Techniques in Cementation for Hip Hemiarthroplasty

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Summary

Hip fractures in the elderly population remain a significant public health concern. With a rise in the incidence of osteoporosis, orthopaedic surgeons must be familiar with different fixation options in both trauma and arthroplasty to minimize complications and implant failure following treatment of femoral neck fractures. Cemented hip hemiarthroplasty is a reliable method for restoring functional mobility and early rehabilitation after femoral neck fractures, but the technical aspects of the procedure are challenging. If used effectively, however, cementation decreases implant loosening and the risk of periprosthetic fracture, thereby decreasing the potential for reoperation in this vulnerable population. We describe a technique for ideal cementation of the femoral component of a hip hemiarthroplasty and discuss the indications and implications in specific patient populations.

Introduction

By the year 2050, there will be an estimated 3.9 million hip fractures worldwide and 700,000 in the United States.[1] The impact of this phenomenon on the community is tremendous, in that there remains a 30% risk of mortality in elderly patients who sustain a hip fracture within one year.[2] Patients must be immediately mobilized to limit short-term complications such as urinary tract infections, pneumonia, and deep venous thrombosis, but also to mitigate the decline in functional independence.[3]

The use of cementation in hip hemiarthroplasty has several advantages. With focus on decreasing the incidence of revision surgery and post-operative complications, cemented fixation in osteoporotic bone has been shown to have up to a 10-fold decrease in the rate of periprosthetic fracture.[4-7] According to a study of over 347,000 patients in the Norwegian Hip Arthroplasty Registry, 10-year implant survival was lower in the uncemented group compared with the cemented group for patients over the age of 65.[8] In one recent randomized clinical trial of 160 elderly patients with a femoral neck fracture at minimum two year follow-up, increased peri-operative fracture and subsidence, and decreased Oxford hip scores were reported in the uncemented group compared with the cemented group. However, there was no difference noted in mortality rates at any timepoint.[9]

There are also many practical advantages of cementation. Prior to implantation, the version of the stem can be adjusted in small increments. In addition, some surgeons may choose to add antibiotics to the cement as an added method for infection prophylaxis. Cement interdigitates with the larger trabeculae of osteoporotic bone thus allowing for immediate post-operative weightbearing. In elderly patients at risk of delirium, dementia, and falls, the reduced immediate osseous integration of an uncemented stem may put these patients at higher risk of periprosthetic fracture.[10]

Disadvantages of cemented hemiarthroplasty include a slightly longer operative time,[11] a steep learning curve with a heightened focus on avoiding femoral stem varus, an increased risk of fat embolism during cement pressurization, and the potential difficulty of stem extraction during revision surgery.

Procedure

The patient with a femoral neck fracture is positioned in the lateral decubitus position or the supine position depending on the approach performed. The authors advocate for use of the posterior approach. During the surgical approach, attention must be given to avoiding inadvertent injury to the labrum. Since the final prosthesis will rely on the natural negative pressure created by the acetabular labrum, it is important to preserve this suction seal when possible; in the setting of capsular injury from the femoral neck fracture, the capsulo-labral junction may be disrupted and the seal may not be maintained. The posterior capsulotomy commences distally, at the level of the quadratus femoris, with non-absorbable tagging sutures applied to maintain tension on the capsule while progressing proximally. A number 15 scalpel blade can be used to "feather" the labrum from the capsule at the level of the capsulo-labral junction.

Once the fracture site has been exposed and the femoral head is visible, a cobb elevator may be used to rotate the head such that the articular side is visible, taking care not to lever the head out of the acetabulum as this may cause an iatrogenic fracture of the posterior wall. Using the corkscrew extractor (Figure 1) through the denser subchondral bone will facilitate head extraction. Once the corkscrew engages the femoral head, the head is rotated out of the acetabulum inferiorly, again avoiding iatrogenic injury to the acetabulum.

Acetabular exposure may be achieved using a variety of retractors. To aid in the ease of exposure, placing the leg in slight abduction, extension, and internal rotation allows for better visualization. A Shnitt is placed over the anterior lip of the acetabulum to create a small rent in the anterior capsule at the level of the anterosuperior column. A #2 hip retractor is then inserted into the defect and seated on the anterior column. Next, a #7 retractor is placed distal to the transverse acetabular ligament and over the posterior acetabular wall (Figures 2 and 3). The two retractors should be orthogonal to each other. Using a combination of the suction tip and the electrocautery, the pulvinar tissue is removed from the cotyloid fossa. The extracted femoral head is measured using the sizing templates to estimate the component size. Hemiarthroplasty trials can be used to ensure the correct size femoral head has been selected. The ideal fit allows for the femoral head to engage the native acetabulum. Femoral head-acetabular mismatch may result in either femoral head uncoverage if the head is too large, or a high incidence of instability and "rattle" if the femoral head is too small.

Figure 1. Corkscrew used for femoral head extraction.

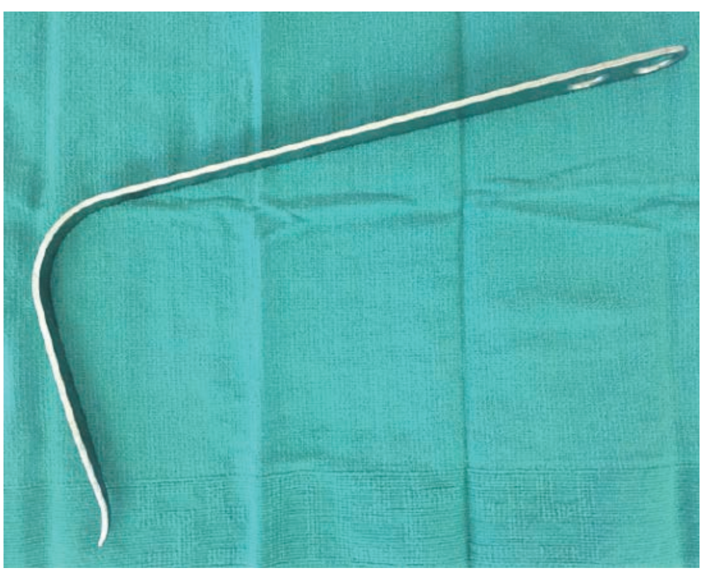

Figure 2. #2 acetabular retractor.

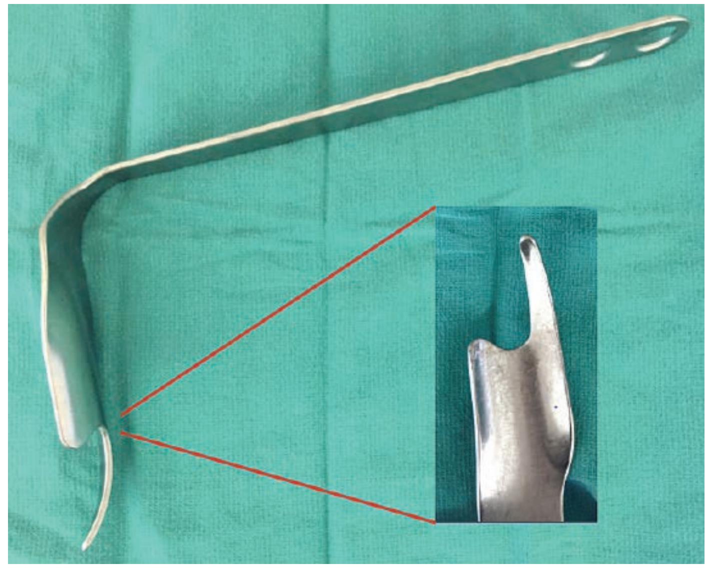

Figure 3. #7 acetabular retractor.

Following femoral head selection, the proximal femur is then exposed. The femoral canal is broached in standard fashion, making sure to achieve a lateral position within the canal to avoid varus implantation. Following trial reduction, the final neck length is chosen. A centralizer approximately 1-2 mm smaller than the final implant diameter is selected to be placed at the distal tip of the stem. If the final stem size is less than 14mm, two bags of polymethylmethacrylate cement are used, while three bags of cement are typically needed for stems greater than 14 mm. A cement restrictor of the appropriate size is placed within the canal 1 cm distal to the distal extent of the intended stem. Prior to placement, the flanges of the cement restrictor are cut in each quadrant, thus decreasing the stiffness during insertion to minimize femoral cortical perforation in osteoporotic bone.

The canal should now be thoroughly irrigated and dried. A femoral lavage brush is used to debride the canal of any excess fat and debris. While the cement is being vacuum mixed on the back table, hydrogen peroxide from a new bottle is dripped into the femoral canal allowing for further desiccation and optimal cement interdigitation. Once the canal is adequately prepared, inform the anesthesia team that cementation will take place. This will alert them to any potential changes in blood pressure, oxygenation, or heart rate that may be associated with the process.

Next, assess that the cement has the appropriate consistency. While holding the cement gun vertically, extrude a small amount of cement. If the cement is moldable yet able to maintain the tubular shape acquired from the cement gun nozzle, proceed with cementation. The cement gun is inserted into the canal to the level of the cement restrictor. Cement is then introduced into the canal, allowing the building pressure in the canal to push the cement gun out of the femoral canal; do not prematurely retract the cement gun. Once the cement adequately fills the canal, a pressurizing device is placed over the proximal femoral canal and additional cement is introduced under pressure (Figure 4). It is critical to re-notify the Anesthesia team of cement pressurization, as this is the time period of highest risk for fat embolism. Finally, implant the prosthesis in the correct version until it is adequately seated. The goal is to create a 2 mm circumferential, uniform cement mantle. Once the version is set and the implant is properly seated, maintain firm pressure on the stem until the cement hardens but do not change the version (Figure 5). Any subtle rotation of the stem during implantation will result in cement mantle imperfections and increase the chances of early component loosening.

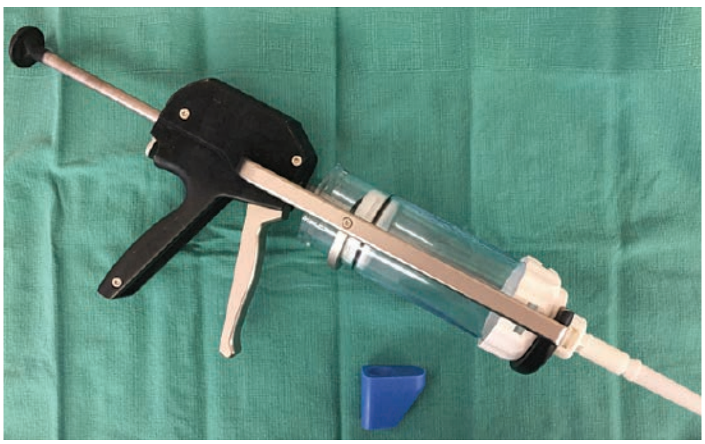

Figure 4. Cement gun with pressurizing rubber attachment to insert into the proximal femoral canal.

Figure 5. Anteroposterior and lateral radiographs of a cemented left hip hemiarthroplasty in an 88 year-old female who sustained a left subcapital femoral neck fracture.

Discussion

Cemented hip hemiarthroplasty is a technically challenging but useful technique for the treatment of osteoporotic intracapsular hip fractures. In this subset of patients with increased medical comorbidities, there are several implications of this technique. In patients with cardiac disease, cementation may be a risky option. In vitro models have shown that the monomer utilized in the cement can cause vasodilatory-induced hypotension via a direct relaxation of the vascular smooth muscle,[12,13] while in vivo models more clearly correlate with the development of pulmonary emboli. However, in one study of twenty patients monitored via transesophageal echocardiography, cementation produced a transient but significant reduction in cardiac output of 33% and a reduction in stroke volume of 44% so there may be some association between the cement monomer and hypotension.[14]

In patients with pulmonary disease, the increased risk of fat embolism is a deterrent to cementation. When implanted, the cement undergoes an exothermic reaction and expands in the spaces between the prosthesis and bone. The increased pressure forces trapped air and medullary contents (i.e. fat) into the systemic circulation under pressure. In older patients with a higher fat to marrow ratio, there is higher risk of fat embolism. Thus, during the cementation process, it is critical to continuously assess the patient for changes in oxygen saturation and blood pressure.

In contradistinction, patients with renal disease and renal osteodystrophy are excellent candidates for cemented fixation. Decreased excretion of phosphate by the kidneys combined with the inability of the diseased kidneys to utilize vitamin D allow for a high calcium-phosphate product and weaker bone, thus putting these patients at higher risk for implant loosening if cement is not used.[15]

When the cementation technique is performed properly, there may be a lower long-term reoperation rate. At one year follow up, Deangelis and colleagues found no difference in functional outcomes or acute complications when comparing uncemented and cemented cohorts.[16] Comparing reoperation rates among elderly patients undergoing cemented vs uncemented hemiarthroplasty, Viberg et al. found that the cemented cohort had a decreased hazard ratio and a superior long-term implant survival rate after three years compared with the uncemented group.[17] The Norwegian Registry evaluated 11,116 hemiarthroplasties in a prospective observational study demonstrating that at five year follow-up, uncemented hemiarthroplasty had a 2.1 times increased risk of revision, most commonly for periprosthetic fracture. While there was a higher risk of intra-operative mortality in the cemented group, longer term mortality risk was not significantly different.[18] In a study by Taylor et al, hemiathroplasty with a cemented implant provided a comparable outcome to the uncemented group in patients without severe cardiac disease, though there was a trend toward better function and mobility in the cemented group6.

Regardless of the technique of femoral component implantation selected, cemented and cementless hemiarthroplasty patients displayed an approximately 18-24% decrease in independence when compared to their pre-operative level of functioning.[6] Thus it is important to evaluate the patient in terms of functional capacity but also medical stability prior to deciding whether a cemented prosthesis is the best option. In otherwise healthy, elderly patients with osteoporosis, cemented hemiarthroplasty using the described techniques is a good option in terms of post-operative pain and reoperation rates.

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