Minimally Invasive Posterior Approach for Hip Resurfacing Arthroplasty

Thomas P. Gross, MD, and Fei Liu, PhD

Summary: With the improvement of metal-on-metal bearings, hip resurfacing has become a viable option for hip arthroplasty in young patients. It is technically more complicated to gain access to the acetabulum while preserving the femoral head. In some countries, this type of bone-preserving hip arthroplasty is used in a substantial percentage of young patients. Little formal instruction exists in most US orthopaedic training programs for this procedure. After gaining experience with over 2000 hip resurfacing arthroplasties (HRA), we describe a technique for performing this operation using a minimally invasive surgical (MIS) technique based on the posterior approach. The Biomet instrumentation was designed to facilitate an MIS technique, but other systems can also be adapted to this technique. Some custom retractors are also described that are critical. Detailed technical instructions are given to help the reader improve his/her results and avoid complications while learning to perform HRA. A prospective analysis has demonstrated improved clinical results and no increased complications when employing MIS techniques for HRA using a posterior approach.

Key Words: hip resurfacing—minimally invasive surgical (MIS)—posterior approach.

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Although many surgeons are familiar with the exposure required for standard stemmed total hip arthroplasty, few surgeons have been trained in the steps required for hip resurfacing arthroplasty (HRA). Therefore, it has become standard to use a much larger incision to better visualize the hip for hip resurfacing. However, as a surgeon becomes more experienced with a technique, he/she learns how to gain access to perform a procedure with more precise division of only the necessary structures. Less exposure is required to place the implants correctly. The patient benefits from a more precise exposure. On the other hand, if the focus on a small incision is too great before a surgeon is very experienced with the requirements for the procedure, there is a risk that complications may increase. Therefore, it is ideal if an exposure is used that is extensile, and a patient is not promised a very small incision. Furthermore, carefully evaluating the results after moving to a smaller incision and comparing them to the results of the same operation done through a larger incision is valuable to be certain that patients are not harmed. It is often difficult to demonstrate an actual benefit from a smaller incision, but it appears logical that the size of the incision that is used should be the smallest possible to still allow an efficient and accurate operation. As more information is disseminated regarding the technical details required for a safe minimally invasive operation, it is hoped that new surgeons entering the field can more rapidly gain proficiency with a shorter learning curve.

Soon after beginning to perform hip resurfacing, the senior author (T.P.G.) was routinely using a 6-inch (15.2 cm) incision since 1999. After performing approximately 430 cases, he decided to move to a 4-inch (10.2 cm) incision in January 2005. Since then, 91% of 1489 HRA procedures have been performed using this technique. We prospectively maintained a database, which was then used to evaluate the results obtained before and after this transition to see if it was safe to continue HRA, using a minimally invasive surgical (MIS) technique. We did not attempt to evaluate pain control and quickness of recovery, because other aspects of the perioperative management protocol, which were also responsible for these results, were also being gradually modified. We were primarily interested in evaluating whether this transition to MIS could be accomplished safely.

SURGICAL TECHNIQUE

Specialized Instruments

Most important are the tools required to place the acetabular component (Fig. 1). A specialized inserter is necessary to allow proper acetabular component placement without excessive inclination. The inserter must detach easily from the component, and a bow must be present to allow tilting the component into a horizontal position without running into the skin. If an inserter with a straight handle is used, the tendency will be to place the component in too much inclination. Although excessive inclination above 55 degrees rarely causes dislocation, it has recently been found to result in edge

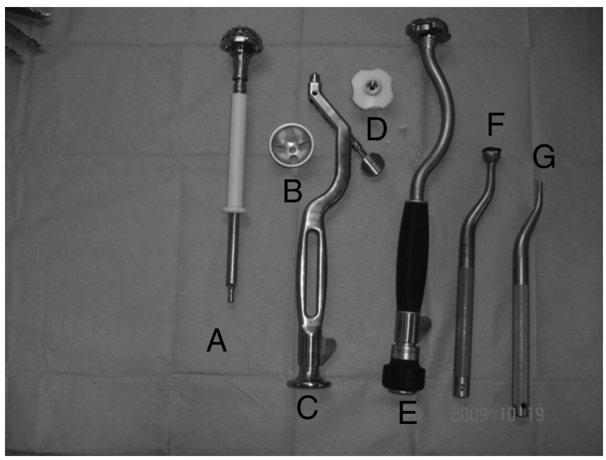

FIGURE 1. Acetabular Instruments: **A,** Straight shaft reamer. **B,** Trial cup (use 2-mm smaller than final cup size). **C,** Bowed handle for trial cup and secondary impactor. **D,** Secondary impactor head. **E,** Bowed cup inserter. **F,** Cup edge tamp. **G,** Cup removal tamp.

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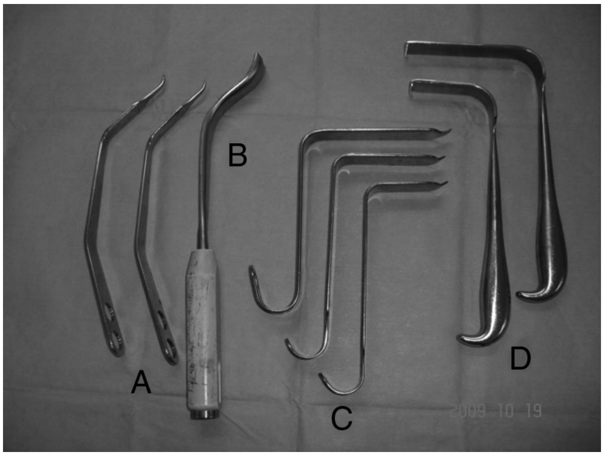

FIGURE 2. Special retractors: **A,** Double-angled Hohmann. **B,** Mueller femoral neck. **C,** Narrow Taylors, 3 sizes. **D,** Narrow Meyerding, 2 sizes.

loading and has been correlated with high wear and a clinical syndrome of adverse reaction to wear debris, also called pseudotumor by some centers.[1–3] In very large muscular or obese patients, an alternative technique using a separate stab incision and a straight impactor is sometimes helpful to achieve a more horizontal acetabular position. In this situation, the secondary impactor head is attached to the straight impactor handle after the handle has been first threaded through a distal stab incision in the skin and the fascial incision.

After the component is placed, sometimes the position needs to be adjusted slightly. It is helpful to have a set of edge tamps to move the component position, and a secondary impactor to again fully seat it.

Specialized retractors (Fig. 2) that are helpful include 2 double angled Hohmanns (DePuy, Warsaw, IN), a Mueller femoral neck retractor, a short and a long Meyerding, and a set of 3 Taylor retractors. Most larger-size retractors become wider as they become longer. For small incision surgery, it is helpful to have longer narrow retractors custom made. Both the long Meyerding and the long Taylor are custom made to be the same width as the standard instrument but to be longer to function in a deep but short incision. A rigid leg length device (Fig. 3) that has been custom developed with Biomet (Warsaw, IN) is also used.

Patient Positioning

A standard operating room table is used. A rigid 3-pad frame (Allen Medical Systems, Acton, MA) is fastened to the table rails and allows the patient to be rigidly pinned in the lateral position (Fig. 4). An arm board supports the lower arm. A second arm board supports the upper arm and pins the chest against the upper pad of the hip frame. A set of 8 folded blankets is placed around the lower leg to create a flat surface on which to rest the upper leg. The frame and pads must be placed in such a fashion to allow unimpeded flexion of the hip to 90 degrees and even adduction at 70 degrees of flexion. Despite this rigid frame set-up, the patient position still moves relative to the table during the operation. Therefore, only internal anatomic landmarks and radiographs should be used to determine component position. We believe that any device that uses landmarks outside of the patient's body (ie, referencing the floor) to guide component position has a high potential to lead the surgeon astray.

Incision Placement

An incision is the window into the body. During the hip exposure, this window, as well as the leg, is moved relative to each other to accomplish different tasks required. We have noticed that a posterior incision that is placed 1 to 2 inches more posterior to the usual incision is better positioned to allow the operation to be performed through a smaller incision (Fig. 5). The patient is rigidly locked in the hip frame as described above, the leg is flexed 30 degrees and is adducted slightly and internally rotated 30 degrees with a large bolster placed under the foot. The posterior border of the tip of the trochanter is marked. A line is drawn in a posterior direction for 1 to 2 cm. This marks the center of a 4-inch slightly curved incision. The larger the soft tissue envelope, the further the incision needs to be moved posteriorly to have the best access. It is helpful to imagine an exposure plane that must travel at a 45-degree angle to the horizontal. Starting at the center of the hip capsule, it must bypass the greater trochanter and exit at the skin incision. This is often difficult to judge in a large patient. If the leg cannot be positioned in the above-described position, this will affect the position of the skin incision. During the operation, if the surgeon notices that the skin incision is malpositioned, the incision can be extended in either direction without difficulty. It is best to mark possible extensions at the start so that a more cosmetically pleasing result is achieved during the incisional extension.

If the subcutaneous fat is detached for several centimeters from the fascia, the skin window does become more mobile, but a deeper depression at the incision site may occur after healing, which is often less cosmetically appealing to women than a longer incision.

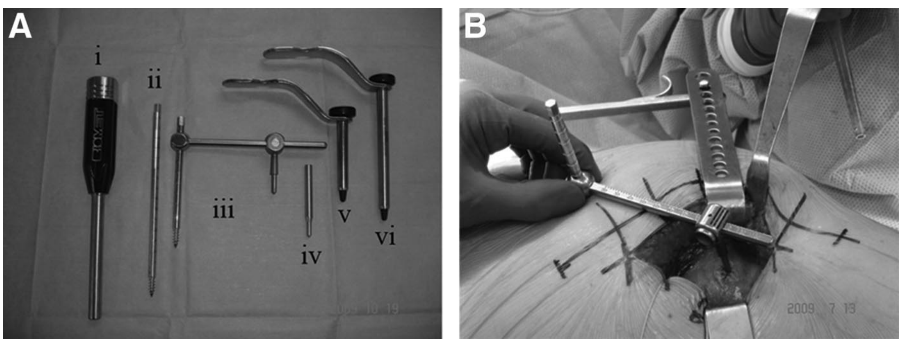

FIGURE 3. **A,** Leg length device (i) Threaded pin driver. (ii) Long threaded pin (ileum). (iii) Short threaded (ileum) pin and measuring bar. (iv) Tip extender for trochanteric side. (v) Short trochar and sleeve. (vi) Long trochar and sleeve. **B,** Measurement.

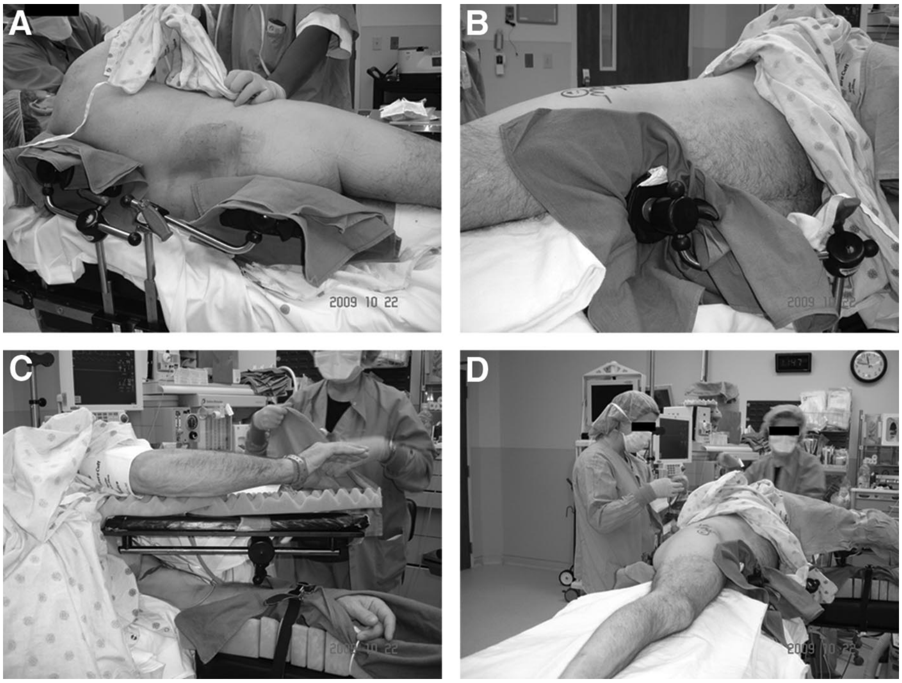

FIGURE 4. Patient positioning using Rigid Frame: **A,** Two posterior pads (thoracic and sacral). **B,** One anterior pubic pad. **C,** Upper arm and anterior chest board. **D,** Position with blankets.

Key for Success

Acetabular Visualization

The 2 most important objectives that must be achieved to get adequate exposure to perform hip resurfacing through the posterior approach are:

1. A complete 360-degree division of the hip capsule, and
2. The creation of an adequate superior pocket in which to place the femoral head.

This allows the surgeon to reproducibly gain access to the acetabulum. There are certain thin flexible female dysplastic patients who are exceptions to this rule. On the other hand, in thickly muscled stiff males with extensive osteophytes and large femoral heads the surgeon must be certain to follow the above rules for a successful outcome. Unfortunately, these patients are typically considered the "ideal" resurfacing candidates. Struggling with a poor exposure is the most common reason that results in poor implant position.

FIGURE 5. Posterior Incision: standard and 4 inch MIS.

Femoral Head Exposure

Typically releasing the insertion of the conjoined tendon (gluteus maximus and fascia lata) from the posterior femur is required to adequately rotate the femur to resurface the head. A 1- to 2-cm release is routinely performed directly off the bone with the electrocautery to avoid bleeding. This does not need to be repaired because the femoral attachment of this tendon is very long along the linea aspera and reestablishes itself without difficulty.

Sciatic Nerve Protection

Some experts have stated that release of the conjoined tendon prevents sciatic nerve injury. We have noticed that stretch injury to the sciatic nerve is best avoided by not internally rotating the femur past 30 degrees when the hip is flexed to 70 degrees during femoral preparation. For access to the anterior femoral neck, the hip is instead extended to a 45-degree flexed position, and then more internal rotation is safely possible (Fig. 6).

Inadvertently cutting the sciatic nerve is best avoided by using the electrocautery as a nerve stimulator. Either regional anesthesia or general anesthesia without neuromuscular blockade can be used. An assistant always keeps their hands on the foot during dissection around the posterior structures. We have found that the foot will jump from electrical transmission when the electrocautery device comes within 1 cm of the nerve. If the cautery tip is moved slowly during dissection, the location of the nerve is safely identified before it is actually cut or visualized. Nerve stimulation must be differentiated from direct muscle stimulation, which typically makes the whole leg jump.

Vascular Preservation of the Femoral Head

The blood flow to the femoral head is probably impaired with all surgical approaches used for hip resurfacing.[4,5] Studies have

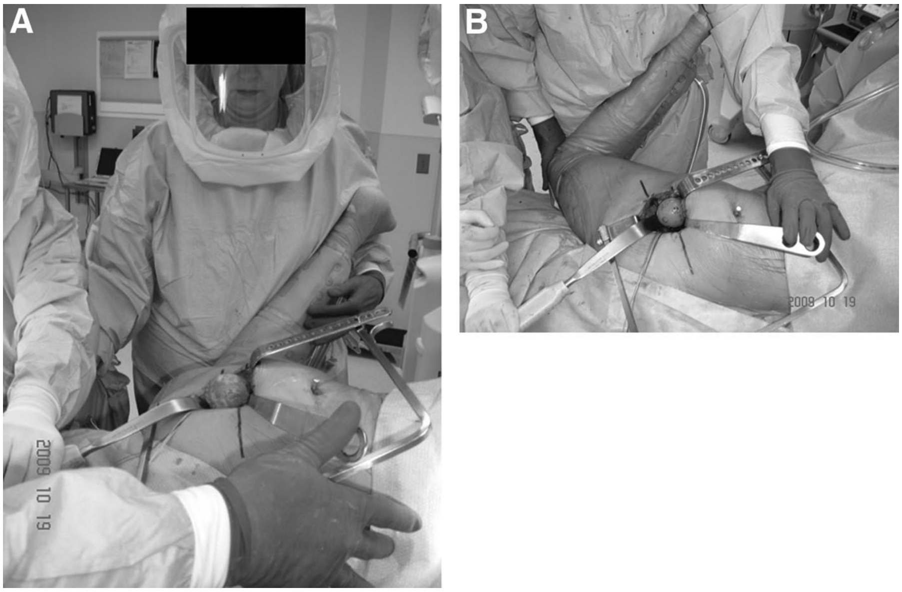

FIGURE 6. Femoral positions: **A,** Femoral head position: 70 degrees flexion, axial load, no more than 30 degrees internal rotation. **B,** Anterior femoral neck position: 45 degrees flexion, axial load, 45 degrees internal rotation.

shown similar complication rates with various approaches.[6] The branches of the medial circumflex artery that supply the posterior femoral neck and a portion of the femoral head are always divided when a posterior approach is used. However, some surgeons believe that preserving the posterior femoral neck soft tissue such as the periosteum and a capsular cuff may limit the vascular damage to the head and may theoretically decrease complications when using the posterior approach. The disadvantage of preserving these posterior structures is that the anatomy of the neck becomes obscured, making accurate femoral component placement more difficult. The surgeon must balance these facts when planning his/her approach. However, with a guide based on the femoral neck and a judicious partial removal of posterior osteophytes, the periosteal soft tissue can routinely be preserved.

Femoral Component Alignment

Various mechanical guides have been developed to aide the surgeon in aligning the femoral component. We show 4 that are available from Biomet (Fig. 7). Often, the femoral head is not centered over the neck in patients who are undergoing HRA. We believe that recentering of the head and especially recreating anterior offset is important. Moving the prosthetic head center superiorly allows the surgeon to avoid notching the femoral neck. There is consensus that the stem should ideally be placed neutral or in slight valgus relative to the neck if possible. It is our opinion that a guide based on the femoral neck is the best type to accomplish these goals. The senior author designed the Neck Axis Guide and has been using it since 2005. Marking the posterior, superior, and inferior neck axes and transposing them onto the femoral head gives the pin starting point (Fig. 8). The posterior axis should primarily parallel the calcar. When the pin guide is then placed on the neck and the crossing point of the axes are used as a starting point, good pin alignment can be routinely achieved (Fig. 9). Typically, the starting point is 1 to 2 cm superior to and 0.5 to 1 cm anterior to the attachment of the ligamentum teres. The pin is initially only placed 1 to 2 cm deep into the bone. The feeler gauge is used to check the pin position (Fig. 10). The pin position can then easily be modified slightly using a freehand technique. The pin is pulled back and then redirected into a slightly improved position. If the position is verified to be perfect by the feeler gauge, the pin is driven home through the lateral cortex.

Acetabular Component Alignment

Although dislocation is rare with large metal bearings, recent evidence suggests that acetabular inclination should be less than 55 degrees to avoid edge wear and clinical adverse wear reactions in patients.[7,8] This also depends on component design and size. No ideal lower limit has been established. An ideal anteversion position has not been established. Therefore, based on the limited scientific evidence available, we have decided that currently an "ideal wear" position for the component is within a range of inclination of 30 degrees to 50 degrees. To accomplish this, our research has found that an intra-operative x-ray with a component position measured between 35 degrees to 45 degrees results in an inclination angle in the ideal wear position 95% of the time on a well-positioned postoperative office x-ray. Anteversion is still best judged intra-operatively as the position that maximizes impingement-free range of motion in both flexion and extension. However, it is easy to overly antevert the acetabular component in dysplastic patients with an oblong acetabulum. In dysplastic cases, there is often a wall deficiency in the anterosuperior corner. If the surgeon aligns the component with this deficient edge, excessive anteversion and sometimes even anterior instability may result.

Another problem that arises with large metal bearings is psoas tendonitis. There are several reasons why this may be seen more frequently with HRA than with standard total hip resurfacing (THR). First, patients are more active, routinely engaging in activities that traditionally patients have not with THR. Second, the edge of the resurfacing component is typically more prominent than the leading plastic edge of a traditional THR. For a given reamed cavity, the metal portion of a traditional acetabular component is typically buried, whereas the edge of a resurfacing component may overhang the edge of the bone adjacent to the path of the psoas tendon (Fig. 11). Finally, many resurfacing patients are young men with hard bone. There may be a tendency to inadequately centralize the acetabular cavity resulting in a greater chance of component overhang adjacent to the psoas tendon in these patients.

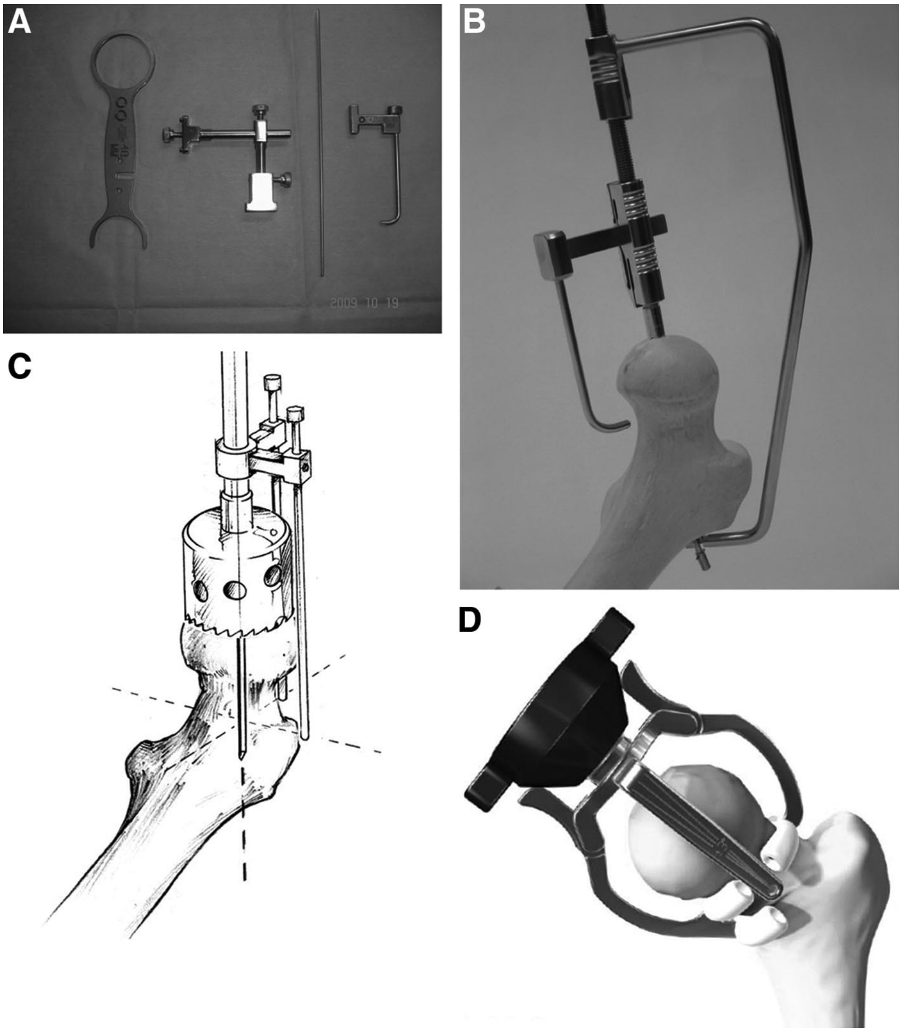

FIGURE 7. Femoral targeting devices: **A,** Gross neck axis guide: alignment based on neck axis intersection and capture of superoinferior neck diameter at head-neck junction. **B,** McMinn-style guide: alignment based on templating from preoperative anterioposterior external rotation. **C,** Head referencing guide: alignment based on center of head and neck axes. **D,** Neck referencing clamp guide: alignment based on neck capture.

To avoid psoas tendonitis, we advocate burying the anteroinferior edge of the component below the bone edge. Our experience is that this can be accomplished 95% of the time. If this is not possible, the surgeon should consider releasing the psoas tendon directly off of the lesser trochanter. This results in a lengthening, without a noticeable loss of flexion strength and may prevent psoas tendonitis.

We emphasize that the cavity must be reamed deeply enough so that all of the following objectives can be met:

1. The anteroinferior edge is buried below bone adjacent to the psoas to avoid tendonitis.
2. The anterosuperior edge is buried below the acetabular wall to avoid femoral neck impingement in flexion and internal rotation (except in dysplasia).
3. The component is inclined between 30 degrees and 50 degrees to avoid excessive wear.

If the cavity is not reamed deeply enough, some compromise of these principles must be made.

Therefore, the recommended technique is to centralize the acetabular cavity by first reaming with an aggressive cup reamer that has the same size as the femoral head. Reaming should be performed at a 60-degree angle to the body until the reamer has cut the medial wall away up to the quadrilateral plate (Fig. 12). The reamer should be directed slightly posterior to avoid the anterior inferior wall (to preserve it). Reamer sizes are increased by 2-mm increments and finally by a 1-mm increment to undersize the final cavity by 1 mm with respect to the implant outer diameter. In very hard bone, the posterior inferior edge is then reamed slightly oblong with the last 2 reamer sizes to allow adequate component seating. The component is impacted with enough anteversion to seat the anterosuperior corner just at the edge of the acetabular wall. The component is placed horizontal enough that both the transverse acetabular ligament and the anteroinferior acetabular wall protrude over the component edge. The anteroinferior osteophytes are then carefully removed with a Kerrison rongeur. Using an osteotome may cause a section of the thin wall in this area to break off exposing the edge of the component to the psoas tendon. Other osteophytes are removed in the standard fashion.

Avoiding Blood Loss

In addition to the MIS technique, several intraoperative strategies are used as components of a comprehensive blood management protocol that allows us to virtually eliminate the need for transfusion.

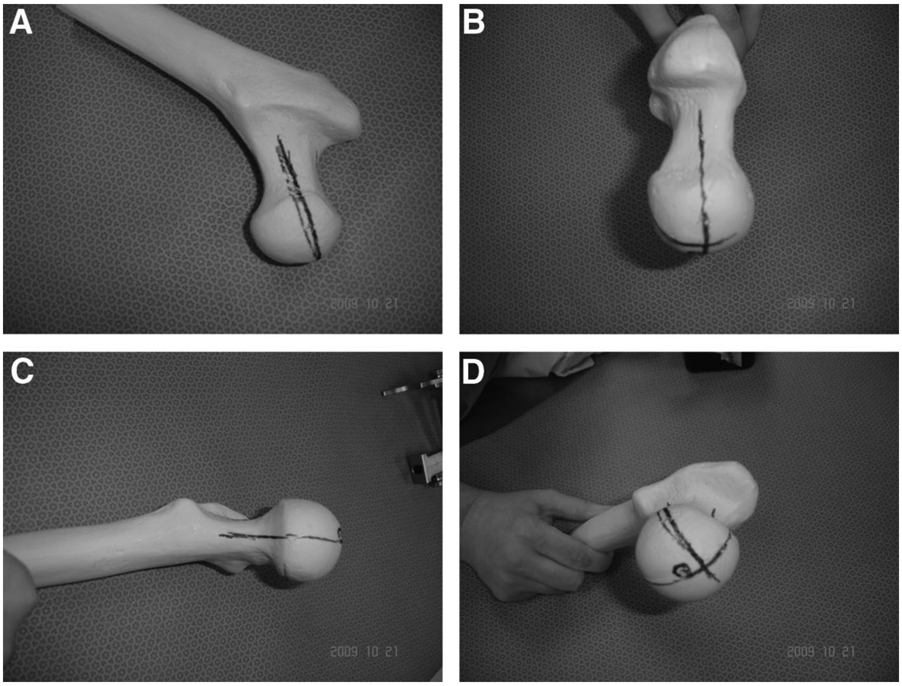

FIGURE 8. Axis lines on femoral model: **A,** Posterior axis: should parallel the calcar and is achieved by imagining the desired stem position on an anterioposterior external rotation. **B,** Superior axis: bisects neck. **C,** Inferior (calcar) axis: bisects neck. **D,** Starting point and ligamentum teres: A secondary reference point; the starting point is typically 1 to 2 cm superior to ligamentum teres and 1-cm anterior to it.

1. All dissection after the initial skin incision is carried out with the electrocautery device set at 60 coagulation.
2. The Aquamantys System (Salient Surgical Technologies, Portsmouth, NH) tissue sealer is used throughout to shrink and seal blood vessels.
3. Platelet concentrate is used to decrease bleeding and stimulate the healing process.
4. Three liters of epinephrine irrigation is used before closure.

Posterior MIS Technique

Instrumentation for HRA is brand specific, but most concepts are universal. This procedure is described using the Biomet instrumentation designed by the senior author (T.P.G.). Most of these steps will also be possible with some modification, using instruments from other companies.

1. Wear a body exhaust system with a headlight.
2. Position the patient in the lateral position in a rigid frame (Fig. 4) with blankets creating a firm flat surface for the operative leg. Place a large sterile bolster under the foot to internally rotate the hip (2 blankets in a pillow case).
3. Make a 4-inch curved incision centered over a point 2-cm posterior to the posterior trochanteric tip with a knife (Fig. 5).
4. Use electrocautery on coagulation setting 60 for all further dissection. Use the bipolar tissue sealer intermittently to minimize bleeding.

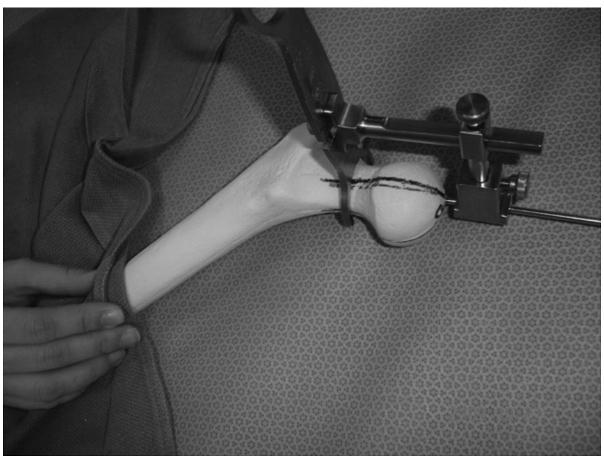

FIGURE 9. Targeting device on femoral model: The starting point is the neck axes intersection, the guide gives the pin direction. The smallest lollipop gauge that fits loosely on the neck (neck size) is used. This also gives the smallest possible femoral size. Typically the actual component size is 4 to 6 mm (2–3 sizes) larger.

FIGURE 10. Pin check with Feeler gauge: Feeler gauge corresponding to the neck size is used. If this clears circumferentially at the head-neck junction, notching should not occur. The pin must move freely without tissue impingement on it or the K-wire.

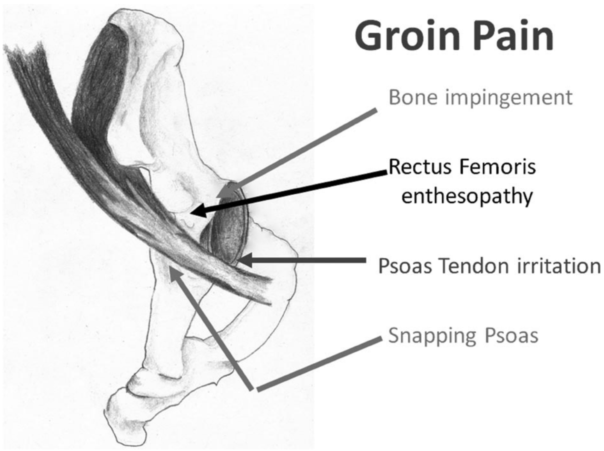

FIGURE 11. Psoas tendonitis from anteroinferior acetabular overhang: avoid reaming away this acetabular bone.

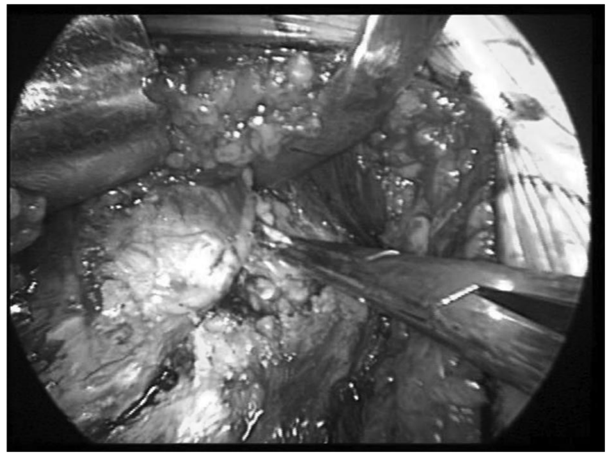

FIGURE 13. Identify piriformis: All short rotators are identified and tagged, and separated from the capsule.

5. Divide the subcutaneous tissue down to the fascia; do not detach the subcutaneous tissue from the fascia except at the inferior aspect of the wound.
6. Divide the fascia in a curved fashion along the posterior trochanteric border; extend the fascial incision 3 to 4 cm beyond the corner of the skin incision in both directions. Ideally the fascial incision ends up close to the conjoined tendon in the inferior wound.
7. Place a Charnley retractor with the short hook posterior and the bow superior.
8. Divide trochanteric bursa tissue and reflect a flap posteriorly.
9. Extend the bursal flap by dividing the quadratus femoris off of the femur starting at the border of the vastus lateralis.
10. Clear the edge of the gluteus medius (GMe) and minimus (GMi). Palpate the piriformis tendon between them. Place a double angled Hohmann retractor under the medius to expose the piriformis (Fig. 13).
11. Clear the fat off of the tendons of all 3 short rotators. With the hip still internally rotated, cut the tendons close to their attachment under the edge of the trochanter. Proceed slowly, they will pop off under tension and you can avoid cutting the hip capsule.

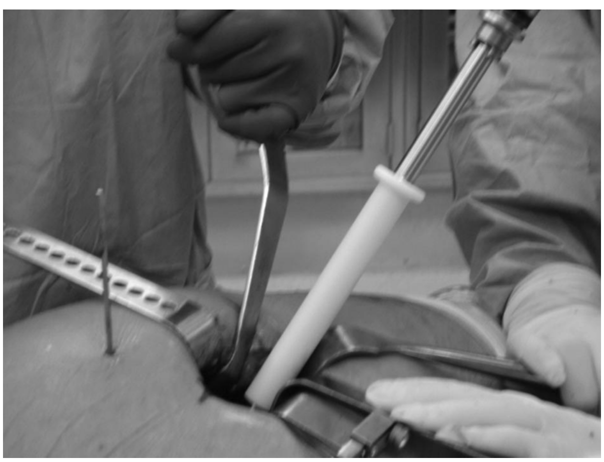

FIGURE 12. Reaming acetabulum: straight reamer is best for power and accuracy in hard bone.

12. Dissect each muscle off of the capsule. The interval between the obturator externus (OE) and the inferior capsule is the hardest to identify. Place locking tendon stitches with 3 bites into each tendon using number 0 fiberwire suture. Clamp each one separately.
13. Place the long Meyerding retractor on the OE and clear the interval between it and the capsule all the way down to the transverse acetabular ligament. To avoid severe bleeding from the medial circumflex artery, pre-treat the tissue adjacent to the OE with the tissue sealer intermittently.
14. Elevate the edge of the GMi with the cautery and place the double angled Hohmann under it. Use 2 Hohmanns and create a large pocket under the GMi. Release the posterior edge of the GMi from the ileum and reflect it forward. This is the first step in creating the femoral head pocket.
15. Divide the posterior half of the capsule from the femoral neck. Leave a 1-cm cuff of capsule attached to the neck. Be careful to avoid damaging the neck periosteum when dividing the capsule. The superior limb of the capsular incision should be well under the GMi. The posterior inferior capsular incision should extend to the posterior attachment of the transverse acetabular ligament.
16. Elevate the capsular flap off of the ileum superiorly (Fig. 14) with the cautery and reflect it posteriorly. Tag the capsule with a 0 PDS suture and clamp it.
17. Place a rigid threaded leg length pin through both cortices of the ileum 4 fingerbreadths superior to the tip of the greater trochanter. Measure length to a mark on the greater trochanter (Fig. 3).
18. Ask an assistant to hold the leg in abduction, slight flexion, and internal rotation. Enlarge the femoral head pocket in a superior and anterior direction by using 2 Hohmanns and gradually elevating the GMi off of the ileum with the cautery; when 3 cm of ileum are visible above the acetabular rim, the pocket is usually large enough (Fig. 15).
19. Keeping the anterior-most Hohmann in place, dislocate the hip and ask an assistant to apply gentle traction to the internally rotated and adducted leg. Under direct vision excise the anterosuperior quadrant of capsule with the cautery (Fig. 16). Then clear the anterior edge of the acetabulum and connect this pocket with the previously

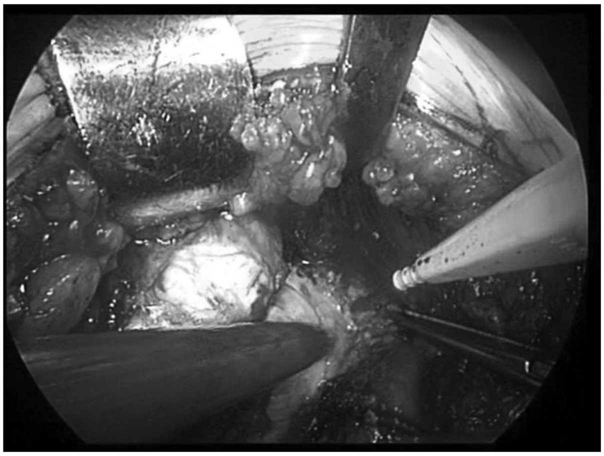

FIGURE 14. Reflecting superior posterior capsule: Reflected posterior to preserve it and to allow access to the ischium for the Taylor.

created femoral head pocket (at this point the surgeon should be certain that a sufficiently large femoral head pocket has been created).

20. Now further internally rotate the hip to 90 degrees and extend the hip, perching the femoral head on the acetabular rim. Place a short Meyerding retractor to expose the inferior capsule. Release the capsule.
21. Push the femoral head into the superior pocket. Place a Hohmann under the neck and over the anterosuperior corner of the acetabulum. Divide the anteroinferior capsule under direct vision until the cut meets the previous gap created by excising the anterior superior capsule (Fig. 17). The Hohmann can be repositioned more superiorly, giving better visualization, after a portion of this cut is completed (at this point the surgeon should be certain that the capsule has been cut 360 degrees).
22. The femoral head is prepared first for 2 reasons. The first is to debulk it and improve acetabular exposure. The second is to determine the minimum head size possible.
23. The femoral head position is achieved when the assistant places the leg in 70 degrees of flexion, 20 degrees adduction, and 30 degrees of internal rotation. An axial force is applied to the knee to deliver the head out of the wound. The Mueller and the double-angled Hohmann retractors are used to expose the femoral head and neck (Fig. 6A).
24. The lollipop gauges (Fig. 7A) are used to determine the size of the patient's head and neck. The inner border of the guide represents the inner surface of the component, and therefore the diameter of the barrel reamer required for this size component. The neck guide that just fits over the largest (superoinferior) diameter of the neck determines the smallest femoral component possible without notching the neck. We believe that the prosthetic femoral head should be the same size as the original head. Often the arthritic head is expanded by peripheral osteophytes. Typically the head size measured with the guide is 4 to 6 mm larger than the smallest possible size based on the neck sizing. Of course there is a large amount of variation of the head to neck ratio in the population.
25. The pin is placed by the technique described above using the lollipop gauge that just fits on the neck (Fig. 9). This assures that the pin is centered in the neck and that we can

FIGURE 15. Excising superior anterior capsule: 3 cm of ileum must be cleared superior to the acetabular rim.

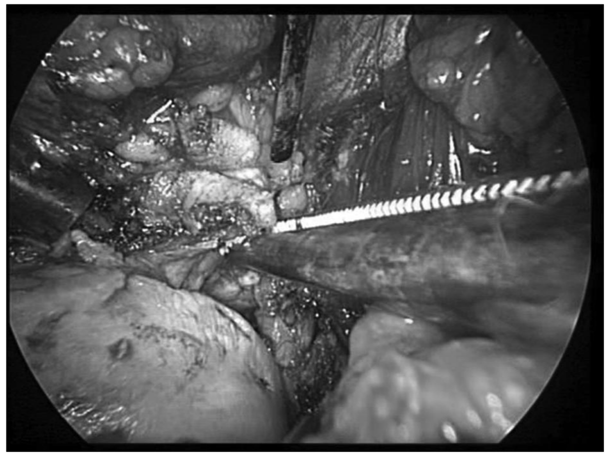

FIGURE 16. Excising anterior capsule: In a left hip, the excision is carried out under direct vision to the 9 o'clock position.

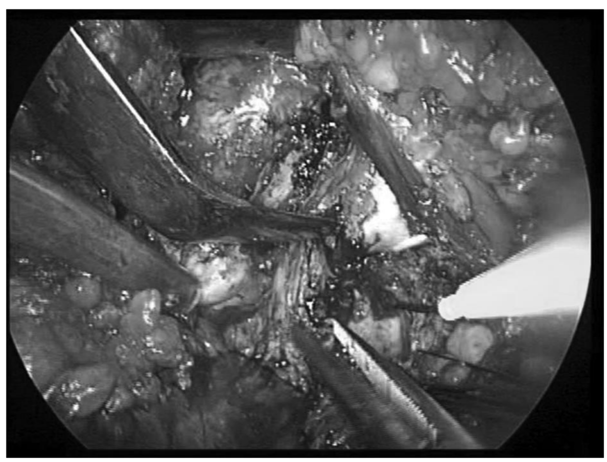

FIGURE 17. Dividing Inferior capsule: cut through remaining capsule until psoas muscle and tendon are seen and until the superior resection is encountered at 9 o'clock.

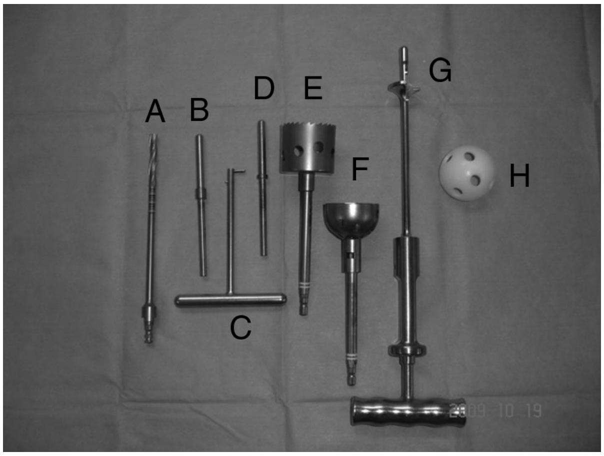

FIGURE 18. Femoral Instruments: Measured resection technique. Color coded. **A,** Cannulated 8-mm reamer. **B,** Standard collar post for 6-mm resection. **C,** T-handle post remover. **D,** Plus 6-mm collar post for 12-mm resection. **E,** Barrel reamer. **F,** Hemispherical captured reamer: depth of reaming is determined by collar in window and by the leading edge of the reamer. **G,** Stem hole round off tool. **H,** Trial head.

later downsize if necessary. The femoral head is prepared using a measured resection technique (Fig. 18).

26. A trial is placed to protect the head and the leg is placed in the anterior neck position (Fig. 6B). All anterior osteophytes and cam lesions are removed to restore anterior offset. Posterior and neck osteophytes are generally left in place because they do not affect the range of motion and removing them may disturb residual femoral head blood flow. The head is placed back into the pocket with a Hohmann under the femoral neck.
27. The acetabulum is prepared as described above. In the Biomet system, the acetabular component outer diameter is always 6-mm greater than the head size previously chosen. The acetabular cavity is under reamed by 1 mm and the acetabular component is impacted (Fig. 19). If, during reaming, our evaluation tells us that a smaller acetabular component is best,

FIGURE 19. Inserting acetabular component: Bowed handle allows surgeon to achieve horizontal inclination through a small incision.

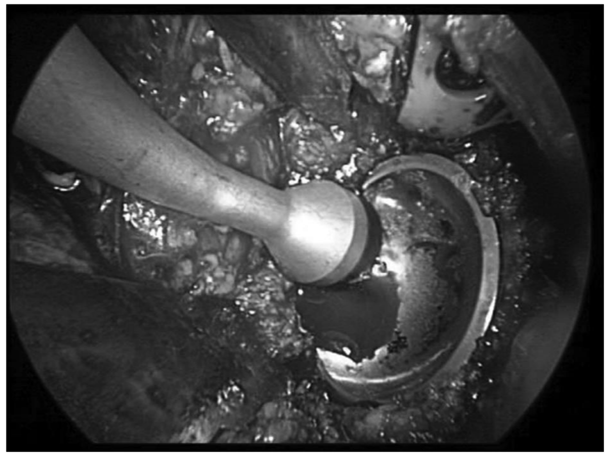

FIGURE 20. Adjusting cup position: Always reimpact cup with secondary impactor after this step.

we can place the desired acetabular component and return to the femur to downsize it accordingly. We already know the smallest femoral size possible based on our previous neck measurements. Acetabular component position can be adjusted with an edge tamp (Fig. 20) and reimpacted with the secondary impactor if necessary (Fig. 1).

28. The femoral size is adjusted if necessary and the femoral component is inserted. We prefer uncemented fixation with a device that is fully dual coated with titanium plasma spray and hydroxyapatite and has a diametrical 1-mm press-fit (Fig. 21).
29. Final implantation is shown (Fig. 22).
30. The posterior capsule is imbricated under the GMi muscle with a 0 PDS suture.
31. The short rotators are repaired back as closely as possible to their original starting positions (Fig. 23). Two trochanteric drill holes are used for the OE. One drill hole and a suture through the base of the GMe tendon are used for the OI. Two sutures through the GMe tendon are used for the piriformis. An arthroscopic suture passer is used to pass the suture through the drill holes. All sutures are tied down with the hip in abduction and external rotation on the bolster to remove tension. These tendons are always repairable, except if there was an extreme external rotation contracture at the start of the operation.
32. The quadratus/bursa layer is repaired with a running 0 PDS suture to the vastus lateralis and the GMe.
33. The fascia is closed with a running locking 1 PDS plus several additional interrupted figure of 8 stitches with the same material.
34. The subcutaneous layer is closed with a running suture of 0 PDS followed by interrupted 2-0 and then 3-0 Monocril sutures.
35. Dermabond is placed on the skin followed by an Acticoat silver impregnated antibacterial 7-day dressing.

COMPARATIVE STUDY

Materials and Methods

We began employing this MIS technique for HRA in February 2005 and have used this technique in over 1350 cases. Since beginning to perform HRA in 1999, we have prospectively gathered data on all patients and entered them in a database. To be

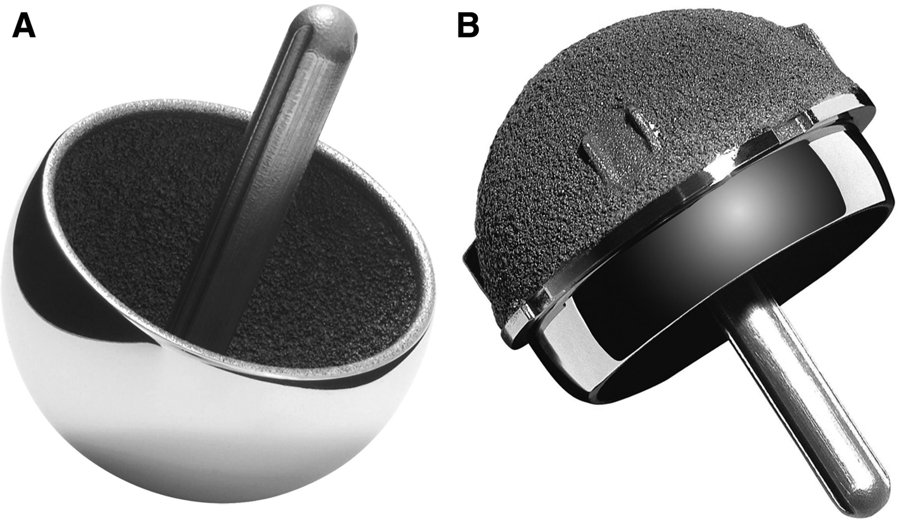

FIGURE 21. BIOMET: **A,** Uncemented Recap: Apex thickness is always 6 mm. **B,** Recap/Magnum HSR: cup apex is always 6 mm and peripheral thickness is 3 mm. Outer diameter is a full hemisphere and inside coverage arc is approximately 165 degrees.

certain that there would be no added risks suffered by patients, we decided to formally evaluate the first 100 cases done using the MIS technique (study group) and compare them to the last 100 consecutive cases done just before starting this protocol (control group). The study group was enrolled between February and August of 2005 and now has an average 3.4 years of follow-up. The control group was enrolled between July 2004 and January 2005, and has an average follow-up of 4.2 years. The demographics, diagnoses, and preoperative scores were not statistically different (Table 1). Hospital stay was defined as the number of days after the operative day that the patient remained in the hospital (the day of surgery was not counted). Institutional review board approval has been obtained for this study.

The implants used were Biomet Recap cemented femoral components and Magnum acetabular components (Biomet, Warsaw, IN). They were designed for use together as a metal-on-metal total hip resurfacing system and were approved for this use throughout the world. In the US, however, the Food and Drug Administration considers their use for this purpose an off-label indication.

Results

We did find a significantly higher Harris Hip Score (HHS) at the final follow-up, and a lower estimated blood loss (EBL) in the MIS HRA group. There were no differences in the rate of complications of the 2 groups. The study group had 2 femoral neck fractures, whereas the control group had 1 femoral neck fracture, and 2 loose acetabular components. The amount of follow-up, was of course, different between the 2 groups, but no complications were noticed after 2-year follow-up in either group. There was also no difference in the operation time, transfusion rate, hospital stay, acetabular inclination angle, or University of California at Los Angeles activity score between the 2 groups (Table 1).

Discussion

We have given a detailed description of a technique for MIS posterior HRA and compared the results between 2 similar groups of patients collected prospectively. At this point, there is no scientific evidence that 1 approach to HRA leads to a better outcome or is associated with fewer complications. One report finds no difference when comparing the anterolateral to the posterior approach.[6] In a study of 50 HRAs, MT found an improvement in the 3-month clinical score (HHS, 78 vs. 70) and a decrease in the EBL (566 vs. 683 mL), but no difference in the transfusion rate (1.5 units), the operative time (136 minutes), the length of hospital stay (3.1 days), the complica-

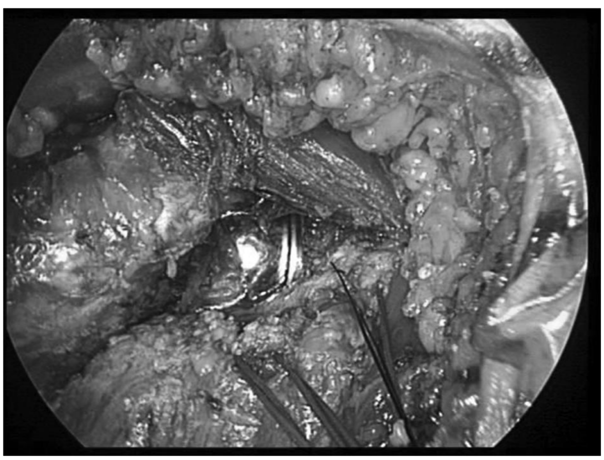

FIGURE 22. Final Implantation.

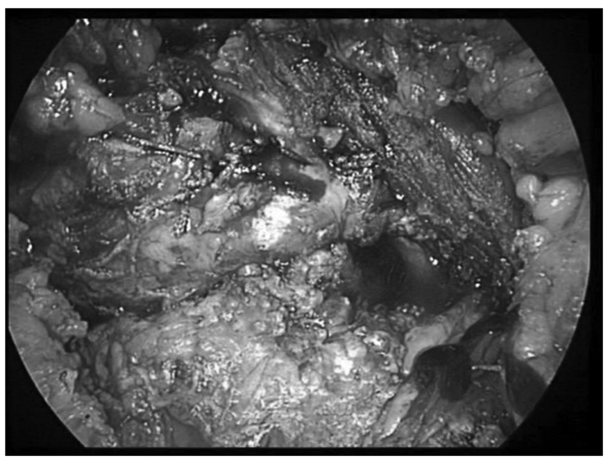

FIGURE 23. Short rotators repaired through bone.

TABLE 1. Comparison Study Between MIS and Standard HRA

	MIS vs. Standard		
	MIS	**Standard**	**Value**
Number of Hips	100 consecutive hips in 92 patients	100 consecutive hips in 92 patients	—
Implant information	Cemented Biomet Recap/Magnum	Cemented Biomet Recap /Magnum	—
Operation Date	Feb, 2005–Aug, 2005	Jul, 2004–Jan, 2005	—
Gender	67%	68%	—
Average age	52 ± 7	50 ± 9	—
Average BMI	26 ± 4	28 ± 6	—
Pre-operative HHS score	52 ± 13	53 ± 11	—
Diagnosis			
OA	77	82	—
Dysplasia	5	1	—
ON	12	10	—
Others	6	7	—
Operation Time (min)	110 ± 12	106 ± 25	0.10
Hospital Stay (days)	2.3 ± 1.2	2.3 ± 0.9	0.51
EBL (ml)	206 ± 131	222 ± 119	0.04
Length of Incision (inch)	4	6	—
Transfusion			
Autologous	0	0	—
Homologous	0	0	—
Cell Saver	1	4	—
Acetabular Size (mm)	57 ± 4	56 ± 4	0.21
Average Fu (years)	3.4 ± 0.6	4.2 ± 0.6	>0.001
HHS	96 ± 6	92 ± 13	0.04
UCLA Activity Score	7.8 ± 1.8	7.2 ± 2.1	0.08
VAS score in regular day	0.4 ± 0.9	0.4 ± 1.0	0.92
VAS score in worse day	1.3 ± 1.8	1.8 ± 2.3	0.15
Acetabular inclination angle	41° ± 6°	42° ± 7°	0.43
Radiolucency	0	0	—
Complication/Revision	2 Femoral Neck Fractures	1 Femoral Neck Fracture	—
		2 loose acetabular components	—
Deceased	0	0	—

OA indicates osteoarthritis; ON, osteonecrosis.

tion rate or the final clinical score when a MIS anterolateral approach was prospectively compared with a standard anterolateral approach.[9] In a study of 232 MIS posterior HRA, McMinn retrospectively compared them to a much larger database of traditional incision HRA. He reported that the hospital stay was reduced by 1 day (5.8 vs. 7.2 days), but the operating time was the same (70 minutes). Blood loss, transfusion rates, or complications were not compared.[10]

We also found some advantage in the clinical results in the MIS group. The operative time was not different and most importantly there was no increased rate of complications. We therefore continue to use the MIS technique in approximately 91% of our HRA cases. The incision is extensile, and we do not hesitate to increase the length if any difficulties of exposure are encountered during the operation. Although we did not directly compare HRA to traditional THR, the incision length, EBL, transfusion rate, and hospital stay that we report compare favorably with those generally reported for THR and call into question claims that HRA is necessarily a more extensive operation.

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