Review article

Treatment options for chronic pelvic discontinuity

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ABSTRACT

Chronic pelvic discontinuity is a distinct and unique challenge seen during revision total hip arthroplasty (THA) in which the superior ilium is separated from the inferior ischiopubic segment through the acetabulum, rendering the anterior and posterior columns discontinuous. The operative management of acetabular bone loss in revision THA is one of the most difficult challenges today. Common treatment options include cage reconstruction with bulk acetabular allograft, custom triflange acetabular component, a cup-cage construct, jumbo acetabular cup with porous metal augments, or acetabular distraction with a porous tantalum shell with or without modular porous augments.

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1. Introduction

Chronic pelvic discontinuity is an important and difficult complication of total hip arthroplasty (THA), estimated to be the cause of 1–5% of all acetabular revisions.^{1,2} The most common reasons for revision THA are instability/dislocation, mechanical loosening, and infection.³ Revision THA is becoming more common due to an increasing number of primary THA procedures being performed annually. Kurtz et al. demonstrated a projected increase of 137% of total hip revisions by the year 2030.^{4,5} The advent of technological advancements in THA have allowed us to address patients with increasing life expectancy and greater demands on the implants. However, the issue of chronic pelvic discontinuity can be expected to become more common.⁶

Pelvic discontinuity occurs most often in patients of female gender, with a history of prior pelvic radiation or rheumatoid arthritis.¹ The two most common classification systems are the AAOS Classification System and the Paprosky Classification,^{7,8} with the Paprosky Classification providing treatment recommendations based on the degree and location of bone loss, thus allowing for pre-operative planning.⁹ In addition, follow-up studies have demonstrated adequate validity and reliability of this classification system.¹⁰

There are three important factors in regards to achieving a successful outcome when treating pelvic discontinuity: the

amount of bone stock remaining, biologic in-growth potential, and the healing potential of the discontinuity.^{11,12} Treatment options include cage reconstruction with bulk acetabular allograft, custom triflange acetabular component (CTAC), a cup-cage construct, jumbo acetabular cup with porous metal augments, or acetabular distraction with a porous tantalum shell with or without modular porous augments. This review article discusses classification, evaluation, reconstruction options and outcomes of chronic pelvic discontinuity.

1.1. Classifying acetabular bone defects

The Paprosky classification is the most commonly utilized system for acetabular bone loss. The system's findings are based on the location of the hip center of rotation in reference to the superior obturator line, the presence of osteolysis at the ischium and at the tear drop, and the relation of the hip center of rotation relative to Köhler's (ilioischial) line.

Three types of bone defects are described. Type I defects have an undistorted acetabulum with intact anterosuperior and posterior columns. Type II defects have acetabular distortion but still have retention of the anterosuperior and posteroinferior columns. These are further broken down into A-C subclassifications. Type IIA defects have anterosuperior bone loss with less than 3 cm of superior migration. Type IIB defects have superolateral bone loss with less than 3 cm of superolateral femoral head migration. In Type IIC defects, there is medial migration of the hip center with disruption of Köhler's line.

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Type III defects are characterized by acetabular distortion and loss of column support such that trial components will be partially or completely unstable upon initial implantation. These defects are divided into Type IIIA and Type IIIB. Type IIIA defects have an ‘up and out’ pattern with superolateral loss with 30–60% of the columns being disrupted. There is superolateral migration of the hip center >3 cm but Köhler’s line is typically intact. Type IIIB defects have an ‘up and in’ pattern with superomedial hip center migration, >3 cm, >60% compromise of the columns, and with violation of Köhler’s line.⁸ Pelvic discontinuity can be seen in Type IIC and IIIA defects but are more commonly associated with Type IIIB defects.

1.2. Pre-operative evaluation

Favorable clinical outcomes are based on careful evaluation and pre-operative planning. Patients often present clinically with pain, difficulty with ambulation and leg-length discrepancy due to migration of the cup and hip center. A detailed history should be documented regarding the index procedure as well as pre- and post-operative symptoms. A full series of radiographs should be obtained including an anteroposterior (AP) pelvis, AP and lateral of the hip, and a cross-table lateral of the hip. In some cases, a computed tomography (CT) can be a powerful adjunct to assess the degree and location of bone loss, as it is frequently underestimated on plain radiographs.¹³ In cases with severe medial migration, CT angiography should be obtained to understand the relationship of intra-pelvic neurovascular structures to the acetabular component.

Pre-operative laboratory evaluation including white blood cell count, erythrocyte sedimentation rate, and C-reactive protein should be obtained before all revision THAs.¹⁴ Elevated markers should prompt a pre-operative hip aspiration.

1.3. Treatment options

A successful reconstruction is predicated on the ability to achieve stable fixation of a cementless construct, the biology of the remaining bone stock, and the ability to heal the chronic discontinuity. Chronic pelvic discontinuity is typically associated with poor biology and acts similarly to an atrophic or fibrous non-union. In revision THA, cementless acetabular components have demonstrated improved survivorship as compared to cemented components, and newer interventions focus on stable fixation

utilizing cementless implants.¹⁵ Treatment options include cage reconstruction with bulk acetabular allograft, custom triflange acetabular component, a cup-cage construct, jumbo acetabular cup with porous metal augments, or acetabular distraction with a porous tantalum shell with or without modular porous augments.

1.4. Cage reconstruction with bulk acetabular allograft

Historically, massive bulk allograft, used in conjunction with a cemented liner in the setting of chronic pelvic discontinuity had a 50% failure rate.^{16,17} Additionally, there is concern for this type of reconstruction due to graft resorption and infection risks associated with the allograft.

Another method of fixation was an independent acetabular cage used as a bridging device to span the ilium and the ischium. Again, outcomes were poor with high rates of complication and reported failures of up to 50–60%.^{18–20} When there is inadequate bone to support a cage construct, bulk allograft can be used in conjunction with a cage. This will provide stability until the allograft incorporates by creeping substitution. Studies have shown satisfactory outcomes with failure occurring due to lack of biologic ingrowth of the cage, leading to eventual loosening or cage breakage.^{20–22} With the advent of trabecular metal implants, bulk allografts were used less frequently, due to improved biologic ingrowth and no concerns for implant resorption.

1.5. Cup-Cage construct

With the availability of porous trabecular metal implants and their increased ability for biologic ingrowth, the cup-cage construct has gained enthusiasm as a useful treatment option. These constructs are protected by a cage while biologic fixation is achieved at the host bone-cup interface. This technique involves the placement of a highly porous jumbo acetabular cup against host bone, with or without porous metal augments, and a cage that spans the defect with fixation into the ilium and ischium.

Early outcomes have been favorable, demonstrating survivorship >85% in series.^{2,23,24} A recent long term study by Amenabar et al. demonstrated five- and ten-year survivorship of 93% and 85% with revision for any reason as the end point.²⁵ Another recent study by Martin et al. demonstrated 100% survivorship of 27 hips treated with a cup cage construct at five years.²⁶ However, there is concern with this construct as the cup is typically placed too vertical and relatively retroverted to accommodate the cage.

Fig. 1. A distractor is used to assess motion at the fracture site.

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Fig. 2. Distractor is switched to an extra-acetabular position and reamed on reverse until the acetabulum is maximally distracted.
(All images borrowed with permission from *The Bone and Joint Journal*, adapted from Sheth NP, Melnic CM, Paprosky WG. Acetabular distraction: an alternative for severe acetabular bone loss and chronic pelvic discontinuity. *The bone & joint journal*. 2014;96-b(11 Supple A):36–42. Reproduced with permission of the Licensor through PLSclear)

Fig. 3. The reamer will disengage from the handle upon engaging the columns.

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Implantation of this requires the surgeon to ensure that the cemented polyethylene is placed in the correct anteversion and inclination.

1.6. Custom triflange acetabular component

CTACs can also be used for large acetabular defects with severe bone loss. A three-dimensional CT scan is obtained and used to create a plastic model of the pelvis. A model is then created of the defect from which a custom triflange device is manufactured. The

device can be porous and/or hydroxyapatite coated and have flanges to the ilium, ischium and pubis. CTACs have shown excellent mid-term results with survival rates as high as 100% at 5 years and 90% at 10 years.^{27–30} However, these are expensive implants with typically a 6-week lag time from time of initial scan to implant completion. There is complex pre-operative planning and during implant removal, iatrogenic bone loss may lead to an imperfect fit of the implant. In addition, instability rates as high as 21% have been reported.³⁰ Long-term results are still pending to determine how such a stiff construct will affect host bone.

Fig. 4. If correct sized trial is chosen, the superior and inferior hemi-pelvis will move as a unit.

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1.7. Jumbo acetabular cup with porous metal augments

Another technique for reconstruction is the implantation of highly porous metal acetabular components in conjunction with porous metal augments. Osseointegration and bony ingrowth are paramount for long-term survival of revision cementless acetabular components. Trabecular metal implants have a lower revision and complication rate than other methods, as demonstrated by a recent systematic review.³¹ Favorable outcomes have been reported, with survivorship from 92 to 100%.^{12,32,33} These early to mid-term results are promising, but long-term data is still pending.

1.8. Acetabular distraction

In response to these imperfect reconstruction options, the technique of acetabular distraction, with or without porous tantalum augments, was introduced and reported in 2012 by Sporer et al.³⁴ This technique is based upon placement of an extra-acetabular distractor to allow for peripheral or lateral distraction and central or medial compression at the discontinuity. Augments are used for intra- and extra-cavitary defects and are subsequently unitized to the cup via cement.^{11,34,35} Early outcomes are promising, with one out of twenty (95%) patients needing to be revised for aseptic loosening. Long-term survivorship and clinical results are still unknown.

1.9. Authors preferred technique – acetabular distraction

The technique was originally described by Sporer et al. in 2012.³⁴ The acetabulum is approached via a standard posterior approach and the component is removed. Movement is assessed at the fracture site and independent motion of the superior and inferior segments is indicative of discontinuity (Fig. 1). Fibrous

tissues and other interposed tissue is debrided until healthy bleeding bone is seen. A detailed assessment should be taken of bone loss defects, allowing proper augment selection and placement (Fig. 2).

For this technique to be successful, the cup requires a stable anterosuperior and posteroinferior column fit. Anterosuperior and posteroinferior column loss are classified as intracavitary defects, and the augments are used for primary construct stability and should be placed prior to implantation of the shell. Posterosuperior bone loss is extracavitary and the augment is utilized as supplemental fixation. In true IIIB defects, posterosuperior augments typically provide primary implant stability and should be implanted before the liner.¹¹

Augments are positioned and secured with multiple screws. The acetabulum is maximally distracted via an extra-acetabular distractor. With this in place, the acetabulum is reamed on reverse to prevent further host bone loss until there is adequate interference fit between the anterosuperior and posteroinferior columns at which point the reamer will disengage from the reamer handle (Figs. 3, 4). A trial shell is placed and if proper distraction is achieved, the acetabulum will move as a unit (Fig. 4).

Prior to final implantation, crushed cancellous autograft is placed into the defect and a porous metal acetabular shell is placed with unitization to the augments with cement. At a minimum, four screws are inserted through the cup into host bone with preferably two screws inferiorly into the ischium or superior pubic ramus ("Kickstand" screw to avoid abduction failure of the acetabular shell). The liner is cemented in the proper inclination and anteversion. The distractor is removed after the cement has cured. Trial reduction is performed and the appropriate head/neck length are selected to optimize hip stability.

Post-operatively, touchdown weight bearing is recommended for 6 to 12 weeks to allow biologic fixation, with progression to weight bearing as tolerated at 3 months.^{11,34,35}

2. Conclusion

Acetabular bone loss and chronic pelvic discontinuity in revision THA is a challenging and increasingly frequent problem. Appropriate pre-operative workup and stabilization techniques are needed to obtain long-term cementless fixation and construct stability. The Paprosky classification system should be used in order the help guide the appropriate treatment intervention.

Many treatment options are available and demonstrate satisfactory outcomes. Our treatment of choice for chronic pelvic discontinuity is acetabular distraction technique with or without the use of porous metal modular augments. Data regarding treatment outcomes of distraction are limited, but early outcomes are promising, and this is the author's preferred treatment for chronic pelvic discontinuity.

Conflict of interest

None.

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