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Case report

Triflange acetabular reconstruction for pelvic discontinuity through a direct anterior approach

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ABSTRACT

A 74-year-old female patient presented to our clinic with pelvic discontinuity after multiple revision total hip surgeries requiring custom triflange acetabular reconstruction, which we accomplished through a direct anterior approach to the hip. The direct anterior approach to the hip has grown in popularity but still has the reputation of being a minimally invasive approach without the capacity for extensile exposure in the revision setting. We describe the extensile technique and demonstrate through our case the ability to perform the most challenging cases through this approach and discuss the potential benefits of its utilization.

Introduction

The prevalence of revision total hip arthroplasty (THA) has dramatically increased and is expected to continue to rise [1,2] in direct proportion to the exponential increase of primary THA in the upcoming decades [3,4]. Despite advances in surgical technique and technology, revision THA for large acetabular defects, such as pelvic discontinuity, remains a challenge even for the most experienced arthroplasty surgeons. Pelvic discontinuity is defined by a loss of bony support between the ilium, inferior ischium, and pubis. Often, the minimal host bone stock prevents conventional implantation of stable implants. Custom triflange reconstruction has emerged as an effective technique in certain patterns of acetabular deficiency.

Performing revision THA through varying surgical approaches, such as the posterior, modified Hardinge, and modified Watson Jones, has been well described in the literature [5-7]. Although the direct anterior approach (DAA) through the Smith-Petersen interval has gained popularity over the past 15 years [8-11], few studies have evaluated its efficacy in revision arthroplasty [12-15]. This can be attributed to the fact that DAA has been marketed and shown to be a minimally invasive approach by sparing soft-tissue trauma and muscle inflammation [16-18]. However, the goals of revision THA for acetabular reconstruction focus on surgical visualization, exposure, and restoration of hip stability. A review article by Manrique et al. [12] demonstrates the utility and surgical technique of DAA for revision THA while minimizing muscle damage. The authors emphasize the importance of appropriate acetabular and femoral exposure to ensure correct component positioning while maintaining soft-tissue integrity. However, unlike the other well-reported surgical hip approaches, there is a paucity of literature evaluating postoperative recovery and short-term and long-term clinical outcomes after extensile DAA for revision THA.

Our practice has evolved and adopted the DAA as an approach that has the flexibility of being extensile and allows for appropriate acetabular and femoral exposure in the most difficult cases. Extensile exposure through the DAA can be challenging depending on patient factors and surgeon experience. Patient selection is important for success, especially as a surgeon develops their skills through this interval, and admittedly, our patient was a preferred candidate for this technique. We present a case of pelvic

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discontinuity treated with a custom triflange via the DAA. To our knowledge, this is the first report in the literature of pelvic discontinuity treated with a custom triflange through the DAA.

Case history

A 74-year-old female presented to our clinic with constant left groin pain and instability symptoms after an augmented revision left THA. Her index procedure was a metal-on-metal THA that failed 12 years later for which she received a revision surgery with a superior iliac augment. After subsequent failure and progressive osteolysis, she presented to our clinic and we began preoperative planning for re-revision surgery including laboratory evaluation which found her to be free of infection. She was otherwise in good health, with a body mass index of 19.7 and a past medical history of mild hypertension and hypothyroidism. Her past surgical history included multiple revision surgeries for her right hip, resulting in a baseline Trendelenburg gait and the use of a rolling walker. However, upon presenting with left hip protrusion, she was confined to a wheelchair. Radiographic analysis, including computed tomography, revealed that the cup dissociated from the augment and had protruded into the pelvis, with associated pelvic discontinuity (Fig. 1A). Her prior incision was through an anterolateral approach, but owing to severe greater trochanter osteolysis, we decided to avoid the abductors by using the DAA interval. We planned for custom triflange reconstruction and collaborated with the manufacturer (Zimmer Biomet, Warsaw, IN) to tailor the implant specifically for implantation through an anterior approach, by modifying the flange position on the ischium and moving the superior flange slightly anterior to improve access from an anterior, rather than a posterior exposure (Fig. 1B). This was a custom product that incorporated a dual mobility liner, which was produced via humanitarian exemption with the Food and Drug Administration and is not a standard offering from this company.

We perform the DAA with the patient supine on a standard operation room table with both legs prepped and draped. A standard incision is made from a point midway between the anterior superior iliac spine (ASIS) and the tip of the greater trochanter (Fig. 2A). The proximal incision may be curved laterally to avoid crossing the hip flexor crease, especially when avoiding the pannus in obese patients. In the case of extensile acetabular procedures, we carry the proximal incision up to the ASIS and then laterally along the iliac crest (Fig. 2B). Careful cautery of the perforating lateral femoral circumflex vessels is performed to prevent problematic bleeding while paying attention to avoid injury to the terminal inferior branch of the superior gluteal nerve [19]. This nerve has been found to be in close approximation to the medial border of the tensor fascia lata (TFL), usually within 10 mm proximal to the entry point of the ascending branch of the lateral circumflex femoral artery [19].

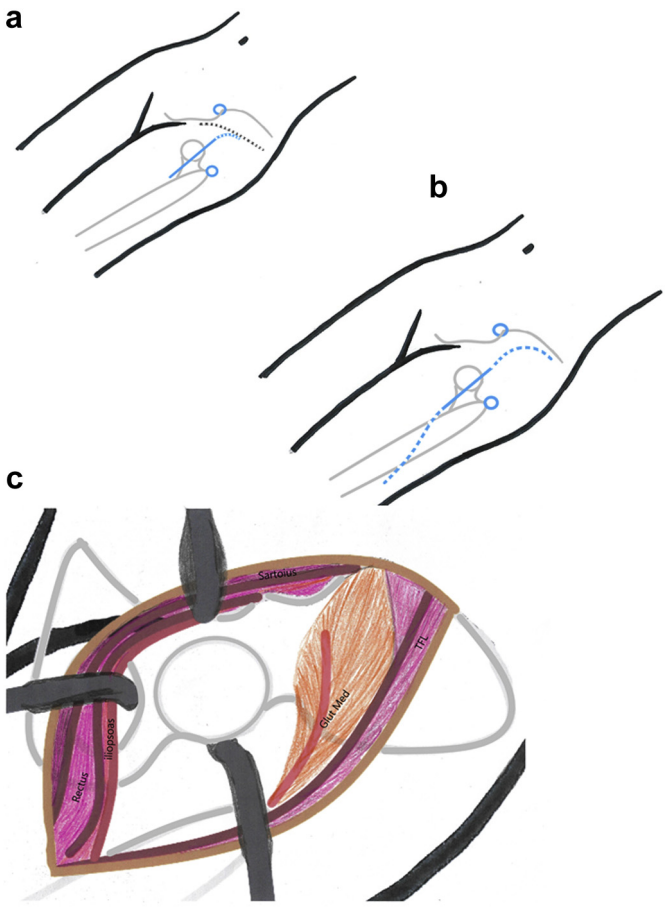

Figure 2. (a) Standard DAA. (b) Dotted line delineating the extensile incision. (c) Diagram of deep dissection and retractor placement.

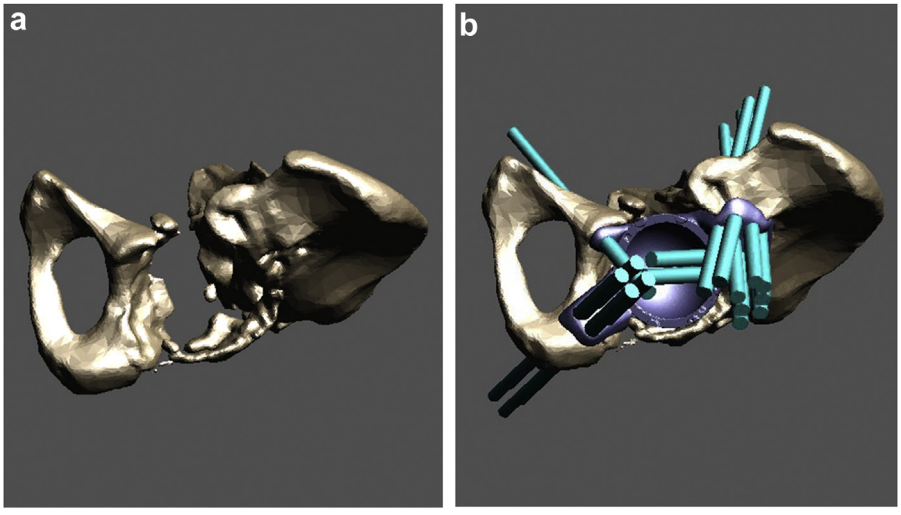

Figure 1. (a) Three-dimensional computed tomography reconstruction demonstrating acetabular discontinuity. (b) Custom triflange showing the anterior flange screw trajectories anteverted as much as possible, as well as the posterior flange modified to sit on the anterior ischium.

Deep proximal dissection explores the interval between the rectus femoris and the gluteus medius (Fig. 2C). Palpation of the superior neck through this interval guides the position of a cobra retractor over the superior capsule. A cobb is then used to sweep soft tissue off the capsule and define the inferior neck. A large curved Hohmann style retractor is then placed inferiorly under the capsule. The cobb is then used to sweep the rectus off the anterior capsule medially, to the level of the anterior column, while releasing adhesions with the electrocautery. A second cobra is exchanged with the cobb on the anterior column for medial retraction. An arthrotomy is made from the acetabular rim to the intertrochanteric line slightly inferior to the middle of the neck. This capsule is then released superiorly off the acetabulum as well as the femur and then resected. The inferior Hohmann is then replaced inside the capsule, and the superior cobra is placed lateral to the trochanter. At this point, in revision cases where the femoral stem is maintained, the femur is dislocated with manual traction and a bone hook, and then the ball is removed. A Mueller-type retractor is placed posterior to the acetabulum to gain full acetabular exposure and retract the femur posteriorly.

The outer iliac wing is exposed in a subperiosteal fashion, and the TFL may need to be released to gain exposure to place a cage or lateral flange of the triflange on the ilium. If necessary, the inner surface of the iliac wing can be explored by releasing the sartorius and inguinal ligament off the ASIS and subperiosteally elevating the iliacus from the internal iliac crest. Further extension into the inner table of the acetabulum can be accomplished by release of the rectus femoris from the AIIS, allowing for full exposure of the acetabulum, anterior column, and inner table for the use of augments or plate application.

Inferiorly, subperiosteal dissection is carried out along the pubis and ischium, until adequate exposure is obtained, and is maintained with careful placement of Hohmann's anteriorly above the pubis and posterior to the ischium, making sure to remain on bone as to avoid any contact with the sciatic nerve. The acetabulum is prepared by lightly reaming to obtain bleeding bone. We seat the superior acetabulum first and then align the ischial flange. Once the implant is well seated, a superior acetabular screw is placed up the ilium. The rest of the triflange is attached with screws into the ilium and ischium, and a single screw is placed into the pubis. The acetabular liner is then impacted, and depending on trial stability, the appropriate neck length is chosen with attention to leg length and stability; the bearing is chosen depending on the case (standard, constrained, dual mobility, and so forth). We prefer to close without a drain, with a deep running suture, followed by

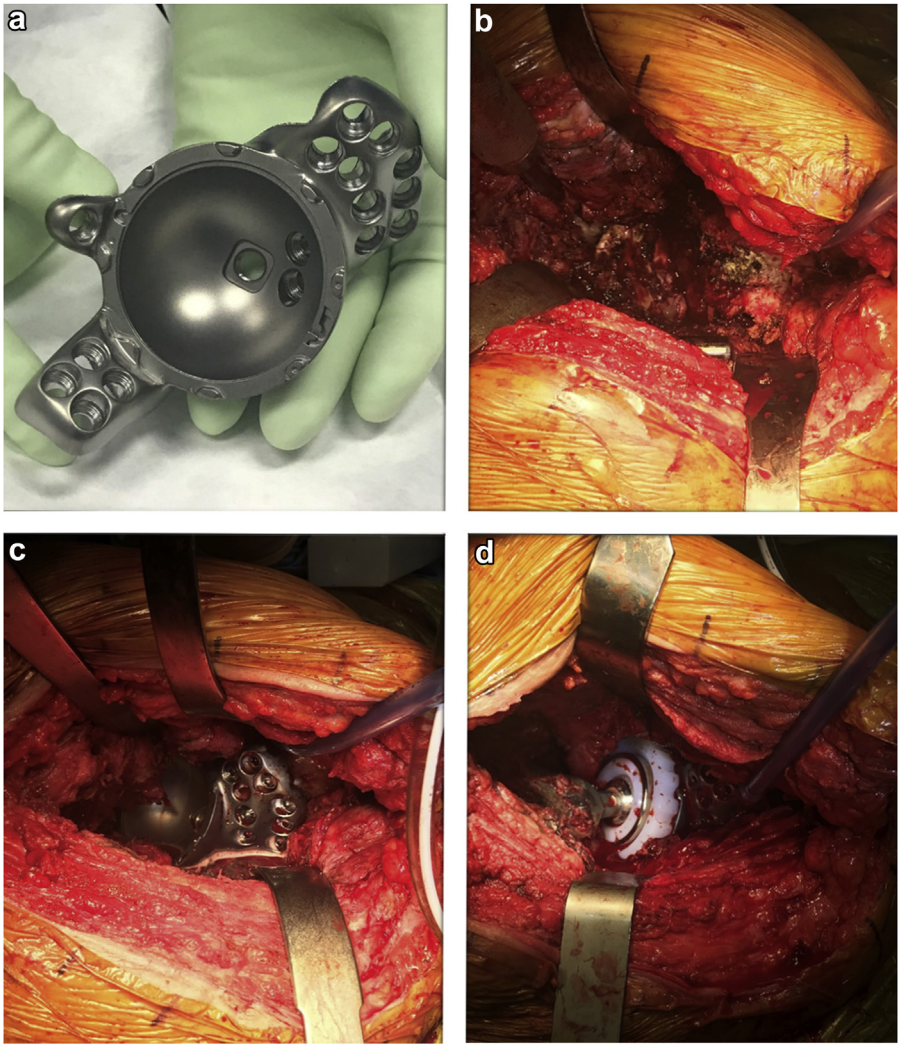

Figure 3. (a) Custom triflange implant. (b) Exposure showing paucity of bone stock. Left hip where proximal is on the right side of the screen. (c) Exposure with implantation of component. (d) Hip reduced.

subcutaneous absorbable braid, and finally horizontal mattress 2-0 nylon. We frequently use incisional negative-pressure dressings in revision cases.

In this specific case, the prior anterolateral incision was used and extended proximally and slightly distally to allow for access to the sartorius-tensor fascia lata interval. Further dissection ensued as per the technique described previously (Fig. 3). After dislocation and removal of the head, the femoral stem was determined to be stable, so we proceeded without stem removal. Exposure was less difficult in her case because there was no remaining greater trochanter, although the abductor sleeve remained intact. This allowed us to obtain full exposure with only a small release of the TFL off the anterior ilium and for mobilization of the femur posterior to the acetabulum for full exposure. The triflange component was implanted in conjunction with a 48-mm dual mobility head. During surgery, she lost 1 L of blood and received 2 units of packed red blood cells intraoperatively and 4 more units postoperatively.

Her postoperative course was otherwise without complication, and she began 10 percent weight bearing on day 1 and was transferred to rehab on postoperative day 4. At 8 weeks postoperatively, she was pain free and was transitioned from partial weight bearing to full weight bearing and successfully returned to walking with the assistance of a wheeled walker. At 1 year postoperatively, the patient is doing very well and reports walking 1 mile almost daily with the assistance of a walker and without pain. Her 1-year follow-up films show that the implant has remained stable with evidence of bony consolidation (Fig. 4).

Discussion

Severe acetabular defects, such as pelvic discontinuity, continue to pose one of the greatest challenges in revision hip reconstruction. Although the introduction of trabecular metal acetabular components and porous coated metal augments has dramatically improved the arthroplasty surgeon's ability to reconstruct acetabular deficiency, there may be several scenarios that preclude reconstruction using standard revision components [20]. Custom devices such as CT-based triflange shells offer the advantage of bridging bony defects with immediate rigid fixation and have shown to have results comparable to other methods used to manage major acetabular deficiencies [20-26]. Most revision THA studies have reported surgical exposure using an extensile posterior approach, while some have reported on modified Hardinge and Watson-Jones approaches [5-7]. To our knowledge, this is the first report in the literature to describe implantation of a custom triflange device using an extensile direct anterior hip approach.

Instability after revision THA via the posterior approach has been reported up to 15% in the literature [27-32]. Alberton et al. [28] reported dislocation in 115 (7.4%) patients of 1548 revision hip arthroplasties. Instability after revision arthroplasty has shown to have decreased with the utilization of a posterior capsular repair. In a meta-analysis involving 13,203 revision THAs, Masonis and Bourne [33] found a 3.23% dislocation rate for the posterior approach (3.95% without posterior capsular repair and 2.03% with posterior capsular repair) and 2.18% for the anterolateral approach. Suh et al. [6] reported that the cohort without a capsular repair has

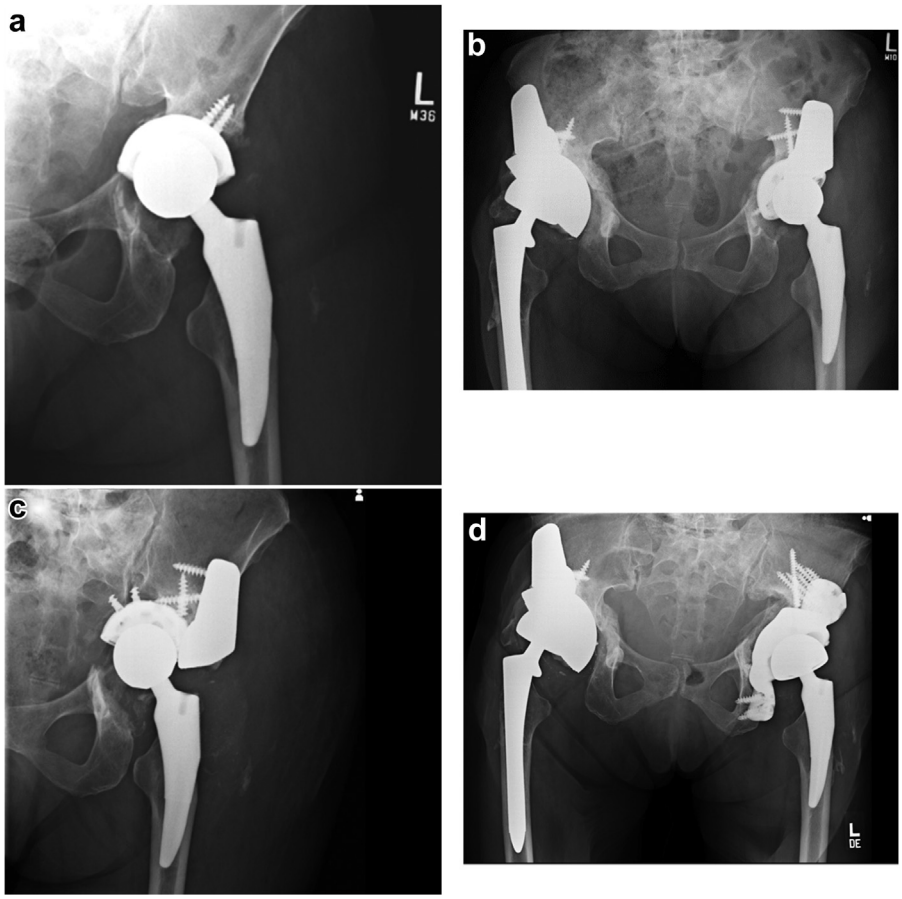

Figure 4. (a) Presenting film with MoM hip and osteolysis with protrusion. (b) Postoperative film of revision with augmentation showing implants in good position. (c) Failure of revision with recurrent protrusion. (d) Film showing a stable implant with osseous consolidation at 1 year postoperatively. MoM, metal-on-metal.

10% dislocation vs 1.9% dislocation in the group with repair ($P = .020$). These studies highlight the importance of the integrity of the posterior structures, but further research is needed to clarify if this risk is avoided through anterior-based approaches.

The DAA to the hip has gained popularity over the past decade because of the increased attention in minimally invasive surgery and improvement in rapid recovery protocols, especially in today's cost-conscious health-care environment. Several studies evaluating DAA in primary THA have shown decreased intraoperative muscle trauma and damage [16], decreased postoperative narcotic requirements [10], improved postoperative walking scores [10,34], shorter hospital stay [10,35], increased rate of home discharge [8], more rapid return to assistive device–free ambulation, quicker postoperative walking speed [11], and decreased rates of instability [36-39]. Switching to this technique from a more traditional approach does incur a learning curve, during which time there is a higher risk of complications. This has been the foundation of many criticisms of the DAA including reports of higher intraoperative femoral fracture rate, early femoral component loosening, increased time under anesthesia, blood loss, and wound complications [36,40-46].

Other concerns of the DAA include maintenance of TFL integrity. In a recent study, Grob et al. [19] reported on a patient with postoperative TFL atrophy after a primary THA through the DAA, and their subsequent cadaver study found that the terminal inferior branch of the superior gluteal nerve regularly coursed along the medial surface of the TFL within 10 mm to the insertion of the ascending branch of the lateral circumflex femoral artery where it is at risk of injury during exposure or cautery. Other studies raise similar concerns including increased damage to the TFL when compared with the posterior approach [16]. On the contrary, a study by Bremer et al. [47] found consistent integrity of the TFL based on postoperative MRI. We are very careful to protect the TFL through attentive positioning, retractor placement, exposure, ligation, and gentle retraction.

Recent reports have described similar extensile anterior hip approach techniques for revision surgery [14,15], which includes a recent series by Spanyer et al. [48] describing the added benefit of being able to place an anterior column plate on the internal ilium. Honcharuk et al. [15] demonstrated the use of acetabular augmentation for lateral rim defects through an anterior hip approach for complex revision THA. Similar to Manrique et al. [12], the authors emphasized superior acetabular exposure in the revision setting with the anterior approach and simplified ability to address defects in any acetabular region. The DAA is also extensile distally, although there is concern for neurovascular compromise to the vastus lateralis and lateral portions of the vastus intermedius [49]. A study by Kennon et al. [50] found no clinical neurologic deficits with the DAA, and techniques have been described [14] to avoid potential neurologic compromise by leaving a bridge of tissue with the nerve supply undisturbed, which is our preference. A detailed discussion is outside of the scope of this article.

Triflange reconstruction may be more difficult in more muscular or obese patients, especially through the DAA. Surgeons should be very comfortable with the DAA before using it for more challenging pathology. We have been performing all primary and revision THAs through the DAA since 2012. While we prefer the extensile DAA for acetabular reconstruction, our patients' smaller body habitus made this case less difficult than it otherwise might have been. Another caveat is that we deviated slightly from the standard extensile exposure described by elevating our skin flap from her prior direct lateral incision. Our patient was unique because of her prior incision as well as the absence of the greater trochanter, but pelvic discontinuity is an atypical pathology that requires case-by-case adjustments to address the pathology at hand.

We appreciate that many of the proposed benefits of the DAA pertain to its utilization as a minimally invasive procedure for primary arthroplasty and do not suggest that these benefits remain uninfluenced when proceeding to an extensile DAA. One of the main criticisms of the DAA is that exposure is limited, suggesting that the surgeon's options are restricted in the event of intraoperative complications or that a separate incision may be required in the case of revision. However, with its increased utilization, a further understanding of the DAA's extensile capacity is important for occasions when one may need more exposure than initially anticipated. This select case demonstrates that the DAA may be more versatile than previously suggested. Further studies are needed to explore utility and long-term results of the DAA in the revision setting.

Summary

Our case report serves as an ideal illustration that the anterior column be readily accessed via a DAA exposure, and the extensile nature of the approach allows for access to the posterior column for screw implantation as well as to the ischium. Almost all the reported literature on DAA is for primary THA, while its utility for revision THA is yet to be widely established. Our case adds a datapoint on what is capable and safe through this interval. Further prospective studies are needed to determine the short-term and long-term clinical outcomes of an extensile DAA approach for revision THA.

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