

# Tissue-Preserving, Minimally Invasive Total Hip Arthroplasty Using a Superior Capsulotomy

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## Introduction

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Conventional total hip arthroplasty in its many forms has been well established as a reliable procedure with predictable recovery. The high volume of procedures has allowed the incidences of the most common post-operative complications to be determined. Early complications vary widely by surgical approach and method of fixation, but generally include infection, dislocation, abductor morbidity, intra-operative fracture, and, rarely, nerve palsy. Preliminary reports of total hip arthroplasty using minimally invasive techniques have shown a tendency towards higher, rather than lower, complication rates [1, 6, 17, 19, 20]. Reasonable goals for evolving total hip arthroplasty include reducing the incidence of these peri-operative complications while simultaneously accelerating recovery.

The incidences of complications following conventional total hip arthroplasty depend largely on the surgical approach used to perform the procedure.

- THA performed using a posterior exposure may be complicated by post-operative dislocation [10, 18].
- THA performed using a direct lateral exposure may be complicated by incomplete abductor muscle recovery [5, 15].
- THA performed using a trans-trochanteric exposure may be complicated by trochanteric non-union and dislocation [16].
- THA performed using an anterior exposure may be complicated by abductor muscle injury and difficulty instrumenting the femur [6, 8, 9].

The current chapter reviews the rationale, technique, and results of tissue-preserving minimally invasive

THA using a single incision through a superior capsulotomy.

## Rationale and Design of the Surgical Technique

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While at first glance, less invasive techniques might be anticipated to offer only short-term, but no long-term benefits. In fact, the principle of preserving all of the important structures around the hip joint is well founded. The principle of tissue preservation may facilitate early recovery because these methods are also minimally invasive, but the greatest benefit may be in the long term for hip-joint stability, muscle strength, and the more normal state of the soft tissues surrounding the joint at the time of any revision procedure. Further, since dissection of the surrounding soft tissues is minimized, the hip joint remains extremely stable, allowing unrestricted motion post-operatively, with minimal risk of dislocation.

Design of any minimally invasive total hip technique requires decisions regarding patient position, dependence on or independence from imaging and or traction, the ability to perform a trial reduction, and the tissue intervals to be used to avoid releasing important structures.

## Patient Position

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The lateral position was chosen for this procedure for several reasons. In the lateral position, gravity facilitates separation of the subcutaneous tissue layers and the posterior borders of the gluteus medius and medius are easily visualized. Since the lateral position is the most

common position used to perform THA in the United States, the position is familiar to many surgeons, affording an opportunity to transition from familiar, conventional techniques to a more tissue-preserving technique. This also allows the rapid transition from a minimally invasive technique to a conventional technique if any aspect of the surgery cannot be adequately managed through a more limited tissue interval.

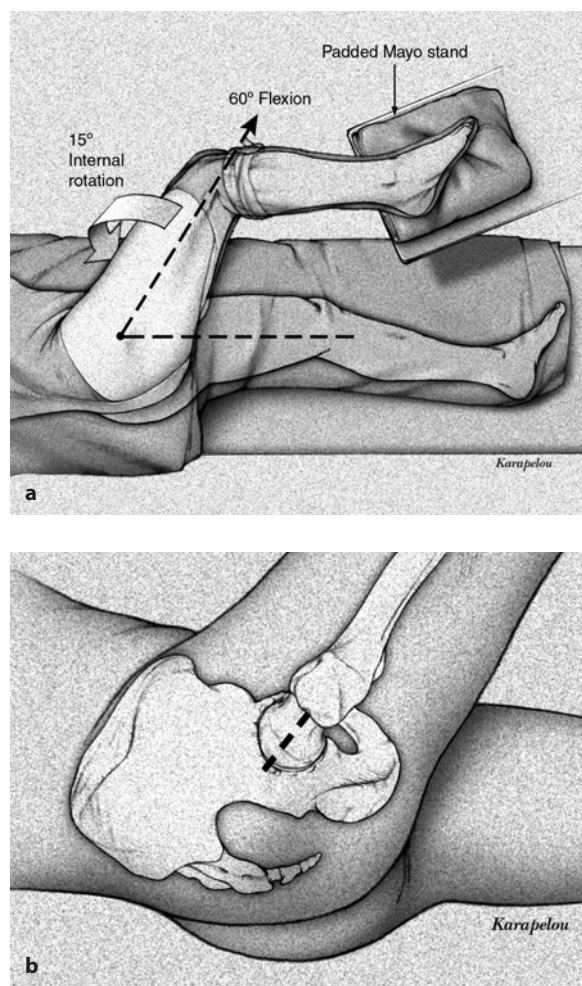
### Tissue Intervals

Minimizing abductor morbidity is essential for rapid recovery of muscle strength following surgery. Similarly, avoiding release of the posterior capsule and short external rotators is essential to allow full, unrestricted motion following surgery. Any successful minimally invasive technique must be performed without disturbing these structures. Minimizing abductor morbidity requires that components be inserted either posterior or anterior/inferior to the gluteus medius and minimus. Splitting of the abductors for insertion of the femoral component cannot be performed because of the adverse affect on abductor recovery. Similarly, allowing unrestricted motion after surgery dictates that the posterior capsulotomy and short rotators cannot be incised [18, 21]. Further, posterior displacement of the femoral head out of the acetabulum requires partial disruption of the posterior capsule and short external rotators, even if they are not incised surgically. This means that the femoral head must be excised without dislocation or dislocated anteriorly to prevent injury to the posterior structures.

Anterior exposures such as the Watson–Jones and the Smith–Petersen exposures provide excellent visualization of the acetabulum but poor exposure of the femur. Performing the entire procedure, including femoral component insertion, through one of these exposures requires either some release of the anterior gluteus medius and minimus or skeletal traction. The use of skeletal traction during surgery has the great disadvantage that the performance of a trial reduction is either extremely difficult or not possible at all. Assessment of the reconstructed hip for stability, soft-tissue tension, and prosthetic impingement is a critical aspect of performing total hip arthroplasty, especially when hard bearings are used. As a result, this procedure was designed to be performed without the use of skeletal traction and to allow trial reduction for proper assessment of the joint.

### 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). A 6–8 cm incision is made starting at the tip of the greater trochanter and extending proximally (■ Fig. 7.74). The skin incision can be longer in heavier patients as necessary. The gluteus maximus fibers are bluntly separated in line with their course to reveal the thin bursa tissue overlying the gluteus medius. The posterior border of the gluteus medius



■ Fig. 7.74. 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 anteversion)

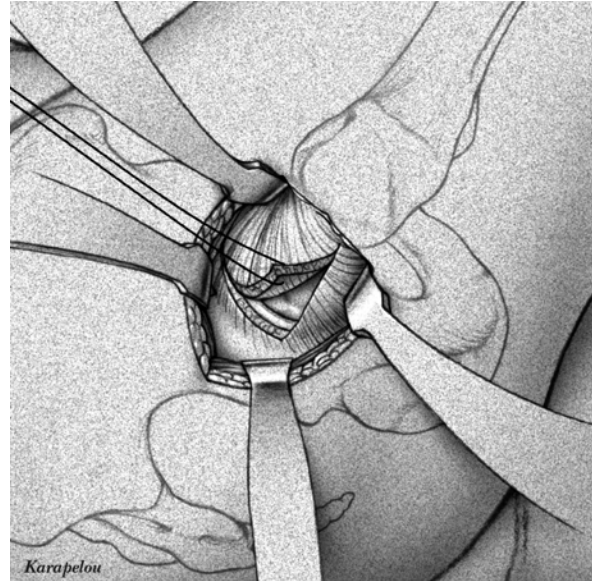
is mobilized anteriorly to reveal the piriformis tendon. The anterior border of the piriformis tendon is developed to reflect the piriformis posteriorly. The insertion of the piriformis can be released and repaired as necessary since most uncemented femoral components require removal of the bone that the piriformis tendon inserts upon. A blunt Hohmann retractor is placed in between the short external rotators and posterior capsule. The posterior border of the gluteus minimus muscle is developed and the minimus is mobilized anteriorly, taking care to fully develop the interval between the minimus tendon insertion and the anterior capsule. A blunt Hohmann retractor is placed around the anterior femoral neck in between the minimus and capsule. A spiked Hohmann retractor is placed into the anterior ilium to protect the medius and minimus. A second spiked Hohmann retractor is placed into the posterior/superior ilium. These four retractors allow complete exposure of the superior capsule and are levered to form four corners of a rectangle to maintain exposure throughout the procedure (■ Fig. 7.75).

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 by creating two incisions in the anterior capsule; one along the acetabular rim, and one along the anterior femoral neck, deep to the minimus tendon insertion. The two blunt Hohmann retractors are then switched from being extracapsular to intracapsular, around the femoral neck anteriorly and posteriorly (■ Fig. 7.76).

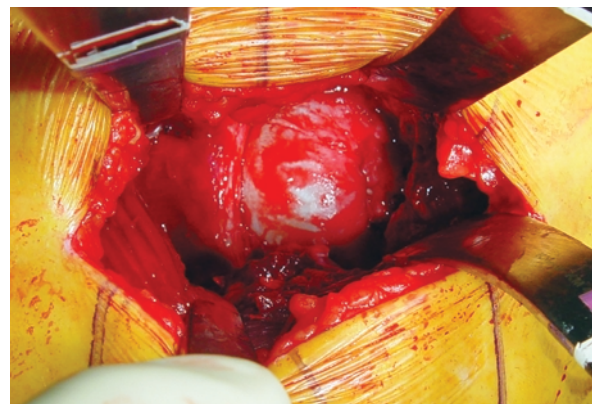
With the trochanteric fossa fully exposed and the surrounding tissues protected, a reamer is placed through the superior part of the femoral neck into the medullary canal. A tapered metaphyseal miller is used to expand the proximal opening, ensuring that subsequent reamers pass in line with the femoral 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 head and neck are left in situ during this part of the procedure because the head provides stability to the femur during broaching, the neck provides a fulcrum for leverage retractors, and it also provides reinforcement to the calcar region to reduce the likelihood of femoral fractures during femoral preparation (■ Fig. 7.77). The femoral broach is left in place.

Once the femur is fully prepared, a pelvic reference frame is percutaneously affixed to the pelvis if surgical

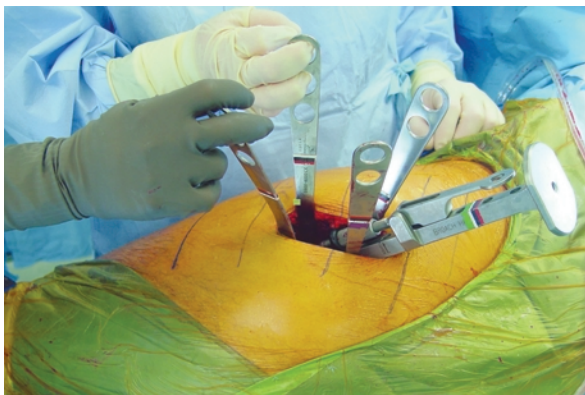
navigation of the pelvis is to be performed [2–4, 7, 11–14]. A pre-reconstruction leg-length measurement is made. If fluoroscopic navigation is to be used for acetabular component insertion, fluoroscopic images may be



■ Fig. 7.75. The superior capsulotomy, leaving the posterior capsule intact



■ Fig. 7.76. Exposure of a right hip through a superior capsulotomy. The femoral head and labrum are seen in the center of the photograph. The blunt Hohmann in the upper left is inside the anterior capsule, around the femoral neck. The spiked Hohmann in the upper right is in the ilium, underneath the minimus and medius. The spiked Hohmann in the lower right is inside the ilium above the posterior-superior portion of the acetabulum. The blunt Hohmann in the lower left is inside the posterior capsule, around the femoral neck. The entire THA procedure can be performed through this exposure

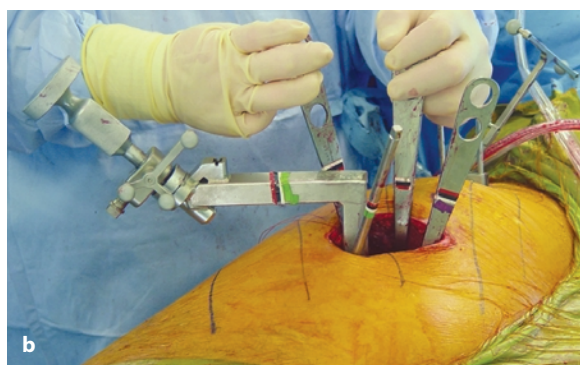
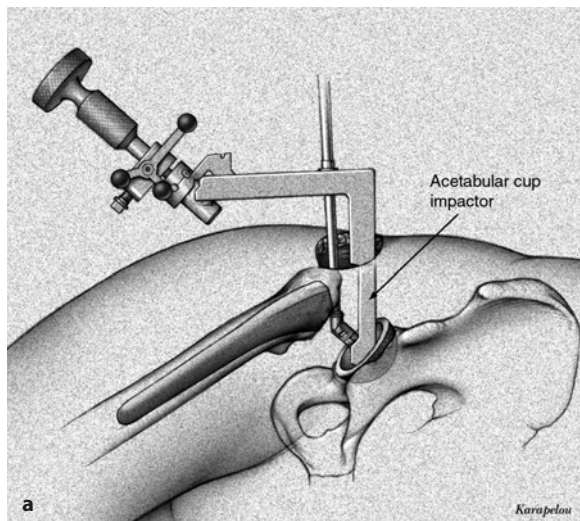


**Fig. 7.77.** Femoral broach fully inserted through the exposure. The femur is fully prepared through the top of the femoral neck, prior to removal of the femoral head so long as the hip adducts sufficiently to allow this. The femoral head is left in place to stabilize the femur during preparation and to allow leverage retractors (blunt Hohmanns) to facilitate exposure

acquired at this point. The femoral neck is then transected, using the blunt Hohmann 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 CT-based navigation is being used, data points on the pelvis and acetabulum are now acquired, to achieve pelvic registration, after excision of the femoral head and prior to acetabular reaming.

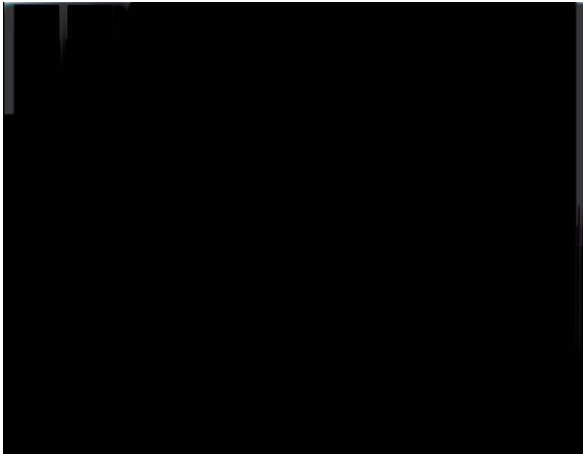
The blunt Hohmann retractors are now placed around the acetabulum anteriorly and also posteriorly in the lesser sciatic notch. The entire acetabulum can be seen and remnants of the labrum are excised. A very low profile, 45-degree-angled reamer is then used to prepare the acetabulum. A z-shaped acetabular impactor is used to insert the acetabular component (**Fig. 7.78**). If surgical navigation is employed, the cup is generally inserted with a goal of 41° of abduction and 25° of anteversion (**Fig. 7.79**). While acetabular screws are rarely used for fixation, they may be inserted by passing the instruments from posterior, just above the edge of the retracted posterior capsule. Alternatively, screws may be inserted percutaneously through the Watson–Jones interval, using standard hip-arthroscopy cannulas and straight screw-insertion instruments.

After the cup is inserted, potentially impinging bone is trimmed, the trial or real acetabular liner is inserted,



**Fig. 7.78.** **a** Acetabular insertion device with a reference frame for surgical navigation. The impactor turns 45° from the cup plane to allow the instrument to exit the incision. Adding a 90°- and a second 45° angle allows the cup-insertion handle to be oriented in line with the cup. **b** Navigated acetabular impactor during cup insertion. The cup impactor is designed with two 45°- and one 90° angle to allow the cup impactor to exit the incision above the greater trochanter while still allowing impaction of the cup in line with the cup axis. (Acetabular cup impactor courtesy of Wright Medical Technology, Memphis, TN)

a trial femoral head is inserted, a trial neck is affixed to the broach and reduced into the trial head in situ using a bone hook for traction and maximal muscle relaxation. The head and neck are not generally 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 intra-operative radiograph



■ Fig. 7.79. Display of CT-based cup navigation during insertion of the acetabular component



■ Fig. 7.80. 7.5 cm incision at the completion of the procedure. The procedure has been performed leaving the abductors and posterior capsule fully intact



■ Fig. 7.81a,b. Pre- and post-operative radiographs of an uncemented alumina ceramic-ceramic total hip arthroplasty performed surgical navigation using the tissue-preserving, minimally-invasive technique described

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.

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 repaired with transosseous suture. The gluteus minimus and medius return to their native positions when the retractors are removed. The fascia overlying the gluteus maximus is closed prior to subcutaneous and skin closure (■ Fig. 7.80). Post-operatively, the patient may progress motion and weight-bearing without restriction (■ Fig. 7.81).

## Clinical Experience and Results

This technique of tissue-preserving total hip arthroplasty can be performed in approximately 95% of primary procedures [14]. Modestly obese patients can often be managed just as effectively as thinner patients although with a slightly longer cutaneous and fascial incision may facilitate exposure. Clinical circumstances that may preclude use of the technique include hips with existing femoral hardware, severe deformities of the femur, and morbid obesity. Clinical assessment of patients postoperatively has shown a dramatic acceleration in return to walking without support as compared to patients treated by the direct lateral exposure by the same surgeon using the same implants. In the first 85 procedures, the two surgical complications were a greater trochanteric fracture repaired intraoperatively and an unrecognized displacement of an acetabular cup during stem insertion requiring prompt cup revision. These complications occurred in procedures #12 and 18 respectively, with no surgical complications in procedures #49 to 85. 48 of the last 50 primary hips performed were performed using this exposure. Of the two that were performed with conventional techniques, one patient had Paget's disease and the other had protrusio. None of the hips have dislocated, despite being allowed to regain motion without restriction. There have been no calcar or femoral shaft fractures.

## Risks, Benefits and Conversion to a Conventional Exposure

Total hip arthroplasty through a superior capsulotomy is an approach that is nearly the opposite of anteriorly based exposures. Using a superior capsulotomy, the femoral instruments can be straight, while the acetabular instruments must be angled. This makes fixing an acetabular component with screws and direct visualization of superolateral screw holes more difficult. Also, since the femur is prepared with the femoral head in place, this technique is more difficult in patients whose hips cannot adduct into the position of sleep. More deformed and contracted hips can be managed by performing an osteotomy of the femoral neck early in the procedure and levering the leg into proper position. Alternatively, the femoral head can be excised prior to femoral preparation.

Reduction of the trail and real components can also be challenging since the tissues surrounding the hip are largely intact and limit displacement of the femur. Complete muscle relaxation at the time of implant assembly is very helpful.

With the patient in a lateral position and the exposure performed posterior to the gluteus minimus, the mini-posterior exposure is the most logical exposure to expand the procedure into if any factors cannot be controlled with the more limited exposure.

There are many benefits to the technique over conventional exposures and anteriorly based minimally invasive techniques. First, anteriorly based exposures must adversely affect the abductors whether the femoral component is placed anterior and inferior to the medius and minimus, or if a second exposure is used to blindly insert the femoral component through or behind the abductors. Second, the entire procedure can be performed through a single, short incision while preserving the abductors, posterior capsule, and short rotators. Since the femur is prepared prior to femoral head excision, the neck and head reinforce the calcar region, reducing the risk of femur fracture, a common complication of minimally invasive techniques. Finally, since the hip is so stable, the risk of hip dislocation appears to be minimized, even without placing any restriction on hip motion post-operatively.

In summary, experience with total hip arthroplasty through a superior capsulotomy demonstrates that the technique combines the rapid abductor recovery of posterior exposures, the hip-joint stability of the direct lateral exposure, and leaves the patient in position for more extensile exposures as necessary.

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