TECHNIQUE OF TISSUE-PRESERVING, MINIMALLY-INVASIVE TOTAL HIP ARTHROPLASTY USING A SUPERIOR CAPSULOTOMY

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Preservation of the tissues surrounding the hip may improve hip joint stability and facilitate recovery. A new technique for performing total hip arthroplasty with a superior capsulotomy allows for maximal preservation of the hip joint capsule and surrounding muscles. Using this technique, the gluteus medius and minimus are reflected anteriorly and the piriformis is reflected posteriorly. The short external rotators and posterior capsule are left intact. In most cases, the femur is instrumented with straight instruments before the femoral head is excised. This provides additional strength and stability to the femur during preparation. The femoral head is excised, rather than dislocated, to minimize disruption of surrounding tissues. The acetabulum is prepared and the acetabular component is inserted with angled instruments. This allows the femur to remain in physiologic positions throughout the procedure. Experience with this procedure demonstrates that, while technically demanding, the patients return to a normal gait more rapidly, with unrestricted motion and weight bearing postoperatively. The procedure offers the opportunity to facilitate recovery while potentially decreasing both short- and long-term surgical complication rates compared with conventional total hip arthroplasty techniques.

KEY WORDS: total hip arthroplasty, superior capsulotomy

Less invasive surgical methods for total hip arthroplasty have the potential to accelerate recovery while minimizing both short- and long-term complications.[1] The choice of surgical technique is critical to both the surgeon and patient because new, less invasive methods have the potential to either improve or worsen the results of total hip arthroplasty. Preliminary reports of total hip arthroplasty with minimally invasive techniques have shown a tendency toward higher, rather than lower, complication rates.[2-7] Reasonable goals for evolving total hip arthroplasty include reducing the incidence of perioperative complications while simultaneously accelerating recovery.

Whether considering conventional or less invasive methods, complications are primarily driven by the technique and tissue interval(s) chosen. Posterior exposures expose the hip to potential instability,[8-10] transgluteal exposures expose the hip to abductor muscle healing problems.[11,12] Anterior exposures (Watson–Jones and Smith–Petersen) preclude insertion of the femoral component without injury to the anterior portion of the gluteus medius and risk injury to the lateral femoral cutaneous nerve and tensor fascia femoris muscle. Two incision exposures that involve percutanous insertion of the femoral component risk both femur fracture and gross injury to the abductors.[3,6,13,14]

The technique described here involves inserting both the femoral and acetabular components through a single interval through the superior capsule. This technique evolved from a 2-exposure technique whereby the acetabular component was inserted through the Watson–Jones interval, and the femoral component was inserted under direct vision through the superior capsule. Increasing experience with the superior capsular exposure demonstrated that the entire procedure could be performed through this single interval, provided that instruments were designed and manufactured that allow the acetabulum to be prepared and the acetabular component to be inserted at a 45° angle. The creation of these instruments allowed this minimally invasive technique to evolve from a 2-exposure technique into a single exposure, with preservation of the hip joint capsule and surrounding muscles. This technique allows for unrestricted progression of weight bearing and motion postoperatively.

SURGICAL TECHNIQUE

The patient is placed in a lateral position. Most of the procedure is performed with the leg placed in the position of sleep (60° of flexion, 15° of internal rotation, and maximum adduction), with the foot resting on a padded Mayo stand (Fig 1A). A 6- to 8-cm incision is made starting at the tip of the greater trochanter and extending proximally, in line with the femoral shaft axis (Fig 1B). The skin incision can be longer in heavier patients, as necessary. The gluteus

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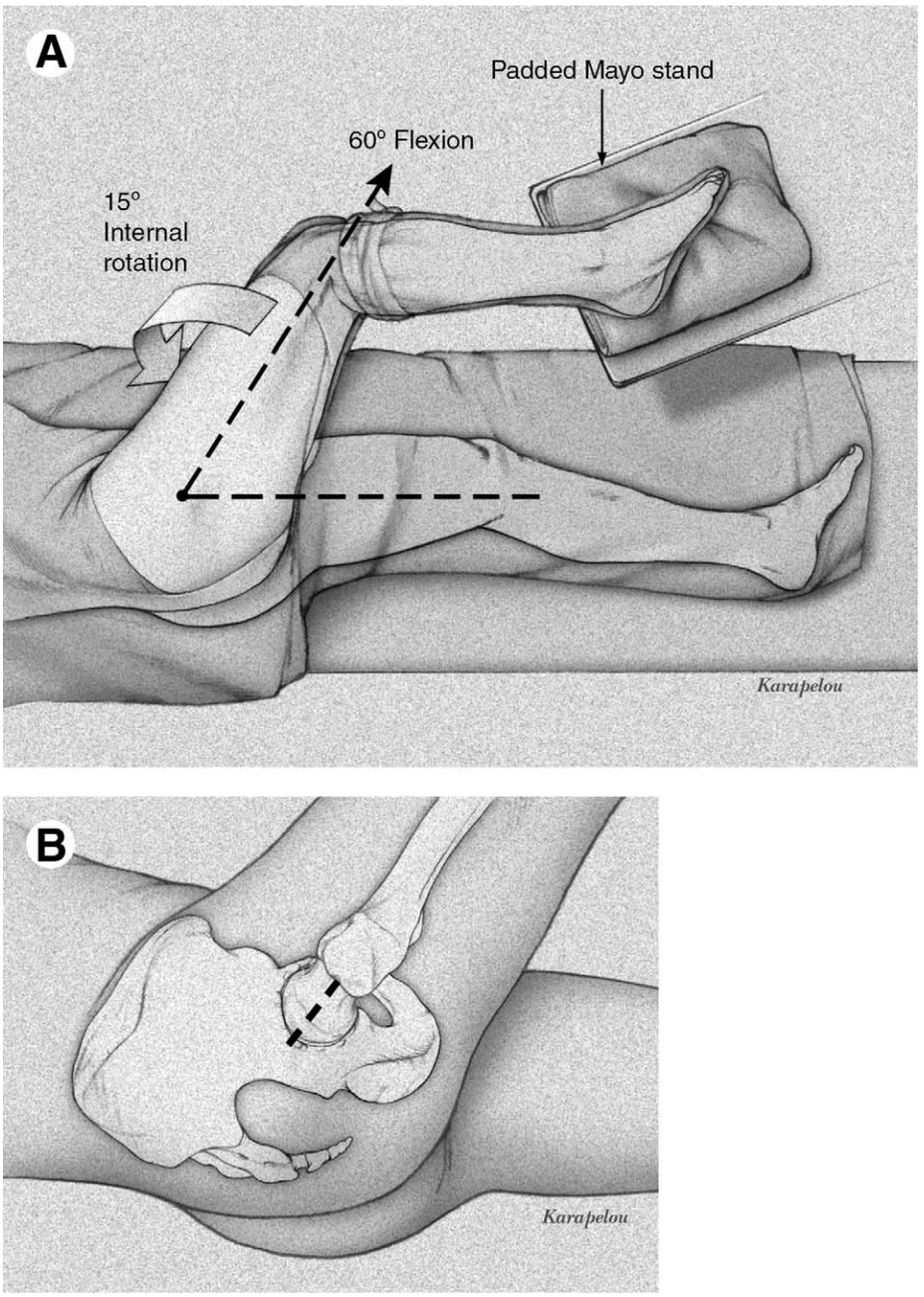

Fig 1. The patient is placed in a lateral position. Most of the procedure is performed with the leg in the position of sleep (60° of flexion, 15° of internal rotation, and maximum adduction) (A). The skin incision is typically 6- to 8-cm long and made in line with the femoral shaft axis, starting proximal to the greater trochanter (B).

maximus fibers are bluntly spread in line with their fibers to reveal the thin bursa tissue overlying the gluteus medius. The posterior border of the gluteus medius is mobilized anteriorly to expose the piriformis tendon (Fig 2). The anterior border of the piriformis tendon is developed to reflect the piriformis posteriorly. The insertion of the piriformis can be released and repaired as necessary, because most uncemented femoral components require removal of the bone that the piriformis tendon inserts on. A blunt homan retractor is placed between the short external rotators and the posterior capsule (Fig 3). The posterior border of the gluteus minimus muscle is identified and the minimus is mobilized anteriorly, taking care to fully develop the interval between the minimus tendon insertion and the anterior capsule. A blunt homan retractor is placed around the anterior femoral neck between the minimus and capsule. The two blunt homans placed around the anterior and posterior capsule provide excellent exposure of the trochanteric fossa (Fig 4). Two spiked homan retractors are then placed into the ilium to maintain the proximal portion of the exposure. One is placed anteriorly, protecting the medius and minimus. The other should be placed just above the posterior/superior rim of the socket, taking care to stay away from the sciatic notch. These 4 retractors allow for complete exposure of the superior capsule and are levered to form 4 corners of a rectangle to maintain exposure throughout the procedure.

A vertical capsulotomy is performed from the trochanteric fossa to the acetabular rim along the previous course of the retracted piriformis tendon. An anterior capsular flap is developed by creating 2 incisions in the anterior capsule—one along the acetabular rim for ~2 cm, and one along the anterior femoral neck, deep to the minimus tendon insertion (Fig 5). A traction suture is placed in the

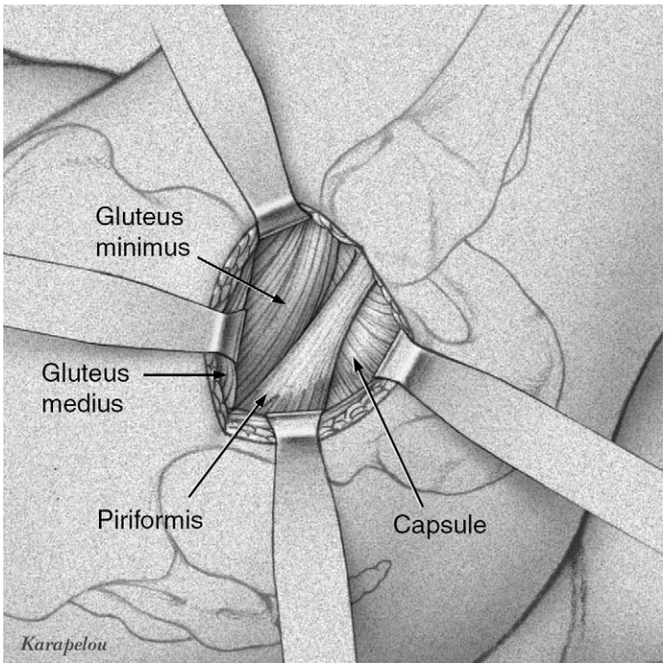

Fig 2. Right hip, with the gluteus medius retracted anteriorly to reveal the piriformis and gluteus minimus.

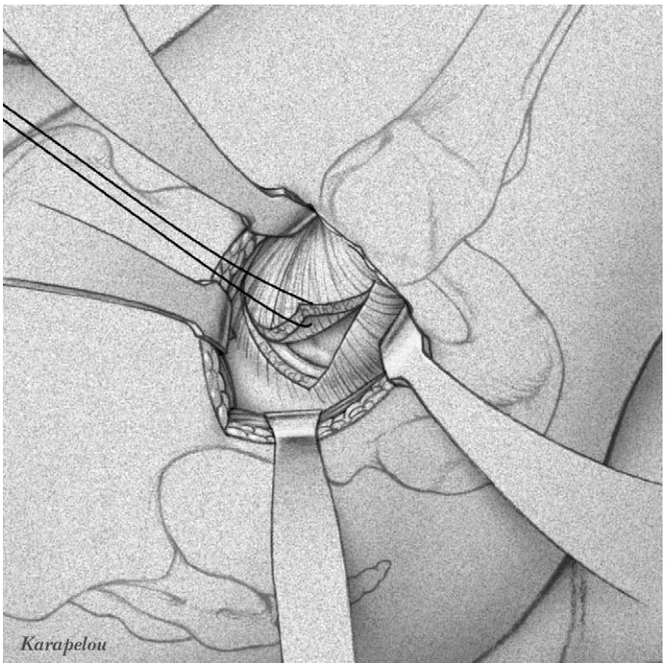

Fig 4. The superior capsulotomy, leaving the posterior capsule intact.

anterior capsule. The 2 blunt homan retractors are then removed and replaced inside the capsule and around the femoral neck anteriorly and posteriorly (Fig 6).

With the trochanteric fossa fully exposed and the surrounding tissues protected, the femur is prepared before removal of the femoral head. In hips where there is sufficient remaining motion in adduction and internal rotation, the femoral head and neck are left in place at this stage of the procedure, because the head provides stability to the femur during broaching and the neck provides a fulcrum for leverage retractors and also reinforcement to the calcar region, reducing the likelihood of femoral fractures during femoral preparation (Fig 6). In hips with abduction or external rotation contractures, the femoral neck must be transected first before preparation of the femur. In these

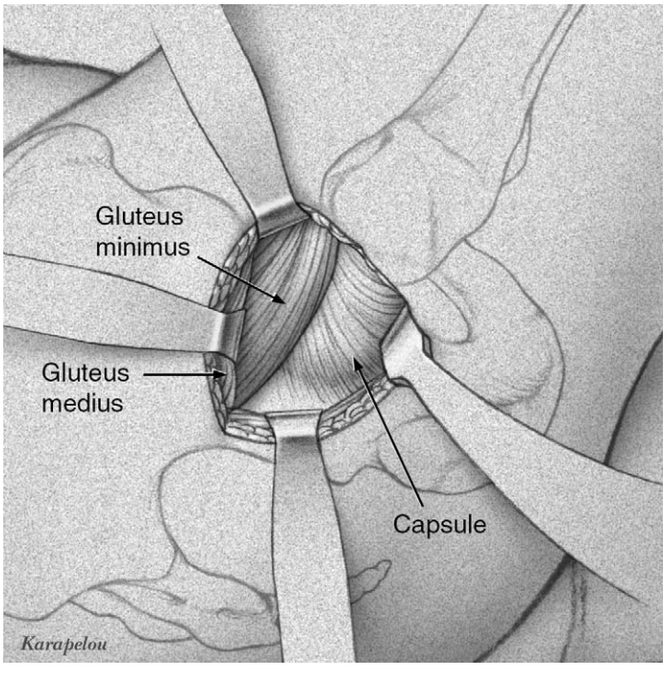

Fig 3. Right hip with the piriformis tendon incised at its insertion and retracted posteriorly with a blunt homan retractor placed between the short external rotators and posterior capsule. The gluteus minimus is then mobilized anteriorly, leaving its origin and insertion intact.

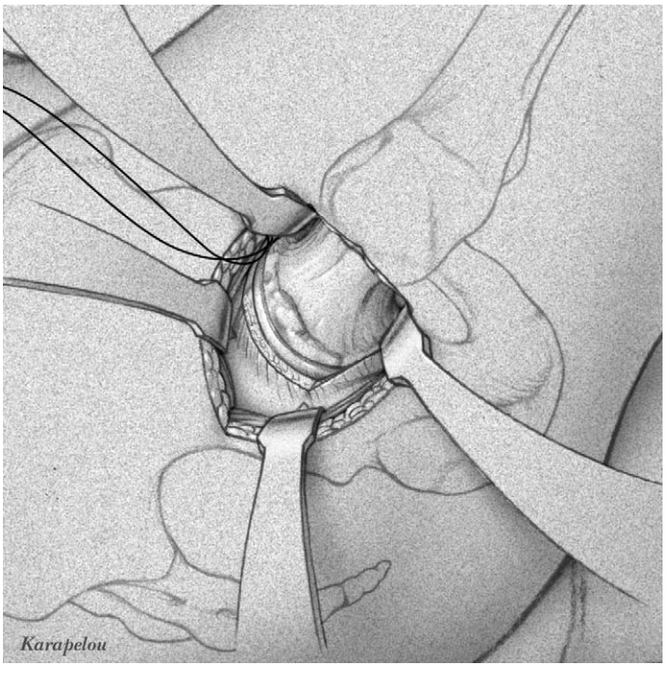

Fig 5. Blunt homan retractors are placed inside the hip joint capsule around the anterior and posterior femoral neck. The femur is now in position for reaming and broaching.

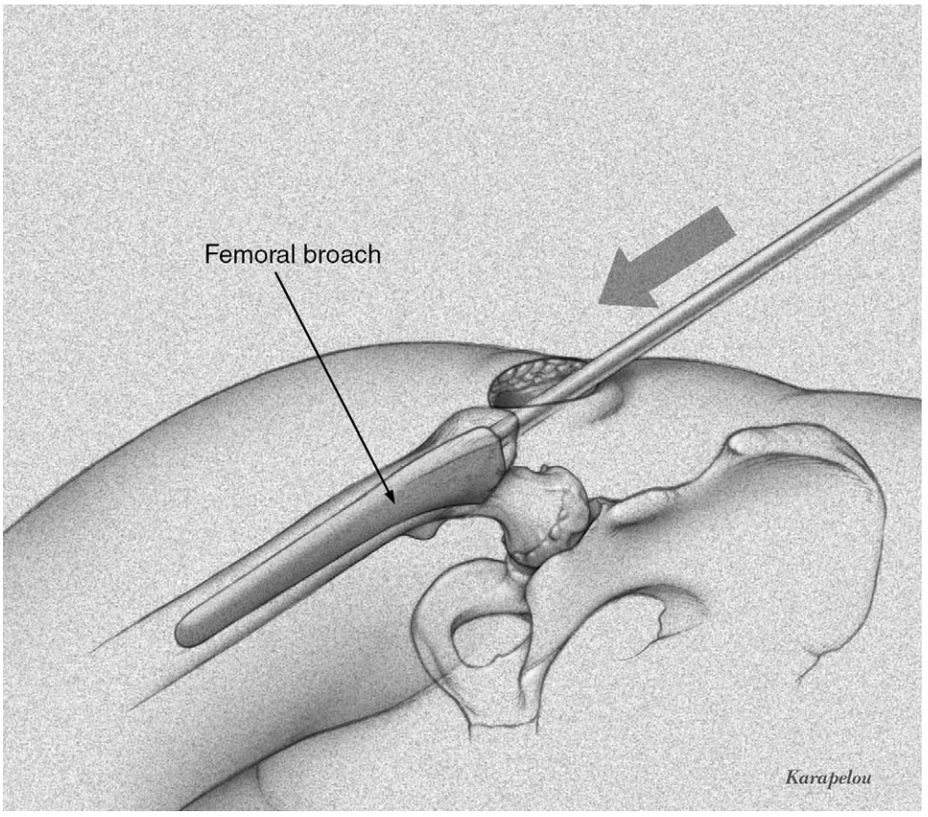

Fig 6. The superior portion of the head and neck are removed to allow reamers and broaches to pass into the femur. The head is normally left in situ to maintain stability of the femur and to allow the use of leverage retractors.

cases, the femoral head can be excised either before or after femoral preparation.

In the typical situation where the head and neck are left in place, a reamer is placed through the superior part of the femoral neck into the medullary canal. A guide wire is placed into the femur to palpate the inside of the femur for evidence of eccentric reaming, as necessary. A tapered metaphyseal miller is used to expand the proximal opening, ensuring that subsequent reamers pass in line with the femoral shaft axis. After the diaphysis is reamed to size, the superior portion of the head and neck are removed with an osteotome to allow the femur to be prepared with broaches. The femoral broach is left in place.

Once the femur has been fully prepared, a pelvic reference frame is percutaneously affixed to the pelvis, if surgical navigation of the pelvis is to be performed.[15-22] A prereconstruction leg length measurement is made. If fluoroscopic navigation is to be used for acetabular component insertion, fluoroscopic images may be acquired at this point. The femoral neck is then transected, with blunt homan retractors to protect the surrounding soft tissues from the saw blade. The femoral head can also be split longitudinally to facilitate excision. Shanz screws are placed into the head/neck segments to control the bone fragments as they are excised. If computer tomography-based navigation is being used, data points from the pelvis and periacetabular region are acquired to achieve pelvic registration.

The blunt homan retractors are now placed around the acetabulum anteriorly and also posteriorly in the lesser sciatic notch. The femur is pistoned proximally 1 or 2 cm to allow for fine-tuning of the neck cut with a saw or calcar miller. The entire acetabulum can be seen and remnants of the labrum are excised. A very low-profile 45°-angled reamer is then used to prepare the acetabulum (Fig 7). A Z-shaped acetabular impactor is used to insert the acetabular component (Fig 8), typically with the assistance of surgical navigation (Fig 9). Although acetabular screws are rarely used for fixation, they may be inserted by passing the instruments posteriorly, just above the edge of the retracted posterior capsule.

After the cup is inserted and potentially impinging bone trimmed, the trial or real acetabular liner is inserted with a trial femoral head and neck. The trial neck is reduced into the trial head in situ with a bone hook for traction and maximal muscle relaxation. The head and neck are typically not assembled before reduction because the surrounding soft tissues are so stable that even displacement to allow reduction of a 32-mm head may be difficult or cause disruption of surrounding tissues. An intraoperative radiograph may be taken to confirm proper component size and position as necessary. Trial reduction should produce a hip that cannot be dislocated in any direction without traction. The procedure is specifically designed to include a trial reduction, because assessment of the hip for impingement, tissue tension, and instability are important aspects of total hip arthroplasty.

After satisfactory trial reduction, the trial components are removed, the real acetabular liner and femoral head are inserted, the real femoral component is inserted, and the femoral neck is again reduced into the femoral head in situ as before. The hip joint capsule is closed, the piriformis tendon may be reattached on the trochanteric fossa, and the gluteus minimus and medius return to their native positions when the retractors are removed. The fascia overlying the gluteus maximus is closed before subcuta-

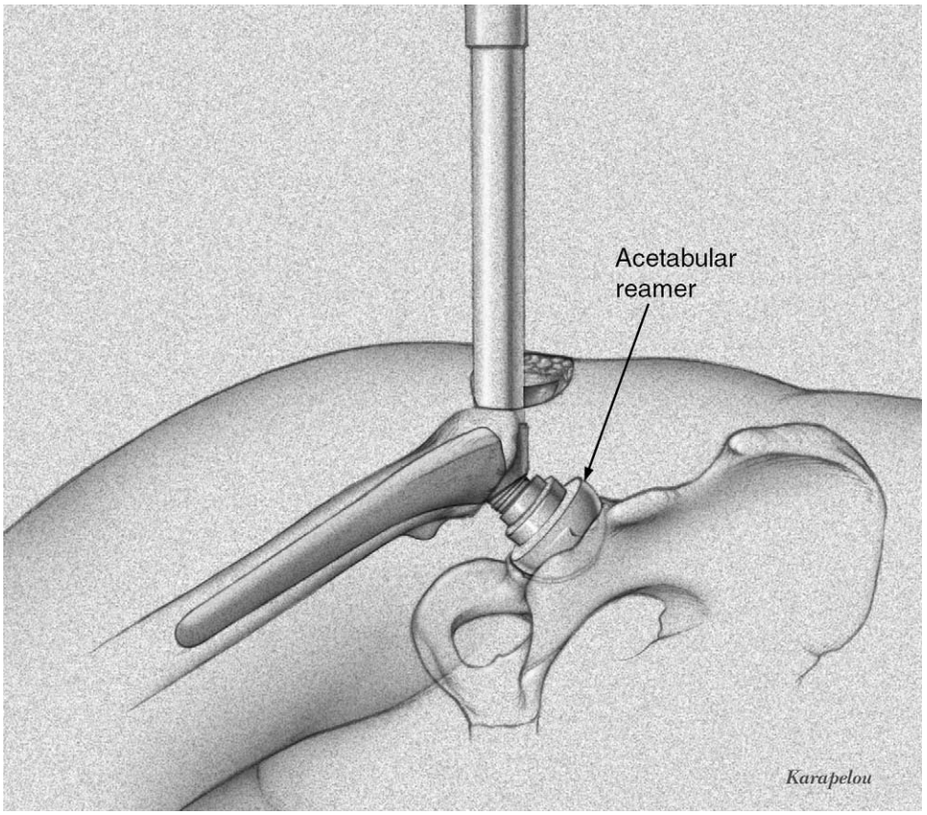

Fig 7. After the femur is prepared, the femoral head is removed to allow preparation of the acetabulum using a 45° angled reamer.

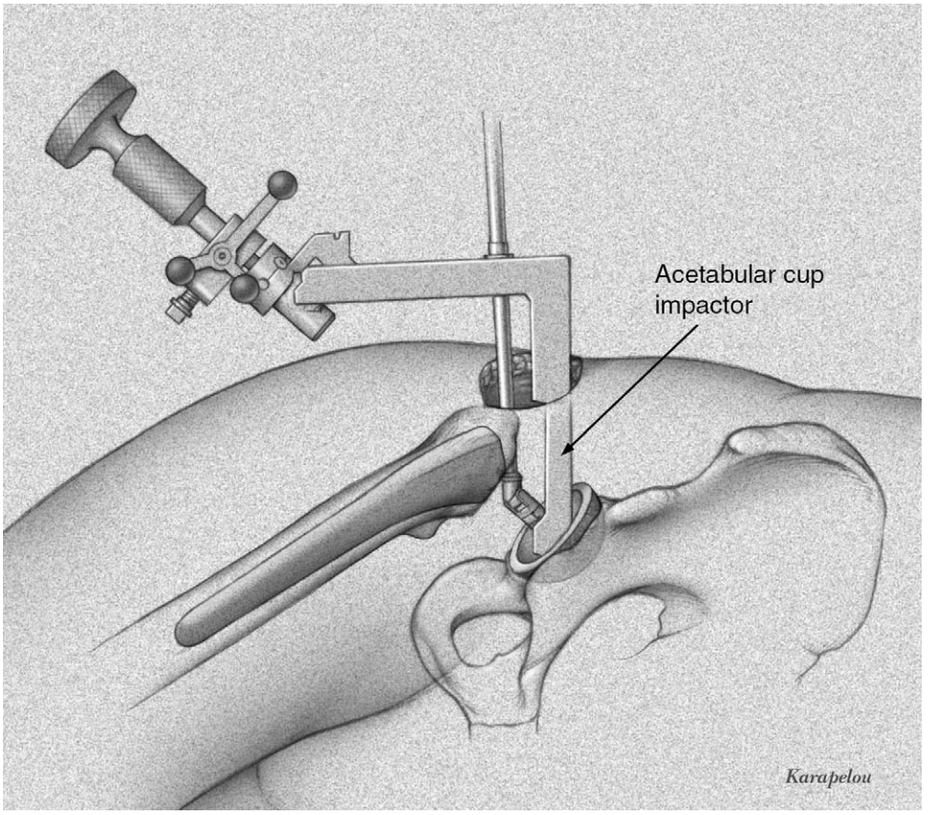

Fig 8. An acetabular impactor with multiple angles is used to allow impaction of the cup in line with the cup axis, while exiting the incision above the greater trochanter.

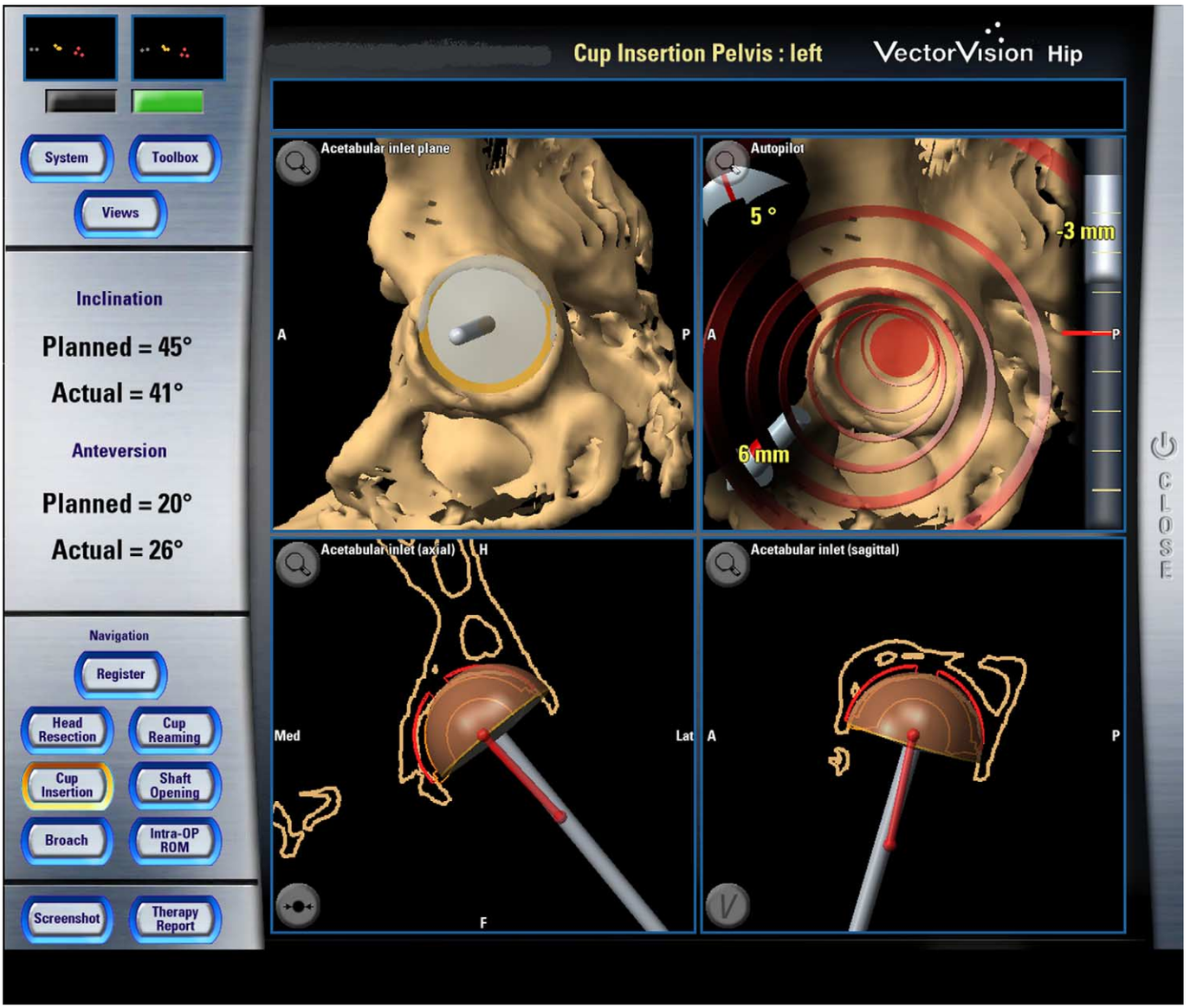

Fig 9. The display of CT-based cup navigation during insertion of the acetabular component. (Color version of figure is available online.)

neous and skin closure (Fig 10). Postoperatively, the patient may progress motion and weight bearing without restriction (Fig 11).

CLINICAL EXPERIENCE AND RESULTS

This technique of tissue-preserving total hip arthroplasty can be performed in 80-95% of primary procedures.[22,23] Experience with 105 total hip arthroplasties performed with the tissue-preserving technique has shown that modestly obese patients can often be managed just as effectively as thinner patients, albeit with a slightly longer cutaneous and fascial incision. Surgical complications in this series included one greater trochanteric fracture fixed intraoperatively, one transverse acetabular fracture during cup impaction, which healed uneventfully, and one acetabular component displaced during a reduction maneuver, which went unrecognized until after surgery, requiring prompt correction. There were no femur fractures or

Fig 10. Photograph of the 7.5-cm incision at 6 weeks following the procedure. The procedure has been performed leaving the abductors and posterior capsule fully intact. (Color version of figure is available online.)

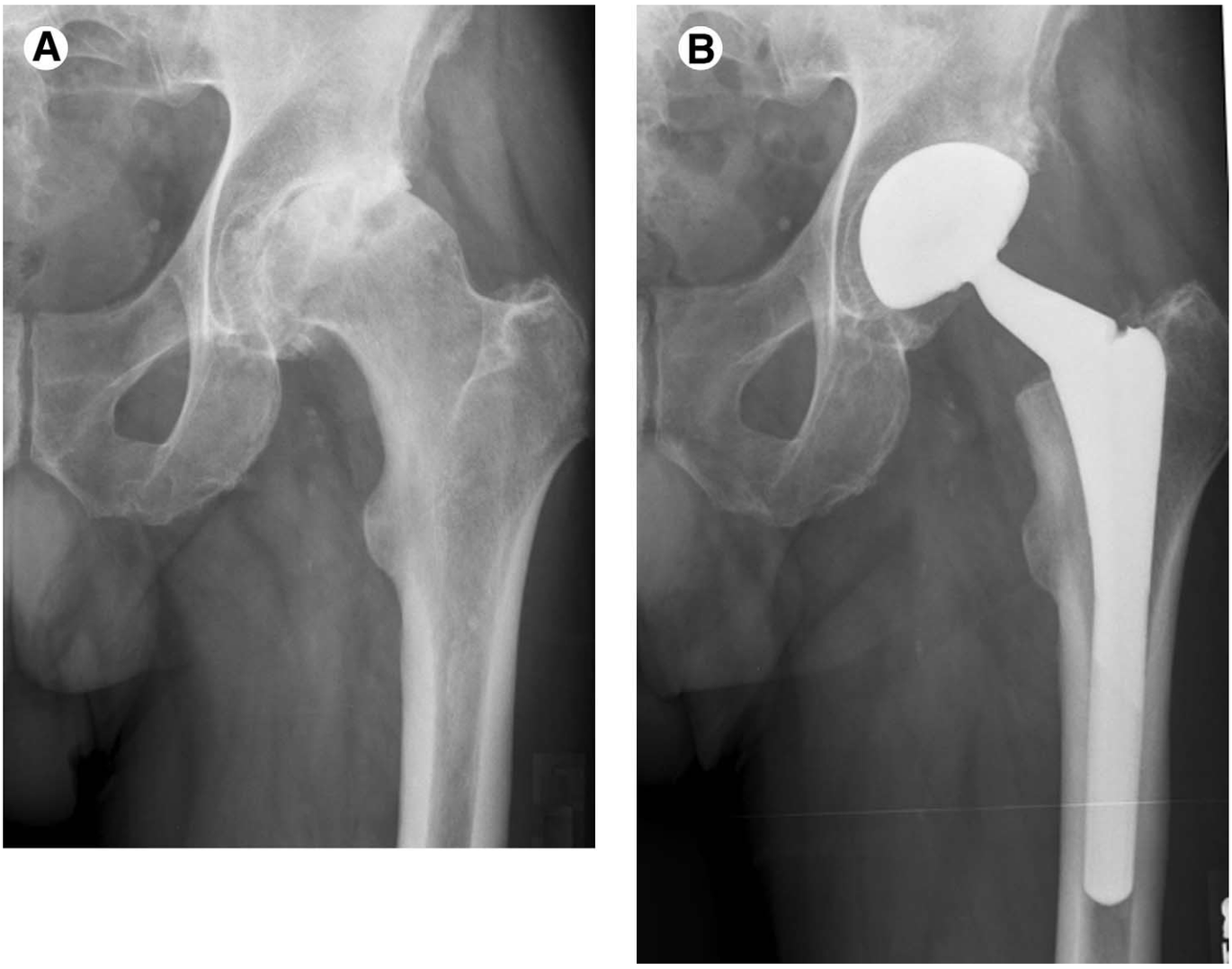

Fig 11. (A) Pre- and (B) postoperative radiographs of an uncemented alumina ceramic-ceramic total hip arthroplasty-performed surgical navigation using the tissue-preserving, minimally-invasive technique described.

dislocations. Of the 105 procedures, the last surgical complication occurred in 47th procedure. In a prospective study of recovery following surgery, the technique has been documented to dramatically accelerate return to normal, unaided walking without increasing perioperative complication rates.[24]

The technique described here was designed to allow rapid transition to the posterior exposure, as necessary. Clinical assessment of patients postoperatively has shown a dramatic acceleration in return to walking without support compared with patients treated by the direct lateral exposure by the same surgeon with the same implants. Although the technique can be used in the vast majority of patients, clinical circumstances that would preclude use of the technique can typically be identified preoperatively. Existing femoral hardware, severe femoral deformities, and morbid obesity are 3 presenting circumstances that would favor a more conventional exposure.

CONCLUSION

Total hip arthroplasty performed though a superior capsulotomy, though technically demanding, preserves the surrounding tissues, allows for unrestricted motion and weight bearing after surgery, and offers the potential for reducing the incidence of both short- and long-term complications compared with conventional total hip arthroplasty techniques. After the initial learning curve, which can be mastered in a bioskills laboratory or by gradual transition from a mini-posterior exposure, it appears that surgical complications may actually be lower than with conventional techniques. Specifically, preservation of the posterior capsule and short external rotators favors this technique over a mini-posterior exposure with capsular incision and attempted repair in terms of postoperative hip joint stability. Preservation and protection of the abductors favors this technique over transgluteal exposures and exposures that attempt to insert the femoral component anterior to the gluteus medius in terms of abductor strength recovery. Preparation of the femoral component with the head left in situ reduces the likelihood of femoral fractures during bone preparation compared with techniques that prepare the femur after femoral head excision. Finally, preserving and protecting the abductors strongly favors this technique over techniques that involve semi-blind, percutaneous insertion of the femoral component,

which risks both femoral fracture and gross abductor injury.

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