Review Article

Direct Anterior Approach for Total Hip Arthroplasty: Indications, Technique, and Results

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Abstract

The direct anterior approach (DAA) to the hip was initially described in the 19th century and has been used sporadically for total hip arthroplasty (THA). In the past decade, enthusiasm for the approach has been renewed because of increased demand for minimally invasive techniques. New surgical instruments and tables designed specifically for use with the DAA for THA have made the approach more accessible to surgeons. Some authors claim that this approach results in less muscle damage and pain as well as rapid recovery, although limited data exist to support these claims. The DAA may be comparable to other THA approaches, but there is no evidence to date that shows improved long-term outcomes for patients. The steep learning curve and complications unique to this approach (fractures and nerve damage) have been well described. However, the incidence of these complications decreases with greater surgeon experience. A question of keen interest to hip surgeons and patients is whether the DAA results in improved early outcomes and long-term results comparable to those of other approaches for THA.

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Traditionally, elective total hip arthroplasty (THA) has been done with one of two approaches, direct lateral or posterior. Several years ago, in conjunction with increased demand for minimally invasive surgery, other approaches began to be used more frequently. Some of these approaches, specifically the two-incision approach, enjoyed only limited use. The direct anterior approach (DAA) to the hip appears to have greater longevity in terms of its popularity. Making use of the Hueter interval between the tensor fascia latae (TFL) and sartorius muscle to expose the hip, the DAA uses a true internervous, intermuscular plane. Proponents claim that the approach is associated with less muscle damage and pain as well as rapid recovery after hip arthroplasty.[1-3] Most US surgeons' familiarity with the approach is limited, but these claims have generated intense interest in the DAA. Many who are now using this approach for hip arthroplasty have learned to do so after completion of formal orthopaedic training, typically at courses sponsored by industry. Implant manufacturers, hoping to capitalize on the DAA's popularity, have introduced new instrument sets and even surgical tables specifically designed for use with the DAA. However, unique complications associated with the DAA have been described, and no data demonstrate that the DAA is associated with improved long-term outcomes. An understanding of the history and development of this approach, the surgical technique, and its outcomes will help the surgeon better evaluate the role of the DAA in contemporary hip arthroplasty.

History

Carl Hueter, a prominent German academic surgeon, first described the anterior approach to the hip in his 1881 publication, *Der Grundriss der Chirurgie* (*The Compendium of Surgery*).[4] Hence, the DAA is often referred to as the Hueter approach or as utilization of the Hueter interval. The approach is more commonly known by the description published by Smith-Petersen[5] in 1917. His description and frequent use of the DAA for mold arthroplasty exposed American surgeons to the approach.[5,6]

In 1950, French surgeons Judet and Judet[7] also described the use of the DAA for hip arthroplasty. O'Brien[8] reported on his satisfactory experience with the DAA for hip arthroplasty in 1955. In the late 1950s and early 1960s, Charnley's low-friction arthroplasty and the use of the trochanteric osteotomy gained popularity as a reliable and reproducible approach for THA. Subsequently, the DAA became less popular for hip arthroplasty, and most orthopaedic residents learned the technique as a way to treat hip infection in children. In 1980, Light and Keggi[9] published the first American experience on the use of the DAA for modern THA in a series of 104 procedures. The mean surgical time was 65 minutes, and the procedure required a transfusion of an average of 1.9 units of blood. No intraoperative complications were reported. The mean length of hospital stay was 12.8 days.

The use of a modified version of the original Smith-Petersen approach has only recently gained popularity.[10,11] A description of a DAA performed on a hip fracture table increased interest in this well-established approach for THA.[12] However, it was the search for less invasive surgical approaches that generated real enthusiasm for the approach.[13] Many surgeons continue to use a fracture table, but others perform the procedure using a standard operating room (OR) table.[11,14,15]

Indications and Contraindications

Indications for the use of the DAA are similar to those for THA. As with more traditional approaches, certain patient factors make this approach challenging. Recently, the American Association of Hip and Knee Surgeons Evidence-based Committee recommended against elective THA in patients with a body mass index (BMI) >40.[16] This recommendation applies to the use of the DAA, as well. Although obesity can make any THA approach difficult, subcutaneous fat in the anterior hip region tends to be minimal compared with other aspects of the hip (posterior and lateral). Thus, it has long been our practice to encourage weight loss before THA is performed in patients with a BMI >40. Patients with a large abdominal panniculus, particularly those with tissue that overlaps the upper thigh, present an additional challenge when using the DAA. This overlapping tissue can create a moist environment that can result in chronic skin irritation or fungal infection. In our experience, these patients are prone to wound problems and require extra vigilance to ensure proper healing of the skin incision.

Careful consideration also should be given to patients with a history of previous hip surgery or retained instrumentation. It is not possible to remove plates from the lateral aspect of the femur through this approach, but screws are easily removed with additional small incisions. If the need arises, distal or proximal extension of the dissection can be performed. However, this is challenging for surgeons with limited experience. Therefore, in patients who require more extensive surgery (eg, femoral shortening osteotomy, acetabular augmentation) at the time of THA, the use of another approach may be warranted unless the surgeon has extensive experience with straightforward cases. However, given sufficient experience with primary procedures, many surgeons use the DAA for all THAs, including revision procedures.

Anatomy

The anterior aspect of the hip has few palpable landmarks, and many critical structures must be noted. The anterior superior iliac spine (ASIS) is the most easily identified structure. Typically, this bony prominence is palpable at the lateral aspect of the abdomen, superior to the level of the pubis. The ASIS is the anterior-most tip of the iliac crest and is the origin for the sartorius muscle and the inguinal ligament. The pubis is typically palpable at the midline.

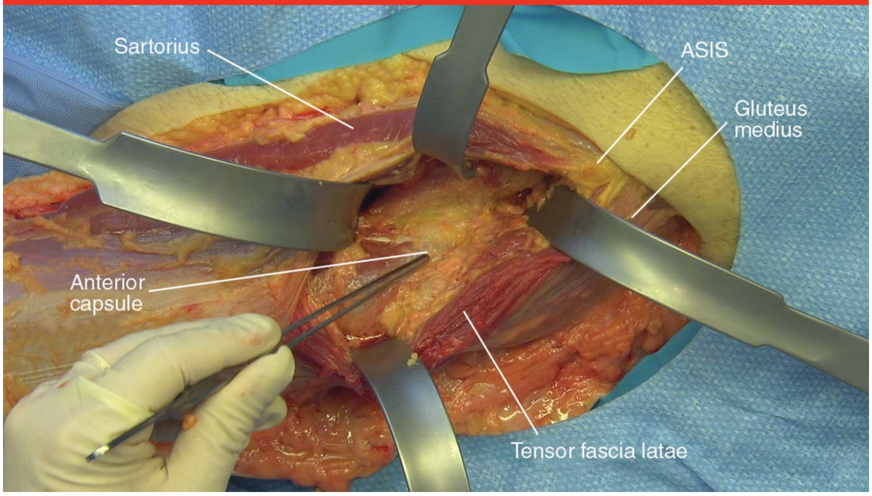
The origin of the TFL muscle and the anterior origin of the gluteus medius muscle are lateral to the ASIS (Figure 1). The lateral femoral cutaneous nerve (LFCN) runs under the inguinal ligament and over the surface of the sartorius and TFL muscles. The neurovascular bundle containing the femoral artery and vein as well as the femoral nerve lies medial to the sartorius muscle. Knowledge of the neurovascular bundle's location is critical during all portions of the DAA. The rectus femoris muscle lies deep to the sartorius and TFL muscles and is divided proximally into two heads: direct and reflected. The direct head originates from the anterior inferior iliac spine, whereas the reflected head originates from the anterior lip of the acetabulum. The gluteus minimus muscle originates from the iliac wing and rests along the anterolateral aspect of the hip capsule. This muscle inserts on the lateral aspect of the greater trochanter with the gluteus medius, making up the abductor complex. The vastus lateralis and vastus intermedius muscles lie deeper still, originating from the anterior aspect of the femur at the intertrochanteric line. The iliopsoas muscle and tendon initially lie anterior to the hip capsule but then pass to the medial side of the femoral neck and insert on the lesser trochanter. A thorough familiarity with hip anatomy is critical to avoid complications during the DAA.

Patient Positioning

The DAA is typically done with the patient in the supine position. At our institution, the patient is positioned on a traditional OR table with the pelvis placed on a small bump that is placed transverse to the OR table and is centered at the level of the ASIS (Figure 2). The bump is approximately 3 inches thick and measures 8 by 15 inches. The bump provides a small amount of femoral extension, which facilitates broaching and creates a space where the femur can displace during exposure of the acetabulum. The pelvis must be level when resting on the bump. Failure to achieve a level pelvis after bump placement can result in relative anteversion or retroversion of the acetabulum, potentially disorienting the surgeon during surgery. Intraoperative assessment of pelvic alignment is recommended before final cup insertion, with the ASIS and pubis used to establish coronal orientation. Some surgeons prefer to place the bump and position the patient's ASIS at the flexion point of the OR table, which allows extension of the pelvis during surgery. This position lowers the leg, improving the angle for insertion of the femoral component. In our practice, when we plan to flex the bed during surgery, we check this flexion point before sterile preparation of the leg (Figure 3).

The patient is placed on either the far left or right side of the OR table based on the surgical hip (ie, left side for the left hip, right side for the right hip) to allow the maximum amount of room for positioning of the surgical leg during surgery. In addition, an extra arm board is placed opposite the surgical hip at the foot of the table (Figure 4). This extra arm board provides additional room to maneuver the legs during surgery. Finally, leg length is assessed to ensure that the shoulders and hips are aligned when the patient is positioned straight on the table. Impervious plastic drapes are used to isolate the surgical field, and sterile skin preparation can commence.

Figure 1



Intraoperative photograph demonstrating the anatomic dissection of the anterior aspect of the hip. The Hueter interval can be seen between the tensor fascia latae and the sartorius muscles. ASIS = anterior superior iliac spine (Courtesy of Stryker, Kalamazoo, MI.)

Figure 2

Photograph demonstrating patient positioning for the direct anterior approach for total hip arthroplasty. A bump is centered under the anterior superior iliac spine.

OR Tables

The use of special OR tables has helped to popularize the DAA for THA. These tables are most commonly used in the setting of fracture care. However, many surgeons have found them to be helpful for the DAA to the hip. These tables allow the patient to be positioned supine with both legs placed in supportive boots. There is no contact between the table and the patient distal to the pelvis, and a radiolucent

Figure 3

Photograph demonstrating placement of the bump at the flexion point of the operating room table. With the patient and bump centered over the hinge, the table can be extended during the procedure to simplify exposure of the femur.

Figure 4

Photograph demonstrating patient positioning at the side of the table with an extra arm board placed opposite the surgical hip at the end of the table to allow more room to maneuver the leg.

platform can be placed under the pelvis. Intraoperatively, the surgical leg can be extended, adducted, and externally rotated to facilitate exposure of the proximal femur and placement of the femoral stem. In addition, a hook can be attached to the table in a sterile fashion during surgery to help elevate the proximal femur. The radiolucent nature of a fracture table allows the surgeon to easily obtain intraoperative radiographs to guide positioning of THA components. However, special tables do represent a substantial cost and have been associated with unique complications (eg, ankle fractures) that are not traditionally associated with THA.[12] In addition, the use of these tables is associated with additional requirements such as the use of radiation gowns for surgeons using radiography and more extensive patient positioning, which adds time to the procedure, especially early in the learning curve. At our institution, we prefer to use a standard OR table.

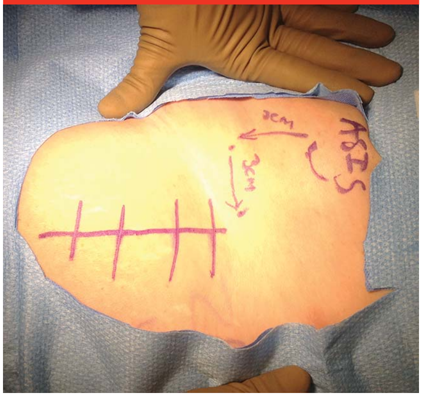
Surgical Technique

The incision typically begins approximately 3 cm distal and 3 cm lateral to the ASIS. For most patients this point lies near the groin crease (Figure 5). Alternatively, the incision can be centered over the body of the TFL muscle if the muscle is easily palpable. From the starting point, the incision progresses distally and laterally over the TFL and is carried down to the level of the fascia over the TFL (Figure 6). It is critical to confirm the location of the TFL muscle. Typically, several perforating vessels enter the muscle at the mid portion of the body and are used to confirm the correct location. Another method is to digitally dissect proximally to the ASIS and confirm through palpation that one is lateral to the ASIS.

The fascia of the TFL muscle is split in line with the muscle fibers. The medial edge of the fascia is then dissected from the muscle and a fat strip is seen (Figure 7). Blunt digital dissection is performed superiorly and medially, following the fat strip over the superior aspect of the femoral neck. A blunt retractor is placed over the extracapsular superior neck. Another sharp retractor is placed medial to the TFL muscle and over the lateral edge of the femur, just distal to the intertrochanteric ridge. Careful dissection is performed to separate the TFL from the sartorius muscle. Several large vessels lie between these two muscles (divisions of the ascending branch of the lateral femoral circumflex artery) and must be carefully ligated (Figure 8).

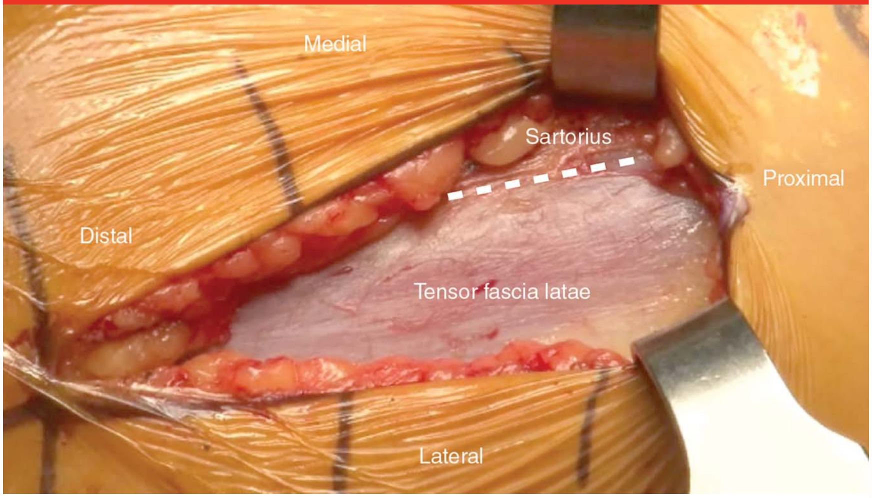
Once the muscles are safely separated, a second blunt retractor is placed over the extracapsular inferior portion of the femoral neck. The anterior fat over the hip capsule is now visible. A rongeur is used to remove some of this fat to permit visualization of the capsule. A bump can then be placed under the knee or an assistant can hold the hip in slight flexion. This maneuver relaxes the

Figure 5



Clinical photograph demonstrating markings for the skin incision. Typically, the incision is begun approximately 3 cm distal and 3 cm lateral to the anterior superior iliac spine (ASIS), depending on the patient's size and body habitus.

Figure 6



Intraoperative photograph demonstrating a superficial view of the direct anterior approach to the hip (dashed line). The lateral femoral cutaneous nerve traverses the anterior surface of the sartorius muscle.

rectus femoris muscle and the femoral vessels as a blunt retractor is placed over the anterior aspect of the acetabulum. We typically use a lighted retractor for this step. The reflected head of the rectus is gently released with electrocautery to improve exposure.

At this point, the surgeon should have an excellent view of the hip capsule. A capsulectomy or capsulotomy can be performed to allow visualization of the femoral neck (Figure 9). We prefer to perform a capsulectomy because it provides better exposure of the femur and acetabulum. The superior and inferior femoral neck retractors are moved so that they are intracapsular. The femoral neck is cut in situ with an oscillating saw, and the femoral head is removed. We find it easier to make two cuts in the femoral neck, creating a "napkin ring" of bone that allows removal of the bone and femoral head separately. A corkscrew is used to remove the femoral head.

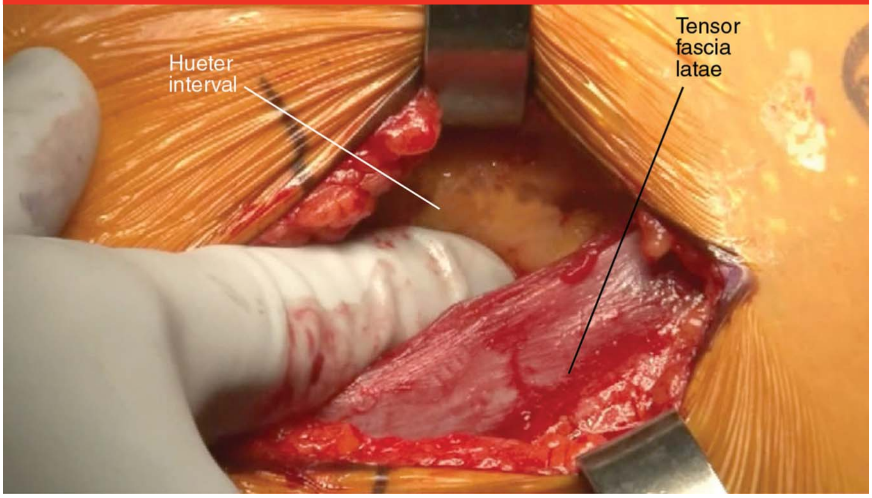
One of the blunt retractors is now moved such that the tip is over the transverse acetabular ligament to retract the inferior hip capsule and iliopsoas tendon. The inferior hip capsule can be split using electrocautery to allow insertion of the retractor and improve exposure (Figure 10). The sharp retractor is repositioned to the posterior aspect of the acetabulum. Once the labrum and cotyloid fat are removed, reaming begins. Offset acetabular reamers and offset cup insertion handles are available to aid reaming and cup placement. There is a tendency to excessively antevert and abduct the cup, especially early in the learning curve, and efforts should be made to avoid this.

Once the cup is positioned, exposure of the femur is begun. As with all THA approaches, the natural position and angle of the femoral shaft during the DAA will not allow safe broaching and preparation for placement of the femoral stem. Elevation of the femur to allow broaching is the most important and difficult step in the DAA. To accomplish this task, the femur is first moved to a position of adduction and external rotation. If the patient has been positioned appropriately, the table can be flexed to allow extension of the leg. This maneuver will better align the femur for broaching. If a special OR table is used, this can be done with the assistance of the table.

A Mueller retractor is then placed over the posterior portion of the femoral neck to retract the medial tissues. Another Mueller retractor is placed over the superior portion of the greater trochanter with the hip abductor muscles behind it to permit separation of the hip capsule and the muscle. A release of the lateral hip capsule from the femur is performed using an electrocautery device. This release is best accomplished while distracting the femur toward the anterior aspect of the wound. The distraction can be done with a bone hook placed in the femoral canal or around the lateral aspect of the femur. Manual or mechanical distraction can be used at the surgeon's discretion. During the capsular release, particular attention should be paid to releasing the posterolateral area of the trochanteric fossa to allow anterior translation.

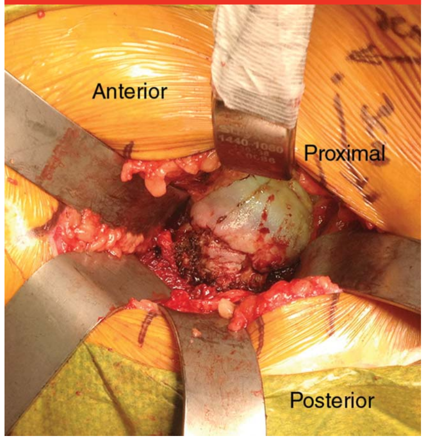
Once the release is complete, the femur should translate into the anterior aspect of the wound, allowing enough exposure for broaching and stem implantation (Figure 11). Offset broach handles can aid in safe and accurate broaching and seating of the femoral stem (Figure 12). With the trial head and neck on a broach and the hip

Figure 7



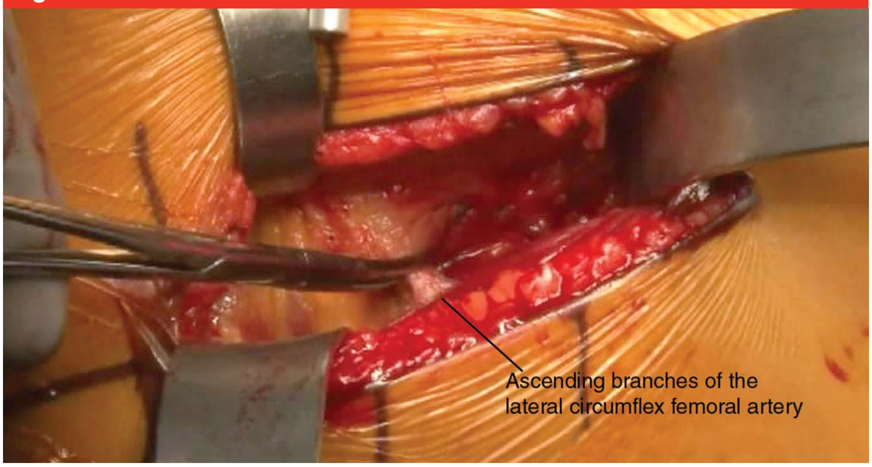
Intraoperative photograph demonstrating the Hueter interval in relation to the tensor fascia latae muscle.

Figure 9



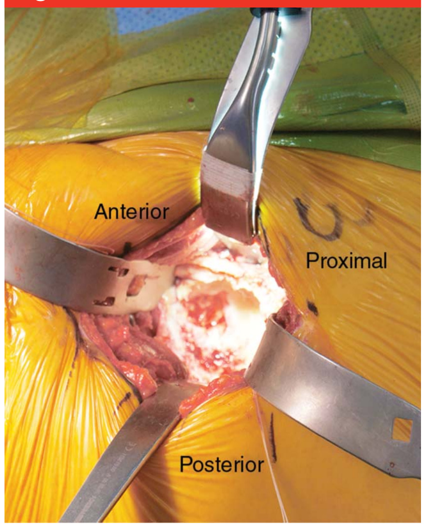
Intraoperative photograph demonstrating the femoral neck after the hip capsule has been resected.

Figure 8



Intraoperative photograph showing the ascending branches of the lateral circumflex femoral artery in the distal portion of the Hueter interval.

Figure 10



Intraoperative photograph demonstrating the acetabulum after the removal of the femoral head and labrum.

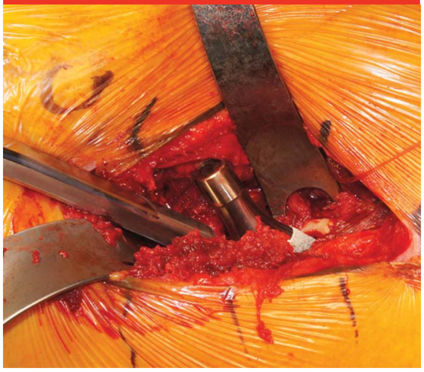
reduced, the DAA easily allows for radiographic confirmation of broach size and position, if so desired.

Pearls and Pitfalls

A common challenge for surgeons, especially early in the learning curve, is determining the appropriate interval for dissection. The most dangerous mistake is to proceed too far medially to the same interval as the neurovascular bundle. Identifying the perforating vessels and positioning the incision over the TFL fascia to the lateral side of the ASIS will help prevent this error. Moving the reamers in and out of the acetabulum can be challenging, as well. We have found it helpful, when struggling with insertion of the reamers, to place and remove the reamer head independent of the reamer handle. The reamer head is placed into the acetabulum and put into position with a Kocher clamp. Once it is positioned, the reamer handle is attached. This procedure is reversed for removal.

Elevation of the femur for broaching is another challenge. In addition to the previously stated guidelines, patience and dedication to a thorough release will make the process easier. It is also helpful to remember that the insertion of the abductor

Figure 11

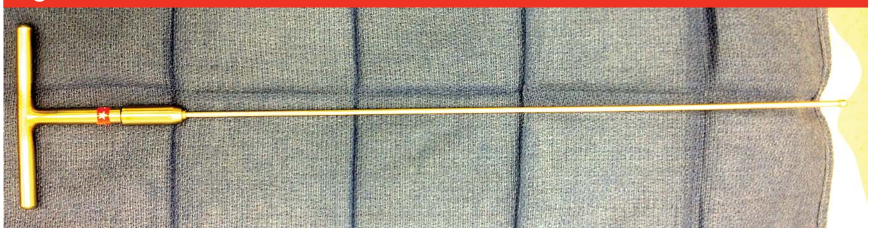


Intraoperative photograph demonstrating insertion of the femoral stem following proper release of the femur, which allows elevation of the proximal portion of the femur to ensure safe broaching and insertion of the device.

Figure 12

Photograph of an offset broach handle. These handles can make femoral preparation easier and safer.

Figure 13



Photograph of a guidewire on a handle. This tool is used to ensure proper direction when broaching the femur and helps to prevent perforation of the femoral canal.

muscles on the trochanter is on the lateral aspect of the bone, and the "saddle" where the trochanter meets the femoral neck can be released from the hip capsule. Perforation of the femoral canal with a broach is another risk. We have found it helpful to use a guidewire that is placed on a handle to identify the femoral canal and the direction the broach is to travel (Figure 13). This tool can be used many times during broaching to ensure that the broach always progresses in a direction that is in harmony with the intramedullary canal.

Outcomes

As minimally invasive surgery has become popular, claims of superior outcomes associated with such procedures have been common. In general, proponents believe that, compared with other approaches, the DAA is associated with less muscle damage and pain,[17-19] quick recovery,[20] and better gait mechanics postoperatively. However, scant evidence exists to support these claims. Most studies of the DAA are retrospective, and the two randomized trials that are available are underpowered, single-center studies that could be performed in a more rigorous manner.[1,20] In terms of the extent of muscle damage associated with the DAA for THA, authors have used postoperative MRI, biochemical markers, or visual inspection to demonstrate decreased damage.[17-19] Each of these studies was small (<30 patients per group) and most were observational or retrospective in nature. One study measured creatine kinase levels following THA with either the DAA or the mini-posterior approach and found these levels to be five times greater after the mini-posterior approach.[18] The authors suggested that this finding implies less muscle damage with the DAA, but no clinical significance can be extrapolated.

Recently, Barrett et al[20] published a randomized study of 87 patients who underwent THA with the DAA or posterior approach. The procedures were performed by the same surgeon, and levels of pain and function were measured at several postoperative intervals. The authors concluded that patients treated using the DAA had less pain initially and better function at 6 weeks postoperatively, but all measureable difference between the two groups disappeared by 6 months.[20] Although the patients were randomized, more men than women were treated with the DAA, which potentially introduces bias in speed of recovery. Another retrospective study comparing the DAA and the posterior approach found that patients treated with the DAA were discharged from the hospital sooner and mobility returned quicker than in those treated with the posterior approach.[1] However, analysis of the demographic data showed that patients treated with the DAA had a significantly lower BMI. Other studies had similar findings: the authors feel that there is a quicker return to function after the DAA compared with other approaches.[2,3,21,22] This improved functionality seems to disappear over time, and most studies are unable to demonstrate a difference beyond 6 months postoperatively. One small study compared the DAA with a direct lateral approach and found no difference between the two approaches in terms of early postoperative pain.[23] Two retrospective studies did report reduced pain after the DAA compared with traditional approaches.[24,25] However, additional large, rigorously conducted, prospective, randomized studies that directly compare outcomes and pain associated with the DAA and other approaches are needed before a superior approach can be definitively determined.

Restoration of gait mechanics is a goal of THA and a frequent topic in the literature on the DAA. In a prospective randomized study of patients treated with the DAA or anterolateral approach for THA, Mayr et al[3] performed gait analysis and found that patients treated with the DAA had better stride time and cadence speed at 6 weeks postoperatively, whereas patients treated with the anterolateral approach had more improvement in step time. Varin et al[26] found that, although patients who underwent the DAA or direct lateral approach for THA had gait anomalies compared with normal controls, those treated using the DAA had limb motion that was closer to normal. However, there was no control for preoperative gait anomalies. Maffiuletti et al[27] reported gait impairments regardless of approach. However, patients who underwent surgery with the DAA were less stiff when walking early in the postoperative period than were those treated with the posterior approach, but those differences disappeared by 6 months. Overall, there seem to be some benefits associated with the DAA for THA compared with other approaches, but some limitations exist, as well. The enthusiasm exhibited by strong proponents of the approach is not necessarily supported by the literature; thus, more study is needed.

Complications

Many studies have described the steep learning curve associated with mastering the DAA.[28-30] Most studies find that the complication rate decreases when surgeon experience is >100 cases.[21,28] For many surgeons who perform THA, it could take well over a year to reach that number of cases, making true mastery of the DAA unattainable.

For experienced surgeons, major complications associated with THA using the DAA are rare and comparable to those of other approaches.[2,10,21] Dislocation is a risk regardless of the approach used, including the DAA, although it has been shown to be very stable, with dislocation rates after THA through a DAA reported to be 0.96% to 1.5%.[31,32] However, this low rate is concurrent with increased use of larger femoral head implants, a phenomenon that has led to decreased dislocation rates for all approaches.

Damage to the LFCN and potential meralgia paresthetica are commonly described complications associated with the DAA. Paresthesias of the LFCN are common, but the reported incidence ranges widely from <1% to as high as 67%.[2,33] The large variation appears to hinge on how aggressively surgeons interrogate patients postoperatively about LFCN symptoms.[33] Most paresthesias largely resolve, and few patients report functional limitation.[2,12,33,34] True meralgia paresthetica is extremely rare (<1%).[14] However, this complication can be distressing to the patient and should be discussed extensively as part of informed consent.

Perforation of the femoral canal and fractures associated with the DAA (eg, fractures of the greater trochanter, calcar fractures) have been well described in the literature.[12,32,35] In addition, the use of a fracture table for the DAA has also been associated with ankle fracture.[12] Most surgeons find that the incidence of fracture decreases with increased surgeon experience[32,35] and, once sufficient experience has been attained, is no more common than that associated with other approaches.[29] Finally, local wound complications have also been described given the moist nature of the groin area. These complications typically resolve with wound care alone.[35]

Summary

The DAA for hip arthroplasty has gained popularity as patient demand for less invasive surgical techniques has increased. Modern surgical instruments combined with specially designed OR tables have made the technique more accessible to orthopaedic surgeons. However, the learning curve can be steep and mastery requires hundreds of cases. Although there is literature available to support the use of the DAA, large randomized trials are lacking. Once a surgeon has mastered the DAA, the technique should be viewed as a viable alternative approach for a highly successful surgical procedure.

References

Evidence-based Medicine: Levels of evidence are described in the table of contents. In this article, references 1 and 23 are level I studies. References 3, 16, 17, 19, 22, 26, 27, 33, and 35 are level II studies. References 2, 18, 21, 24, 25, and 30 are level III studies. References 7, 9-13, 28, 29, 31, 32, and 34 are level IV studies. References 4-6, 8, 14, 15, and 20 are level V expert opinion.

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