# The Treatment of Acetabular Bone Defects with an Associated Pelvic Discontinuity

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**Pelvic discontinuity is encountered frequently during acetabular revision in patients with severe acetabular bone loss. Prompt recognition of the discontinuity and appropriate intraoperative treatment are essential for a successful clinical outcome. The treatment of the discontinuity is dependent on the remaining host bone, the potential for healing of the discontinuity, and the potential for biologic ingrowth of acetabular components. If healing potential of the discontinuity exists, the discontinuity should be treated in compression with a posterior column plate and structural allograft or with the use of trabecular metal acting as an internal plate. If healing potential for the discontinuity does not exist, the discontinuity should be bridged and treated in distraction with an acetabular transplant supported with a cage, a trabecular metal component with trabecular metal augmentation, or with the use of a custom triflange implant.**

**Level of Evidence: Therapeutic study, Level III-1 (case-control study). See the Guidelines for Authors for a complete description of levels of evidence.**

One of the most challenging aspects of acetabular revision surgery relates to the management of a pelvic discontinuity.[2] Pelvic discontinuity is described as "an uncommon condition occurring in association with total hip arthroplasty (THA) when the hemipelvis is separated superiorly and inferiorly by loss of host bone or a fracture through the acetabular columns."[1] With the increasing lifespan of pa-

tients with THAs and a trend toward surgery at younger ages, the volume and complexity of revision surgery should increase. Cementless acetabular components have shown improved long-term survival compared with cemented components.[3] However, patients with cementless acetabular component fixation can present with extensive bone loss at the time of revision because of the effects of asymptomatic osteolysis and stress shielding. Poor long-term results using an acetabular cage for the reconstruction of severe acetabular defects with an associated pelvic discontinuity have prompted the senior author (WGP) to explore alternative methods of reconstruction. We attempt to classify various types of pelvic discontinuity, provide an algorithm for the optimal treatment of these acetabular defects, and present the short-term results of acetabular reconstruction with an associated pelvic discontinuity using trabecular metal.

## MATERIALS AND METHODS

We retrospectively reviewed the clinical and radiographs on all patients who had an acetabular revision using a trabecular metal acetabular component with or without augmentation for a pelvic discontinuity (Zimmer, Warsaw, IN) at Central Dupage Hospital (Winfield, IL) from January 2002 to December 2003 and compared these patients with a cohort of patients who had a previous reconstruction for a pelvic discontinuity using an acetabular cage. Twelve patients were identified that had an acetabular revision with a pelvic discontinuity using a trabecular metal acetabular component with or without a modular acetabular augment. During this time, no patients with a Type IIIa or a Type IIIb acetabular defect with a discontinuity were treated with alternative reconstruction methods. The mean age at the time of surgery was 61 years (range, 36–89 years). There were three men and nine women. The average radiographic and clinical followup for the cohort of revision patients was 2.1 years (range, 1–3 years). The historical cohort consisted of twelve patients that had either a Type IIIa or a Type IIIb acetabular defect treated with a structural allograft and either a Gap II Restoration Cage (Stryker-Howmedica Osteonics, Kalamazoo, Michigan), a re-

construction cage (DePuy, Warsaw, Indiana) or a Burch-Schneider cage (Protek, Bern, Switzerland). The average radiographic and clinical followup for the cohort of revision patients was 54 months.

A posterior approach was used in all patients. In patients treated with a trabecular metal acetabular reconstruction, the acetabular defect was sized with acetabular reamers in the desired location to find the dimension of the cavity until two points of fixation were achieved (anterior to posterior; anterior-inferior to posterior-inferior; posterior-superior to anterior-inferior). The location of the pelvic discontinuity was assessed and the fibrotic pseudocapsule was removed within the region of the discontinuity between the superior and inferior hemipelvis. Augments were used to decrease the acetabular volume and restore a rim to support a revision cup. The location and orientation of the augments is highly variable depending on the bone-loss pattern. Augments often were placed on the medial aspect of the ilium or they were stacked. It was more common to use the augments with the wide base placed laterally and the apex placed medially. The revision cup had direct contact with the augments and allowed a press-fit. The augments initially were secured to the host bone with the use of multiple screws. Portions of the augments in some cases needed to be removed with a burr or a reamer to optimize the surface-area contact between the revision shell and the augments. Particulate bone graft then was placed into any remaining cavities before the hemispherical revision shell was impacted into place. The interface between the revision shell and the augments was cemented (these interfaces were placed in compression). Multiple-screw fixation was used through the revision shell. The majority of patients received a 36-mm or 40-mm femoral head. Postoperatively, all patients were placed in an abduction brace and the patients followed THA precautions with touch weightbearing for 3 months before being advanced to weightbearing as tolerated.

In the cohort of patients treated with a structural allograft and cage, acetabular reamers initially were used to size the acetabular cavity and identify the location of remaining bone to support the allograft. The ledge of bone on the superior ilium that abutted against the allograft was identified. The acetabulum of the allograft then was prepared on back table taking care to avoid weakening of the graft by excessive reaming. The cage then was sized to the allograft before it was placed into the host. The allograft hemipelvis then was cut in a curvilinear fashion from the greater sciatic notch to the anterior superior iliac spine to maintain a portion of the ilium attached to the acetabulum. The pubic and ischial portions of the allograft then were cut distally to the confluence of the acetabulum with enough length to accommodate the inferior defects. Care was taken to avoid leaving excessive inferior bone on the allograft that would prevents optimal medialization of the inferior aspect of the graft. A female reamer, 1 to 2 mm larger than the acetabular reamer then was used to size the acetabulum and was used to mark and shape the medial aspect of the graft to fit the host defect. A groove in the superior ilium of the allograft was then made to correspond to the ledge of bone along the superior aspect of the native acetabulum. This tongue-and-groove junction provided a stable buttress between the host and the allograft. The allograft then was placed with a press-fit against host bone. The graft was secured provisionally with Steinmann pins before three or four 6.5-mm partially threaded screws and washer were directed obliquely into the ilium from the intra-articular and lateral ilium aspects of the allograft. A pelvic reconstruction plate then was contoured to the posterior column to span the discontinuity, ideally with three screws in the native ilium and ischium. Cage-host bone screws and cage-allograft bone screws were placed for allograft fixation. If possible, the inferior flange of a cage was inserted into a slot in the ischium for additional fixation. A metal shell or a polyethylene (PE) liner then was cemented into the cage avoiding the tendency to place the component in a vertical and retroverted position.

The annual radiographic review consisted of standard anteroposterior (AP) radiographs of the pelvis, AP radiographs of the femur, and Lowenstein lateral radiographs. Radiographs taken preoperatively, immediately postoperatively, and at most recent followup were reviewed. The findings were consensually agreed by two reviewers (SMS and WGP). The preoperative AP radiographs were graded according to the acetabular defect classification of Paprosky et al.[5] The most recent radiographs were compared with the initial postoperative radiographs. Loosening was defined radiographically as a change in the component abduction angle of greater than 10°, or a change in the horizontal or vertical position of greater than 6 mm after correcting for magnification.

## RESULTS

Among patients who had a trabecular metal reconstruction, two patients required the use of a walker, three patients required the use of a cane, and seven patients walked without support for more than six blocks. Eleven had no
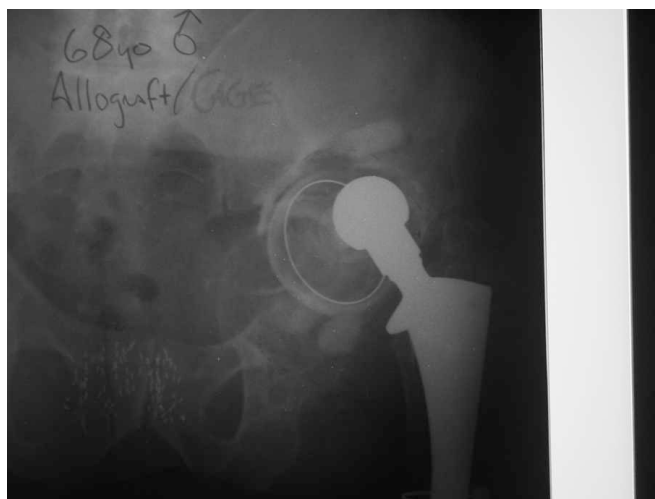


**Fig 1.** A radiograph of a 68-year-old man with a Type IIIb acetabular defect is shown. Note the disruption of Kohler's line, severe ischial lysis, superior migration, and associated pelvic discontinuity.

pain or mild pain and one patient had moderate pain. Among patients who had a cage reconstruction, two patients required the use of a wheelchair, seven patients required the use of a walker, and three patients used a cane. Four patients had no pain or mild pain and eight patients had moderate to severe pain.

Radiographically, one patient with a Type IIIb defect reconstructed with trabecular metal had possible acetabular loosening secondary to screw breakage. This patient is currently asymptomatic and has had no further change in the position of his acetabular component. None of the remaining trabecular metal acetabular components were revised or showed signs of acetabular loosening. Among patients treated with a structural allograft and reconstruction cage, eight of 12 patients had radiographic aseptic loosening or required an acetabular revision.

## DISCUSSION

Reliable and durable fixation of cementless acetabular components requires an environment with adequate biologic potential (intimate contact of viable living bone with the implant) and mechanical stability (motion, < 40–50 μm) to allow for bone ingrowth. Bone loss can compro-
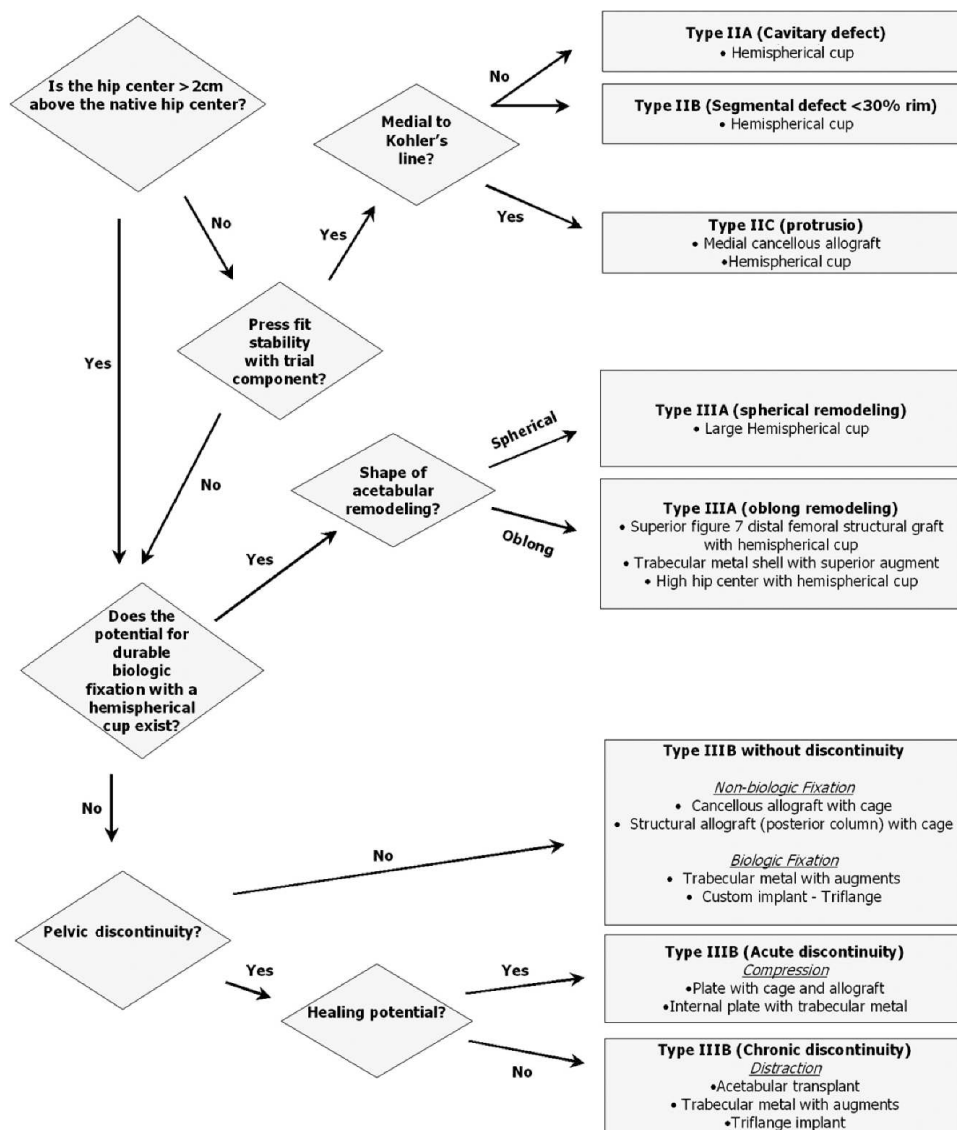


**Fig 2.** An algorithmic approach to acetabular deficiency is shown. Note that once a pelvic discontinuity is identified, the author must evaluate the bone for the potential for healing. Depending on the potential for healing, the discontinuity is treated either in distraction or compression.

mise both of these prerequisites. We think that trial components are a critical aspect of reconstructive surgery and can help determine proper component orientation, assess the remaining bone stock, and can provide guidance regarding reconstructive options. The trial implants can have full inherent stability, partial inherent stability, or no inherent stability. With full inherent stability, the surgeon is able to push on the rim of the trial component without displacing it, and a trial reduction can be done without displacing the trial component. With partial inherent stability, the position of the trial component is maintained while the trial inserter is removed. However, loading the rim of the trial implants causes displacement and the cup position will not be maintained if a trial reduction is attempted. Finally, no inherent stability implies that support of the trial component by host bone is inadequate to maintain placement of the trial in the desired location once the trial inserter is removed.

The Paprosky classification is based on the severity of bone loss and the ability to obtain cementless fixation for a given bone loss pattern.[5] Preoperative radiographic findings on the AP radiographs of the pelvis can be used to predict the type of defect present, allowing the surgeon to plan for the acetabular reconstruction accordingly. The four criteria on the preoperative radiograph that are important to assess include: superior migration of the hip center, ischial osteolysis, teardrop osteolysis, and position of the implant relative to Kohler's line (Fig 1).

Our algorithmic approach to revision of the acetabulum with a suspected pelvic discontinuity relies upon preoperative radiographic and intraoperative findings (Fig 2). The initial decision point relates to the superior migration of the hip center before revision. If the hip center has not migrated more than 3 cm above the superior obturator line, the probability of a pelvic discontinuity is minimal. When the hip center has migrated more than 3 cm above the superior obturator line or the surgeon is unable to achieve full inherent stability of the hemispherical trial, the defect is a Type III defect. The anterior and posterior columns are compressed with a Cobb elevator and motion between the superior and inferior hemipelvis is assessed. Important intraoperative findings include the amount of host bone present, the location of structural defects, and the location of the discontinuity. If a trial component has partial inherent stability, there generally is enough contact with host bone to support ingrowth and the defect therefore is a Type IIIa defect. When there is no inherent stability of the hemispherical trial, the defect is Type IIIb (Fig 3).

In the presence of a pelvic discontinuity, we make an intraoperative determination whether the discontinuity appears to be acute with the potential for healing or chronic without the potential for healing. An acute pelvic discontinuity with the potential for healing will have minimal
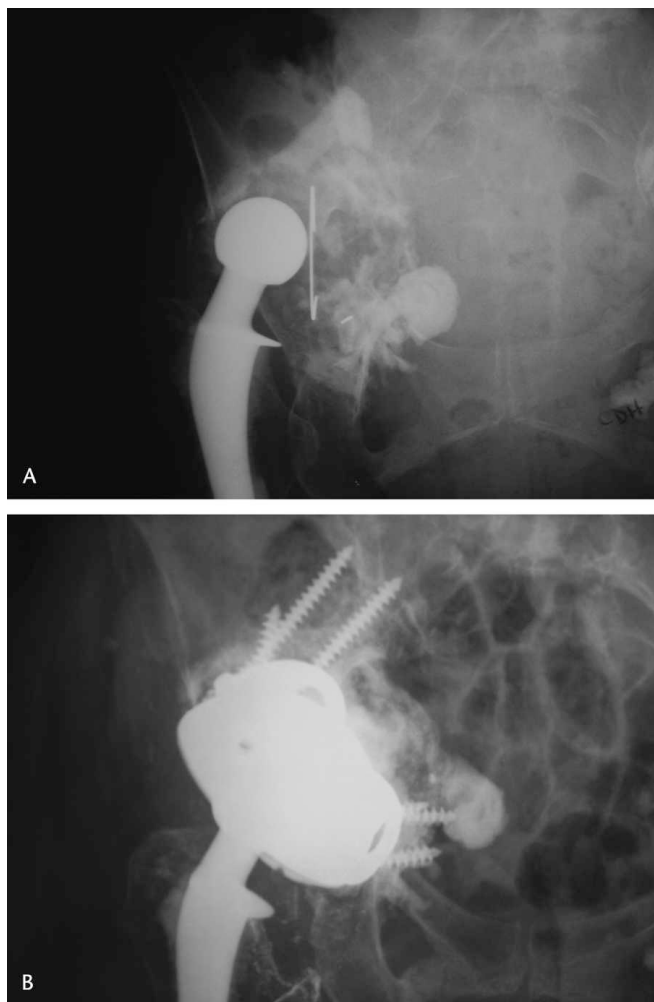
**Fig 3A–B.** (A) A radiograph of a patient with a Type IIIb acetabular defect with an associated pelvic discontinuity is shown. (B) The discontinuity was treated with a trabecular metal acetabular component along with a superiorly and inferiorly placed augment. Multiple screws were placed cephalad and caudal to the discontinuity to act as an internal plate.

gapping between the superior and inferior hemipelvis such that with compression, bony apposition is possible. A chronic discontinuity with the poor potential for healing may have a large amount of fibrous tissue between the hemipelvis, sclerotic or nonvascularized bone or may have had previous irradiation. If healing is possible, we will use compression and plating across the dissociation along with one of the reconstructive approaches described for a Type IIIb defect above. On the other hand, if there is no potential for healing, we choose to distract the discontinuity and insert bone graft into the defect. The initial stability of the structural graft or the modular reconstruction is greatly enhanced with distraction as opposed to compression when there is little chance for host bone to heal the discontinuity.

Type IIIb acetabular defects treated with acetabular transplants and cemented acetabular components (without a cage) have shown poor clinical results (unpublished data). The senior author followed up on 16 patients for a minimum of 8 years (mean followup, 10 years). Six patients had well-functioning implants without loosening, six patients were revised for aseptic loosening at an average 2.9 years, and four patients had radiographically loose implants. Because of the poor results noted with unsupported structural allograft, the senior author then began to use reconstruction cages. Despite the use of an acetabular cage, a high failure rate remained (66%) among this complex cohort of patients when a structural allograft and acetabular cage were combined.

Other authors have reported poor clinical results when pelvic discontinuity is encountered during revision surgery.[2,6] Berry et al[2] reviewed 27 patients and found that patients who had good remaining pelvic bone stock had a higher likelihood of successful treatment than did those patients who had severe segmental bone loss or those who had had previous treatment with irradiation of the pelvis.

The poor clinical results noted in acetabular defects with associated pelvic discontinuity has prompted the senior author to explore the use of a trabecular metal acetabular component with one or two augments to span the discontinuity and provide internal fixation to the superior and inferior hemipelvis. Modular trabecular metal revision systems have not been used long enough to provide definitive recommendations. However, the results of trabec-ular metal remain encouraging both among our current series of patients and as well as other institutions.[4]

The prevalence, younger age, and greater life expectancy of the arthroplasty population promises a continued need for solutions in patients requiring acetabular revisions in the face of severe bone loss. The algorithmic approach we have outlined is an approach that allows the surgeon to predict findings in the operating room, make plans for treating the expected bone loss patterns, and make appropriate judgments regarding reconstructive technique to achieve the best possible durable treatment. Our preference is to achieve cementless biologic fixation when possible and rely on alternative solutions when stability is unable to be achieved.

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