Direct Anterior Approach for Revision Total Hip Arthroplasty: Anatomy and Surgical Technique

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ABSTRACT

There has been increased interest and literature on the efficacy of direct anterior approach (DAA) for total hip arthroplasty (THA). Developments in surgical technique and instrumentation, along with exposure earlier in orthopaedic residency training, may augment the adoption of this approach among practicing orthopaedic surgeons. With the increasing number of primary THA performed through the DAA, understanding the indications and techniques associated with revision THA via the DAA has proved increasingly important. Patient positioning, understanding surgical anatomy and extensile maneuvers, and applying key reconstructive methods are essential for obtaining adequate exposure and fixation. Acetabular exposure can be facilitated through capsular and soft-tissue release, along with extensile approaches to the pelvis and acetabulum. Extensile distal extension can be performed for safe access to the femur, including extended femoral osteotomies. The purpose of this review is to describe indications, surgical anatomy, intraoperative tips, clinical outcomes, and complications after DAA for revision THA.

The prevalence of revision total hip arthroplasty (rTHA) is expected to increase with the exponential projected increase of primary total hip arthroplasty (THA).1 The direct anterior approach (DAA) through the Smith-Petersen interval has gained popularity over the past 15 years.2,3 Developments in surgical technique and instrumentation, along with exposure earlier in orthopaedic residency training, may augment the adoption of this approach among practicing surgeons. With the increasing number of primary THA through the DAA, understanding the indications and techniques associated with DAA rTHA will prove increasingly important.4,5 This review describes indications, surgical anatomy, intraoperative tips, clinical outcomes, and complications with DAA for rTHA.

Indications and Patient Selection

Indications for the use of revision DAA are similar to those for primary THA. Patients with a history of previous hip surgery through DAA including...
revision for anterior instability are optimal candidates. Exposure through another surgical approach for rTHA from a previous DAA creates another surgical window and may further exacerbate postoperative instability. However, DAA revision approach for a patient whose primary THA was done through a different approach is not a contraindication. The advantages of DAA revision may outweigh the potential issues of revising a posterior approach THA, such as recurrent instability. DAA rTHA allows accurate leg-length restoration with comparison to the contralateral limb in the supine position along with fluoroscopy use for acetabular component position.

Patients with a high body mass index (body mass index > 40) may present challenges in either the primary or rTHA setting. The large abdominal pannus is problematic because of the substantial overlapping soft tissue, which creates a moist environment that could result in skin irritation and infection. Nevertheless, careful consideration is given to patients with retained pelvic hardware as seen in posterior column acetabular fractures. Patients requiring access to the posterior column for hardware removal or reconstruction of the retroacetabular surface may not be ideal candidates for revision DAA because posterior pelvic structures may be more challenging to access. Given sufficient experience with primary procedures, many DAA surgeons are using this approach for revision arthroplasty as well. We recommend a stepwise progression in DAA rTHA: isolated head/liner exchanges may be performed initially for revision experience, simple acetabular revisions, followed by progressing to more complex acetabular (Figure 1, Video 1: acetabular and femoral revision via extended direct anterior approach) and femoral reconstruction (Figure 2).

**Patient Positioning**

Primary DAA THA is typically performed in the supine position either on a specialized table (Hana; Mizuho OSI) or conventional table with a bump placed under the pelvis centered at the level of the anterior superior iliac spine (ASIS). Traditional tables may be preferred for rTHA because it allows the surgeon to freely move the surgical extremity for acetabular/femoral exposure without confinement to a boot/spar. The pelvic bump allows adequate femoral extension that is critical for

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**Figure 1**

A. Anteroposterior radiograph demonstrating a loose acetabular cup with a large column defect. B and C, Schematic and clinical picture demonstrating large anterior column and superior acetabular dome defect. D and E, Revision cementless acetabular implant with a superior augment for complex acetabular reconstruction through DAA. F, Postoperative radiographs showing complex acetabular reconstruction and cemented femoral stem.
broaching, reaming, and canal access. Failure to create uniform bump placement may result in poor acetabular anatomic orientation. The patient’s extremity is positioned to the edge of the bed while positioning the greater trochanter at the table hinge for maximum leg excursion. An extra arm board is placed on the contralateral side to allow further leg adduction and maneuverability. Although revision DAA may be performed on a specialized orthopaedic table, understanding the table-specific positioning maneuvers (eg, Trendelenburg positioning of the torso effectively elevates the proximal femur) is helpful to facilitate exposure.

Surgical Anatomy

If a previous DAA incision is present, the same incision should be used, staying lateral and distal to the ASIS to minimize the risk of lateral femoral cutaneous nerve (LFCN) injury. The incision is extended longitudinally along the fibers of the tensor fascia lata muscle (TFL). Dissection is performed down to the fascia of the TFL muscle and incised slightly lateral to the region between the sartorius and TFL to further prevent damaging the branches of the LFCN. In the revision setting, there may be notable scar tissue, so careful identification and dissection is needed to identify the interval between the TFL and hip flexors. Adhesions are common of the TFL to the tensor sheath. The ASIS is an important superficial and deep landmark for dissection and orientation.

After a cobra retractor is placed in the superior aspect of the interval along the extracapsular superior femoral neck, the presence of the rectus femoris muscle and lateral circumflex femoral artery branches directing to the hip joint on the medial side of the surgical field can be identified and coagulated. A second blunt retractor is placed over the extracapsular inferior femoral neck. The

**Figure 2**

A. Anteroposterior radiograph demonstrating a loose-cemented all-polyethylene acetabular component with chronic pelvic discontinuity. B. Intraoperative fluoroscopic image demonstrating acetabular reaming while the stem is translated superiorly for clear acetabular access. C. Revision acetabular final component placement with multiple screw fixation. D. Intraoperative fluoroscopic image showing cup-cage construct for chronic pelvic discontinuity through extensile DAA E. Postoperative pelvis radiograph demonstrating cup-cage revision acetabular THA reconstruction. F. Cup-cage revision acetabular reconstruction with stable alignment and fixation at the short-term 3-year follow-up.
anterior fat over the hip capsule is removed to allow anterior capsular visualization. The reflected head of the rectus in confluence with the capsule, rectus tendon, deeper iliocapsularis, and vastus lateralis (VL) can all be identified before capsulotomy/capsulectomy. The hip is held in slight flexion to allow relaxation of the rectus femoral muscle and femoral vessels as a blunt retractor is placed over the anterior-superior or anterior-inferior aspect of the acetabulum. Care must be taken to place the retractor under the psoas sheath, with the psoas fossa as a landmark while maintaining intimate bony contact along the anterior acetabular rim. However, retractor placement directly along the anterior rim is avoided, if possible, because the femoral neurovascular bundle is closest to the rim at 90° from the center of the acetabulum (16 mm).6

The reflected head of rectus can further be released off the capsule to allow better capsular exposure; this is common in the revision setting. Anterior capsular scar excision is generally required in the rTHA setting because of notable hypertrophy. Debulking of the capsule considerably aids acetabular exposure. If capsular flaps are retained, it can be used for closure after completion of the revision procedure. Proximal exposure can be augmented with the release of the TFL usually 2 to 3 cm off the crest of the ilium. The release is performed through the TFL tendinous portion to ensure tissue cuff repair with interrupted suture at the end. The TFL is reflected off the iliac crest at the most ventral portion along its insertion; dissection is not taken deeper along the crest/outer table surface to avoid iatrogenic injury to the superior gluteal nerve. No change in postoperative rehabilitation is made with a TFL release. If exposure is still inadequate, an iliac wing osteotomy can be performed, although this would rarely be required in the presence of the TFL release. Osteotomy screw fixation sites are often predrilled before osteotomy to ensure stable refixation.

Femoral exposure is initially augmented by releasing the pubofemoral ligament to achieve >90° external rotation.7 The posterior capsule is released subperiosteal from the femur to allow elevation and ease during broaching and reaming. A full thickness superior capsular release can be performed to further improve exposure. This typically generates 1 to 2 cm of ventral translation and allows the femur to translate 1 to 3 cm proximal to the superior acetabular rim.7 If exposure is still inadequate, the leg should be “reset” by redoing retractor placement because this may cause obstructing soft tissues to fall posterior to the elevated femur and improved femoral excursion.7 Posterior external-rotator structures are the last tendons to be released and considered secondary releases if previous techniques do not achieve sufficient exposure.

Release of the structures in the revision setting may also be performed in cases of notable scar tissue/multiply operated hip, notable leg-length discrepancy/leg-length equalization, and/or soft-tissue contractures, such as a notable external rotation contracture of the surgical limb. We suggest following the hierarchy of releases previously published, including a stepwise algorithmic approach for Revision Total Hip Arthroplasty.
approach to the femoral releases (Figure 3). Specifically, the external rotators are released from the proximal femur off the posterior surface after appropriate capsular releases and release of existing scar tissue in the revision setting. The order is generally conjoint tendon, followed by piriformis. The obturator externus should be preserved, except in severe deformity or contracture cases, because this tendon provides a notable checkrein to dislocation. Judicious release of the posterior structures in the revision setting may increase the risk of dislocation, but this must be weighed against restoration of leg length, offset, and deformity correction.

**Extensile Exposure**

**Acetabulum**

Access to the acetabulum can be achieved by positioning the femur in a soft-tissue pocket posterior to the acetabulum. In the presence of a well-fixed femoral stem, hip flexion and slight axial movement will allow retractors to maneuver the femoral stem posteriorly and allow appropriate acetabular visualization for any acetabular procedure. A moist sponge may be placed between the retractor and the femoral neck to prevent iatrogenic trunnion damage. If an orthopaedic table is used in this approach, release of any traction will aid in posterior-superior translation of the femur/retained femoral component.

Retractor placement is critical for access to the acetabulum. The first retractor is placed in the posterolateral aspect of the acetabulum to expose the posterior column. The second retractor is placed carefully over the anterior wall, ensuring not to dive deeply across the anterior capsule to prevent femoral neurovascular injury. Vessels in the inferior aspect of the cotyloid fossa may need cautерization to allow retractor placement along the ischium. Once adequate exposure is achieved, if the cup requires revision, cup explant instruments can be used to minimize the amount of bone loss; offset handles may be used. Once the component is explanted, residual bone stock is inspected to determine if acetabular bone grafting or augments are needed to bolster hemispherical shell fixation.

The incision can be extended toward the TFL iliac insertion and further extended along the iliac crest for 5 to 7 cm for both intrapelvic and extrapelvic access. For intrapelvic extension, the external oblique aponeurosis is exposed along the iliac crest and gluteus medius pillar of the acetabulum. A cobb is used to subperiosteally elevate the abdominal musculature off the iliac crest and iliococcygeus muscle off the inner table of the pelvis. ASIS attachments including the inguinal ligament medially and sartorius laterally with the direct rectus head from the AIIS are taken down as a single sleeve of tissue to continue preservation of the LFCN within the TFL sheath. Inner table exposure can be continued medially while releasing the iliopsoas tendon and muscle along the anterior column inner surface (Figure 4). Hip flexion and adduction can further improve access to the quadrilateral plate medially while taking tension off the femoral neurovascular bundle.

![Figure 4](image)

Intraoperative schematic illustrations made of the hip before (A) and after (B) acetabular revision demonstrating proximal intrapelvic extension of the Hueter approach to allow visualization of the anterior column and iliac crest to the level of the pubic eminence. In the case of this hip, a defect of the anterior column was grafted and the acetabular shell was revised. C, A schematic of the defect and exposure is demonstrated about the hip shown in (A and B). (Adapted from Mast NH, Laude F: Revision total hip arthroplasty performed through the Hueter interval. J Bone Joint Surg Am 2011;93[suppl 2]:143-148.) Adaptations are themselves works protected by copyright. So to publish this adaptation, authorization must be obtained both from the owner of the copyright in the original work and from the owner of copyright in the translation or adaptation.
The ilium outer table can also be accessed through proximal extension of the DAA incision that allows access to the anterior column and most of the posterior column. Because the TFL is mobilized proximally off the iliac crest, the ASIS can be osteotomized for greater mobility. Rather than a large ASIS osteotomy, an

Figure 5
Cadaveric model showing superficial dissection (A and B) down to the anterior-superior iliac spine (*), followed by a fascial incision exposing the tensor facia lata (C). Exposure of the iliac wing down to the true pelvis is made after wafer osteotomy (D) of the anterior-superior iliac spine. (Adapted from Samuel LT, Munim M, Acuña AJ, Sultan AA, Kamath AF: Modified iliac spine wafer osteotomy for exposure during Bernese periacetabular osteotomy. J Hip Preserv Surg 2019;6:421-425.) Adaptations are themselves works protected by copyright. So to publish this adaptation, authorization must be obtained both from the owner of the copyright in the original work and from the owner of copyright in the translation or adaptation.

Figure 6
Illustration (A) demonstrating the iliac osteotomy using the oscillating saw. The osteotomy is performed first with the saw and completed with the osteotome (B and C). The osteotomy should extend to the anterior border of the AIIS. (Adapted from Ziran NM, Sherif SM, Matta JM: Safe surgical technique: iliac osteotomy via the direct anterior approach for revision hip arthroplasty. Patient Saf Surg 2014;8:32.) Adaptations are themselves works protected by copyright. So to publish this adaptation, authorization must be obtained both from the owner of the copyright in the original work and from the owner of copyright in the translation or adaptation.
Alternate wafer osteotomy of the iliac crest (Figure 5) can be used. The supraacetabular anastomosis of the superior gluteal artery along the interspinous crest needs to be ligated to obviate blood loss. Once the TFL is mobilized, the gluteus minimus is dissected subperiosteally along the outer surface of the ilium from anterior to posterior to the greater sciatic notch. It is important to be vigilant about careful soft-tissue mobilization and retractor placement because injury to the neurovascular bundle in the greater notch may affect abductor function. The area underneath the mobilized TFL and gluteus minimus is where augments, acetabular cages, custom triflange components, and other supportive implants can be placed. Inferiorly, subperiosteal dissection is performed anteroinferior and posteroinferior to access the pubis and ischium, respectively. Retractors should be placed carefully posteriorly to avoid sciatic nerve injury. Although stepwise soft-tissue releases aid circumferential acetabular exposure, revision DAA for primary posterior acetabular reconstruction may be more challenging.

**Femur**

The fundamental elements of femoral exposure, especially during revisions, is external rotation, elevation, and adduction. For extensile distal exposure, the skin incision is extended longitudinally and curved laterally toward the distal femur. This can be a continuous incision or separated into a proximal and a distal lateral incision. The anterior TFL border is split distally to reflect the muscle posteriorly and continues laterally into the iliotibial band. The space underneath the iliotibial band is bluntly dissected to separate the tissue from the underlying VL. The VL is elevated distally and lateral to the greater trochanter while preserving a muscular bridge between the vastus and gluteus medius muscle. The VL can be split directly laterally or the posterior border of the vastus can be exposed and lifted off the femur to access the femoral diaphysis. This can be achieved with electrocautery or a Cobb elevator.

Although more difficult, lifting the VL from its posterior aspect may be preferred because the blood supply from the descending branch of the lateral circumflex femoral artery is predominantly through the muscle attachment along the anterior aspect of the femur. The VL posterior blood supply can be identified from the perforating branches of the lateral profunda femoral artery. The VL can be elevated off the femur as far distal as is needed for the revision procedure. Although iliac wing osteotomy may be used for acetabular exposure, a variant of this osteotomy may be used for femoral canal exposure/trajectory, especially with an overhanging iliac wing or shorter interischial distance (Figure 6). The iliac wing may obstruct a straight trajectory of the femoral canal for stem placement. If soft-tissue releases cannot adequately draw the femur superior and laterally away from the pelvis for safe femoral access, an iliac wing osteotomy is considered. Although the osteotomy for acetabular exposure may be a wafer or chevron type configuration, osteotomy for femoral exposure is generally larger and reattached with screw fixation. Drill holes may be performed before iliac wing osteotomy to afford anatomic reduction and ease of screw fixation. With adequate exposure, an attempt to remove a well-fixed component with flexible osteotomes and a pencil-tip burr may be first tried before osteotomy of the proximal femur (Figure 7).

**Femoral Osteotomy**

**Indications**

All variations of femoral osteotomy are performed to improve both acetabular and femoral exposure in complex primary and rTHA. The current indications for
Trochanteric slide osteotomy (TSO) in rTHA are limited, especially in anterior-based revision arthroplasty. An episiotomy-type limited corticotomy may be attempted first for the removal of shorter uncemented stems (Figure 8), which can then be extended into an extended femoral osteotomy as needed. Both the extended trochanteric osteotomy (ETO) and transfemoral osteotomy (TFO) are the workhorses for extensile femoral exposure. These surgical techniques are especially useful for the removal of well-fixed cemented, cementless, metaphyseal, and diaphyseal engaging stems and may be used for septic and aseptic revisions.13 TFO is especially useful in the removal of residual cement in the distal femur, extraction of broken femoral components, and for notable anterior femoral bowing/remodeling.

Extended Trochanteric Osteotomy
Typically, the ETO fragment has a proximal pole defined by the greater trochanter, a posterior border defined by the linea aspera, and anterior border developed with scoring holes using a drill or osteotome, and the distal pole is defined by a horizontal cut in the diaphysis of the femur.14 However, it may be easier to perform an ETO via a DAA by developing the posterior border by scoring holes and the anterior border with an oscillating saw along the midportion of the femoral shaft. A thin-kerf saw blade under saline irrigation is used to perform the anterior-based portion of the ETO. This minimizes bony thermal necrosis and less bone removal for improved reduction and healing. The typical length of the ETO is between 12 and 15 cm but is tailored specifically according to the length of the preexisting stem. Ideally, the transverse cut does not include more than one-third of the circumference of the femoral diaphysis (Figure 9). The posterior border of the linea aspera can be difficult through extensile DAA, so the posterior border of the ETO can be shifted along with VL elevation during exposure.

Transfemoral Osteotomy
The TFO differs from the ETO in circumferential depth and osteotomy orientation. Although the ETO typically incorporates one-third of the femoral shaft diameter, the TFO uses 30% to 50% of the femoral diaphysis (Figure 10). The bony split for the ETO is made in the sagittal plane, whereas TFO is a coronal plane anterior femur-based osteotomy. Similar to the ETO, the location of the distal transverse cut is according to the length of the
preexisting femoral stem (Figure 11). The VL is split with an incision carried from the proximal extent of the muscle to distal of the planned transverse cut. The medial and lateral osteotomy limbs are created directly with an oscillating saw. The medial aspect of the femur can also be scored using a high-speed burr and connecting the holes with an osteotome. Drill holes distally for the transverse cut are usually performed to avoid stress fractures during the osteotomy. The bony fragment blood supply is usually uncompromised from the VL muscle attachment. Similar to the ETO, metallic and/or nonmetallic cables are fixation options after TFO.

Clinical Outcomes

Because the demand for DAA has increased, this approach has also been gaining traction for rTHA. To our knowledge, Kennon et al\textsuperscript{15} first demonstrated the utility of DAA rTHA. A series of 468 patients who underwent acetabular and/or femoral component revision were included, whereas revisions for polyethylene liner exchange and open reduction and internal fixation without component exchange were excluded from the final analysis. In total, 97 patients had cemented femoral revisions, 252 patients cementless femoral revisions, and 119 patients acetabular cup-only revisions. Within 6 months postoperatively, complications included dislocation (cemented femur, \( n = 3 \); cementless femur, \( n = 8 \); and acetabular-only, \( n = 3 \)), periprosthetic fracture (cemented femur, \( n = 14 \); cementless femur, \( n = 45 \); and acetabular-only, \( n = 3 \)), clinically notable hematoma (cemented femur, \( n = 2 \); cementless femur, \( n = 4 \); and acetabular-only, \( n = 1 \)), periprosthetic joint infection (cemented femur, \( n = 2 \); cementless femur, \( n = 8 \); and acetabular-only, \( n = 2 \)), thromboembolic event (cemented femur, \( n = 2 \) and cementless femur, \( n = 1 \)), and cerebrovascular injury/myocardial infarction (cemented femur, \( n = 2 \) and cementless femur, \( n = 3 \)).

Similarly, in a retrospective single-surgeon study, Mast et al\textsuperscript{8} reviewed 51 patients with a mean follow-up...
of 54.5 ± 35.9 months. The most common diagnosis was aseptic loosening, with most revisions for loose cemented acetabular and femoral components. In 57% of cases (29 revisions), the femoral stem was well-fixed and retained. All femoral-sided revisions were accomplished with primary cementless wedge stems or cemented implants without the use of modular diaphyseal engaging stems. The most common complications were acetabular cup loosening (n = 2), heterotopic ossification (HO) (n = 1), limb-length discrepancy (n = 1), and trochanteric fracture (n = 1) without any dislocations.

Recent studies have reported the efficacy of extensile DAA for acetabular revision.5,16,17 Horsthemke et al17 performed aseptic cup revisions in 48 patients with a mean follow-up of 65 months (range, 44 to 121 months). The mean Harris Hip Score improved from 50 preoperatively (range 20 to 76) to 91 (range 57 to 96; P = 0.03) at the latest follow-up. Complications included two infections (4.2%) requiring two-stage revision. One aseptic cup loosening at 25 months (2.1%) in a Paprosky type-3A defect was noted. Similar to previous reports, no episodes of dislocation were observed. We observed one case of femoral nerve injury that resolved and no instances of LFCN injury. The low rates of instability after DAA in rTHA may be important because the general incidence of dislocation after rTHA has been reported to be as high as 39%.18 Ramsey et al5 presented a report on the implantation of a custom triflange through an extensile DAA for a chronic pelvic discontinuity. At the 1-year follow-up, the patient was walking 1 mile daily with a walker and without pain. Further longer term comparative studies are needed to determine the efficacy, implant longevity, and patient-reported outcome measures after DAA for septic and aseptic rTHA.

Complications

DAA patients may have higher rates of wound complications and neurovascular complications because of incision locality (Figure 12).19 Special occlusive20 and negative pressure wound vac therapy dressings can be used to mitigate this complication,21 along with external closure of the skin such as with interrupted nylon suture.

Preservation of the TFL is also critical because the muscle works in conjunction with the hip abductors and is essential in maintaining pelvis stability during standing and walking. In a cadaver study, Grob et al22 found that the terminal inferior branch of the superior gluteal nerve routinely crossed along the medial TFL surface within 10 mm of the ascending branch of the lateral circumflex femoral artery where it is at risk of injury during exposure and ligation. Other studies have also suggested increased TFL damage during DAA when compared with the anterolateral23 and posterior approach.5,24 However, a retrospective study examining 25 DAA THA patients and 25 posterior THA patients found consistent integrity of the TFL and hip abductors on postoperative MRI.2 Careful attention is required during DAA exposure, retractor placement, vascular cauterization, and limb manipulation to mitigate TFL injury.

Lateral Femoral Cutaneous Nerve

The LFCN is a sensory nerve arising from the L2 and L3 nerve roots and courses distally along the posterolateral aspect of the iliopsoas muscle and superficially to the
sartorius muscle. The LFCN pierces the TFL to innervate the superficial anterolateral aspect of the lower extremity. However, the branching pattern of the LFCN is highly variable and often transverses the interval between the sartorius and TFL at different locations (Figure 13). In an anatomic cadaver study of 28 hemipelvis, Rudin et al.26 found three different branching patterns of the LFCN.

Figure 11

A. A schematic representation of cuts made during a transfemoral osteotomy. B and C. Clinical picture demonstrating transfemoral osteotomy that allows complete canal access for stem removal and femoral reconstruction (Schematic image adapted from Sundaram K, Siddiqi A, Kamath AF, Higuera C. Trochanteric Osteotomy in Revision Total Hip Arthroplasty. EFORT Open Access. 2020.) Adaptations are themselves works protected by copyright. So to publish this adaptation, authorization must be obtained both from the owner of the copyright in the original work and from the owner of copyright in the translation or adaptation.

Figure 12

The four major branching patterns of the LFCN. A, Classical branching pattern. B, Late branching pattern. C, Primary femoral branching pattern. D, Trifurcate branching pattern. ASIS five anterior superior iliac spine, and LFCN five LFCN. (Adapted from Vajapey SP, Morris J, Lynch D, Spitzer A, Li M, Glassman AH: Nerve injuries with the direct anterior approach to total hip arthroplasty. JBJS Rev. 2020;8(2):e0109.) Adaptations are themselves works protected by copyright. So to publish this adaptation, authorization must be obtained both from the owner of the copyright in the original work and from the owner of copyright in the translation or adaptation.

LFCN = lateral femoral cutaneous nerve.
LFCN: sartorius type with a predominant anterior nerve branch coursing along the lateral aspect of the sartorius (36%), posterior type (32%), and a fan type with multiple smaller nerve branches of similar thicknesses (32%). The authors also found that in 50% of the specimens, the LFCN divided into two branches superior to the inguinal ligament, whereas the nerve branches coursed along the proximal aspect of the thigh medial to the ASIS in most hemipelvis (62%). The authors concluded that the LFCN injury is difficult to avoid, given the variable nature of the nerve within the surgical interval. The anterior LFCN branch is generally protected by maintaining the incision as lateral and distal as possible, thereby rendering the posterior branch to be the most prone to injury along the proximal aspect of the interval.26

The literature demonstrates a wide range of LFCN neuropraxic injury rates (between 0.1% and 81%) during DAA.15,26-29 Although patients with LFCN injury most often do not present with a major neurological complication, numbness, burning, and dysesthesias along the anterolateral thigh are the most common
reports. This is an important complication to curtail because dysesthesias have been found to be strongly correlated with the quality-of-life outcome scores postoperatively.25,30

**Femoral Nerve**

Unlike LFCN neuropraxia, femoral nerve injury is a more serious and devastating complication that occurs in 0.01% to 2.27% of patients.6,31 Higher risk of femoral nerve palsy has been associated with both anterolateral and DAA, as compared to other approaches.6,25,31 The femoral nerve originates from L2 to L4 nerve roots and travels distally within the psoas muscle. The nerve courses deep to the inguinal ligament and divides into terminal motor branches in the anterior aspect of the thigh. The femoral nerve’s sensory branches innervate the hip and anteromedial aspect of the thigh before tapering distally as the saphenous nerve.25 As the nerve travels deep to the inguinal ligament, it is near the anterior wall of the acetabulum and has been reported to be as close as 1.8 to 2.2 cm.25 Aberrant anterior retractor placement can cause notable nerve injury.

In a cadaver study of 84 hips, Yoshino et al6 explored femoral nerve anatomic variation during its course near the anterior acetabular rim. The authors defined six measurement points along the rim every 30° (from 0° to 150°), with a reference line drawn from the ASIS to the center of the acetabulum as described by Wasielewski et al.32 The mean distance between the femoral nerve and the anterior rim became shorter from 0° to 90° and then progressively longer from 90° to 150° (P < 0.001). The distance at 90° was the shortest at 16.6 mm and correlated positively with iliopsoas tendon thickness and femoral length. Other studies have also shown that retractor placement directly across the anterior acetabulum showed decreased femoral nerve amplitude and raised pressure around the nerve, even if the retractor was placed through the bulk of the iliopsoas muscle.33,34 Therefore, it is important for surgeons to be cognizant of the distance between the femoral nerve and anterior part of the acetabulum when placing retractors.

Extreme hip external rotation, hyperextension, and adduction during femoral broaching, reaming, and intraoperative hip stability testing has been implicated in transient femoral nerve palsy and ischemia.25 Minimizing continued limb manual traction and extreme positioning can potentially avoid the risk of neuropraxia. Although the threshold for limb lengthening is inconclusive, some authors suggest intraoperative nerve monitoring in cases where lengthening greater than 2 cm...
is anticipated because studies have shown femoral nerve tobe more sensitive to lengthening compared with the sciatic nerve.24,26, and 32 Level IV studies.

Patients with femoral nerve injury have variable presentation secondary to both sensory and motor branches. Patients with sensory symptoms often complain of paresthesia or dysesthesias, whereas those with motor deficits present with varying degrees of quadriceps weakness.25 Severe motor deficits inhibit knee extension, causes prominent gait abnormalities, and consequently increases the likelihood of falls.25 Increased postoperative falls have been associated with subsequent periprosthetic femur fractures, especially in the elderly.25

Heterotopic Ossification

The incidence of HO has been reported as high as 19% to 40% after DAA primary THA.38,39 Because the occurrence of HO is common for anterior-based hip approaches, revision DAA may be a viable surgical approach for HO resection. To lower the risk of complications such as excessive intraoperative bleeding and HO recurrence, it is essential to wait until HO maturity.40 Once serial radiographs have shown sharp peripheral edges without continued growth, HO resection can be considered. A bone scan can further determine HO burden metabolic activity.

Summary

Thorough understanding of bony and neurovascular anatomy is essential for performing extensile exposure of the acetabulum and femur for DAA rTHA. The standard incision can be extended proximally toward the ASIS and iliac crest to allow access to both the inner and outer pelvic table for plating, augmentation, and reconstruction devices. Distal extension gives femoral diaphysis access and allows extended trochanteric and transfemoral osteotomies. Additional tips and tricks for DAA rTHA are summarized in Table 1. As surgeons have become more experienced and comfortable with primary DAA THA, the learning curve for rTHA using an extensile DAA remains to be studied. Further longer term comparative studies are needed to determine the efficacy, implant longevity, and patient-reported outcome measures after DAA for rTHA.

Levels of evidence are described in the table of contents. In this article, references 21, 23, 28 are level I studies. References 1, 8, 18, 20, 31, 38, and 39 are level III studies. References 4, 7, 10, 12, 16, 17, 27, 29, 30, 33, 35, 36, and 37 are level IV studies. References Level V: 5, 6, 11, 22, 24, 26, and 32 level IV studies.


References

References printed in bold type are those published within the past 5 years.


