Femoral Derotation Osteotomy Technique for Excessive Femoral Anteversion

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Abstract: Excessive femoral anteversion may lead to increasing stress placed on the anterior acetabulum and soft tissues, which can predispose to intra-articular hip pathology. By addressing the excessive femoral anteversion in combination with intra-articular hip pathology, the results will be durable over time. This technique details how to perform a femoral derotation osteotomy for excessive femoral anteversion after addressing intra-articular pathology with hip arthroscopy in one surgical intervention. This allows the surgeon to address both the underlying pathoanatomy and the resultant intra-articular sequelae.

Hip arthroscopy has shown positive results in patients with symptomatic femoroacetabular impingement with labral tear.[1-3] There are other structural abnormalities of the hip joint that can make arthroscopic treatment alone less likely to be successful including acetabular dysplasia[4] and femoral version extremes.[5-7] Hip arthroscopy cannot address these morphologic abnormalities, and open surgery is often necessitated to change the underlying cause of the hip pain. For acetabular dysplasia a periacetabular osteotomy reorients the acetabulum to improve the coverage of the femoral head by the acetabulum.[8] Hip arthroscopy results are mixed in patients with different ranges of femoral version, with some studies showing worse clinical outcomes with either more retroverted or more anteverted femurs.[5-7,9,10] There has yet to be a study that has examined severe femoral anteversion.

Excessive anteversion may lead to increased stress on the anterior acetabulum and anterior soft tissue structures of the hip. It is hypothesized that because arthroscopy does not address these underlying structural abnormalities of the hip, it is destined for failure because overload of the anterior acetabulum and soft tissues continue despite correcting the resultant soft tissue sequelae of excessive femoral anteversion. For this reason, the senior author now performs hip arthroscopy with the treatment of intra-articular pathology and then concomitant derotational osteotomy of the femur in patients with extreme femoral anteversion. The purpose of this Technical Note is to outline the senior author's (B.G.D.) indication and technique for femoral derotation osteotomy.

Technique

Patients with excessive anteversion can have symptoms similar to other hip patients. In addition to this, they have significant internal rotation of the hip and may have anterior pain with instability testing and posterior pain with posterior impingement testing. The authors' current indications for this procedure are excessive femoral anteversion (>35°) as measured on preoperative computed tomography scan (Fig 1), anterior instability as noted by anterior hip pain with hip extension and external rotation, excessive internal rotation of the hip with the hip flexed to 90° (>65°) (Fig 2), and a subjective complaint of an in-toeing with gait. Patients are worked up for hip pain attempting to diagnose a labral tear with typical impingement testing,

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The authors report the following potential conflicts of interest or sources of funding: B.G.D. receives research support from Arthrex, Breg, ATI, Pacira, and Stryker; royalties from Orthomerica and DJO Global; and consulting fees from Amplitude and Medacta. He is a board member for the American Hip Institute, which funds research and is the institute where our studies are performed, and also a board member for the AANA Learning Center Committee and Arthroscopy Journal. *Full ICMJE author disclosure forms are available for this article online, as supplementary material.*

Received February 22, 2017; accepted May 30, 2017.

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2212-6287/17226/$36.00

http://dx.doi.org/10.1016/j.eats.2017.05.027

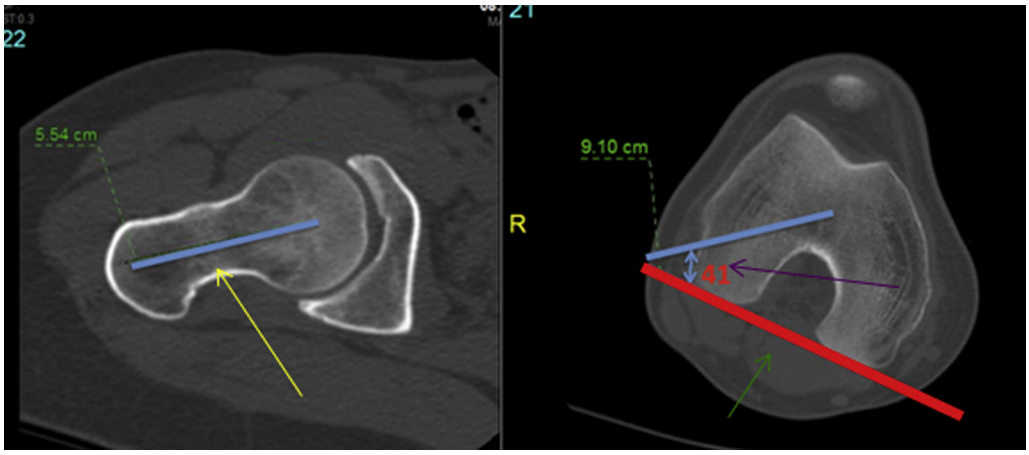

Fig 1. Degree of femoral anteversion as measured on axial images from a preoperative computed tomography (CT) scan. This is a CT scan of the left hip with the patient laying supine on the CT scanning table with the patient's feet internally rotated 15°. On the left, axial images through the hip note the femoral neck with a blue line drawn down its longitudinal axis (yellow arrow) noting the angle the femoral neck produces. On the right, an axial image at the knee notes the posterior condylar axis by the red line (green arrow) from the medial to lateral posterior femoral condyle. These 2 lines form the anteversion angle of the hip (angle noted by the purple arrow). (R, right).

in addition to posterior impingement testing (extension external rotation causing posterior hip pain). Because of the amount of anteversion, these patients are predisposed to have anterior hip instability that can be tested for by observing anterior hip pain with extension and external rotation that loads the anterior soft tissue structures of the hip. All patients are taken through physical therapy for a minimum of 3 months trying to increase hip stability, lumbar, and core strength. The amount of anteversion of the hip is measured as shown in Figure 1, with serial axial cuts through the knee to obtain the posterior condylar axis and comparing this line with a line drawn down the long axis of the femoral neck. These 2 lines form the anteversion angle.

The patient is set up in the supine position on a hip arthroscopy table with a perineal post in position for traction. Fluoroscopy is brought in from the contralateral side with the arthroscopy monitor at the head of the bed and the fluoroscopy monitors at the foot of the bed (Fig 3). Arthroscopy is conducted to address the intra-articular hip pathology and resect cam and pincer lesions as necessary. The senior author (B.G.D.) conducts a transcapsular iliopsoas lengthening in all patients undergoing femoral derotation for excessive anteversion because the contact pressure between the head-neck junction will increase after derotation has been performed (Table 1).

After arthroscopy has been completed, the perineal post is removed and fluoroscopy is brought in over the hip. A 3- to 4-cm incision is placed approximately 3 finger-widths proximal and approximately 2 cm posterior to the tip of the greater trochanter. The skin is incised down to the abductor fascia. This fascia is then longitudinally incised as distal as possible to allow easy placement of future soft tissue protection guides with minimal soft tissue damage. When the hip can be visualized by fluoroscopy, the starting point is located with a 17.0/3.2-mm guide pin on the anteroposterior and lateral image for a titanium cannulated lateral entry 2 femoral recon nail expert system (Synthes, Westchester, PA). The preferred starting point for the senior author (B.G.D.) is just medial to the greater

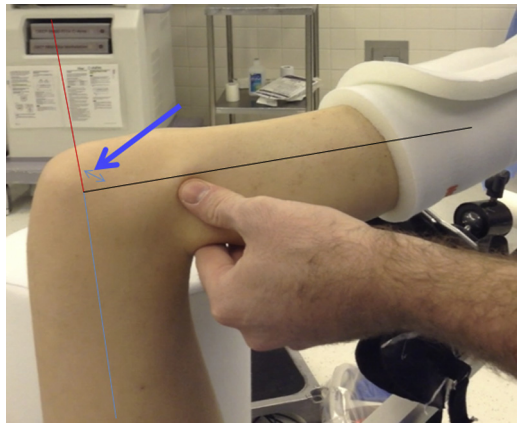

Fig 2. The patient is lying supine on the operating room table with the right leg being examined. The examiner's left hand is holding the patient's knee stable, whereas the right hand is manipulating rotation with the hip flexion angle held at 90° throughout. A blue line is drawn denoting the axis of the femoral shaft. When the patient's leg is in 0° of rotation, the tibia would be following the red line. The figure shows the patient in maximal internal rotation that is the angle (noted by the blue arrows) the red line (0° of rotation) makes with the black line (maximal internal rotation of the hip that in this patient is noted to be 85°).

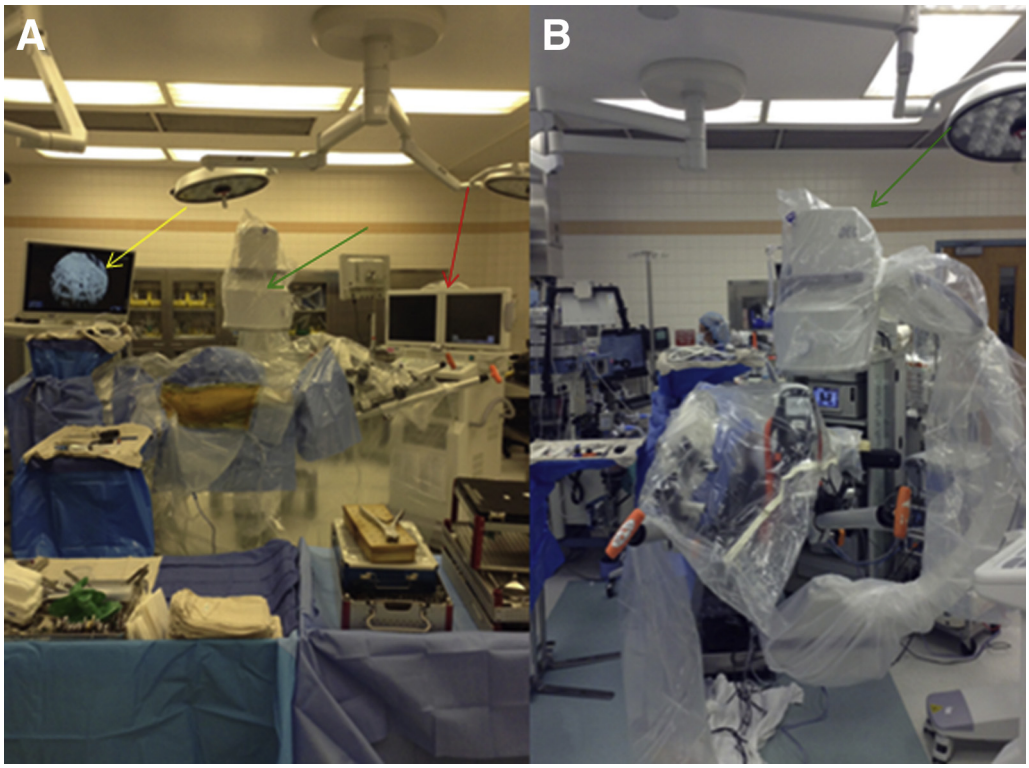

Fig 3. Note the setup for both the arthroscopic and open portion of the case for a right hip. Head and anesthesia is to the left and the foot is to the right; the patient is supine on the traction table. Fluoroscopy enters the field from the contralateral side (green arrow) with monitors for fluoroscopy at the foot of the bed (red arrow). The arthroscopy monitor is placed at the head of the bed (yellow arrow) (A). A picture looking at the setup from the foot of the bed with the patient's right side being to the left of the screen and the left side on the right side of the screen. Fluoroscopy is coming in from the contralateral left side (green arrow) (B).

trochanter on the anteroposterior and directly over the femoral shaft on the lateral image. Placing the guide pin on the outer aspect of the greater trochanter is avoided because of the risk of damaging the abductor tendons. The guide pin is then drilled to just below the level of the lesser trochanter. The 15.0-mm opening reamer is used with a 17.0-mm soft tissue protection sleeve. The 2.5-mm reaming rod with a ball tip (950 mm) is then placed in the medullary canal. The ball tip guidewire is placed down to just above the level of the physeal scar of the distal femur and then the length is measured with a Synthes

Table 1. Pearls and Pitfalls for Femoral Derotation Osteotomy of the Femur for Excessive Femoral Anteversion

Pearls	Pitfalls
• Over-ream by 1.5 mm to ensure that distal femur can rotate around the nail • Use 2 pins proximally and distally in case one is knocked loose • The anterior pins proximally and distally must be perfectly parallel as should the posterior pins as a double check • Leave the ball tip guidewire in place when performing osteotomy as it prevents gross displacement of the nail • After nail and distal interlocks are placed, backslap to maximize compression before proximal locking • Keep the patient paralyzed throughout the procedure, which allows easier manipulation of distal/proximal segments of bone • If planning on backslapping or dynamizing the intramedullary nail, select a slightly shorter nail and countersink the nail a few centimeters. • Leave the soft tissue protector in place when reaming and then irrigate and suck out all debris before removal (minimize HO). • Perform transcapsular iliopsoas release to avoid iatrogenic internal coxa saltans postoperatively	• Maintain Hohmann retractors on bone around femur to ensure that neurovascular structures are safe • Not placing pins securely in bone and in the tract of the nail can result in them falling out and then no way to measure version change • Some patients with extreme femoral anteversion can have skeletal dysplasia and the size of their canal may not be amenable to intramedullary nail, this needs to be recognized preoperatively

HO, heterotopic ossification.

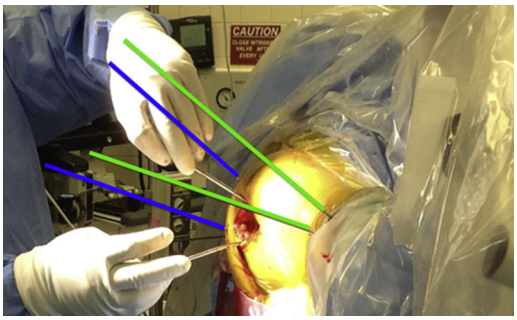

Fig 4. The patient is supine on the traction table and the picture is taken from the foot of the right leg. Before performing any osteotomy or correction, an anterior and a posterior pin are placed proximal on the femur (blue), and then an anterior and a posterior pin are placed in the distal femur (green) perfectly parallel to the proximal pins. This photograph shows the initial parallel position of the proximal (blue) and distal (green) pins before osteotomy. It is critical to be parallel because this angle is used as the zero point for after the osteotomy is performed the angle will then be changed to the correct amount of version change desired.

intramedullary nail measurement device. When between sizes the shorter size should be used.

Reaming is now performed with the soft tissue sleeve still in place to avoid damage to abductors and avoid introducing bone debris from reaming into the abductors. The usual nail with a diameter of 10 mm is used. The goal is to remove very little endosteal bone with reaming. The authors recommend reaming 1.5 mm larger than the desired nail size (11.5-mm reamer) to allow some rotation adjustments of the femur around the nail. This nail comes between sizes 9 and 16.

To observer the change in version, pins are now placed in the proximal and distal segment of the femur. Two 2.0 Steinmann pins are place proximally anterior and posterior to the nail entry sight in the peritrochanteric bone. Two 2.0 Steinmann pins are also placed in the distal segment. These 2.0 Steinmann pins are placed in the metaphysis of the distal femoral bone anterior and posterior to the eventual intramedullary nail. The anterior and posterior distal pins should be placed parallel to the corresponding anterior and posterior proximal pins as judged by an assistant at the foot of the bed (Fig 4). After they are placed, the surgeon verifies that the pins are parallel. The change in version is calculated preoperatively. The target version is usually between 15° and 20° depending on the severity of the preoperative deformity. A sterile goniometer is set to the angle of desired change (i.e., if preoperative anteversion is 45° and target version is 20°, the goniometer is placed at 25°).

Using fluoroscopy, the osteotomy site is planned approximately 5 to 6 inches below the lesser trochanter. A 3-inch-long incision is then centered at this point. The incision is made through the skin and subcutaneous fat down to the fascia lata. The fascia lata is split in line with the incision, and the vastus lateralis is elevated off the fascia lata; it is then elevated of the lateral intermuscular septum and the femur is identified. Two large Hohmann retractors are placed along the anterior and posterior femoral cortices after the soft tissue has been stripped off this segment of bone. The transverse osteotomy is then conducted. A 4.5-mm drill bit is used to make slots along the anterior and posterior cortex of the bone. Then the drill is used to get as much of the medial cortex as possible through these slots. A large oscillating saw is used to cut the lateral cortex of the bone. If the osteotomy is not yet complete, a 0.5-inch straight osteotome is used to complete it. The intramedullary ball tip guidewire being in place will prevent any gross displacement of the bones from one another. The distal segment of the femur is now externally rotated by externally rotating the foot to approximate the desired angular change for the patient. This will likely change to some degree as the nail is placed, but is used to get the segments close to their final position. The appropriate length/diameter Synthes lateral femoral recon nail is then placed over the ball tip guidewire with the nail inserter screwed onto the nail. Two lobster claws are used to provisionally hold the proximal and distal segment as close together as possible and to maintain external rotation of the distal segment as the nail is placed. Frequent images of the hip and knee are taken as the nail is malleted into position to ensure that the nail is buried just below the cortex of the entry sight and not coming close to the articular surface of the knee. Once the depth of the nail is satisfactory, the angles of the proximal and distal pins are again checked with a sterile goniometer. Ensuring that the pins are not loose is important because if placed improperly the nail can dislodge them. This is why 2 sets of pins are placed. When an appropriate angular change is confirmed (Fig 5), the distal interlocks are placed under fluoroscopic guidance. The rotation change is checked again. If satisfied, then the nail is backslapped until adequate compression is achieved.

The aiming arm of the nail is then tightly placed onto the nail inserter. The proximal locking position for the screw should be used. Before drilling the hole for this screw, the correction in rotation should again be confirmed to ensure that it is appropriate. Two 5.0 static screws are then placed and the construct is locked into place. All incisions are thoroughly irrigated to get rid of bone debris, and the postoperative range of motion is checked and compared with the preoperative range of motion. There should be less internal rotation and more

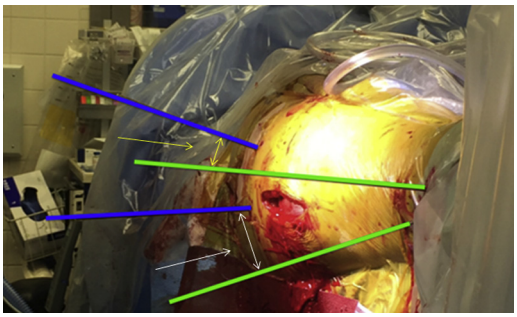

Fig 5. The patient is supine on the operating room table with picture being taken from the patient's right foot. The pins that were placed parallel in previous steps are now no longer parallel. This allows the surgeon to assess the amount of version that has been corrected. Excessive anteversion has been corrected by externally rotating the distal segment by approximately 20° (angle made between the anterior blue/green pins and/or posterior blue/green pins). The angle between the anterior proximal (blue) and anterior distal (green) pins is noted with the yellow single and double arrow (approximately 20°). The change in angle from the proximal posterior (blue) and distal posterior (green) pins is noted with white arrows (approximately 20°). Two sets of pins are used in case one set becomes loose.

external rotation if performed correctly. The surgical technique is also shown in Video 1.

Discussion

This Technical Note goes step by step through the senior author's (B.G.D.) technique on how to treat patients with extreme femoral anteversion with concomitant intra-articular pathology (Tables 2 and 3). This approach has been used by the senior author (B.G.D.) for patients with extreme anteversion (>35°), notable in-toeing gait, internal rotation of >65°, and pain with anterior instability testing with good short-term outcomes. Identifying patients at higher risk for failure of arthroscopy alone is paramount to optimizing results after surgical intervention in this difficult patient population.

The ability to treat intra-articular pathology and change extreme femoral anteversion in one procedure may prove to be advantageous. Patients with increased femoral anteversion have been shown to have worse results with arthroscopy and concomitant psoas release.[7] The authors concluded that the psoas may have some anterior stabilizing force and release may render the unstable joint in the patient with excessive anteversion. In the patient with excessive anteversion, the anterior structures of the hip including the anterior acetabulum, labrum, direct head of the rectus, and psoas may be loaded more than those in patients with normal version. Recently, Li et al.[5] noted that dysplastic patients with arthritis had significantly more femoral anteversion than dysplastic patients without arthritis. This may suggest that increased femoral anteversion may play a role in instability or anterior joint overload, which may increase joint degeneration in the dysplastic population. We hypothesize that in patients who have extreme anteversion (>35°) arthroscopy alone would only temporarily solve issues of hip pain, but that they would likely come back because of their underlying pathoanatomy.

The authors are currently collecting results of hip arthroscopy in patients with extreme anteversion (>30°)

Table 3. Equipment Needed for Hip Arthroscopy With Concomitant Femoral Derotation Osteotomy for Excessive Femoral Anteversion

Equipment needed
• Fluroscopy
• 4.5-mm drill, 0.5-inch osteotome, large oscillating saw
• Synthes titanium cannulated lateral femoral Recon Nail. Expert nail system
• Synthes 17.0/3.2-mm guidewire
• 17.0-mm soft tissue protection sleeve
• Synthes reamers of appropriate size up to 1.5 mm larger diameter than the nail required
• Four 2.0-mm Steinmann pins
• Sterile goniometer
• Screw on Synthes backslap device
• 4.2-mm drill bit with an appropriate length 5.0 screw for proximal distal interlocks
• Synthes locking aiming arm—use static locking option
• For proximal screw—12.0-mm Synthes protection sleeve, 8.0 drill sleeve, 4.2-mm trochar, 4.2-mm drill, and appropriate length 5.0-mm screw

Table 2. Advantages and Disadvantages of Hip Arthroscopy With Concomitant Femoral Derotation Osteotomy for Excessive Femoral Anteversion

Advantages	Disadvantages
• Correct underlying pathoanatomy that likely leads to hip dysfunction	• May require overnight stay in hospital
• Intramedullary nail allows immediate weight bearing when arthroscopic restrictions are removed	• No studies on femoral derotation in the hip preservation population
• Have 2 sets of pins to measure version change from femoral derotation	• Open procedure with hardware placed, so theoretically a higher infection rate than arthroscopy alone
• Likely improves preoperative instability noted on examination	
• Improves in-toeing noted on preoperative examination	
• Improves excessive internal rotation and decreased external rotation noted preoperatively	

treated with arthroscopy and concomitant femoral derotational osteotomy and will publish them when >1 year results are available on a substantial cohort.

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