Multiple classification systems for acetabular deficiency exist, but perhaps the simplest means of surgical decision making is to identify which pelvic structures remain. From proximal to distal, this can be identified as follows:

(1) The sacroiliac (SI) joint and a portion of the ilium.
(2) The entire ilium with a normal SI joint.
(3) The iliac neck, but no columns.
(4) The anterior column, the posterior column, or both.
(5) The anterior andor posterior walls.
(6) The medial wall.
(7) The inferior pelvis and obturator ring.
(8) Although surgeons debate which components need to be present to use various reconstructive techniques, each discussion below emphasizes which structures should be present for the most reliable and durable reconstructions.

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Revision Acetabular Components with Augmentation

The simplest massive acetabular reconstruction is the use of a larger or multifixation cup component. This involves full exposure of the residual acetabulum, and identification of what components remain. To place a revision cup, the acetabular columns and everything proximal should generally be present. Debate exists in the use of this technique with pelvic discontinuities. In thinking about this, borrowing from the acetabular trauma thought process may prove useful.

In classifying transtectal fractures in trauma, the location of the fracture when compared to the tectum determines treatment. Infratectal transverse acetabular fractures are the most stable, and technically allow the simplest trauma management. Similarly, periprosthetic discontinuities that are infratectal, existing below a portion of the weight-bearing dome, have a stable weight-bearing surface, and may allow the "ligomento-taxis" type of reconstruction to be most successful. Those involving the weight-bearing surface (transtectal in trauma parlance) have the least continuity between any portion of the dome and the iliac neck, and have the least intrinsic stability for this technique.

Creation of a new, spherical (or ovoid if augments are to be used) defect allows the cup to be impacted. Supplemental screw fixation is then often used, with some designs having screws in multiple planes through both the iliac neck and the remaining acetabular rim.

Trabecular metal augments can be used to fill cavitary defects, and can be implanted similar to bone graft. Cement is then used to adhere the acetabular cup to the augment. They can also be screwed into place to bridge columnar defects, with similar cup implantation being performed. These types of reconstructions are most used with contained cavitary defects, defects in the acetabular walls, and small segmental columnar defects. All of these reconstructions require normal bone biology to be present for ingrowth, and should be forgone if the bone is not felt to be alive, as osseointegration will not occur.

Reconstruction Rings

Reconstruction rings are the most common form of non-biologic acetabular reconstruction, and have been used for decades. Their effectiveness is dependent on their proper use, as a permanently stable reconstruction *must* be obtained initially or the device will be doomed to failure. Many ring constructs have some form of infra-acetabular fixation, either a flange for the ischium or a hook to be placed within the obturator foramen (Fig. 1). These devices therefore require intact ischial structures for stable fixation.

Reconstruction rings provide excellent fixation in anatomically normal, but biologically inert, bone. whereas there are those with an ingrowth surface, most are not designed for this, and instead gain stability upon the remaining intact bone, often in combination with infra-acetabular fixation. Cemented liners are then used to complete the reconstruction. These devices

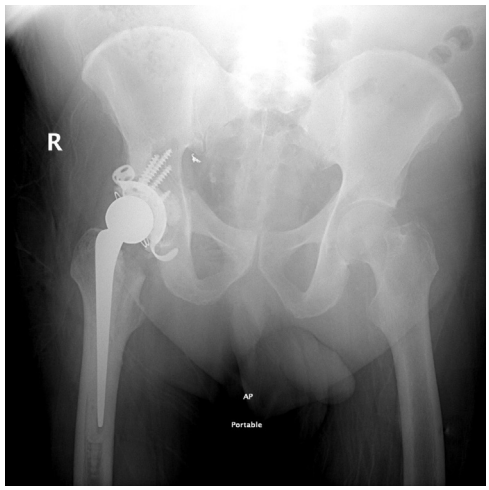

Figure 1 A reconstruction ring stabilizing an acetabular fracture through metastatic renal cell carcinoma. The anterior column has a massive cavitary defect, but the entire posterior column and wall, as well as the anterior wall, are present, allowing acetabular ring reconstruction. Cement is used as augmentation medially, but not anteriorly, as the defect is not contained. All screws are into the intact posterior column and iliac neck.

can successfully bridge large cavitary defects, and are quite useful in protrusio cases, provided enough columns are left to support them. They also can reconstruct segmental, columnar defects, as long as one column is available for support. In situations where the bone is viable, but severe cavitary defects exist (such as protrusio in rheumatoid arthritis), bone grafting under the ring may increase bone stock over time. In non-biologic reconstructions (such as radiation osteonecrosis) cement is used behind the cup to fill defects.

Reconstruction rings will often fail in situations with massive pelvic discontinuity. The ischial fixation is generally not sufficient to support a massive medial defect when the columns continue to diastase, and the reconstruction will migrate medially (Fig. 2). Reconstructing this type of defect often requires a more robust prosthesis, and a more extensive reconstruction.

"Ice Cream Cones"

Hemipelvic "ice cream cones" are specialized prostheses consisting of an acetabular component with a large "cone" stem designed to be implanted through the iliac neck toward the SI joint. They rely upon the fact that, even with severe acetabular destruction, the posterior iliac bone remains robust to the SI joint, as it comprises the "weight-bearing arch" of the sacrum. These are custom designed and created prostheses, are not FDA approved, and are used complying with FDA custom device guidelines.

Ice cream cones require little to no acetabular walls, and can bridge severe columnar defects, being able to be used in discontinuities where little to no columns remain. They do require some portion of the weight-bearing dome to be present, partially as a guide to ream