

# Cementing Multihole, Metal, Modular Acetabular Shells Into Cages in Revision Total Hip Arthroplasty

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## Abstract

Acetabular components of total hip arthroplasties can loosen and migrate, sometimes resulting in severe osseous pelvic deficiencies that make reconstruction with standard acetabular components impossible. Reconstructive techniques used in this setting commonly involve placing a cage or ring for reconstruction. All-polyethylene acetabular components traditionally are cemented into these constructs. Disadvantages of this technique include possible recurrent dislocations, disassociation of polyethylene component from cement, and polyethylene wear. Traditional reconstructive techniques require major revision of the construct to address such problems.

In this article, we describe a technique in which a multihole, metal acetabular shell is cemented into a cage or ring, permitting use of modular liners. This technique results in secure fixation to the cage and gives the surgeon the option of changing liners in cases of wear or instability. We report outcomes in 13 cases with follow-up ranging from 3 months to 133 months.

Cementing a modular metal shell into a cage can be a viable alternative to cementing a polyethylene liner. This technique has resulted in durable fixation of shell to cage in our experience and permits use of variable liner options.

Although the number of total hip arthroplasties (THAs) being performed in the United States is increasing, revision THAs are more common.<sup>1</sup> Many acetabular revisions can be successfully performed with standard or jumbo cementless acetabular cups, but major osseous deficiencies typically require reconstruction with a cage or cup/cage that bridges gaps in the pelvis and obtains fixation of the arthroplasty components.<sup>2,3</sup> Cages and rings have been combined with all-polyethylene acetabular components (ie, all-polyethylene cups, or APCs) to reconstruct pelvic

bone defects, but complications, including APC dissociation (Figure 1) and postoperative instability, can occur despite stable fixation of cage to pelvis.<sup>4</sup> The incidence of dislocations with pelvic reconstruction rings using APCs has been reported to be 11%.<sup>4</sup> If an APC has to be replaced because of wear, then major surgery may be required to extract the worn cup and cement a new cup in its place.

In this article, we describe a technique in which a metal, multihole acetabular shell is cemented into the cage or ring construct, avoiding some of the complications associated with traditional techniques by permitting use of a variety of liners.

## Materials and Methods

We retrospectively reviewed the cases of all of Dr. Bolanos' patients who underwent acetabular revision THA with cage reconstruction between February 1, 1998 and October 9, 2006. During this period, we were cementing a modular metal shell into the cage instead of an APC or polyethylene liner. All patients who underwent revision THA with cage reconstruction during the study period were included. Bone defects were treated with structural or morselized bone allograft. Every reconstruction involved use of an antiprotrusio cage or ring secured to the pelvis with screws, and a multihole acetabular shell cemented into place with a polyethylene liner applied. Elevated rims, lateralized liners, and constrained liners were used as needed to optimize stability. Femoral components

Figure 1. Dissociation of cemented all-polyethylene liner from cage construct.



**Authors' Disclosure Statement:** Dr. Ries reports he is a consultant with intellectual property licensed to both Smith & Nephew and Stryker and is a consultant for OrthoAlign. Dr. Bolanos reports no actual or potential conflict of interest in relation to this article.

were retained. Cage size was based on matching the osseous deficiencies. Shell size was determined by the inner diameter of the corresponding cage. Liner size was based on matching the shell and femoral head. During this period, none of the patients had other reconstructive techniques, such as trabecular metal augmentation, in combination with a modular acetabular shell, cup/cage reconstruction, or custom triflange components.

Patients engaged in protected weight-bearing ambulation for 3 months after surgery and were then permitted full, unrestricted activity. The primary outcome was mechanical failure of the reconstruction, or reoperation (Table). All reconstructions in this series consisted of acetabular revisions for aseptic loosening.

### Surgical Technique

Six consecutive cases of pelvic discontinuity and 7 cases of segmental acetabular bone loss required use of cages or rings. Reconstruction cages were used to secure fixation to the ilium and ischium. With the technique described in this article, we used screws with rounded, prominent heads rather than flat heads between the cup and the cage or ring (Synthes, 6.5 mm) to ensure adequate cement mantle. The rounded screw heads were left prominent to approximate the function of cement pegs found on APCs. Screws were placed into the anterior, superior, medial, and posterior aspects of the cage to ensure adequate cement mantle between cup and cage. This was confirmed with trial placement of the cup into the cage before cementation and observation of the uniformity of the space between cup and cage. Trial placement also confirmed that the screws did not interfere with appropriate positioning of the cup. A multihole, metal acetabular cup was then cemented in the cage or ring such that cement extruded around the shell and into the holes of the cup and the cage, securing the cup to the cage. Use of

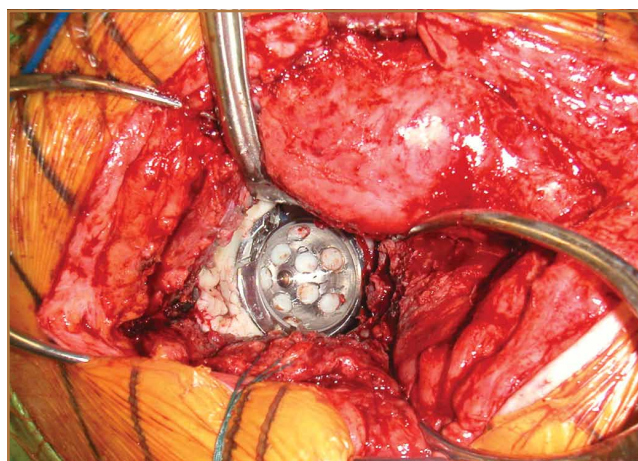


Figure 2. Intraoperative photograph of cemented multihole metal cup.

a multihole, metal shell resulted in excellent cement fixation because the multiple holes created multiple circumferential cement pegs. Various liner options could then be used to optimize stability of the reconstruction. In some cases, excessive cement extruded into the interior aspect of the shell and hardened before curettage. If the excess cement could interfere with complete seating/locking of the liner, then a high-speed burr was used to easily remove cement (Figure 2). Polyethylene liners were then inserted into the shell. Femoral reconstruction was then performed, if needed, and stability of the arthroplasty checked. This technique allows the surgeon to then select from a variety of polyethylene liners as needed to optimize stability. Liners with elevated rims, lateralized liners, and constrained liners could be interchangeable options with this technique.

Table. Patient Demographics and Outcomes

Patient	Sex	Age, y	Follow-Up, mo	Complications/Reoperations
1	F	72	98	Revised for recurrent dislocations
2	M	78	27	Died of emphysema; hip was functioning well
3	F	74	3	Died of cancer; hip was functioning well
4	F	62	19	None
5	M	74	83	6 years after surgery, revised for loose cage
6	F	65	133	None
7	F	79	37	None
8	M	61	116	None
9	F	74	55	None
10	F	84	71	None
11	M	86	72	1 year after surgery, revised for cup dissociation after multiple falls; no subsequent complications
12	F	68	56	None
13	F	67	64	None

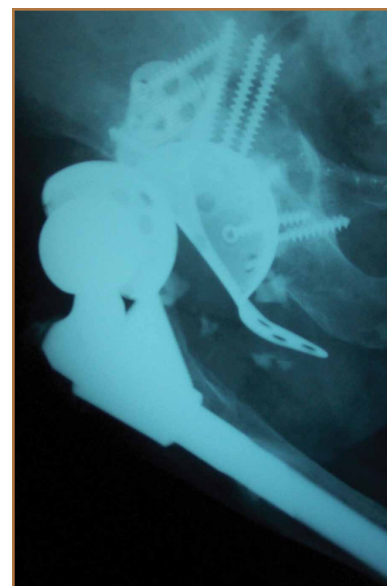


Figure 3. Dissociated multihole shell from cage construct.

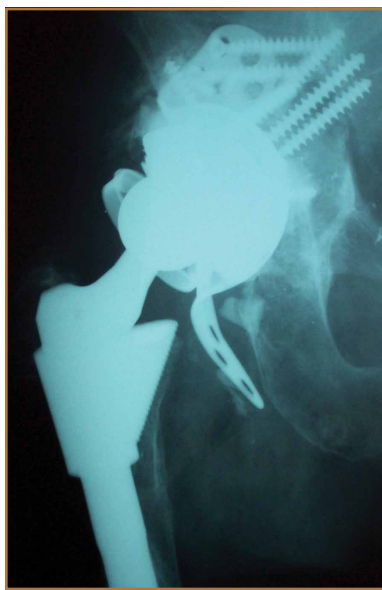
## Results

Thirteen patients with major osseous deficiencies of the pelvis were treated using this technique. At mean follow-up of 64.2 months (range, 3-133 months), 10 of the 13 patients had favorable outcomes without further surgery. One patient developed recurrent aseptic loosening that required re-revision, another patient developed recurrent instability that required acetabular liner and femoral head exchange, and a third patient with poor balance fell multiple times. This patient's ninth fall resulted in dissociation of the acetabular shell from the cage (**Figure 3**), treated with placement of another cemented multihole metal shell with a standard liner. As dislocations recurred, the liner was changed to a constrained liner (**Figure 4**). The patient did not have any further dislocations or other hip-related problems. Integrity of cemented shell-cage fixation was maintained in 12 of the 13 patients at final follow-up.

## Discussion

We have described a novel technique that facilitates reconstruction of major osseous deficiencies of the pelvis. The technique involves cementation of a multihole, metal acetabular shell into a cage or ring, permitting use of modular liners. The modularity in this approach to major hip reconstruction provides stability-optimization options that are not available with APCs. So far, the technique has demonstrated more advantages than disadvantages, so the indications for its use would be whenever a cage is used for pelvic reconstruction. Traditional techniques involve cementing an APC into the cage or ring. Use of multihole, metal shells for this purpose has several theoretical advantages. Multiple holes and the textured surface allow more interdigitation of cement with cup than APCs do; this interdigitation may improve the durability of the cemented interface. Cement also extrudes through the holes of the cage to secure the cup to the pelvis, as is done with cementation of APCs. Introduction of trabecular metal shells may also provide an even more secure bond to the shell, compared with APCs, though durability of a cemented trabecular metal interface has not been established. In addition, mechanical alignment guides cannot fasten as securely onto some APCs.

Nonmodular, cemented, metal-backed acetabular components, which were commonly used in hip arthroplasties at one time, were abandoned because of their relatively high loosening rate and because of advantages noted with modular compo-



**Figure 4.** Constrained liner placed into metal, multihole shell.



**Figure 5.** Cemented nonmodular femoral components make treatment of stability problems challenging. A variety of liner options, possible with use of modular acetabular shells, allows easier surgical treatment of instability, decreasing risk for dislocations.

ponents.<sup>5</sup> The nonmodular components had been developed because of their theoretical advantages of improved distribution of forces into the cement mantle.<sup>5,6</sup> However, those models had a relatively smooth metallic surface, which probably did not bond as well to cement as the shells used with the technique described in this article.

Dislocations can occur because of inadequately placed cups. Metallic cups can be improperly positioned, as can APCs. An advantage of the technique we have described over APCs is that liners with raised rims can be inserted with the apex placed wherever needed to best address instability. Dislocations can also occur because of factors such as inadequate offset and cognitive impairments. Our technique allows use of offset liners and constrained liners. Although these options may not prevent further dislocations, they often mitigate instability issues. Constrained liners and lateralized liners can be easily placed, and elevated rims can be swiveled as needed for stability. As use of cementless, metal-backed, modular acetabular components is common in primary THAs, most surgeons are familiar with the modular liner options available with use of the technique described in this article.

In this setting, modular, metal acetabular shells have the advantage of allowing surgeons to use the alignment guides they are accustomed to using. Modularity is another significant advantage over APCs. When an APC wears down, the component must be extracted to permit implantation of a new APC. With metal shells, a worn liner can be exchanged relatively easily. Modularity also gives surgeons many more options for addressing instability. Elevated rims can be moved, head sizes can be changed, and lateralized or constrained liners can be implanted easily. By comparison, with APCs, stability can be addressed only by modifying the femoral component or taking hip precautions which restrict range of motion of the hip. Modification of the femoral component is not possible with nonmodular femoral components in place (**Figure 5**). A potential disadvantage of this technique is increased cost associated with use of another component.



This small series of patients has had an excellent rate of success with cementation of multihole, metal-backed acetabular components into a cage or ring. These components may offer more secure fixation than APCs to cement extruded into the multiple holes, and improved metallurgy, such as trabecular metal. Surgeons who want to use modular components may prefer this technique because it allows them to select from various liner options. Surgeons should consider this technique for patients who need major pelvic reconstruction, though a larger study with longer follow-up is needed to determine its long-term durability.

Although the novel technique we have described has been helpful in our experience, this study had several limitations—small series, retrospective study, relatively short follow-up, lack of control group and functional data—that may have affected its conclusions. Further study and follow-up are needed to better determine the utility of this technique in clinical practice.

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