

## Brief Communication

# Technique for a Composite Femoral Intramedullary Plug in Cemented Hip Arthroplasty

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**Abstract:** A brief technique to place a cement plug on top of a polyethylene is presented. This technique has helped the authors obtain better cement mantles when they are plugging the canal in total hip replacement. **Key words:** femoral intramedullary plug, cemented hip arthroplasty, technique, biomechanical studies, hip replacement.

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Currently, more than 200,000 hemiarthroplasties and total hip replacements are performed every year in the United States [1]. Modern cementing techniques have considerably improved the longevity of total hip replacement [2]. Data have demonstrated a femoral loosening rate of <3% at 10 years with the use of a cemented femoral component [3]. In contrast, most cementless series have significant osteolytic changes and high failure rates after only 7 years [4,5]. In light of these data, an increasing number of surgeons are using a cemented femoral component.

First-generation cementing techniques consisted of hand mixing of the cement and finger packing of the cement into the femoral canal. Modern (second-generation) cementing techniques consist of pressurized insertion of the cement, centrifugation or vacuum mixing, and plugging of the intramedullary canal. These changes decrease the porosity of the

cement, increasing its fatigue strength. Pierson and Harris [6] demonstrated the improvement in clinical outcome observed with modern cementing techniques.

Biomechanical studies have been performed to determine the effects of centrifugation and vacuum mixing on the mechanical properties of polymethylmethacrylate (PMMA) [7,8]. These studies clearly have demonstrated the beneficial effects of the preinsertion treatments of PMMA. Pressurized insertion of the cement has also been the subject of several investigations [9,10] and has been shown to have a significant effect on the strength of the cement–bone interface strength [10].

The intramedullary plug prevents cement from being displaced distally in the femoral canal at the time of cement pressurization and allows for higher cement intrusion pressures. High insertion pressures allow for better penetration of the cement into the endosteal cancellous surface, creating a stronger bone–cement interface [11]. The increased interface strength has resulted in a longer clinical life for total hip replacements [2,3,6]. Hungerford and Krackow [12] introduced a new technique using a plastic cement restrictor designed for use in acetabular perforation—the *Mexican hat*—as a femoral intra-

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medullary plug. Mallory [13] introduced a bullet-tipped, flanged polyethylene plug for use in occlusion of the canal.

We published a study that demonstrated the superiority of PMMA plugs over synthetic and bone plugs in cadaveric bone. At that time, however, only 2 commercially available polyethylene plugs were obtainable in the market. In 1996, at least 8 different companies manufactured plugs of different styles and designs. Some of these plugs are of universal size and are to be used in every femur. Some of them have sizers that allow the surgeon to select the appropriate plug. In a laboratory study of synthetic plugs, there was a high incidence of both cement leakage and distal migration when subjected to pressurization [14]. In a study using cadaveric femora, most of the plugs tested were unable to withstand pressures of 50 psi, a pressure below the average produced by commercially available cement guns during pressurization. PMMA plugs had no migration or cement leakage at pressures above 100 psi for longer than 6 minutes [15]. These studies were done in cadaveric bone without intramedullary bone circulation. Insertion of a PMMA plug in the presence of active intramedullary bleeding is more difficult.

A technique similar to ours was described by Harris and McLaughlin in 1993 [16]. This article describes a modified technique that allows easier, more accurate insertion of a PMMA plug. We currently employ a technique using polyethylene and PMMA plugs together, which combines the advantages of both plugs. The polyethylene plug allows for accurate depth placement of the femoral restrictor and decreases the volume of cement needed to make an adequate PMMA plug. The PMMA plug then gives the restrictor greater strength for cement pressurization without cement leakage.

### Technique

The proximal portion of the femur is exposed, and the femoral neck is cut in the standard fashion. The femoral canal is then reamed with straight reamers followed by serial broaching. Trial components are then placed, and a trial reduction is performed to confirm the correct size of the components. The trial components are then removed. The femoral canal is then prepared by pulsatile lavage, brushing, and drying. The canal diameter at a level 2 to 3 cm below the anticipated end of the prosthesis is measured using a commercially available measuring device, and a plug size is selected. We use a polyethylene plug manufactured by DePuy, and there are 7 different plug sizes (range, 8.5 to 23.5 mm). The

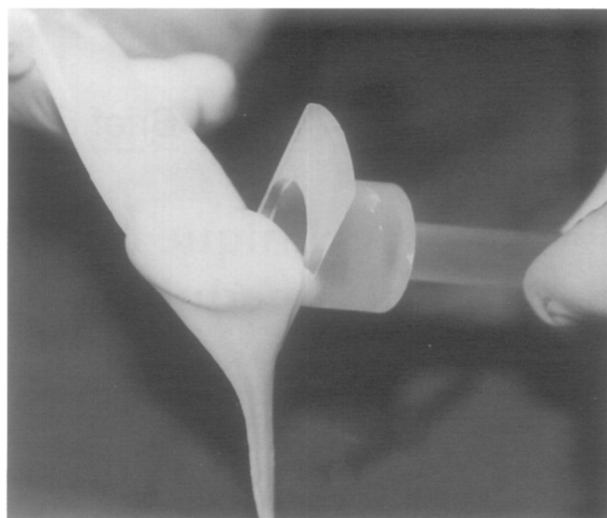


Fig. 1. Cement being placed in syringe.

recommended plug diameter should be at least 1 mm greater than the canal width. The plug is then inserted to a level 2 to 3 cm below the tip of the prosthesis. The canal is then packed with epinephrine-soaked gauze sponges to inhibit venous bleeding. The epinephrine mixture is made by adding 5 1-mL ampules of a 1:1,000 solution of epinephrine to 500 mL of normal saline solution to make a concentration of 1:100,000.

One half pack of Simplex-P cement (Howmedica, Rutherford, NJ) is then prepared using the manufacturer's specifications. When the cement no longer sticks to the surgeon's glove, it is placed into a medullary plug syringe. This syringe is a long narrow syringe that is calibrated from distal to proximal

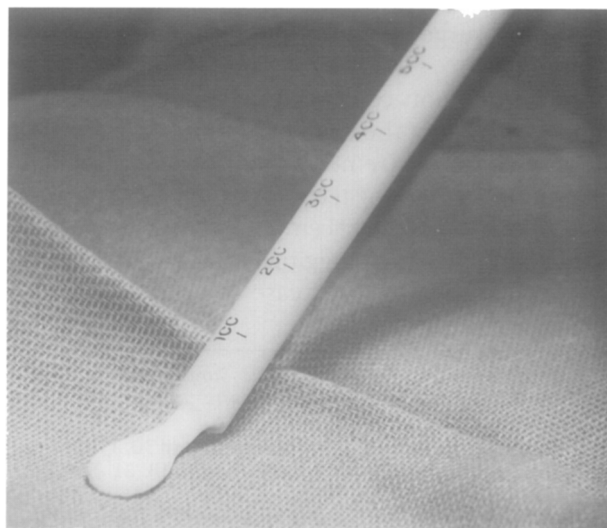


Fig. 2. Cement plug being delivered.

with volume in cubic centimeters on one side and distance in centimeters on the other (Fig. 1). Five to 10 cm<sup>3</sup> of cement is placed into the syringe, and all but 1.5 cm<sup>3</sup> is discarded (Fig. 2).

The epinephrine-soaked sponges are then removed, and the canal is dried. The syringe is then placed into the medullary canal to the level of the medullary plug, and the cement is injected. The syringe is then rotated several times clockwise and several times counterclockwise to free the cement from the syringe. This rotation must be done to prevent removal of the cement plug with withdrawal of the syringe.

The distal end of the syringe is rubbed into the patient's subcutaneous fat to prevent it from sticking to the cement. It is then reinserted into the medullary canal, and the cement plug is tamped gently into place. Using the calibrated portion of the syringe, the depth of the plug is measured to ensure it is at least 1.5 cm beyond the anticipated level of the tip of the prosthesis. The syringe is then removed. The trial broach is then inserted to assure the surgeon that there is enough space for the actual prosthetic devices. At this time, mixing of the cement for insertion of the femoral component is begun, and by the time it is ready for injection, the cement portion of the plug is polymerized and securely bonded to the wall of the femur.

Potential problems with our technique include the cost of purchasing the syringe and the second half batch of cement. The time factor is also an additional cost. The total cost of the material purchases is about \$150.00. The amount of time involved in allowing the plug to dry costs approximately an additional \$150.00. Long-term outcome of cemented devices is affected by the quality of the cement mantle [3]. Additional costs involving the placement of this cement plug should be offset by increased longevity of the stem.

Potential complications of our technique include the errant cement. This could cause problems during the insertion of the stem. Such problems can be avoided by placing the broach within the canal while the plug is hardening. The bottom of the rasp pushes the soft plug distally and does not allow cement to interfere with the centralizer on the stem.

Our technique is probably best suited for patients with wide medullary canals. In standard femurs, the off-the-shelf polyethylene plugs probably suffice.

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