Bilateral pelvic discontinuity: a unique condition characterized by high failure rates of current treatment

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Abstract

Background: Bilateral pelvic discontinuity is characterized by complete dissociation of the superior and inferior pelvis secondary to bone loss or fracture. The end result is a freely mobile inferior pelvis at the level of each discontinuity which presents a significant reconstruction challenge. This clinical entity has not been described previously, and the results of surgical treatment are not known.

Methods: We retrospectively reviewed all identified cases of pelvic discontinuity (PD) treated with revision THA at one institution. We identified 133 pelvic discontinuities. Within this group, 6 patients had bilateral simultaneous PDs. Preoperative, intraoperative, and postoperative data and radiographic imaging were reviewed preoperatively and postoperatively for the characteristics of the dissociation and assessing PD healing and fixation of components after surgery.

Results: There were no preoperative factors that could distinguish these patients from the rest of the group of discontinuities (3 rheumatoid arthritis, 2 osteonecrosis of the femoral head, 1 developmental dysplasia). The reconstructions performed included 2 cup/cage, 5 posterior plating and uncemented cup, 3 cage alone, and 2 cups only. Ten of 12 hips had at least 1 complication postoperatively. At final follow-up, only 1 patient (17%) had radiographic evidence that both discontinuities had healed (posterior plate with uncemented cup).

Conclusions: Bilateral pelvic discontinuity is rare but presents the surgeon with a major reconstructive challenge. Only 1 patient went on to radiographic healing with current treatment strategies. Continued motion of the contralateral pelvic dissociation may account for the high failure rates. Surgeons should be aware of the challenges presented by this diagnosis and develop strategies to improve outcomes.

Introduction

Pelvic discontinuity (PD) is an uncommon mechanism of failure in total hip arthroplasty (THA) that is characterized by dissociation of the superior and inferior hemipelvis through the acetabulum [1–5]. This is commonly the result of a fracture and bone loss secondary to osteolysis or previous revision surgery [1,3,6]. The American Academy of Orthopedic Surgery (AAOS) categorizes PD as a type IV bone deficiency [1], and discontinuity has been further categorized as type IVa (PD with a cavity or mild segmental bone loss), type IVb (PD with a large segmental or combined defect), and type IVc (PD in a previously irradiated pelvis) [6].

We have identified a subgroup of patients with synchronous bilateral pelvic discontinuity (BPD). We are differentiating synchronous vs metachronous BPD because of the unique biomechanical environment and increased complexity associated with surgical management. In BPD, there is complete dissociation of the superior and inferior pelvis. This condition has not been previously described to our knowledge, and this article is the first to characterize this problem and report results of treatment.

Material and methods

Institutional review board approval was granted for this study. Our institutional joint registry was used to identify all THA revision...
cases that were performed for PD from 1997 through 2011. All cases of suspected PD were confirmed at the time of surgery. A specific code is present in our joint registry databases to identify patients with PD at revision operation. The medical records and radiographs of all patients were reviewed, and patients with bilateral synchronous PD were identified. Using each patient’s electronic and/or paper medical records, the following preoperative demographic data were obtained: sex, age, pre and postoperative Harris Hip Score, underlying diagnoses, and previous revisions.

Inclusion criteria included patients > 18 years who were identified as having a bilateral synchronous PD at the time of revision THA. All other acetabular fractures and bilateral metachronous pelvic discontinuities were excluded as were patients who had PD secondary to an acetabular tumor resection.

Preoperative radiographic evaluation was performed on all patients before revision for PD (Fig. 1). All patients had a minimum of an anteroposterior (AP) pelvis and an AP and lateral radiograph of the involved hip. In addition, some patients had Judet films, false profile views, or a computed tomography of the pelvis. The senior authors (DJB, DGL, RJS) reviewed all preoperative imaging and classified acetabular bone loss by both the AAOS and Paprosky classifications.

Intraoperative data were obtained from operative reports and included operative approach, type of acetabular and pelvic reconstruction performed, amount and type allograft used, acetabular component characteristics, and whether a constrained liner was used.

Postoperative radiographic evaluations of all patients were reviewed to determine acetabular component stability and PD healing. The senior authors reviewed all radiographs for the following information: radiolucency around the hardware, fracture line healing, radiolucencies around the acetabular component, and acetabular component stability.

Cup stability was determined by reviewing a series of radiographs and identifying an absence of progressive radiolucent lines, absences of radiolucent lines in all 3 Charnley acetabular zones, no migration of the cup, and no breakage of fixation screws. We defined PD healing as bridging bone across the fracture line, no fixation hardware failure, and no evidence of bone ingrowth to an uncemented cup above and below the previous PD, resulting in “unitizing” the hemipelvis.

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Postoperative clinical assessment included all complications, reason for and types of revisions, and postoperative Harris Hip Score. Patients were routinely followed clinically and radiographically at 3 months, 1, 2, 5, and 10 years postoperatively.

Results

We retrospectively reviewed 133 revision THAs treated for PD from 1997 through 2011. We identified 6 patients with simultaneous BPD. The patient age range at revision surgery was 49-73 (mean: 58) years. All 6 patients were women. Underlying conditions leading to initial THA included rheumatoid arthritis (3), osteonecrosis of the femoral head (2), and hip dysplasia (1; Table 1). None of the patients had received previous therapeutic radiation to the pelvis. Two patients were deceased at final follow-up at 5 and 10 years after the revision surgery, respectively. The mean follow-up period was 6 (range, 3.8-11.5) years. Five of 6 patients had at least 1 revision hip operation before being treated for BPD. Eleven of 12 hips had AAOS category IVB, and 1 hip had IVA type bone loss. According to the Paprosky classification, 1 hip had type 2B and 1 hip had type 2C, 5 had type 3A, and 5 hips had type 3B subtle bone loss. Of note, the common finding of obturator ring asymmetry seen in PD was not seen in some patients because of “pseudonormalization” of obturator ring rotation due to BPD.

Figure 1. (a) AP pelvis radiograph demonstrating BPD. (b) Postoperative AP pelvis radiograph after revision to a cup cage construct of the left hip. (c) Postoperative AP pelvis radiograph after revision to an uncemented cup with superior augment of the right hip 3 months after the left hip revision. (d) AP pelvis radiograph 10 months after left hip revision demonstrating continued BPD and bilateral acetabular component loosening.
The average time between treatment of one hip and the opposite hip for PD was 9.5 (range: 2-166) months. The reconstructions performed included 5 posterior column plating and uncemented cup, 3 cage constructs alone, 2 cup/cage constructs, and 2 uncemented cups only (Table 1). All hips intraoperatively were confirmed to have a PD with motion through the discontinuity site. Three hips had bulk allograft used at the time of revision surgery (2 posterior column plate and uncemented cup and 1 cage construct). Three patients had tantalum acetabular augments placed for bone loss. The average cup size used was 60 (range: 54-70) mm. The femoral head diameter was 22 mm in 1 hip, 28 mm in 3 hips, 32 mm in 6 hips, and 36 mm in 2 hips.

Final radiographic follow-up demonstrated only 1 patient went on to heal the bilateral discontinuities for an overall union rate of 17% (Table 1). All hips intraoperatively were confirmed to have a PD with motion through the discontinuity site. Three hips had bulk allograft used at the time of revision surgery (2 posterior column plate and uncemented cup and 1 cage construct). Three patients had tantalum acetabular augments placed for bone loss. The average cup size used was 60 (range: 54-70) mm. The femoral head diameter was 22 mm in 1 hip, 28 mm in 3 hips, 32 mm in 6 hips, and 36 mm in 2 hips.

The one patient that went on to radiographic healing was treated with a posterior column plate and uncemented cup on one side and an uncemented cup with porous metal augments on the other side. She was a 49-year-old woman at the time of the first discontinuity surgery, and her medical history was significant for osteonecrosis of the femoral head because of sickle cell disease. The discontinuities were treated approximately 34 months apart. She had a normal postoperative course after each surgery.

Five hips in 3 patients had further acetabular revisions or component removal (Table 1). One patient had cup revision and pelvic plating of one hip for implant loosening and persistent discontinuity, and revision to a bipolar hemiarthroplasty on the contralateral hip for continued discontinuity. One patient had resection arthroplasty of one hip for infection and conversion of one hip to a constrained liner for recurrent dislocation. One patient had conversion of one hip to a constrained liner for recurrent hip dislocation. Both the average preoperative and postoperative Harris Hip Scores were 54.

| Number | Sex | Side | Diagnosis | Revision type | Final cup stability | PD healing | Complications | Re-revision |
|--------|-----|------|-----------|---------------|---------------------|------------|---------------|-------------|
| 1      | F   | R    | RA        | Cage construct| Loose              | Not healed | None          | Posterior column plate and uncemented cup |
|        |     |      |           |               |                     |            |               | Conversion to bipolar due to persistent discontinuity |
| 2      | F   | R    | RA        | Posterior column plate/uncemented cup | Stable | Not healed | Infection/dislocation | Resection arthroplasty |
|        |     |      |           | Cage + posterior column plate | Stable | Not healed | Hip dislocation | Constrained liner |
| 3      | F   | R    | RA        | Uncemented cup only | Stable | Not healed | None          | None |
|        |     |      |           | Cup cage construct | Stable | Not healed | None          | None |
| 4      | F   | R    | ONFH      | Uncemented cup only | Stable | Not healed | Dislocation/periprosthetic femur fracture | Constrained liner |
|        |     |      |           | Posterior column plate/uncemented cup | Stable | Not healed | Greater trochanteric fracture | None |
| 5      | F   | R    | ONFH      | Uncemented cup only | Stable | Not healed | None          | None |
|        |     |      |           | Posterior column plate/uncemented cup | Stable | Not healed | Dislocation/sciatic nerve neuropraxia | None |
| 6      | F   | R    | Dysplasia | Cup cage construct | Stable | Healed | None          | Greater trochanteric fracture |
|        |     |      |           | Cup cage construct | Stable | Healed | None          | None |

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**Table 1** Patient demographics.

**Discussion**

BPD is a rare reconstructive problem occurring in only 5% of patients with PD in this series. BPD has not been previously described, and therefore, to our knowledge, this marks the first description of this patient population. This entity is valuable to describe because of the unique biomechanical problems associated with the problem and also the exceptionally high rate of failure of current treatment strategies. This unique clinical entity has been associated with substantially worse implant survival rates compared to the results of patients with unilateral PD (17% vs 75%-98%) [5,7].

BPD results in complete dissociation of the superior and inferior pelvis secondary to bone loss and fracture through the bilateral acetabula. All patients in this study had synchronous BPD. The biomechanics of the problem are unique because the entire inferior hemipelvis is detached from the superior hemipelvis. When one side is stabilized during a staged reconstruction, the other side remains mobile which may destabilize the fixed side leading to subsequent failure (Fig. 2). In addition, the biologic factors leading to BPD in these patients, which typically represents a transverse acetabular stress fracture through deficient bone, may also predispose to poorer healing potential.
Risk factors have been described previously for unilateral PD [6]. These risk factors included both female gender (\(P < .001\)) and rheumatoid arthritis (\(P = .003\)). We noted similar findings in our patient population with BPD. All 6 patients were females.

Standard AP pelvis views identified 100% of the cases of BPD. However, we recently published our results evaluating preoperative radiographic findings in patients with unilateral PD [8]. We defined PD as (1) a visible fracture line through the pelvis on 2 orthogonal views (ie, either on the AP pelvis radiograph and on a true lateral radiograph or on both Judet views) and (2) a visible fracture line on the AP pelvis film, true lateral radiograph, or Judet film in combination with 1 of 2 secondary findings suggesting translation or rotation of the inferior hemipelvis relative to the superior hemipelvis (either medial translation of the inferior hemipelvis or obturator ring asymmetry). Among the patients who had an AP radiograph, lateral radiograph, and Judet films preoperatively, all 47 hips (100%) of cases were identified using the criteria listed in our study. However, on standard AP films of the pelvis with BPD obturator ring asymmetry may not be seen or may be subtle. This is likely secondary to a pseudonormalization of the position of the inferior pelvis. In unilateral PD, the inferior hemipelvis often is rotated abnormally relative to the superior hemipelvis which creates radiographic asymmetry of the obturator rings.

PD healing was seen in only 1 of 6 patients at final follow-up; thus, poor results were achieved in this series of patients treated with the current standard methods for PD. The clinical results also were poor with an average Harris Hip Score after all treatments of 54, the same as the preoperative score. One explanation for these results pertains to the lack of overall pelvic stability obtained with current treatment methods. We routinely achieved a rigid construct on one side of the BPD at the time of revision. However, on average, there were 9.5 months before the contralateral PD was treated. This presumably allowed continued motion through the contralateral PD and secondary failure of the ipsilateral construct before PD healing could occur. One might hypothesize benefits of treating these bilateral problems in a more concurrent manner, however, the practical problems of limiting weight bearing after very large reconstructions and of the medical stress and risk of closely spaced or simultaneous large procedures present limitations.

This is a retrospective case series of patients with BPD and therefore has all of the limitations associated with this type of study. Our series includes only 6 patients with BPD because of the limited number of patients with this clinical problem. The small patient population and fact that the results are from 1 institution limit the generalizability of these findings.

Conclusions

We have identified a previously undescribed patient population with BPD. Current reconstructive options designed for a unilateral PD were associated with high failure rates and poor clinical outcomes. Further investigations into alternative treatment modalities may benefit patients with this difficult problem.

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