Treatment of Large Acetabular Defects: A Surgical Technique Utilizing Impaction Grafting into a Metallic Mesh

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Abstract *Background:* Revision total hip arthroplasty in cases with severe acetabular bone loss is challenging. In the presence of combined cavitary and segmental defects without superior acetabular coverage, reconstructions with a structural acetabular allograft protected by a cage or a custom-made triflange cage have been the treatment of choice. The current paper describes an impaction grafting into a mesh for uncontained defects in revision total hip arthroplasty. *Description of Technique:* After restoring containment with a mesh fixed with small fragment screws, defects were restored using impaction grafting combined with a cemented all-polyethylene cup. *Patients and Methods:* Fourteen consecutive acetabular impaction graftings were performed by two surgeons. All patients had a type 3B defect according to the Paprosky classification. *Results:* No re-revisions or radiographic failure was detected in the early follow-up period. *Conclusion:* Impaction grafting into a mesh is an interesting treatment option to restore bone in combined cavitary and segmental defects.

Keywords revision total hip arthroplasty · acetabular bone loss · impaction grafting · metal mesh · allograft

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Introduction

The reconstruction of large acetabular bone defects is one of the most challenging aspects of revision total hip arthroplasty. The purpose of the acetabular reconstruction is to obtain a stable, durable fixation of a new socket to reestablish the center of rotation and, if possible, restore bone stock.

During revision surgery, simple acetabular defects, either cavitary or segmental, can be managed with conventional non-cemented hemispherical acetabular components. However, combined cavitary and segmental defects are more challenging, particularly those without superior acetabular coverage precluding the use of a conventional non-cemented, non-augmented socket.

Such defects have been traditionally addressed with the use of structural allograft, highly porous metal shells with or without a cage, or the use of a custom triflange cup [1, 7]. The long-term results of revision surgery with these reconstructive options have been suboptimal due to the lack of bony ingrowth of the cage or custom-made triflange cup to the deficient iliac bone [12].

Impaction grafting is an attractive treatment option to restore acetabular bone defects in revision total hip arthroplasty; however, it generally requires a contained defect [4, 10]. Flexible reconstruction meshes can be used to convert uncontained defects into contained defects, thus providing a stable cavity for impaction bone grafting reconstruction and cemented cup fixation. The use of impaction grafting for the reconstruction of acetabular defects with and without the use of adjuvant metal meshes was described by Slooff et al. [11]. The revision technique is appealing as it theoretically addresses the three main goals of acetabular reconstruction: providing stable, durable fixation of a new cup; restoring the center of rotation; and restoring the bone stock.

This article presents our experience of 14 consecutive patients who underwent cemented acetabular revision surgery using impaction grafting and a metallic mesh. In addition, we reviewed indications and results of this technique in the literature.

Description of Technique

All patients were operated on by utilizing a posterolateral approach providing extensive acetabular exposure (Fig. 1). None of the cases required trochanteric osteotomy. To visualize the acetabulum, a soft tissue sleeve including the gluteus minimus and medius is elevated of the ilium, and a Steinman pin or bent Hohman retractor was placed superiorly. In addition, the posterior capsule is elevated of the posterior acetabular rim to visualize the posterior defect. After placing an Aufranc Retractor medially, the loose socket is removed, and the acetabular cavity is cleared of all soft tissue. Now, the uncontained defect is fully visualized, and a metallic mesh (Stryker, Mahwah, NJ) is contoured to cover the segmental defect (usually posterior and superior). The rim mesh is fixed to the acetabulum with small-fragment Arbeitsgemeinschaft für Osteosynthesefragen (AO) screws inserted through the mesh. The screws should be approximately a centimeter apart (Fig. 2). The best fixation can usually be achieved in the proximal anterior and posterior columns as well as the proximal ilium along the defect rim. If necessary, a central mesh can be used to provide a central buttress for graft impaction in case of a medial defect. In patients with pelvic discontinuity, the posterior column needs to be visualized, and an approximately 8-cm×1-cm-long mesh can be contoured to the posterior column and fixed with small-fragment AO screws. Impaction grafting has been traditionally done with either fresh frozen cancellous chips (cases 1–9) or a mixture of handmade 4–7-mm corticocancellous chips from a femoral head allograft mixed with Vitoss® (Orthovita, Malvern, PA) (cases 10–14). The graft should be washed with warm water to remove fat and improve graft stability upon impaction [6]. The bone is impacted in a step-wise fashion utilizing a Charnley impactor or a 36-mm head impactor. After thorough compression of the bone graft, a new socket can be cemented by utilizing antibiotic-containing bone cement (Palacos with Gentamycin, Zimmer Inc, Warsaw, IN) into the allograft (All-Polyethylene Reflection Cemented Cup; Smith & Nephew, Memphis, TN) (Fig. 3, Table 1). The patients were mobilized to touch weight

Fig. 1. Extensive posterolateral acetabular exposure with massive bone loss.

Fig. 2. The screws were approximately a centimeter apart.

bearing for 8 weeks and kept on two crutches weight bearing for an additional 4 weeks.

Patients and Methods

All consecutive acetabular revisions using impaction grafting and a metallic mesh in the practice of two arthroplasty surgeons (who were blinded to the study) were included. Hospital and office charts were retrospectively reviewed. Patient's demographics, diagnosis, acetabular defect according to American Academy of Orthopaedic Surgeons (AAOS) [5] and Paprosky classification [8], surgical technique, rehabilitation protocol, and early clinical and radiographic results were recorded.

Fourteen consecutive acetabular impaction graftings were performed by two surgeons using impaction grafting of a defect that has been contained with a metallic mesh, followed by implantation of a cemented polyethylene cup

Fig. 3. A new socket was cemented into the allograft.

Table 1 Summary of the 14 consecutive acetabular impaction graftings performed by using impaction grafting of a defect that has been contained with a metallic mesh, followed by implantation of a cemented polyethylene cup

Case	Type of mesh	Number of screws	Graft type	Cement type	Concomitant femoral revision	Duration of protected weight bearing (months)	Follow-up (months)
1	Rim	9	Lyophilized	Simplex	Yes	3	38
2	Rim	5	Fresh frozen	Simplex	No	3	18
3	Rim	8	Fresh frozen	Simplex	Yes	3	12
4	Rim	5	Fresh frozen	Simplex	No	3	8
5	Rim	6	Fresh frozen	Simplex	No	3	7
6	Rim	7	Fresh frozen	Simplex	Yes	3	3
7	Rim	12	Fresh frozen	Simplex	Yes	3	24
8	Rim	8	Fresh frozen	Simplex	Yes	3	3
9	Rim	12	Fresh frozen	Simplex	Yes	3	3
10	Rim	10	Fresh frozen and Orthovita chips	Palacos	Yes	3	35
11	Rim	11	Fresh frozen and Orthovita chips	Palacos	Yes	3	30
12	Rim	7	Fresh frozen and Orthovita chips	Palacos	No	3	18
13	Rim, anterior wall, posterior wall	17	Fresh frozen and Orthovita chips	Palacos	No	3	12
14	Rim, posterior wall	10	Fresh frozen and Orthovita chips	Palacos	No	3	9

(Table 1). There were ten female and four male patients, with an average age of 70.1 years (range 35 to 85 years) and an average BMI of 29.4 (range 22.3 to 39.6). Twelve patients presented with an uncontained defect type 3 according to the AAOS classification, and two patients had an additional pelvic discontinuity (type 4 defect). All 14 patients had a type 3B defect according to the Paprosky classification. Ten patients underwent revision because of a loosened cemented all-polyethylene acetabular component and four patients because of a failed uncemented hemispherical acetabular component. Revision was performed on an average of 19 years after the index procedure (range 6–35 years). There were 12 combined segmental and cavitary defects, and two patients presented with a pelvic discontinuity.

Example 1: Large Uncontained Defect

An 81-year-old man underwent left total hip arthroplasty in 1986. He had been doing well until the end of 2010, when he noted increasing pain. On radiographs, there was an aseptic loosening of both components with a massive osteolysis behind the polyethylene acetabular cup. Intraoperatively, there was massive bone loss, posteriorly and superiorly in the acetabulum with an absent superior acetabular rim. First, a hemispherical mesh (Stryker, Mahwah, NJ) was shaped to reconstruct the superior rim and was fixed with screws onto the ilium and along the anterior and posterior wall. Using the mesh as a superior buttress, two allograft heads were now hand-piecemealed into 4–7-mm chips. The graft is now washed with warm water to remove all fat and finally mixed with Vitoss® (Orthovita, Malvern, PA) and blood and impacted into the defect. Now, an all-polyethylene Reflection cemented cup (Smith & Nephew, Memphis, TN) was cemented into the graft (Fig. 4).

Example 2: Large Uncontained Defects and Pelvic Discontinuity

An 88-year-old woman after total hip replacement in 1992 presented with 7–8 months of progressively worsening pain

in the right groin and hip that rated as 8/10. On radiographs, there was an aseptic loosening of the acetabular component with significant osteolysis. A CT scan confirmed pelvic discontinuity. After the socket was cleaned of all osteolytic membranes, the posterior column was exposed, and an 8×2-cm mesh was contoured onto the posterior wall and fixed with proximal and distal small-fragment screws. After stabilizing the pelvic discontinuity, a hemispherical mesh was now contoured to the acetabular rim to bridge the superior defect. The defect now constrained was filled with the described mixture of allograft and Vitoss® (Orthovita, Malvern, PA) and thoroughly impacted before a polyethylene Reflection shell was cemented into the graft (Fig. 5).

Results

Our early institutional experience with this established revision technique has been favorable with no re-revisions or implant migration detected at a mean of 16 months (range 3–38 months) of follow-up (Table 1). One patient experienced postoperative dislocation, which was treated with close reduction. There was no deep implant infection, no case of heterotopic bone formation, or periprosthetic fracture.

Discussion

The restitution of the lost bone stock is one of the biggest challenges of acetabulum revision surgery. Classification systems for the acetabular defect allow unification in the defect and can give guidelines for treatment. The AAOS classification system described by D'Antonio et al. [5] grades the acetabular defect in five types: segmental, cavitary or combined deficiencies, pelvic discontinuity, and arthrodesis. The Paprosky classification system [8] stratifies the degree of bone loss based on radiographic parameters to guide the identification of reconstructive options.

In the present case series, 12 patients were classified as type 3 and 2 patients as type 4. All patients were treated with

Fig. 4. Preoperative (a) and postoperative (b) radiographs with large uncontained defects.

impaction bone grafting, a metal mesh, and a cemented acetabular cup. At the latest follow-up, the patients had an excellent pain relief and a good range of motion and no radiographic evidence of implant migration.

Impaction grafting using a reconstruction mesh allows the reconstruction of the acetabular bone loss and the use of a small polyethylene socket which can be cemented in a near-anatomic center of rotation. A histological study on 24 human acetabular biopsies has shown revascularization and incorporation of the bone graft [13]. Despite encouraging clinical

results [3, 4, 10] impaction grafting is controversial in the presence of acetabular defects. The comparison of these results with other series is difficult, because investigations with homogeneous groups treating with this method are rare.

Buttaro et al. [2, 3] has shown that impaction grafting using a reconstruction mesh and cemented acetabular component is a reliable technique for treating bone loss, but they do not suggest it for severe combined deficiencies—only for acetabular defects of medium severity. The overall survival rate was 90.8% at an average of 35.8 months (24–56 months;

Fig. 5. Preoperative (a) and postoperative (b) radiographs of a patient with large uncontained defects and pelvic discontinuity.

95% CI, 68.1–97.6) [2]. In 2009, Zhou et al. [17] found an increase of the Harris hip score from an average of 47.7 points preoperatively to an average of 89.2 points at an average follow-up of 63 months in 58 patients. In a study of Comba et al. [4], the survivorship rate in 142 revisions treating with impacted bone allografts was 95% after a follow-up of 51 months. Only 11 required a supplemental mesh. A study by van Haaren et al. [15] reported on a high failure rate of impaction grafting for acetabular revision. Seventy-one revision surgeries were investigated for review, where 20 were needed to be re-revised, producing a survival rate of only 72%, which is considerably lower than that in other series [10, 11, 16]. The use of rim meshes, or combination of rim and medial meshes, was more frequent in the failed (15, 75%) than in the successful group (29, 57%). They attributed the high failure rate to the proportion of large, non-contained defects in their study. Unfortunately, they do not describe their failure mechanisms. In 1998, Schreurs et al. [9] found a 94% survival rate after 11.8 years. Fifty-four of 58 hips were covered with a thin vitallium wire mesh. In a more recent paper, the same group focused on extensive acetabular defects and reported on a 10-year survival rate of 88% with the end point acetabular revision surgery and 95% with the end point acetabular revision for aseptic loosening in 25 patients (27 hips) [14].

The main weakness of the current paper is its short follow-up. Although none of the follow-up radiographs showed evidence of acetabular component migration, longer-term follow-up is necessary to determine the durability of this reconstruction. Since the current technique allows for bone grafting of these large defects, it is likely that later revision surgeries will face better bone stock for component fixation.

Longer follow-up investigations and further studies will be necessary to assess long-term results. But our short- and mid-term results are encouraging, and we believe that acetabular impaction grafting using mesh reinforcement is a viable option in the salvage of large acetabular defects encountered during revision THR.

Disclosures

Conflict of Interest: Johannes Buckup, MD and Emiliano Alvarez Salinas, MD have declared that they have no conflict of interest. Alejandro Gonzalez Della Valle, MD is a paid consultant for Orthosensor, outside the work. Friedrich Boettner, MD is a paid consultant for Smith and Nephew and Ortho Development, has received grant funding from Smith & Nephew, received payments from DJ Ortho for lectures including service on Speakers Bureaus and has patents with the Hospital for Special Surgery, outside the work.

Human/Animal Rights: All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5).

Informed Consent: Informed consent was waived from all patients for being included in the study.

Required Author Forms Disclosure forms provided by the authors are available with the online version of this article.

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