Ranawat/Burstein Cemented Primary Series

BIOMET
ORTHOPEDICS, INC.

Biomet's Ranawat/Burstein Hip System has been designed and developed in cooperation with Chitranjan Ranawat, M.D. and Albert Burstein, Ph.D., of the Hospital for Special Surgery, New York, New York.
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Pre-operative Planning

The goal of hip reconstruction is to attempt to reproduce the normal kinematics of the hip by recreating the functional geometry of the acetabulum and proximal femur. Pre-operative planning is mandatory to assess the operative challenges which will be encountered at surgery. The radiographic evaluation of the patient should include three standard views: a standing anteroposterior view of the hip and proximal femur of the affected side which allows visualization of the femur to the level of the isthmus. The degree of magnification should be known for the study. If this is unknown, radiographic markers can be utilized for assessment. The templates for this system assume 20 percent magnification. The X-rays should be inspected for areas of deficient bone, osteopenia, or deformity such as dysplasia, protrusio, or excessive femoral anteversion. The presence and location of significant osteophytes and bone cysts should also be determined. If stress-risers in the femur, such as cortical perforations or screw holes are present, a stem should be selected which bypasses the most distal stress-riser by two bone diameters.

Acetabular Templating

After initial inspection, the teardrop, representing the inferior margin of the medial acetabular wall, should be identified bilater-ally. Using a radiographic marking pen place a point at the most inferior aspect of each teardrop. Next, draw a line connecting these points. Locate a point along this line one centimeter lateral to the inferior teardrop. This is the point at which the most inferomedial aspect of the acetabular component will lie when properly positioned. From this point, draw a second line superolaterally at 45 degrees to the first line. This 45 degree line will allow the surgeon to intraoperatively assess the degree of cup abduction and superolateral bone coverage. This eliminates dependence on knowing the position of the pelvis on the table. Using the marking pen, identify the most superior point of the acetabular dome. Measure the vertical distance between this point and the horizontal line and compare the measurement to the contralateral side. This measurement will allow identification of bone loss of the acetabular dome, which must be accounted for to correctly reconstruct the center of rotation of the hip. Using the acetabular templates, identify the cup size which best matches the profile of the acetabulum without excessive subchondral bone removal. The teardrop and iliopubic line should be used as reference points to determine medial cup placement. The inferior margin of the cup will sit at the level of the bottom of the teardrop. This area is at the level of the transverse ligament at surgery. The proper size acetabular component will not require removal of extensive subchondral bone. Measuring the mouth of the acetabulum from the teardrop to the superior rim represents an alternative technique to cup size measurement without templates.

Step 1

Femoral Templating

Using the marking pen, locate the femoral head center of rotation. If significant deformity of the head is present, identifying this point can be difficult. A Mose template can be enlisted to help determine this point. Next, locate the superior aspect of the lesser trochanter. Measure the distance between these points. This measure is the lesser trochanter-to-center head distance (LT-CH distance). This is the distance which must be recreated intra-operatively to maintain the leg length or exceeded to lengthen the limb. Again, this measurement can be compared to the contralateral side. To determine the location of the femoral neck cut, measure along the femoral neck axis from the point identifying the center of the femoral head. For this prosthetic system, the distance from the collar to the center of rotation of the head, when a minus 3mm neck is chosen, is 30mm. Therefore, assuming no acetabular bone loss or migration, the center of rotation can be maintained by performing the neck cut at a distance of 30mm from the point identifying the center of the femoral head along the neck axis. Therefore, by knowing the location of the center of the femoral head, the neck cut location can be predicted. Using the femoral templates to identify proper stem size, the outline of the femoral stem should be matched to the profile and endosteal diameter of the medullary canal without need for cortical reaming. The templates include allowance for an adequate cement mantle. The dotted line provided on the femoral templates indicates the diameter of the reamed envelope. The solid line represents the profile of the Ranawat/Burstein stem. The neck measurement which best approximates the center of rotation of the femoral head should be noted. The relationship of the tip of the greater trochanter and the lateral wall of the femoral cortex should be noted to maintain the line of reaming in the neutral axis. Note that in the varus hip, the greater trochanter will lie medially and encroach on the center of the medullary canal. In this instance, reaming of the trochanter is required to obtain a neutral position of the stem. Once these measurements are made and the correct implant size is determined, few surprises should be encountered intra-operatively. The small amount of time needed to pre-operatively template will help ensure proper implant size and cement mantle thickness while maintaining correct anatomic relationships.

Step 2

Patient Positioning & Surgical Approach

To promote maximum intrusion of the cement into the cancellous bone, it is important to reduce the amount of bleeding from bony surfaces as much as possible. This is especially important when cementing the acetabular component where pressurization is difficult and poor cement technique correlates with early prosthetic interface failure. The use of controlled and monitored hypotensive anesthesia is therefore recommended. This can be accomplished with the aid of epidural anesthesia. In addition to lowering the patient's blood pressure, this type of anesthesia is effective in reducing the incidence of venous thrombosis after hip arthroplasty. After the epidural anesthetic has been given, the patient is positioned on the hip table in the decubitus position (Figure 1). The position of maximum hip adduction will increase the ease with which the surgeon can approach the proximal femur for reaming and broaching. Surgical Approach Although there are several surgical approaches to the hip which afford an excellent surgical result, the posterior approach (technique of Moore) is used by the author routinely as it allows excellent exposure of both the acetabulum and the proximal femur and minimizes disruption of the abductor mechanism. The hip region is prepped with triple Betadine application from the knee to the umbilicus and sterile draping is carried out with the operative leg draped free. Using the marking pen, the highest point on the iliac crest, center of the greater trochanter, and center of the femoral shaft are mapped out. These three points should approximate a straight line when the patient's leg is in the neutral position. A long posterolateral incision is made, centered over the greater trochanter, which parallels the femur distally and angles posteriorly by 30 degrees proximal to the trochanter (Figure 2). The superficial fascia, deep fascia, fascia lata, and aponeurosis over the gluteus maximus are split in line with the incision. The gluteus maximus is split bluntly in line with the muscle fiber direction. Hemostasis is achieved with electrocautery. Two cotton lap pads soaked in antibiotic solution are applied to the skin margins. The Charnley self-retaining retractor is placed below the fascia lata level to expose the proximal femur. The gluteus maximus insertion on the femur is detached with electrocautery with care being taken to control bleeding from the first perforating branch of the profunda femoris artery should it be encountered. A thin bent Hohmann retractor is placed between the gluteus medius and gluteus minimus proximally. Proceeding from a proximal to distal direction, the femoral insertions of the gluteus minimus (posterior portion), piriformis, obturator internus, gemelli, and quadratus femorus muscles are detached to expose the posterior hip capsule. Bleeding from branches of the medial circumflex artery will be encountered when detaching the quadrants femoris muscle from the femur. An Aufranc retractor is placed below the inferior capsule. A capsulotomy is performed at the femoral insertion of the posterior capsule from the twelve o'clock to six o'clock position. The labrum is cut at the twelve o'clock and five o'clock positions. The posterior capsule and short external rotators are tagged with nonabsorbable suture for later repair through drill holes in the greater trochanter.

Figure 1

Figure 2

Step 3

Femoral Head Resection

At this point the hip should be easy to dislocate by manipulating the leg into flexion, adduction, and internal rotation, unless there are significant osteophytes, protrusio deformity, or excessive anteversion of the femur or acetabulum. Prior to amputation of the femoral head, the center of the femoral head and the coronal midpoint of the greater trochanter are marked with electrocautery or the marking pen (Figure 3). The distance between the center of the femoral head and the top of the lesser trochanter is measured. This distance should approximate the one taken from the pre-operative radiograph. The femoral offset is measured from the center of the femoral head to the midpoint of the greater trochanter (Figure 4). These measures form the basis for restoration of proper leg length, offset and functional geometry of the femur and hip joint. Basing the neck cut on the minus 3mm neck length component, the femoral neck is cut with the oscillating saw at a point 28mm below the center of the femoral head along the axis of the neck (Figure 5).

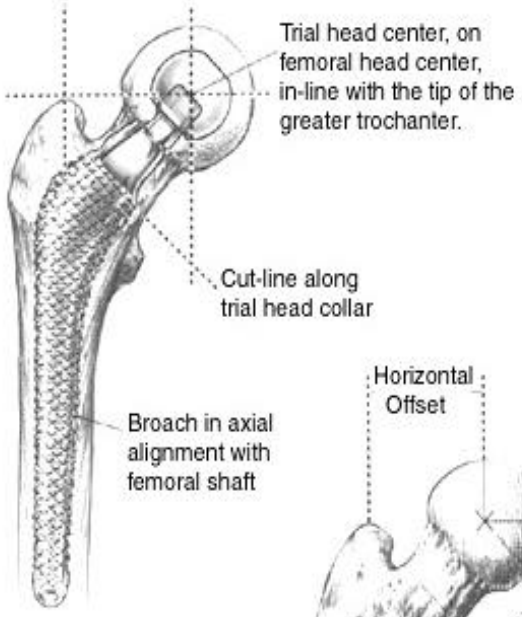
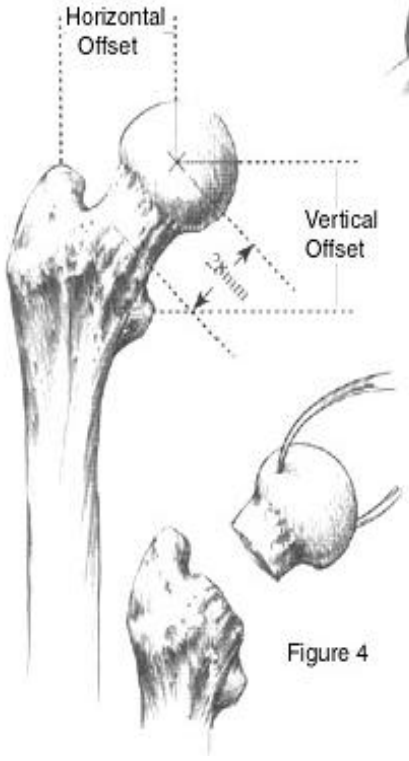


Figure 3



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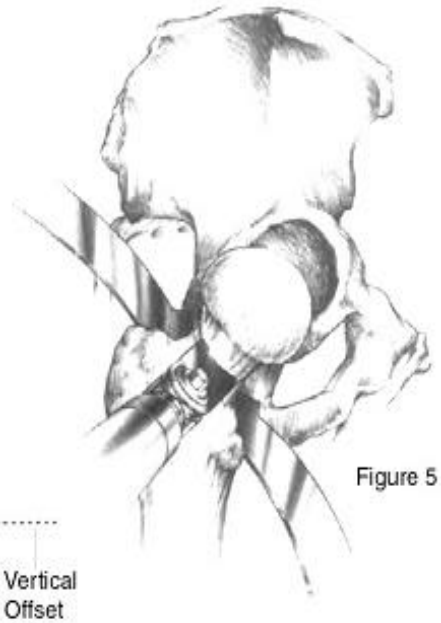
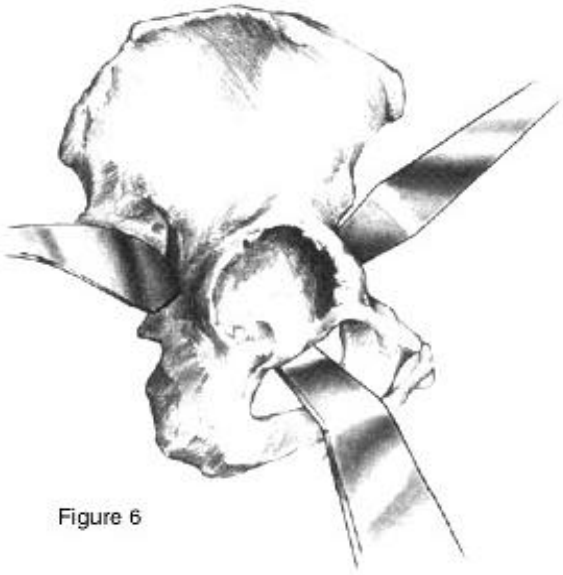


Figure 5

Step 4

Acetabular Exposure

Following removal of the femoral head, the table is tilted toward the operating surgeon. The acetabulum is exposed by placing a C-retractor in front of the anterior margin of the acetabulum to retract the femur anteriorly. The inferior acetabulum is exposed by placing an Aufranc retractor below the transverse acetabular ligament. The posterior acetabulum is exposed by interposing a wide bend Hohmann retractor inside the capsule and the labrum posteriorly (Figure 6). This retractor is seated with the mallet. The superior acetabulum is exposed by placing a large unthreaded pin in the ilium to retract the gluteus medius. The labrum and inferior capsule are removed completely using sharp dissection (Figure 7). The oblique head of the pubis and part of the anterior capsule at the level of the anterior inferior iliac spine are detached with a knife to facilitate displacement of the femur anteriorly. The transverse acetabular ligament is debulked by removing the segment facing the acetabulum along the line of its fibers and the medial vessels. The fovea is cleaned of all soft tissue. The fovea can be obscured by osteophytes which should be identified on pre-operative radiographs. Care should be taken at the rim to clear away all soft tissue. This step will then allow identification of the medial and inferior acetabular floor and help determine the extent of the reaming process.



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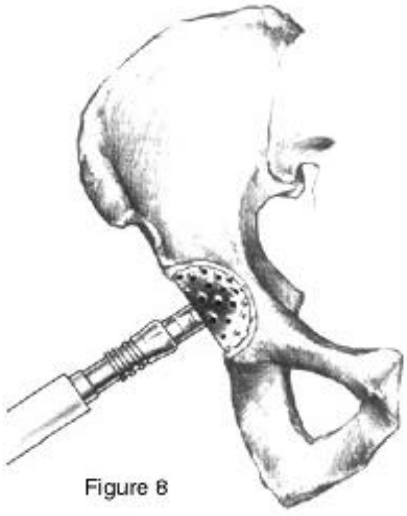


Figure 8

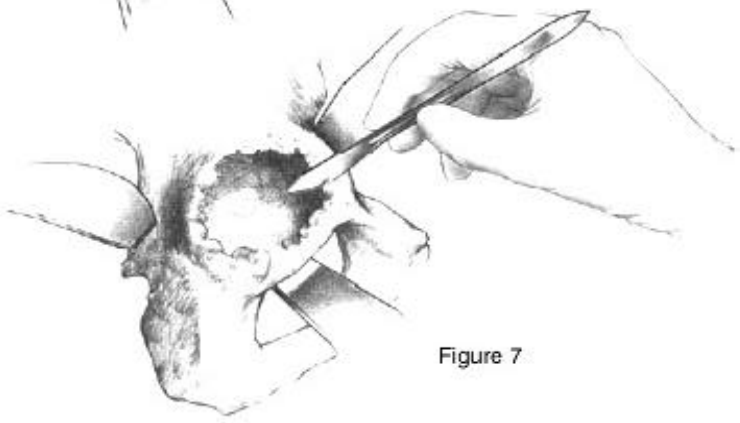


Figure 7

Step 5

Acetabular Reaming

Acetabular reaming is initiated with a reamer size that fits easily into the socket. This allows reaming based on the anatomic center of the acetabulum. Initial reaming should be carried out to identify the medial wall. Reaming should medialize the socket to this point but care should be taken not to compromise or violate the medial wall (Figure 8). If too small a reamer is chosen to begin with, the reaming process may begin eccentrically, thus removing excessive anterior or posterior wall bone stock with resultant non-anatomic placement of the acetabular component. Acetabular landmarks must be clearly understood to prevent eccentric or over aggressive reaming. Reamer size is increased sequentially until there is concentric removal of all soft tissue and cartilage remnants. There should also be a uniform punctuate bleeding bed of subchondral bone present (Figure 9). After completion of reaming, fixation holes should be made in the subchondral plate. A single primary fixation hole should be created in each of three areas: the acetabular dome, ischial ramus, and pubic ramus (Figure 10). Additional holes can be created at the surgeon's discretion with a curette or power bur. The cup sizer corresponding to the last reamer used is inserted into the acetabulum (Figure 11). The acetabular cup sizers are the same size as the actual implant plus the cement and should fit well into the acetabulum. This will allow an estimation as to the depth to which the cemented socket should reach while maintaining an adequate cement mantle.

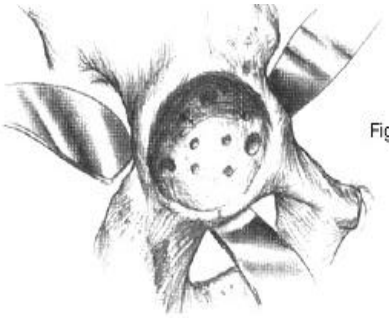


Figure 10

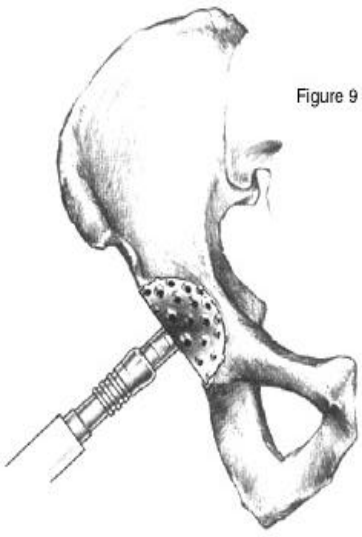


Figure 9

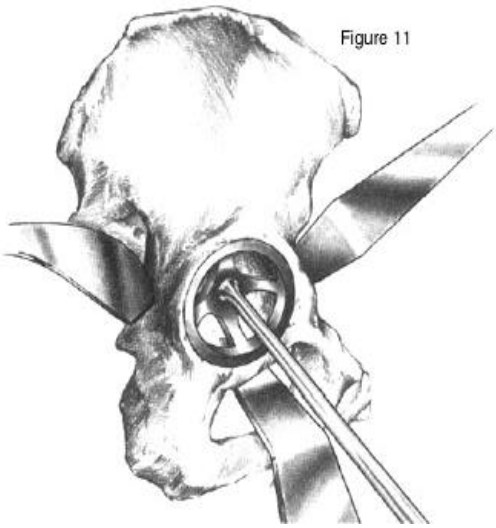
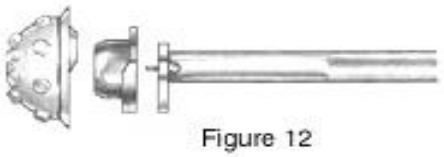


Figure 11

Step 6

Cup Insertion

The acetabulum is then lavaged, suction applied, and the socket dried thoroughly. At this point, if proper hypotensive anesthesia is achieved (mean blood pressure below 60mm Hg), the socket field should be relatively bloodless. The selected cup is mounted on the insertion device in the proper orientation to place the elevated portion in the posterior superior position (Figure 12). The cement is mixed and is inserted into the acetabulum in bolus form when it has achieved a doughy state (Figure 13). The cement is pressurized with a large bulb syringe with the bulb inserted against the cement bolus for 30 seconds to 1 minute (Figure 14). Care should be exercised to prevent migration of cement under the transverse acetabular ligament. The cup, mounted on the insertion guide, is then pressed gently into the socket and driven deeply into the acetabular bed of cement (Figure 15a). The angle guideallows assessment of proper cup position which is 40 to 45 degrees of abduction or lateral opening and 10 to 15 degrees of anteversion. In cases where there is extreme femoral anteversion, it would then be desirable to have the cup in a neutral position with regard to anteversion/ retroversion (Figure 16a). An alternative style cup inserter with a quick release mechanism may be used if preferred (Figure 16b).



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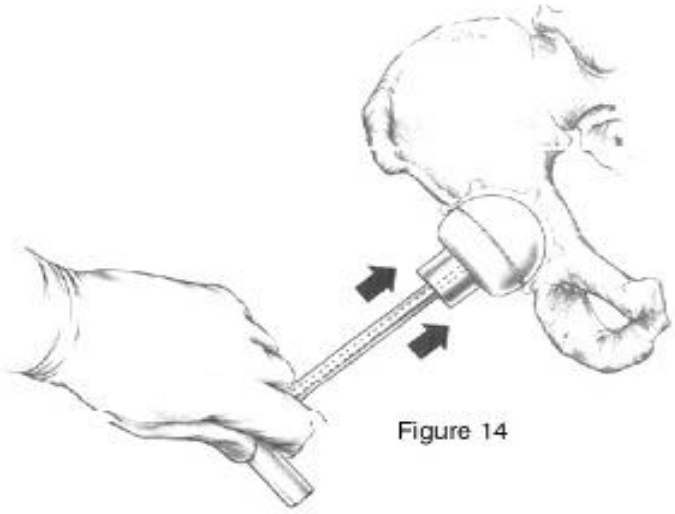


Figure 14

Figure 13

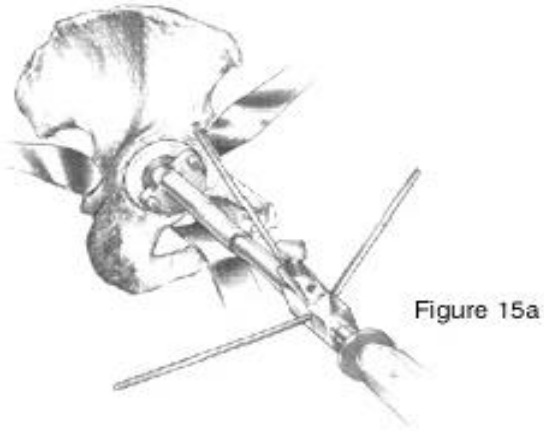


Figure 15a

Step 7

Cup Insertion cont.

When the acetabular component is in place, the polyethylene spacer pegs in the dome of the outer cup will not bottom out against the acetabular bed. The pegs are only 2mm in depth and are designed to rest on a lmm bed of cement-NOT on bone (Figure 16b). At this time, the acetabular cup is again checked to ensure proper orientation; however, this must be accomplished before the cement begins to cure. If the component is not in the correct orientation, realign the component with the positioner. Note: the driving instrument should not be removed from the acetabular component until the cement is completely cured. It is essential that the cup be compressed into the acetabulum and the positioner be held as still as possible with constant pressure until the cement has hardened. The cup is then released from the inserter. Take special measures to remove all excess bone cement from the edges of the component by utilizing curettes and osteotomes. Attention can now be turned to the femoral component.

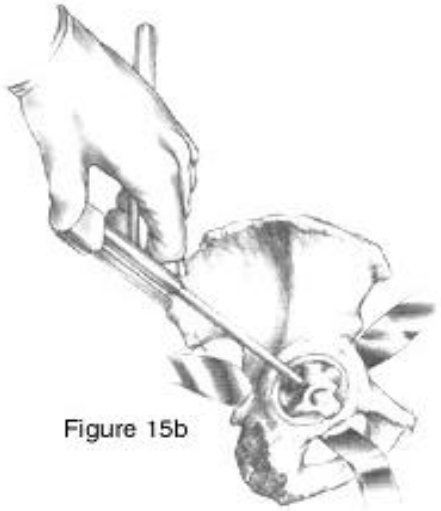
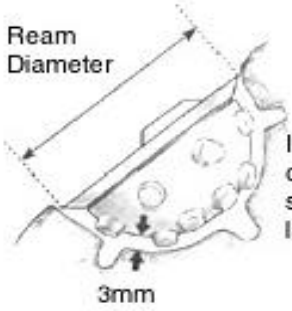


Figure 15b

Figure 16b



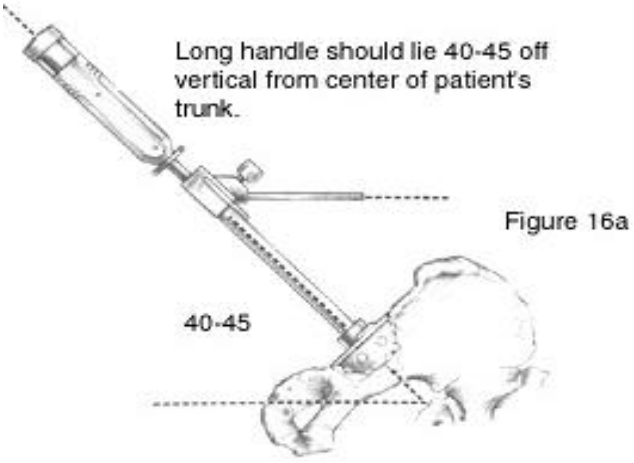
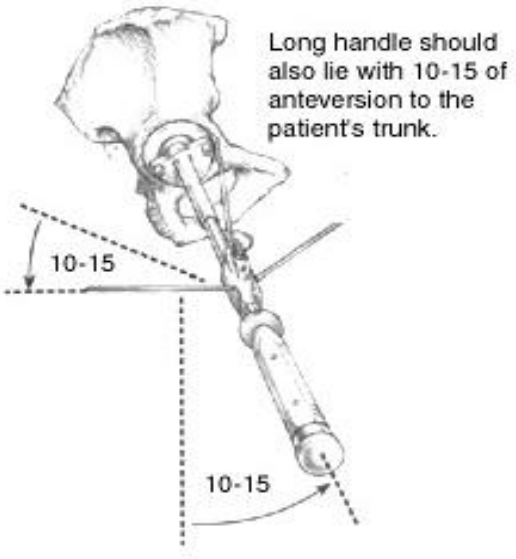


Figure 16a



Step 8

Femoral Reaming

A moist lap pad is placed over the socket in preparation of femoral reaming. The table is returned to the vertical position and the femur is allowed to flex about 45 degrees and adduct fully. The femoral retractor is placed inferior to the proximal femur. The Aufranc retractor is placed medially and a narrow bent Hohmann is placed laterally to protect the abductor mechanism. The remnants of the insertions of the short external rotators are removed with sharp dissection The remnant of the superior femoral neck is removed with sharp dissection. Prior to opening the femoral canal, a hollow chisel is utilized to remove the remnant of the superior femoral neck and to access the lateral section of the proximal femoral shaft. The femoral neck is referenced to establish the correct anteversion of the chisel. The chisel should be positioned laterally to clear a channel for advancement of the tapered reamers without interference from the dense bone surrounding the trochanter (Figure 17). A common difficulty in maintaining correct reamer orientation with the proximal femoral shaft axis, and consequently the correct positioning of the component, is normally a result of insufficient bone removal at the medial aspect of the trochanter. Failure to create an adequate channel in this dense bone can cause the reamer tip to wander into a varus position. Removing adequate bone laterally may help to prevent varus reaming of the femur. The femoral medullary canal is opened with a small starter reamer. A tapered side cutting conical reamer one size smaller than templated is then introduced into the femoral canal. This is followed by the reamer of the templated size (Figure 18). Manual reaming is recommended over power reaming to avoid excessive removal of bone. The tapered, conical design of the canal reamers and their side cutting feature help avoid notching or perforation of the femur. If the greater trochanter overhangs the neutral axis of the medullary canal, this portion of the trochanter should be reamed. This will prevent varus reaming of the canal and varus positioning of the component. Care should be exercised to keep the reaming laterally into the greater trochanter to allow straight unobstructed placement of the rasp and stem into the prepared canal. Reaming is completed when resistance or “chatter” from cortical endosteal bone is encountered.

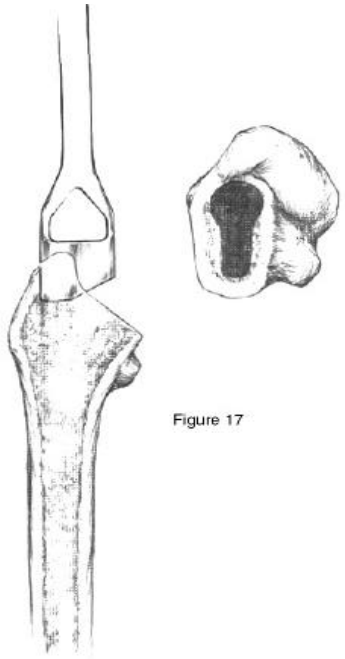


Figure 17

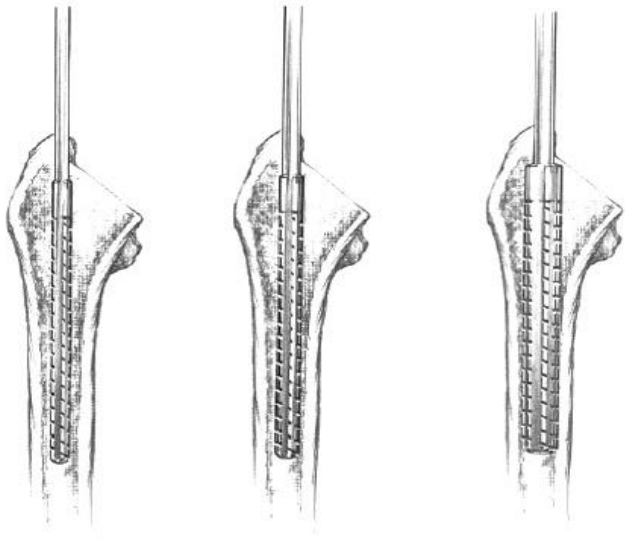


Figure 18

Step 9

Femoral Broaching

When reaming is completed, metaphyseal broaching commences. Broaching is conducted with the same size broach as the last reamer used (Figure 19). When impacted into the femoral canal, the broach should be oriented to match the natural anteversion of the femoral neck or 10 to 15 degrees of anteversion from the knee axis (Figure 20). If excessive anteversion is present, stem position can be altered to reduce the degree of stem anteversion. The broach is impacted to the line marking the junction between the neck and shaft. The broach templated from the pre-operative radiographs often matches the broach at surgery (Figure 21). The fit of the broach should be snug in the cut neck antero-posteriorly.

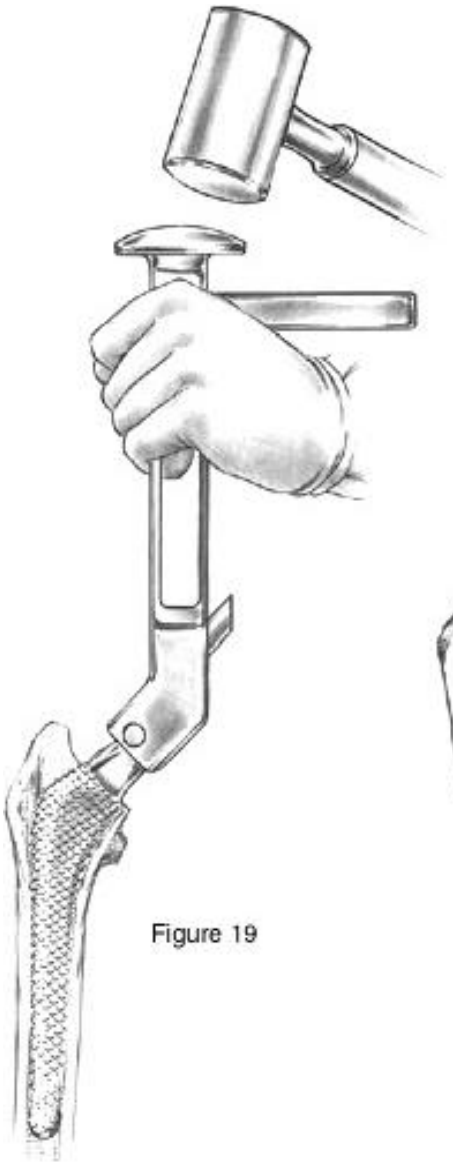


Figure 19

Figure 20

Figure 21

Step 10

Trial Reduction

A trial reduction is carried out with the last broach in place. The minus 3mm neck provisional head is placed on the trunion of the broach (Figure 22). The lesser trochanter-to-center head distance and the lateral offset are measured to determine if they have been restored correctly (Figure 23). If these distances are shorter than measured initially, longer neck sizes can be substituted to lengthen both of these measures. The hip is then reduced and combined anteversion of the components along with anterior and posterior stability and tissue tension are assessed (Figure 24). Neck selection will be determined by the need to achieve hip stability. The desire to achieve equal leg lengths should be a secondary consideration. With the patient in the lateral position, the cup and trial modular head should be concentric to each other with the leg in neutral adduction and abduction and with 40 degrees of neutral rotation of the hip. This hip joint has a combined anteversion of 40 degrees and lateral opening or cup abduction of 45 degrees.

Figure 22

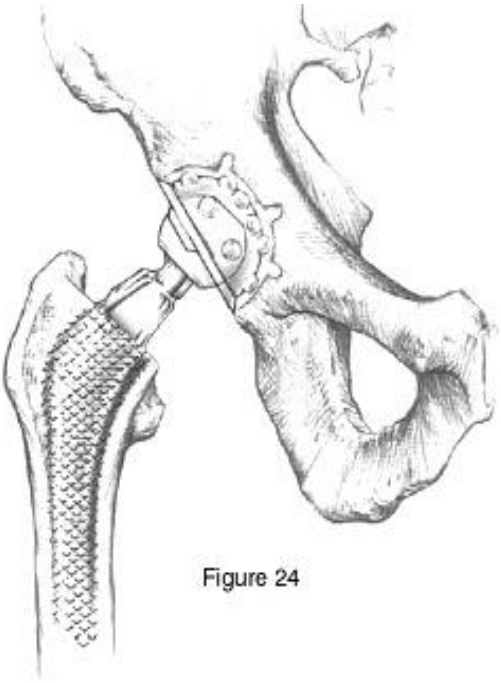


Figure 24

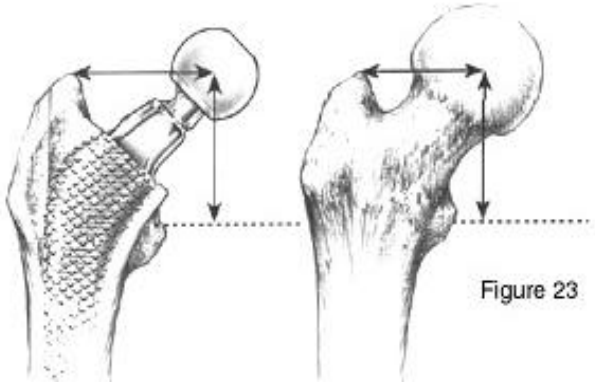


Figure 23

Step 11

Stem Insertion

The trial head and broach are removed from the femur. The appropriate stem size and cement restricter are selected. The femoral component is undersized by 2mm circumferentially as compared to the broach, to allow for a uniform cement mantle. A distal centralizer can be added to the femoral component to ensure central positioning of the stem within the mantle distally. The cement restricter is attached to the insertion rod and the proper depth is marked on the rod with the marking pen. The proper depth allows for 1 to 2cm of cement distal to the stem tip. Suction is applied to the femoral canal and the cement restricter is inserted with the mallet. The cement is then mixed and poured into the cement gun. The canal is then cleaned thoroughly with the pulsatile lavage. Suction is applied and the canal is packed with absorbent gauze down to the level of the cement restricter. The gauze is removed and the cement introduced into the canal in a retrograde fashion with the pressurizing wedge firmly seated in the mouth of the metaphysis. When the canal is filled, the long barrel on the gun is exchanged for the short barrel. The pressurizing wedge is reintroduced and further pressurization of the cement column carried out to achieve maximal intrusion into cancellous bone (Figure 25). Next, the appropriate stem is selected and the distal positioner is attached. It is important to understand that the component is undersized 2mm circumferentially as compared to the broach, to allow for a uniform lmm cement mantle. The femoral stem is then manually inserted into the cement column with aid of the stem pushing device (Figure 26). As the implant descends, the centering sleeve provides a cement mantle of consistent thickness in the distal portion of the canal (Figure 27).

Figure 25

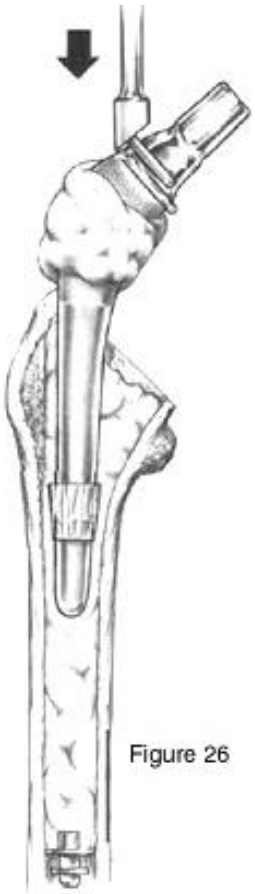


Figure 26

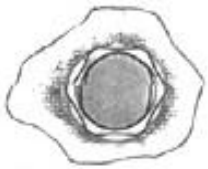


Figure 27

Step 12

Stem Insertion cont.

The anteversion is continually monitored during insertion. The stem can be seated further with the mallet and femoral head impactor. Excess cement is removed proximally and the cement is allowed to harden (Figure 28). A second trial reduction using provisional modular heads can be conducted if there is a question of proper restoration of leg length and offset. If the component needs to be removed for any reason, extraction can be carried out using the extractor assembly around the neck trunion and a large slap hammer (Figure 29). Care is taken to thoroughly clean the trunion prior to seating the final modular head. The head is seated with the head impactor and mallet (Figure 30). A 2mm drill is used to create two holes is the greater trochanter for reattachment of the short external rotators. Care is exercised not to damage the prosthesis or cement mantle. A suture loop is placed through each hole from lateral to medial using a large Keith needle. The tendon of the gluteus maximus and quadratus femoris are repaired with size 0 polyester interrupted sutures. The sutures used to tag the posterior capsule and external rotators are brought up through the drill holes in the greater trochanter using the suture loops. The leg is brought into extension, slight abduction, and external rotation. The sutures are tied firmly over the greater trochanter. The wound is irrigated copiously with pulsatile lavage saline. A two-limb wound drainage device is placed in the depths of the capsule and exits the thigh anteriorly. The fascia lata is closed tightly with interrupted size 0 polyester and size 0 Vicryl sutures. The drain is placed to bulb suction. The wound is irrigated once more. The subcutaneous tissue and fascia are closed with interrupted 2-O Vicryl sutures. The skin is closed with a running 3-O nylon suture reinforced with several interrupted nylon sutures. The wound is irrigated and dressed with Betadine soaked gauze, 4 x 8 inch plain gauze, and ABD's. The dressing is held in place with a spica bandage.

Figure 28


Figure 29


Figure 30

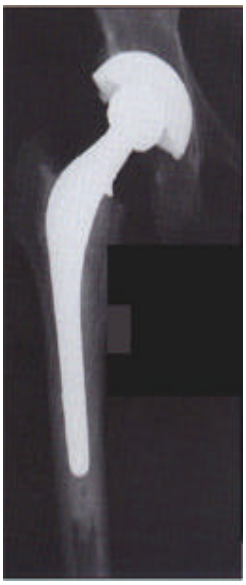
Clinical Evaluations

Pre-operative Evaluation:
Patient is a 60-tear-old female with progressively worsening right hip pain over the past four years. She reports pain in her right groin radiating to her knee. She is unable to ambulate more than two blocks and has difficulty ascending and descending stairs.

Post-operative Evaluation:
Patient is out one month post-operatively. A Ranaway/Burstein porous RingLoc solid actabular shell and Hi-Wall liner were used without cement for the acetabulum. A CoCr Ranawat/Burstein cemented stem was used for the femur . She walks well without any significant limp. Hip motions and function are good. X-Rays show satisfactory alignment and fixation of the hybrid components.

Pre-operative Evaluation:
Patient is a 75-year-old female who has complained of pain in the right hip for the past five years. Which is progressively getting worse. She has disabling pain, limited ambulation and extreme difficulty ascending and descending stairs.

Post-operative Evaluation:
Patient is out one month post-operatively and is doing quite WELL with her total hip. A Ranawat/ Burstein all polyethylene cup and CoCr femoral component were used for reconstruction. She is currently ambulating well with a single cane and will be weaned from it over the next two months. X-Rays show good position and fixation of the cemented components.



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Form No.Y-BMT-388/020702