Anterior Approach Total Hip Arthroplasty with an Orthopedic Table

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Navid M. Ziran and Joel M. Matta

Contents

Key Learning Points

- AA THA is a tissue-sparing procedure with minimal deep soft-tissue dissection and no compromise to the abductor mechanism.
- The use of a special orthopedic table, such as the hana® table, can facilitate both patient setup and exposure for AA THA but is not necessary.
- Femoral exposure is frequently the most technically challenging component of the AA THA procedure and is aided by the orthopedic table.
- Quantitative fluoroscopic guidance provides the surgeon with an anatomic means of implant positioning due to (1) precise determination of acetabular component anteversion/inclination and (2) precise matching of limb length and offset to the contralateral extremity. This fluoroscopic guidance is also aided by the orthopedic table.

Introduction

The AA for THA has grown steadily and rapidly over the past 10 years. In 2003 less than 1 % of US surgeons utilized AA for THA, while a survey at the AAHKS 2012 meeting indicated 19 % of surgeon attendees utilizing AA. The past 3 years have demonstrated strong surgeon interest in this technique with over 800 surgeons per year receiving training at AAOS, ICJR, or industry-sponsored venues on primary and revision AA

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(Numbers provided by ICJR, Depuy Synthes, Mizuho OSI.) [1].

AA follows the Hueter approach also known as the "short Smith-Petersen." The AA was originally described and performed for hip replacement by Robert Judet in Paris in 1947. Judet operated with the patient supine on a special orthopedic table [2]. To date over 20,000 AA THAs have been performed in Judet's department. In the United States, K. Keggi (Waterbury, CT) has performed a modified tensor fascia splitting AA supine on a standard operating table beginning in about 1975 [3]. The senior author began a tensor-sparing AA in 1996 utilizing Judet's orthopedic table – which was then out of production. Beginning in 2003, however, a new and useful orthopedic table became available which the senior author adopted [4] and which also facilitated a US course for surgeons that year.

The senior author began AA to avoid the potential problems of existing approaches: dislocation with posterior approach and abductor weakness with anterolateral approach. AA avoids these potential issues by preserving the abductors, short rotator tendons, and the posterior capsule [4–7].

The primary purpose of the orthopedic table is to enhance access to the femur with a secondary benefit of improved acetabular exposure [4, 5, 8]. The orthopedic table can also facilitate stable hip and pelvis position during intraoperative image intensification [9–14].

Today, most AA surgeries are performed with an orthopedic table or leg positioning device [1, 2, 5–7, 9, 13] though many are also performed on a standard operating room (OR) table [15–18]. Supine position and a radiolucent table, used by most AA surgeons, afford the advantage of rapid and accurate information from image intensification regarding cup position, leg length, and offset [8, 11, 13, 14, 17]. However, AA THA can be performed without intraoperative image intensification as easily as other approaches for THA [8, 18, 19].

A growing number of references support the safety and efficacy of AA when performed by experienced surgeons; however, a surgeon may experience increased complication rates during the learning phase (up to 100 cases) [6, 15, 20]. Documented benefits for experienced surgeons include: low dislocation rate [4–6, 8, 9, 20], improved rate of accurate cup position [9–12, 14], earlier functional recovery [11–13, 16, 17], decreased length of hospital stay [11, 19, 21], and low rates of fracture, infection, and nerve palsy [7, 9–11, 13, 16–18]. All references, however, do not agree entirely with these findings [15, 20, 22].

The beneficial evolution in surgical techniques is driven by several factors including clinical studies, individual surgeon preferences, patient preferences, and cost benefits. Whether or not AA is an improved method for THA over the already-proven methods of anterolateral and posterior approaches remains controversial. The past 10 years of AA growth, however, have shown AA, at a minimum, to be among the good choices for both surgeons and patients. A surgeon should take advantage of available education and training prior to starting AA.

In this chapter, the authors present AA THA as performed by the senior author starting in 1996 and undergoing refinements up to the present day. As in most surgical techniques, the "devil is in the details," and it is the authors' wishes that these details, along with the AA THA technique as a whole, are both conveyed to the reader.

Equipment

- AA THA can be performed on a standard operating room table but is facilitated with the use of a special orthopedic table. The hana® table provides control over lower extremity positioning, and the femoral hook provides improved femoral exposure. Both of these attributes facilitate the procedure by allowing the surgeon to focus on the other technical aspects of the procedure. One surgical assistant is necessary when using this technique.
- Special retractors designed for AA THA also greatly facilitate the procedure. These retractors are sometimes provided by the manufacturers of the implants. Special attention should be given to the retractor placed behind the greater trochanter; this retractor should not

interfere with the broach handle during femoral component broaching.
- Preoperative templating should be performed on either hard copy or digital radiographs of the hip.
- Prior to the case, the surgeon should also communicate with his/her implant representative and confirm satisfactory inventory of all the components (i.e., both standard and high offset stems). Both authors also have the following instruments/systems available: (1) a flexible reaming set to ream the femoral canal, (2) cerclage cables and a plating system to repair iatrogenic femur fractures, and (3) a larger anterior-posterior width femoral component (i.e., Depuy Summit® Stem) in patients with large metaphyseal canals with less cancellous bone.
- A C-arm fluoroscope is not necessary but provides more precise implantation of the acetabular and femoral components based on visual cues and hard film overlay.
- Lastly, fluoroscopy coupled to Radlink Galileo Positioning System (GPS)™ (Gardena, CA), a touch screen imaging hardware/software system, provides more quantitative data to the surgeon during implant placement.

Technique

Positioning and Draping

The patient is brought to the operating room and anesthesia is administered on the gurney. Either general or regional anesthesia can be administered, although the authors prefer general anesthesia with paralysis since it offers more consistent muscle relaxation. The patient is then transferred supine to the hana® table (OSI, Union City, CA). A padded perineal post is placed and the patient is slid down against the post. The arms are placed at 70–80° of abduction with padding placed under bony prominences and no pressure on the ulnar nerve. The patient's feet are placed in padded liners and then inserted into the hana® table boots. The boots are attached to the table spars and locked into position. The table spars should be flexed approximately 5–10°. The legs should be internally rotated approximately 15° in order to maximize the radiographic appearance of neck offset and visualize the "bulge" of the tensor muscle for the approach. The gross traction should be locked on both sides. Hair should be clipped from the mid-thigh, groin, and abdomen. The abdomen (approximately up to the xiphoid) and hip should be prepped and draped to the mid-thigh. The authors prefer to use ChloraPrep® solution. Patient positioning is shown in Fig. 1.

In addition to the anesthesiologist, the operative team consists of the surgeon, his/her assistant, the scrub technician, the circulating nurse/table operator, and the x-ray technician. The circulating nurse, and operating room team in general, should be properly educated on the correct operation of the orthopedic table and/or the Radlink GPS™ system.

Surgical Exposure

The landmarks of the AA are the anterior superior iliac spine (ASIS) and the top of the greater trochanter. The incision begins approximately 1 cm distal and 3 cm lateral to the ASIS directed obliquely distal and posterior towards the anterior border of the femur. If the patient is thin, the bulge of the TFL can be visualized, especially with the leg in slight internal rotation. The incision is ideally located at the junction of the posterior 1/3 and anterior 2/3 portion of the TFL (Fig. 2). Sharp dissection is performed down to the fascia of the TFL. The subcutaneous tissue can be gently finger dissected proximally and distally, but not anteriorly or posteriorly; too much subcutaneous dissection can create dead space for a potential fluid collection. A skin Protractor® (Gyrus ACMI, Scarborough, Massachusetts) can be used at this point, if desired. There are several anatomic clues to ensure that the surgeon is over the TFL. First, the fascia over the TFL is more translucent than the iliotibial band, which is located posteriorly. Next, there is frequently a small fascial perforating vessel directly over the TFL that needs to be coagulated.

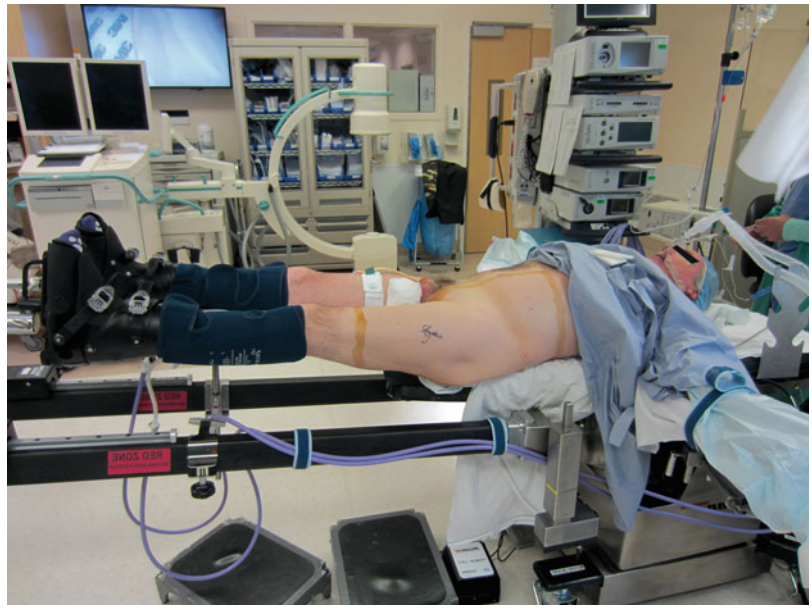

Fig. 1 The patient is positioned supine on the orthopedic table. A perineal post is placed and both lower extremities are affixed to the spars. The lower extremities are internally rotated slightly and the hips are flexed approximately 5–10°

Fig. 2 The incision for AA THA: the landmarks are the anterior superior iliac spine (*ASIS*) and the greater trochanter. The proximal extent of the incision is started 3 cm lateral and 1 cm distal to the ASIS and directed obliquely over the bulge of the tensor towards the proximal femur

The fibers of the TFL should be parallel to the skin incision as shown in Fig. 3.

The tensor fascia is then sharply incised in line with the skin incision and extended slightly proximal and distal to the skin incision. An Allis clamp is placed over the anterior aspect of the fascia, and the TFL muscle is gently finger dissected medially, both proximally and distally, as shown in Fig. 4. There is a definite plane medially, as the TFL is contained in a fascial "pillow." At this point, the anterior inferior iliac spine (AIIS) can be digitally palpated. The lateral femoral neck is distal and directly posterior to the AIIS. In hips with significant arthritis/wear or short femoral necks, the position of the lateral femoral neck may be different (i.e., more proximal). At this point, a Cobra retractor is placed in this "pocket" lateral to the femoral neck and medial to the tensor and the gluteus minimus (Fig. 5). The assistants should avoid placing too much pressure on the tensor muscle during retraction to prevent injury. There should be no muscle located medial to the retractor once it is placed. Sometimes, a small portion of the gluteus minimus is located medial to the Cobra. If this occurs, the retractor should be replaced medial to the gluteus minimus.

Next, the reflected head of the rectus femoris is identified along the anterior neck capsule. A sharp Hohmann retractor is then placed with its tip on the femoral neck and "slid" under the rectus femoris onto the anteromedial neck. The anterior neck capsule is now exposed. A Hibbs retractor is placed on the distal aspect of the tensor muscle retracting it laterally to expose the lateral femoral circumflex vessels. Figure 6 shows the Cobra around the lateral neck, the Hohmann around the medial neck, and the Hibbs retractor gently

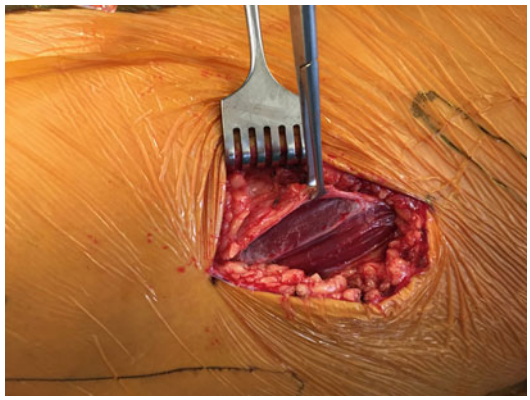

Fig. 3 After the skin incision, the fascia over the tensor muscle is exposed. The fascia is typically translucent with an accompanying vein piercing the fascia. The iliotibial band (*ITB*) is posterior and typically thicker than the tensor fascia

Fig. 4 After the tensor fascia is incised, the tensor muscle is bluntly dissected off the fascia medially, both superiorly and inferiorly

retracting the distal tensor to expose the lateral femoral circumflex vessels.

There may be two "leashes" of the lateral femoral circumflex bundle, one proximally and one distally. These leashes can be coagulated or suture ligated. Figure 7 demonstrates transection of the coagulated lateral femoral circumflex vessels. The fascia over the vastus lateralis is then released using Mayo scissors – this frees up the vastus lateralis and more, importantly, helps to mobilize the TFL muscle. Meticulous and efficient initial exposure is key to the rest of the procedure. The initial AA approach exposure takes approximately 5–10 min.

After the initial exposure, an L-capsulotomy is performed of the anterior neck capsule using a cautery knife. Proximally, the cut is made lateral to the AIIS. Distally, the surgeon can palpate the anterior tubercle of the vastus intermedius origin on the greater trochanter – the cut should be aimed towards the lateral aspect of this protuberance. The cut should then proceed inferomedially along the vastus ridge, proximal to the vastus intermedius muscle. The anterior and lateral capsule limbs are then tagged with #1 Vicryl® suture. A Cobra retractor replaces the Hohmann retractor along the medial neck on the inside of the capsule. The Cobra on the lateral neck capsule is placed inside the capsule. The hip joint should now be exposed (Fig. 8).

Femoral Head Dislocation

A small Hohmann is placed under the anterior capsule along the anterior acetabular rim to expose osteophytes and/or ossified labrum. These ossifications are removed using a 0.5″ straight osteotome. Three turns of traction are applied to the extremity and should open up the joint. If the joint does not open, ensure that the foot is properly placed in the boot, and the contralateral lower extremity gross traction is locked. A skid is then placed first superior to the head (Fig. 9a, b) and then medial to the head. During medial placement, the skid should be placed "around" the head into the medial joint.

A corkscrew is then advanced into the center of the femoral head – during initial insertion, the corkscrew can be angled, but its final position should be perpendicular to the floor (Fig. 10). This angle is important so that when the head is dislocated and the corkscrew handle is externally rotated, it does not damage the tensor muscle. The rotation is unlocked and the leg can be externally rotated about 25°. Dislocation is performed by pushing the head out with the skid and pulling the head "up and out" with the corkscrew (Fig. 11a–d). It is important to pull the head "up and out" in one maneuver. The authors find that general anesthesia facilitates head dislocation compared to spinal anesthesia. If the head does not come out, a 0.75″ curved

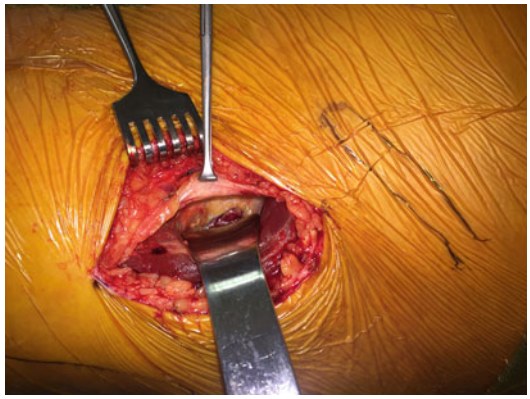

Fig. 5 A Cobra retractor is placed lateral to the femoral neck. The retractor is placed distal and lateral to the AIIS. If muscle is identified medial to the retractor, it is typically the gluteus minimus

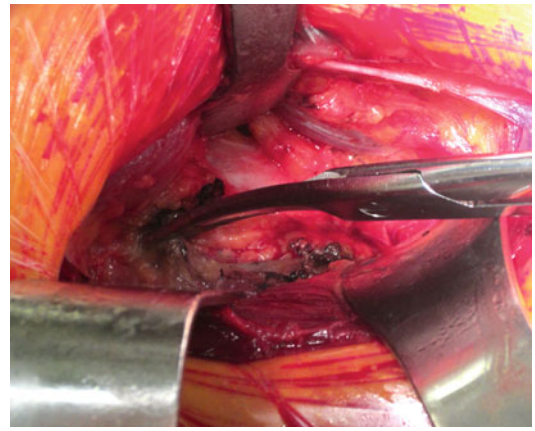

Fig. 7 The lateral femoral circumflex vessels are clamped and cauterized or ligated. There is sometimes a distal leash of these vessels that also needs to be cauterized

Fig. 6 A Hohmann retractor is placed posterior to the rectus femoris around the medial femoral neck. A Hibbs retractor is placed distal to the Cobra and retracts the tensor in order to visualize the lateral femoral circumflex vessels

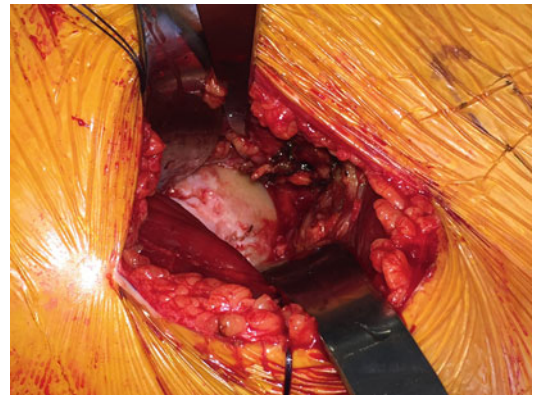

Fig. 8 The joint is exposed after an L-capsulotomy

osteotome can be used to cut the ligamentum teres. Head dislocation can be difficult. Particular attention should be placed on placement of the corkscrew in the center of the head, muscle relaxation, and utilizing proper technique to pull the head out ("up and out" vs. pure external rotation). Another option is to first cut the neck in situ without dislocation and then remove the head. It is the authors' preference, however, to dislocate and relocate prior to the neck cut because this enhances femoral mobility and later femoral exposure.

Neck Osteotomy and Femoral Head Extraction

After dislocation the leg is externally rotated approximately 90°. A small Hohmann is placed along the inferomedial neck anterior to the neck capsule and deep to the vastus lateralis and intermedius. The remaining inferomedial neck capsule attachment is taken off the bone with

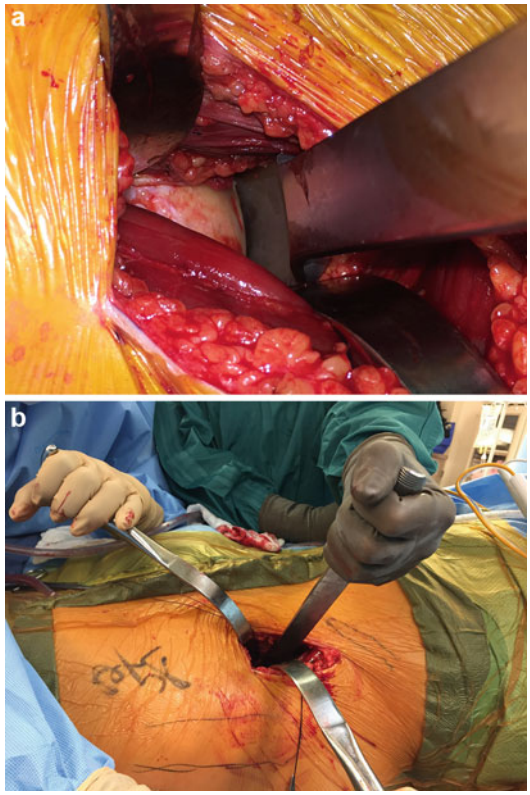

Fig. 9 (**a**) After approximately three turns of traction, a skid is placed in the superior joint space and levered to separate the head and acetabular roof. In (**b**), the skid is placed around the medial aspect of the femoral head into the acetabulum

cautery (Fig. 12). The lesser trochanter should be palpable or visible afterwards. The hip joint is then reduced with internal rotation. Two Cobras, placed lateral and medial to the femoral neck, should be replaced along with a Hibbs retractor. The transverse portion of the femoral neck cut is then performed based on the template (Fig. 13). The saw should be aimed slightly posteromedial to avoid injury to the greater trochanter. The senior author prefers to make the neck cut longer rather than shorter, since it can be planed down if necessary. The longitudinal aspect of the neck cut (through the "saddle") is completed with a 0.5″ straight osteotome. After the cut, the head is rotated out while leaving the posterior Cobra in place to protect the TFL (Fig. 14).

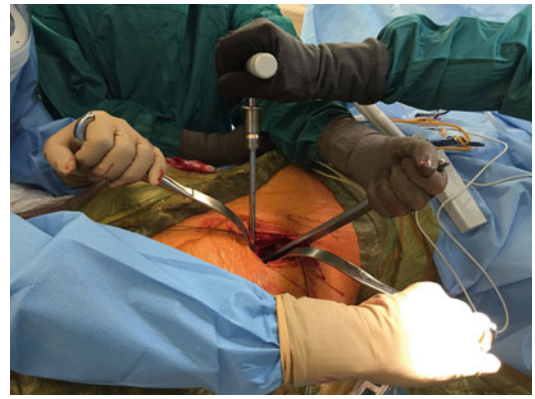

Fig. 10 The corkscrew is drilled into the femoral head so it is perpendicular to the floor

Acetabular Exposure and Reaming

To expose the acetabulum, two retractors are utilized – one anterior and one posterior. The anterior retractor is a Hohmann with a 90° bend in the handle and is placed with the tip over the distal one half of the anterior rim and distal to the pectineal eminence. A Cobra retractor is placed along the posterior rim of the acetabulum. The posterior retractor is placed inside the posterior capsule outside the labrum. The labrum, along with any osteophytes, is then removed. The inferior capsule is longitudinally incised. Reaming is started with a 42 mm reamer in nearly all cases. The reamer is directed medial rather than proximal and slightly anterior to posterior with the handle above the horizontal 10–15°. The reamer is typically not directed in the direction of later cup insertion but rather more transverse. Medial osteophytes should be excised with the initial reamer. Sequential reaming is performed until within 1–2 mm of the templated cup size.

Before reaming to the final template size, fluoroscopy is used to: (1) ensure the surgeon has reamed medially enough, (2) check the proximal-distal position of the reamer and eventual cup position, and (3) estimate the eventual cup size based on the reamer position. The pelvis should first be checked to ensure it is level.

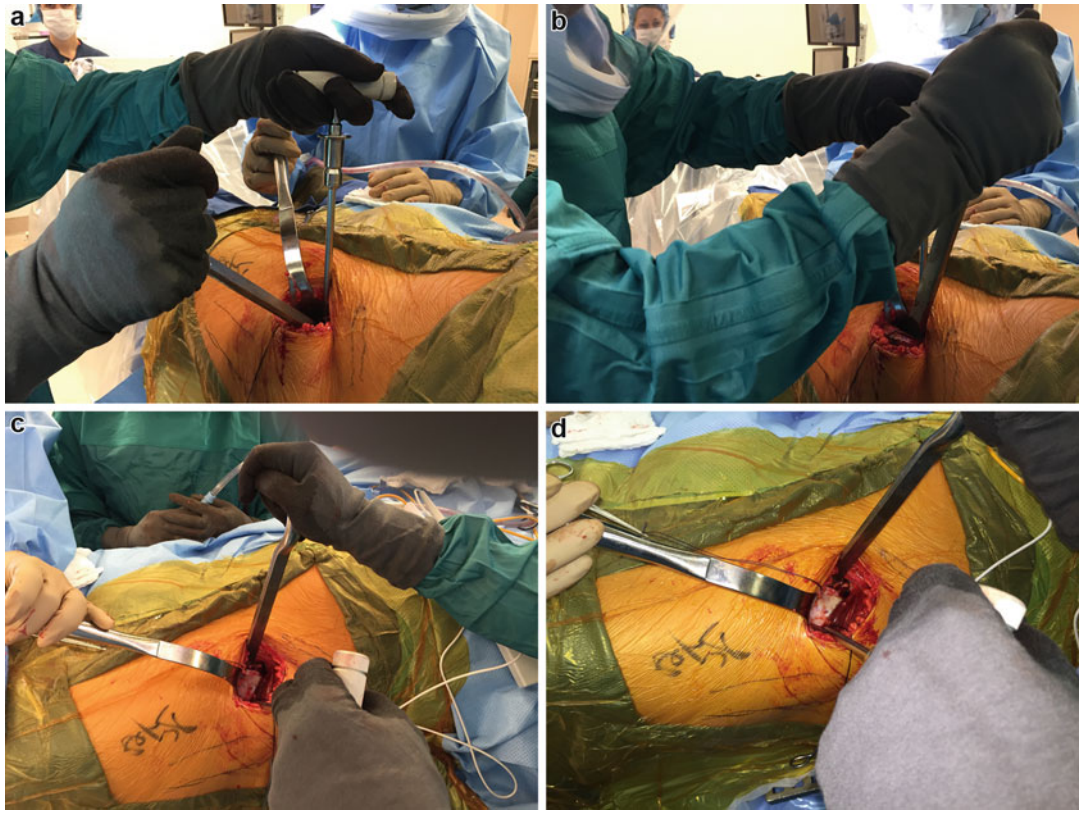

Fig. 11 Femoral head dislocation is performed by pulling the head "up and out" rather than pure external rotation (**a**–**d**). The skid is used as counter-leverage to "push" the head out during this maneuver. The anterior wall is not at risk for fracture, and the surgeon should ensure that the rotation is unlocked

The image should be centered over the pelvis, and the following markers can be used to ensure a level pelvis: (1) the coccyx should point towards the pubic symphysis, (2) the obturator foramina should appear identical (height/shape), and (3) the location of the ilioischial lines relative to the teardrop should be the same. The table is tilted to the right or left until these landmarks are matched (Fig. 15). The C-arm image should also be rotated until the pelvis appears level (the transverse anatomic line is horizontal). The fluoroscope is then centered over the acetabulum to avoid parallax, and the reamer position is checked (Fig. 16a).

Once the surgeon is satisfied with the reamer size, torque feedback, and appearance on fluoroscopy, the actual cup is placed. The Radlink GPS™ software is utilized to ensure accurate cup placement. Prior to placing the acetabular component, the desired values for acetabular inclination and version are entered on the Radlink GPS™ surgeon checklist computer program (Fig. 16b); the senior author prefers to place the cup in 40–45° of inclination and 20–25° of anteversion. Next, a reference line is established from the apex of the teardrop and tangential to the pelvic brim. This reference line eliminates potential for errors with measurements of inclination due to slight variations in image rotation. The visualized ellipse is then placed over the fluoroscopic image of the cup (Fig. 16c, d). The surgeon can make subtle adjustments to the inclination and anteversion to match the radiographic image of the rim of the cup to the digital ellipse.

For surgeons new to the AA, it is common to place the cup with too much inclination and anteversion. The typical orientation of the inserter

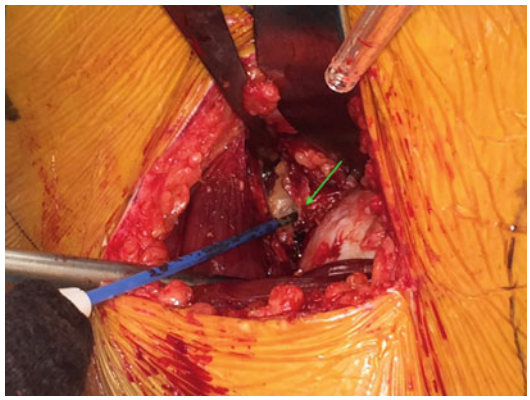

Fig. 12 The head is dislocated and rotated approximately 90°. Care should be taken to avoid injury to the tensor by the corkscrew by excessive rotation. A small Hohmann is placed between the inferomedial hip capsule (*green arrow*) and vastus lateralis. The inferomedial capsule is cauterized until the surgeon can visualize and/or palpate the lesser trochanter. The iliopsoas tendon should not be released

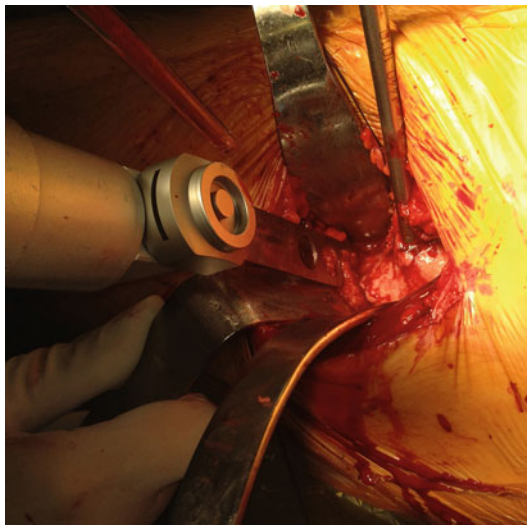

Fig. 13 With the hip reduced, the femoral neck is osteotomized according to the template. Typically, the saw blade is directed posteromedial to avoid injury to the greater trochanter. An osteotome is used to complete the cut through the neck saddle

handle is more parallel to the floor as well as the long axis of the patient (Fig. 16c) than the surgeon expects. This common error can be obviated with the use of Radlink GPS™.

In young patients with more lumbar lordosis, the senior author prefers slightly less anteversion

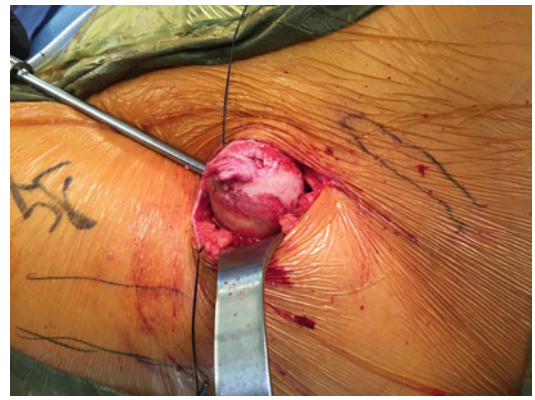

Fig. 14 The femoral head is delivered by "rotating" it out of the acetabulum. The sharp edges of the femoral neck should be directed away from the tensor muscle. Sometimes, the ligamentum teres is still attached and can be detached with a 0.05″ curved osteotome

and inclination since, as these patients age, lordosis decreases and pelvic tilt decreases (the pelvis flexes more) – creating more "effective" anteversion and inclination over time. The position of the pelvis is also different from lying to standing; the pelvis extends upon supine positioning and is more flexed upon standing. Pelvic flexion potentially contributes to more "effective" anteversion, although this precise quantity is unknown.

Lordosis can be estimated from the shape of the obturator foramen – patients with more lordosis have more pelvic tilt and, hence, more obliquity to the obturator foramen and therefore a smaller superior-inferior dimension seen on x-ray. The cup should have a good circumferential fit. After the cup is placed, the hole eliminator is screwed in (if using a single-hole cup), and the polyethylene liner is impacted. The authors utilize the hole eliminator to potentially mitigate against acetabular osteolysis. The implanted cup and fluoroscopic image are shown in Fig. 16e, f.

Femoral Exposure and Preparation

Femoral exposure is the key to a successful surgery and adequate exposure is critical. The hana® orthopedic table utilizes specially designed hooks that mount to a table bracket. The hook is placed

Fig. 15 The pelvis is leveled using the fluoroscope. The following landmarks are used to ensure a level pelvis: the obturator foramen should be the same size/shape, the ilioischial line should bisect the teardrop in approximately the same location, and the coccyx should point towards the pubis

under the vastus ridge and helps "deliver" the proximal femur, protects the TFL muscle, and supports the femur during broaching.

To expose the proximal femur, the leg is placed in slight internal rotation to facilitate hook placement under the proximal femur at the level of the vastus ridge. When placed correctly, the TFL and vastus lateralis will be lateral and medial to the hook, respectively. The gross traction is released. The foot is then externally rotated to 120° with the patella facing laterally at 90°. The rotation is then locked; it is critical that gross traction and all fine traction are released before the leg is extended and adducted to avoid inadvertent strong traction (Fig. 17a), as this maneuver can potentially cause patient injuries. After the leg is extended and adducted, a retractor is placed along the posteromedial neck (Fig. 17b). Another retractor is placed behind greater trochanter. The hook is placed in the support assembly ("bracket"), and the bracket is raised until there is adequate tension to the proximal femur. The lateral neck capsule is pulled medially and sharply released off the medial aspect of the greater trochanter and the gluteus minimus (Fig. 18a). Remnants of the lateral neck are removed with a rongeur, and posterior retinacular vessels are coagulated prophylactically using the Aquamantys® device (Fig. 18b). At this point, the obturator internus and piriformis are visualized on the medial aspect of the greater trochanter; the obturator externus tendon is sometimes visible medial to the greater trochanter (Fig. 19). If the proximal femur lacks mobility, the obturator internus can be released as a posterior sleeve with a longitudinal incision – this can improve the mobility of the femur with little morbidity since these rotators do not "recoil" and will heal in their anatomic positions. If more mobility is needed, the piriformis tendon, which inserts superior to the obturator internus on the anterior aspect of the greater trochanter, can also be incised. Preserve the obturator externus tendon. This tendon has a direct medial pull on the proximal femur and provides the most resistance to hip dislocation.

Once there is adequate exposure of the proximal femur including the calcar, broaching can be started.

Femoral Broaching and Trialing

Broaching should be initiated adjacent to the posterior femoral cortex (Fig. 20a). In order to avoid penetrating the lateral cortex, the surgeon's hand should be directed towards the floor (valgus) to ensure that the stem is going down the intramedullary canal (Fig. 20b). Palpation of the knee can be done to ensure that the broach is heading in the right direction. The authors prefer to maintain the native neck version during broaching. The path of the broach should not be altered significantly in order to maintain the same line-to-line path. For the inexperienced surgeon, there is a potential danger to perforate the posterior-lateral cortex of the metaphysis. The authors' femoral stem preference is a

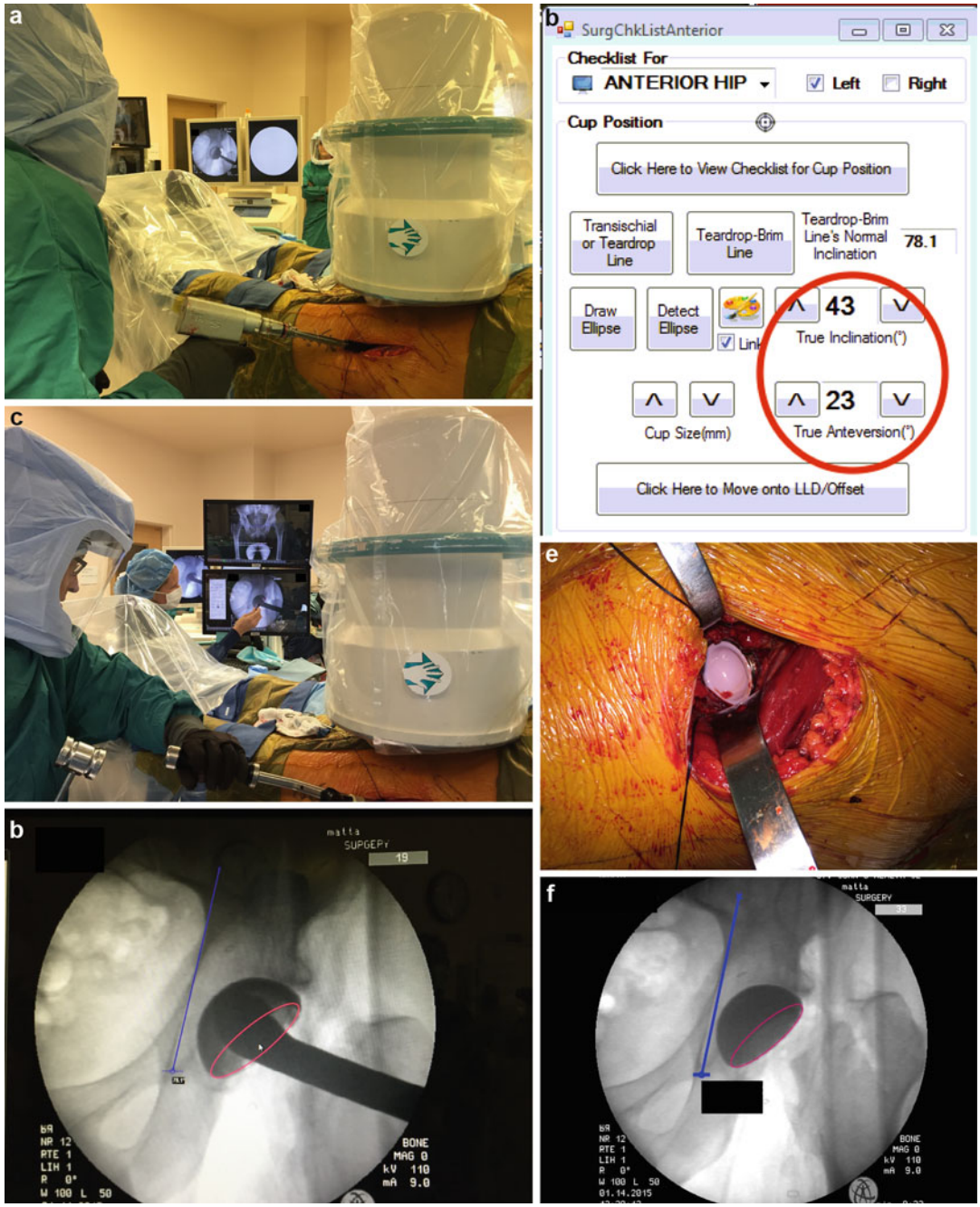

Fig. 16 Final acetabular reaming is done using fluoroscopic guidance. The acetabulum should be centered under the fluoroscope to minimize parallax (**a**). The acetabular cup is placed using the fluoroscope coupled with Radlink GPS™ software to ensure satisfactory inclination and version. The surgeon can enter in his/her preferred goal for acetabular cup inclination and anteversion (**b**), and the ellipse shown on the screen will correspond to the entered numbers (**c**–**d**). (**e**–**f**) shows the implanted cup and liner with the corresponding fluoroscopic image

Fig. 17 During femoral exposure, the affected leg is externally rotated during extension and adduction (**a**). The hook and the posteromedial retractor during femoral exposure are shown in (**b**)

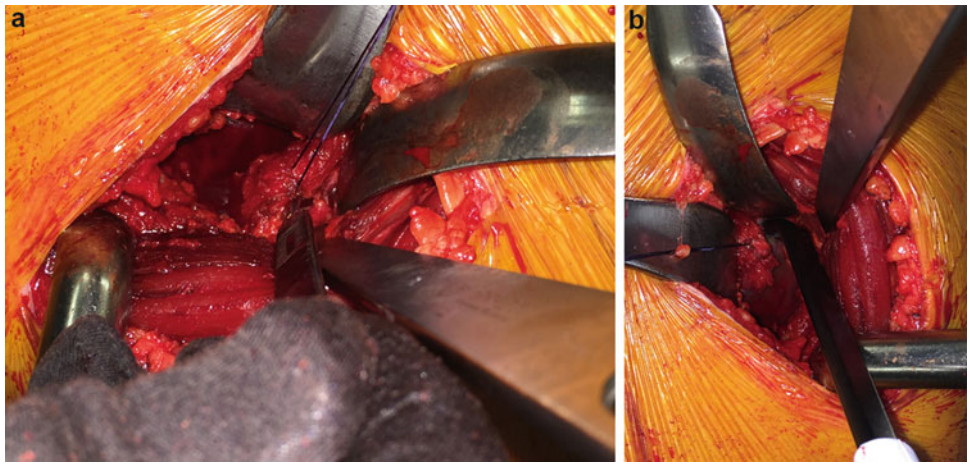

Fig. 18 (**a**) The lateral neck capsule is incised off the gluteus minimus down to the level of the bone. (**b**) An Aquamantys® is utilized to cauterize retinacular vessels after releasing the lateral neck capsule

non-cemented broach only stem (Depuy Corail®). Sequential broaching is performed to the template size. The surgeon can usually hear a change in the sound of mallet impaction as the broach has a tighter fit in the proximal femur. The broach should not be rotated during insertion or withdrawal so that there is a satisfactory cancellous bone mantle. The goal should be a solid metaphyseal fit (Fig. 21).

The calcar should be adequately visualized during broaching, especially as the broach size approaches that of the template, to avoid a potential fracture. Once the appropriate broach size is determined, the trial neck and head are placed. The hook is lowered and removed, the trochanteric retractor is removed, and the hip is returned to neutral flexion. The posteromedial retractor is then removed and the hip is reduced.

The fluoroscope is used again to check that the pelvis is level using the abovementioned landmarks. It is then centered over the contralateral hip. The rotation of the contralateral femur should be determined by (1) the position of the lesser trochanter and (2) the "overlap" of the medial cortex of the anterior and posterior facets of the greater trochanter. The rotation of the proximal

femur, including the position of the lesser trochanter and overlap of the anterior/posterior greater trochanter facets is matched to the contralateral side (Fig. 22). The purpose of the internal rotation is to visualize the maximum neck offset; thus, the proximal femurs should be slightly internally rotated to maximize this offset. The femur should be adducted or abducted as well to match the contralateral side, since this can affect limb length. The surgeon should attempt to eliminate as many confounding imaging and positioning variables to replicate the opposite side. The Radlink GPS™ software will "flip" the contralateral hip image, and the digital images are superimposed to match limb length and offset (Fig. 23a–d). Alternatively, an image taken of the operative hip prior to the neck cut can be used for comparison with the hip with trial components.

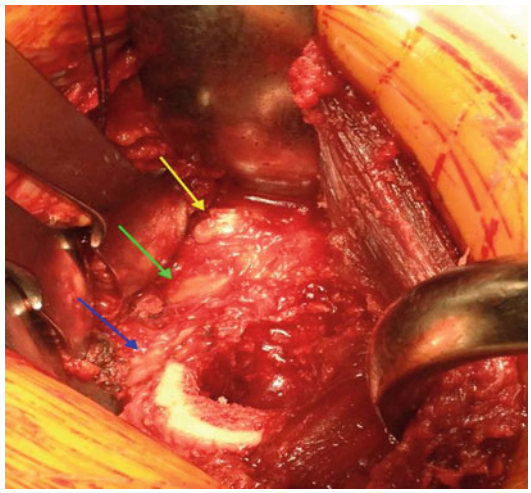

Fig. 19 The piriformis (*yellow arrow*), obturator internus (*green arrow*), and obturator externus (*blue arrow*) are demonstrated in this photograph. The piriformis and obturator internus can be sharply incised to improve mobilization of the proximal femur

It is important for the surgeon to know the difference between the *global offset* (distance between the proximal femur shaft axis to the inferior aspect of the teardrop line) and *femoral offset* (distance between the proximal femur shaft axis to center of femoral head rotation). When overlaying the images, if global offset is decreased, this may be due to medialization of center of rotation; it is more important to match up the *femoral* offset rather than the *global* offset. Leg length should also be matched. If the leg is too short, either a head with longer neck or larger broach stem can be used. If the leg is too long, the broach can be carefully impacted.

Final Implantation

Once leg length and offset are matched, the hook is replaced (with the leg in slight internal rotation),

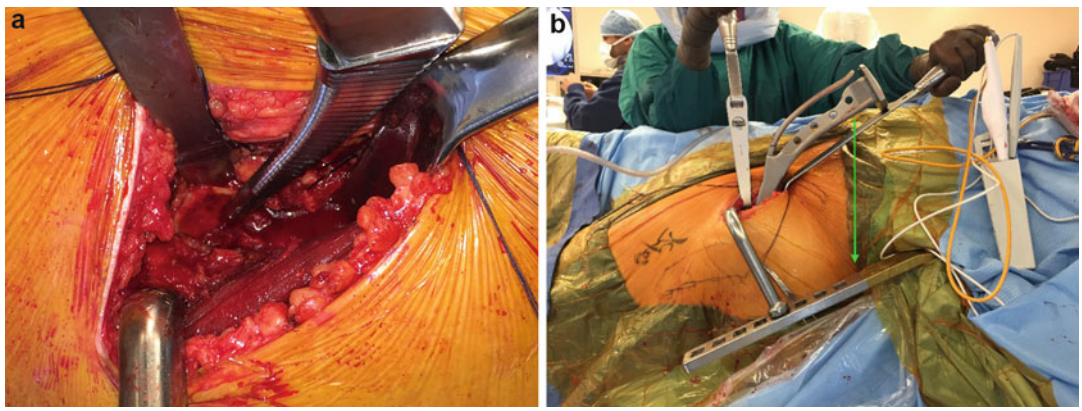

Fig. 20 (**a**) Broaching should be initiated parallel to the posterior femoral cortex. (**b**) The surgeon should push the broach down towards the floor (*green arrow*) during broaching to prevent violation of the lateral femoral cortex

the hip is dislocated, and the extremity is externally rotated, adducted, and extended to the floor. The hook is then elevated to achieve satisfactory tension on the proximal femur and the retractors are placed. If the trial leg length and offset were satisfactory, plane the calcar to the broach face (assuming a collared stem is used). The calcar planar should be rotating before engaging the cortex to prevent binding. The trial implants are removed and the final implants are placed. The stem should be impacted with light blows until seated at the calcar. The final head should be placed on the stem and gently impacted (Fig. 24). Before reduction, the cup should be checked and irrigated for any soft-tissue interposition. The hip is reduced (Fig. 25) and a final fluoroscopic is taken. The wound is irrigated.

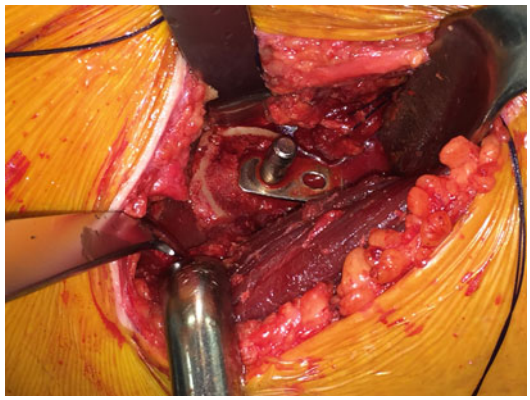

Fig. 21 The femoral trial stem is placed

Wound Closure

Wound closure is performed by tying the two capsule sutures together (Fig. 26a). The fascia is closed with 2–0 Vicryl® (Fig. 26b). The skin is closed with 2–0 Vicryl®, a 3–0 Monocryl® subcuticular stitch, and Dermabond® (Fig. 26c). A sterile dressing is applied.

Approach Extension

The approach can be extended proximally towards the anterior superior iliac spine and curving along the posterior border of the iliac crest to expose the tensor attachment and/or the inner table of the ilium. The incision can be extended distally if access to the femoral shaft is necessary. The vastus lateralis can be elevated and perforating veins should be ligated. This extensile exposure provides the surgeon potential access for revision arthroplasty. Revision exposure may include an osteotomy although detailed and specific revision techniques are beyond the scope of this chapter. The senior author prefers AA for the great majority of hip revisions.

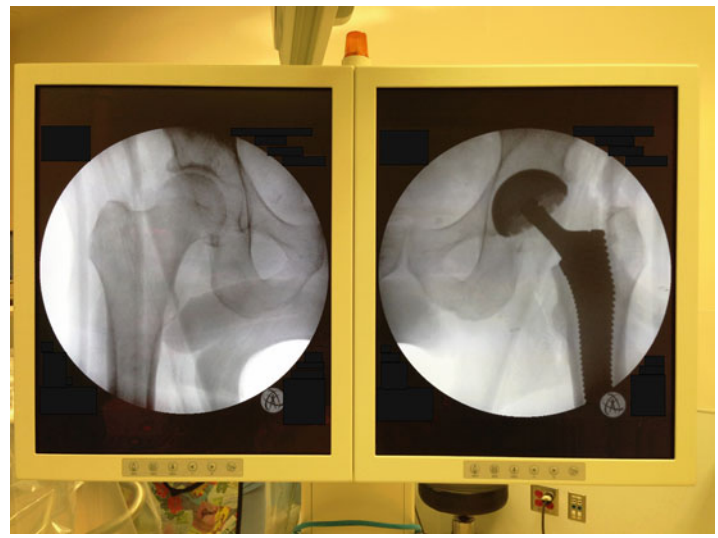

Fig. 22 After confirmation of a level pelvis, the hips are visualized using the fluoroscope

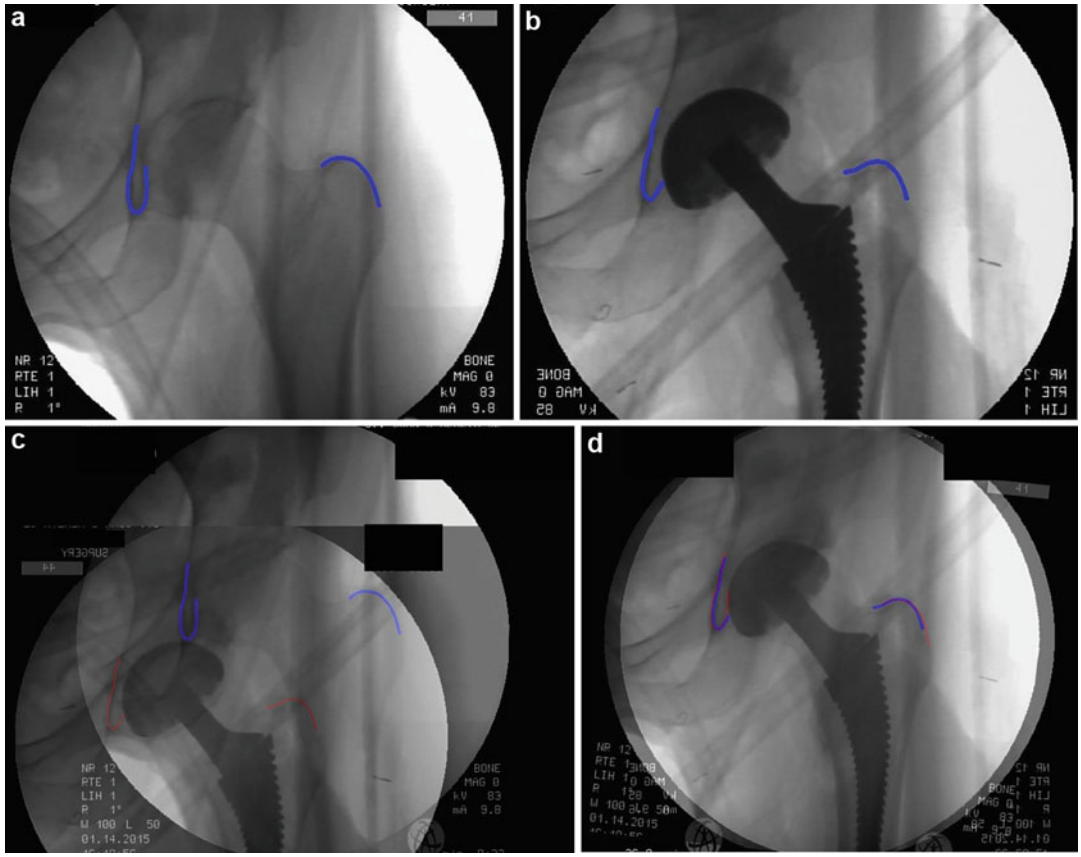

Fig. 23 Using the Radlink GPS™ software, the greater trochanter and inferior aspects of the teardrop are marked on the native hip and the trial hip (**a**, **b**). These images are then digitally overlaid to match leg length and offset (**c**, **d**)

Postoperative Rehabilitation

Patients are weight-bearing as tolerated and receive physical therapy postoperative day zero, if possible. During physical therapy, patients are instructed on gait training and muscle strengthening. There are no hip dislocation precautions and range of motion is as tolerated. Patients should avoid excessive physical activity during the first 2 weeks.

Outcomes

In over 3,000 consecutive, unselected primary AA THAs performed by the senior author, the following complications occurred: four hip dislocations (0.13 %), two deep infections (0.06 %), one case of femoral neurapraxia (0.03 %), two cases of partial sciatic nerve palsy (0.06 %), seven greater trochanter fractures (0.23 %), and three ankle fractures (0.1 %) [4]. The majority of these complications occurred during the first 500 cases by the senior author (1996–2004).

In a multicenter study that examined 5,090 consecutive primary procedures from 2006 to 2013 by five surgeons, the overall perioperative complication rate was 1.93 % (manuscript in preparation). Intraoperative complications included: 41 intraoperative femur fractures (0.8 %) including 29 (0.57 %) calcar fractures, 9 (0.18 %) greater trochanter fractures, and 3 (0.06 %) femoral shaft fractures. Postoperative complications included: 15 (0.29 %) superficial infections, 5 (0.10 %) deep infections, 12 (0.24 %) dislocations, 8 (0.16 %) hematomas, 3 (0.06 %) cases of

cellulitis, 7 postoperative femur fractures including 3 (0.06 %) greater trochanter fractures, 2 (0.04 %) calcar fractures, and 2 (0.04 %) femur fractures, 2 (0.04 %) sciatic nerve palsies, 1 (0.02 %) peroneal nerve palsy, and 1 (0.02 %) intrapelvic bleed [23].

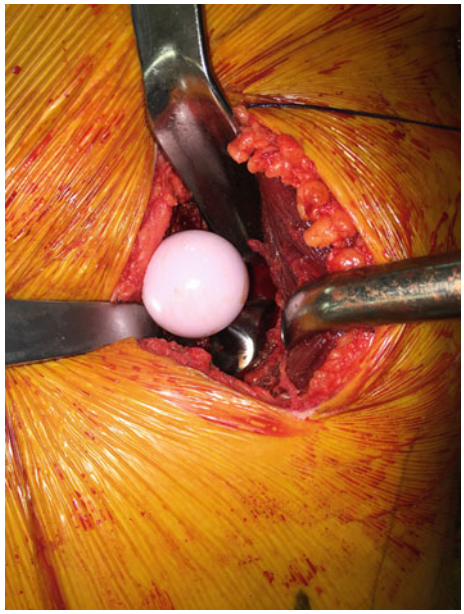

Fig. 24 The actual femoral component and head are placed

Discussion

Osteoarthritis (OA) of the hip affects has a prevalence of 8.7 per 100 individuals in the United States and has significant impact on mental and physical well-being. Total hip arthroplasty (THA), introduced by Sir John Charnley in the early 1960s, is viewed as a landmark innovation in twentieth-century health-care technology to address OA; it helped restore mobility and alleviate pain to millions of individuals suffering from hip OA. The number of partial and total hip replacements in the United States in 2012 was 452,615 [24]. The growth rate is expected to continue as it has in the past – THAs performed in the Medicare population have demonstrated a 1.3 % year over year growth from 2005 to 2011 [25].

Coincident with the increased demand for THA in the United States, the health-care climate is also evolving with greater emphasis on "pay-for-performance" paradigms. As mentioned previously, the authors feel that AA THA fits into this evolving climate. AA THA using a special orthopedic table offers several potential benefits to the patient undergoing an elective total hip replacement including (1) improved acetabular cup positioning, (2) accurate restoration of limb length and offset, (3) minimal soft-tissue trauma with

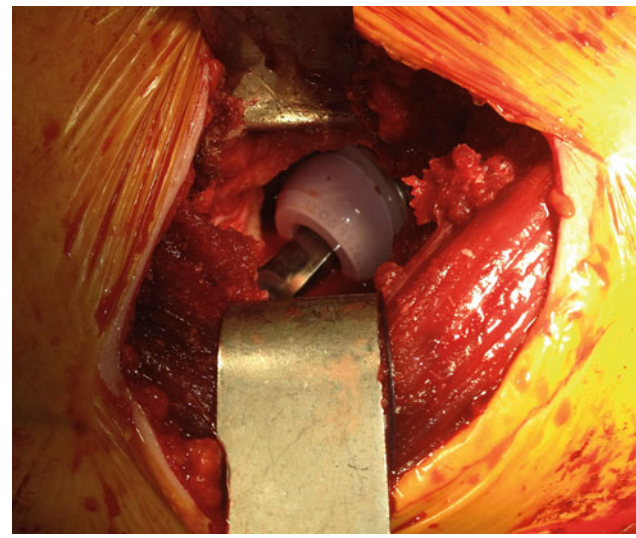

Fig. 25 The hip joint is reduced and visualized to ensure a concentric reduction

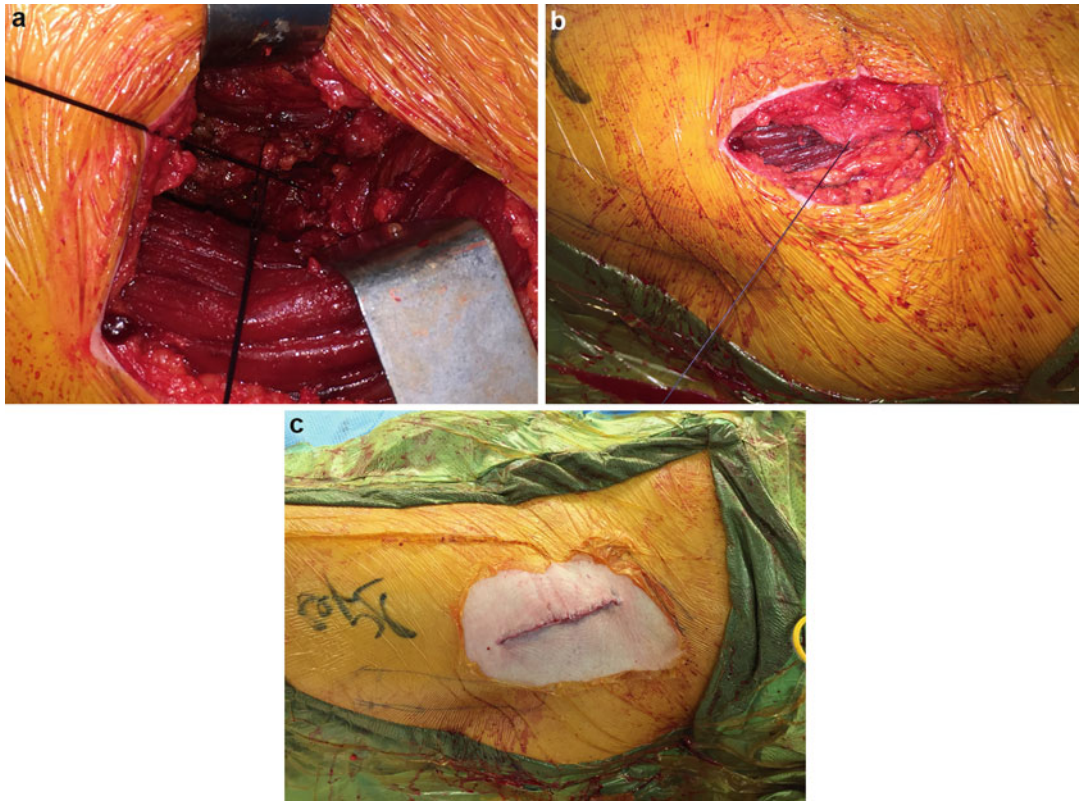

Fig. 26 The capsule is closed with the tagged Vicryl® suture (**a**). The tensor fascia is closed with #1 Vicryl® running suture (**b**). The skin is closed with 3–0 Monocryl and Dermabond® (**c**)

preservation of the external rotators, (4) minimal postoperative pain, and (5) low dislocation rate.

The use of the hana® orthopedic table facilitates the AA THA procedure for the surgeon. The use of the Radlink GPS™ system now offers the surgeon a more precise quantitation of implant position; intraoperative digital assessment tools, such as Radlink GPS™, hold promise for not only the future of arthroplasty surgery but also other orthopedic surgical specialties. Proximal femoral exposure is key to an excellent outcome. While the learning curve for the procedure can be steep for new surgeons, the authors believe that the ultimate benefit to the patient is well worth it. Lastly, the authors would like to communicate some important, anecdotal details which may facilitate the procedure:

1. In obese patients, the correct skin incision may be difficult to identify. If the patient has a large pannus, the surgeon can retract the pannus (i.e., by taping to the table) prior to prepping and draping the patient.
2. The tensor fascia is usually more translucent than the thicker and more posterior iliotibial band. In case the surgeon finds him/herself between the gluteus medius and the tensor (Watson-Jones, or anterolateral, approach), the procedure can still be performed.
3. If the approach does not look quite right, the surgeon is advised to stop and reassess the anatomy.
4. Avoid excessive anterior and posterior subcutaneous dissection when using the Protractor® so as to avoid a hematoma or seroma.
5. In degenerative hips with significant proximal migration, do not cut the direct head of the rectus femoris attachment to the AIIS. Normal bony landmarks can be distorted in these cases.

6. During surgical dislocation, ensure the corkscrew is well placed in the femoral head and not loose. The maneuver, as mentioned before, is "up and out" with one hand, while the other hand pushes the head out with the skid. The anterior wall is not at risk of fracture from the hip skid during this maneuver.
7. Avoid injuring the tensor muscle during the entire procedure, particularly by excessive retraction, or "scraping," with the Hibbs and/or during removal of the femoral head (sharp prominences of the neck osteotomy can injure the tensor).
8. If the neck cut is too long and in the way of the acetabulum, the surgeon can externally rotate the leg to improve exposure rather than re-osteotomizing the neck.
9. Ensure all fluoroscopic views of the acetabulum are centered to avoid any parallax distortion; the image should be rotated so the pelvis image is level to the floor.
10. To improve exposure of the proximal femur, the obturator internus and piriformis can be sharply released off their attachment on the greater trochanter. These tendons do not recoil and maintain their continuity as a "flap." If proximal femur exposure is still an issue, the incision can be extended proximally, and a small portion of the tensor can be released off its origin from the ilium. If after release of the rotators and a portion of the tensor, femoral exposure is still an issue, the incision can be extended further proximal, and the surgeon can perform an iliac osteotomy [26].
11. To avoid broaching through the lateral femoral cortex, keep the broach handle pushed *down* towards the floor. Avoid excessive rotation of the broach during insertion and withdrawal to ensure a tight cancellous bone mantle.
12. Greater trochanter fractures can be prevented by aiming the oscillating saw posteromedial during the neck osteotomy. A reciprocating saw can also be used. Another potential cause of greater trochanter fractures is excessive tension from the femoral hook. The excessive tension from the soft tissues (gluteus medius, piriformis, obturator internus) can avulse the greater trochanter.
13. Lastly, learning the femoral exposure is the key to success with the AA.

Take Home Points

- AA THA is a tissue-sparing arthroplasty procedure that facilitates accurate implant positioning with minimal soft-tissue compromise.
- Potential postoperative benefits include earlier rehabilitation, no need for dislocation precautions, and lower wear due to more accurate implant placement.
- Although a special orthopedic table and fluoroscopy facilitate the procedure, they are not necessary.
- Meticulous and efficient initial exposure is key to the rest of the AA THA procedure.
- Adequate proximal femoral exposure is frequently the most difficult portion of the procedure; the authors have attempted to communicate alternative means to improve proximal femoral exposure in this chapter.
- Like many orthopedic procedures, the surgical details, which are learned from experience, are frequently the initial hurdles in AA THA.

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