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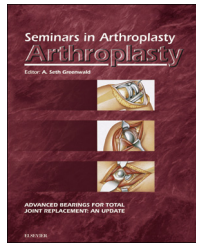

Bone loss: Accommodating a growing void

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ABSTRACT

The rising number of primary total hip arthroplasty procedures being performed annually is assoaced with a concomitant increasing burden of revision total hip surgery. Acetabular and/or femoral bone loss encountered at the time of revison surgery can present a challenging problem. This brief review defines methods by which to classfiy bone loss patterns, presents options for treatment, and reports on clinical outcomes of different treatment.

1. Defining the problem—Causes of bone loss

Acetabular and femoral bone loss at the time of revision total hip arthroplasty (THA) is a challenging problem and the burden of revision THA is steadily rising. Acetabular or femoral bone loss may result from osteolysis, stress shielding, peri-prosthetic infection, peri-prosthetic fracture, aseptic component loosening, iatrogenic bone loss during component removal, and metastatic lesions about the hip [1–3] (Fig. 1). The appropriate treatment is based on location, severity, and specific bone loss pattern.

In the setting of acetabular bone loss, treatment options include impaction grafting with a cemented acetabular component, jumbo hemispherical cup, cementless reconstruction with modular porous augments, structural allograft reconstruction, ring or cage reconstruction, cup-cage construct, or custom triflange acetabular component (CTAC) [4].

Based on the pattern of femoral bone loss, options for treatment include proximally porous-material-coated implants, proximal modular femoral components, extensively porous-material-coated stems, modular and nonmodular tapered stems, impaction grafting with a cemented component, allograft prosthesis composite, or a megaprosthesis [5].

2. Radiographic classifications of bone loss

The most popular classifications used to describe bone loss are the Paprosky classification for acetabular and femoral bone loss, as both classifications categorize bone loss patterns and help determine treatment for each pattern [4,6–10].

2.1. *Paprosky classification—Acetabular bone loss*

The Paprosky acetabular bone loss classification system is based on four radiographic parameters: superior migration of the hip center of rotation in reference to the superior obturator line, degree of osteolysis in the ischium, degree of osteolysis at the teardrop, and violation of the ilioischial or Kohler's line. Use of these four variables allows for objective assessment of bone loss involving the posterior column,

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Figure 1 – Preoperative frog-leg lateral x-ray demonstrating severe proximal femoral osteolysis due to eccentric polyethylene wear.

superior dome of the acetabulum, the anterosuperior column, and the medial acetabular wall [4].

There are three broad categories of acetabular defects. Type I defects are described as an undistorted hemispherical acetabulum with both the anterosuperior and posteroinferior columns remaining intact. In type II defects, the acetabulum is distorted and is no longer a hemisphere, but both columns are still intact. Type II defects are subdivided into A, B, and C based on the direction of bone loss. Inherent to each type II bone loss pattern is less than 3 cm of superior hip center migration. Type IIA defects demonstrate anterosuperior bone loss. Type IIB defects exhibit posterosuperior bone loss. Type IIC defects result in violation of Kohler's line and the hip center of rotation has migrated medially.

Type III acetabular defects are grouped as defects with a severely distorted acetabulum with non-supportive columns. Type IIIA defects exhibit an "up and out" pattern with greater than 3 cm of superior hip center migration, moderate ischial and teardrop osteolysis, and an intact Kohler's line. Type IIIB are "up and in" defects with greater than 60% acetabular bone loss, greater than 3 cm of superomedial hip center migration, and severe ischial and teardrop osteolysis with complete violation of Kohler's line [4,6]. Most commonly, pelvic discontinuities are associated with type IIIB defects.

2.2. *Paprosky classification—Femoral bone loss*

The Paprosky femoral bone loss classification system is based on the location of bone loss (metaphyseal or diaphyseal), the integrity of the proximal cancellous bone stock, and the residual amount of isthmus remaining for diaphyseal fixation [5,9,10].

There are four categories of femoral defects. Type I defects are described as minimal metaphyseal bone loss with an intact diaphysis. Type II defects, the most common pattern, are classified as extensive proximal metaphyseal bone loss with an intact diaphysis. Type II defects exhibit a greater degree of proximal femoral remodeling than seen with type I defects.

Type III and type IV defects are considered to be severe femoral bone loss patterns. Type III defects exhibit severe proximal metaphyseal bone loss and significant proximal femoral remodeling, and they are further sub-classified as type IIIA and type IIIB defects based on the extent of the remaining femoral isthmus (greater than 4 cm and less than 4 cm, respectively). Type IV defects are classified as severe metaphyseal and diaphyseal bone loss with complete femoral canal ectasia, a diaphysis that is no longer supportive, and minimal proximal femoral remodeling [5,9,10].

3. Clinical results of different treatment options for bone loss

3.1. *Acetabular reconstruction*

Acetabular reconstruction is predicated on the integrity of the remaining anterosuperior and posteroinferior columns. The goals of acetabular component revision are to obtain interference fit of a cementless hemispherical acetabular shell between the two columns, intimate contact of the cup, at least 50%, with host bone, and reconstruction that renders a stable construct with physiologic load distribution to the surrounding acetabular bone stock [11]. To prevent abduction failure of the acetabular component, 1–2 inferior or "kick-stand" screws into the ischium or superior pubic ramus should be implanted [12] (Fig. 2).

Figure 2 – AP hip x-ray of an acetabular component revision performed using a cementless acetabular implant. Note the 2 inferior "kickstand" screws placed to avoid abduction failure of the acetabular component.