13

SPAIRE Technique: The Least Invasive Posterior Approach for THR

William A. Leone and John Timperley

Introduction

SPAIRE is a novel adaptation to the familiar posterior approach that Saves Piriformis And (Obturator) Internus with Repair of (Obturator) Externus (SPAIRE technique). For an approach or new technique to add value, it must allow for adequate exposure, safe preparation and implantation of components, and restoration of anatomy and function with minimal surgical complications. The SPAIRE technique is tendon-sparing and represents one end of the spectrum of possible posterior approaches; SPAIRE is the least invasive while the extended trochanteric osteotomy is the most extensile. Because of the stability afforded by maintaining the short external rotators (SERs), patients are mobilized with no postoperative restrictions or "precautions," and special postoperative equipment such as abduction pillows or elevated toilet seats is not necessary.

SPAIRE utilizes the interval between the inferior gemellus (IG) and quadratus femoris (QF). Obturator externus (OE) is the only divided tendon and is ultimately repaired to its anatomic footprint in the obturator fossa. The posterior capsule and QF are also repaired anatomically. In practical terms, leaving most of the SERs intact confers a benefit in judging the leg length and offset. A bone hook is invariably necessary to dislocate the joint after trial reduction as the intact Obturator Internus tendon passes over the head at, or below, the center of rotation of the hip and acts as a strap holding the joint reduced.

Although a total hip replacement (THR) could be carried out through the described interval with conventional instruments, the operation is more straightforward if dedicated instruments are used to facilitate key steps in the technique.[1] In collaboration with Platts and Nisbett of Sheffield, SPAIRE instruments have now been designed to allow good socket exposure and femoral preparation without any damage to the quadriceps coxa (QC) (Figures 1 and 2). Any profit from the sale of these instruments is donated to an orthopedic research charity (https://www.plattsnisbett.com/products/spaire).

Figure 1: SPAIRE instruments, full set. Note the right and left self-retaining SPAIRE retractors.

Figure 2: SPAIRE bent Hohmann and bent Trethowan retractors.

Our hope is that the technical description in this chapter allows replication by any surgeon who is familiar with the posterior approach without compromising the ability to convert to a more extensile exposure.

Background

Dr. Yoshiaki Ito et al.[2] studied the trochanteric attachment of the SERs in detail and demonstrated that obturator internus (IO) is usually inserted in a more caudal, anterior, and medial position than piriformis (P). Dr. Vaarbakken[2] et al. noted that the "short external rotators" act together as a "quadriceps coxa" QC which functions as a primary abductor and extensor of the hip from flexed

positions and is therefore of importance in rising from the seated position and propulsive motions. It became apparent that hip arthroplasty could be performed while leaving all tendons intact except for OE. Throughout this chapter we will refer to the Quadriceps Coxa (QC) to include the piriformis (P), and the conjoined tendon of the Obturator Internus (OI), with the superior Gemellus (SG) and inferior Gemellus (IG).

Several surgeons in South Korea have been carrying out surgery through the same interval. In 2008, Dr. Kim published a paper entitled "Modified Posterior Approach to Total Hip Arthroplasty to Enhance Joint Stability.[4]" He described a study comparing the dislocation rates in three series: routine posterior, posterior plus repair, and external rotator preservation. The diagnosis was avascular necrosis in 83% of the preservation group, and most patients had a low body mass index. He considered that the procedure "may have limited application in patients with primary osteoarthritis, osteonecrosis of the femoral head, or rheumatoid arthritis." Dr. Han[5] has published the results of a series of hemiarthroplasty in patients with neurological disorders. In an unpublished work, Dr. Song reported a very low dislocation rate in a large number of patients having their hips replaced, preserving the external rotators (personal communication with Mr. G.A. Gie, June 2016).

The SPAIRE technique was first described by Hanly et al.[1]. A.J. Timperley has carried out all routine primary hip replacements using this technique since 2016, and routinely introduced the Mako robotic assistance into his practice in 2017; the use of robotic assistance further facilitates socket positioning. Author W.A. Leone used the SPAIRE technique in all routine primary THR beginning in October 2019 using specifically designed SPAIRE instruments but without computer or robotic assistance, a special leg holder, or instrumentation to allow self-retracting of the femur during acetabular preparation and implantation. The two authors have a combined experience in over 1500 patients. The technique we described can be used for all hemiarthroplasty and routine hip replacements.

SPAIRE Technique

Patient Positioning

Position the patient in a lateral decubitus position. Stable pelvic referencing is critical and facilitates accurate cup placement. The authors use positioners with anterior pelvic and posterior sacral/pelvic pads for more rigid support.

Hint: Check that the positioner does not block flexion to 90° prior to draping, so the stability of THR can be fully tested after the implantation.

Note: Final and optimal acetabular cup position is dependent on the pelvis being in as true a lateral position as possible when the cup is implanted. If the pelvis is rolled forward or backward from a true lateral position during final cup implantation and this is not recognized and compensated for, the cup may be mispositioned. A pelvis that is tilted purely cephalad or caudal can result in a cup with excessive inclination or too flat if not compensated for. Therefore, take extra time to precisely position and secure the pelvis. If available, Mako robotic assistance is a valuable tool for accurate and precise socket positioning.

Exposure and Dissection of Posterior Capsule

The incision is positioned over the posterolateral tip of the great trochanter (GT) extending distal along the posterior border of the upper femur. The length of the incision is most dependent on the amount of underlying subcutaneous tissue between the skin and GT.

Note: If the incision is too anterior, it makes cup impaction more difficult with this technique.

Hint: It is much preferred to make a longer incision that results in gentle soft tissue retraction than to struggle through a shorter incision, which can compromise exposure, component position, component stability, and lead to soft tissue trauma.

Next, the underlying subcuticular tissue and deep fascia are divided along the length of the incision. The gluteus maximus fibers are bluntly separated. The hip is extended, abducted, and internally rotated for 15–20°, which exposes the posterolateral GT and the posterior border of the gluteus medius (Figure 3).

Note: We will refer to the SERs that include the P and conjoined tendon of OI with SG and IG as the QC as described by Vaarbakken et al.[2].

Note: This position lengthens the QF and QC making it easier to recognize the interval between the IG and QF muscle. It also positions the sciatic nerve farther from the dissection.

The GT bursa is incised as it overlies the posterior edge of the GT, and the underlying posterior tissue is "swept" with a lap or swab posteriorly. This maneuver exposes the SERs as they transverse the posterior hip joint. The sciatic nerve is identified as well as the interval between the QF and IG (Figure 4).

Hint: Identifying the position of the sciatic nerve allows its position to be checked throughout the procedure.

Figure 3: Initial leg position for exposure: (author W.A. Leone) limb placed in abduction, extension, and slight external rotation supported by foam bolster with foot supported by a padded mayo stand.

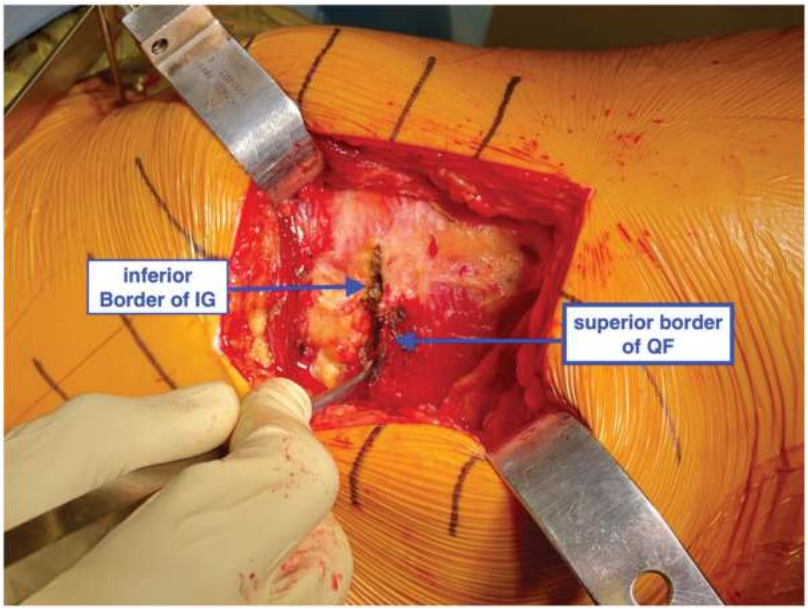

Figure 4: Identifying interval between the IG and QF.

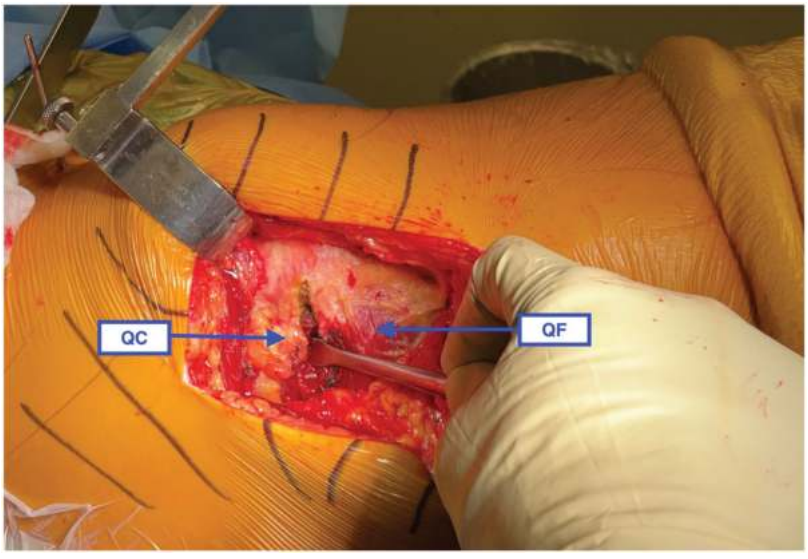

Figure 5: Developing an interval between the IG and QF. Tip of an elevator on underlying hip capsule.

Having identified the interval between the QF and IG, the plane between the QC (IG, OI, SG, and P) and the underlying hip joint capsule is developed. The authors use a periosteal elevator or Cobb elevator to release adhesions, working from inferior to superior. Positioning the hip joint in extension with abduction (lifting the knee) de-tensions the overlying muscles and makes releasing capsular adhesions easier (Figures 5 and 6).

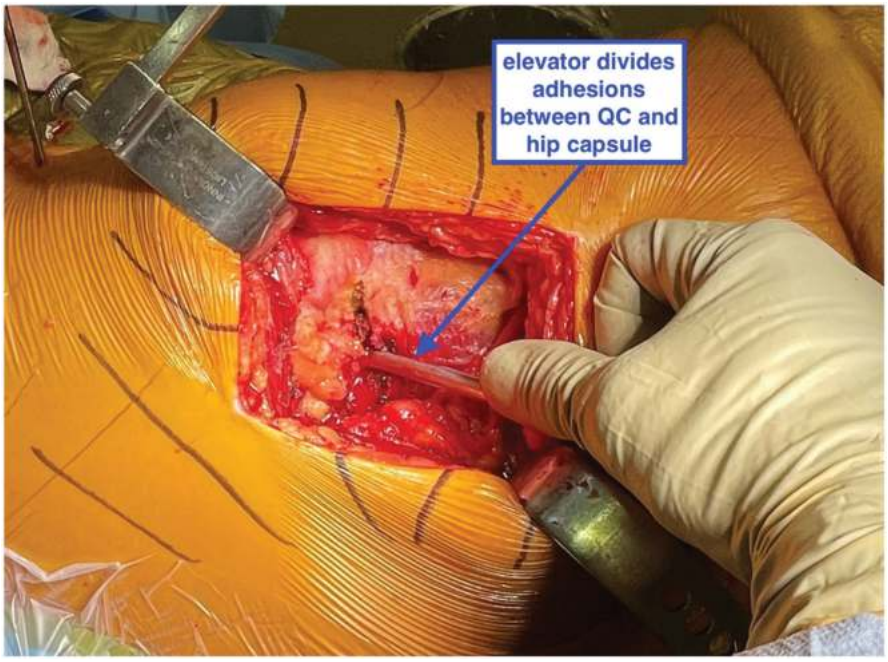

Figure 6: Further developing the interval between the QC and capsule by dividing adhesions with elevator.

Note: When developing the interval between the IG and the superior border of the QF, it is often necessary to cauterize the trochanteric branch of the deep medial circumflex artery as it runs anteriorly along the superior edge of the QF toward the cruciate anastomosis.

Note: It is occasionally necessary to sharply release terminal fibers of the IG from their insertion onto the conjoined tendon with OI. If they are not released, they are likely to stretch and become detached. If this occurs, it does not appear to affect hip stability or the clinical result.

A SPAIRE bent Hohmann-type retractor is useful to retract and protect the QC, while a capsulotomy is performed in an L-shape with the proximal oblique limb (at the 10 o'clock position for a right hip and 2 o'clock position for a left hip). The capsule is released under direct vision using a long diathermy needle with suction along the femoral neck. The diathermy needle "falls" into the interval between the femoral head and the acetabulum. The final release of the capsule and labrum at the acetabular rim is carried out from inside-out, which protects the structures posterior to the acetabular rim including the sciatic nerve. The capsulotomy is extended distal, releasing the OE, QF, and underlying capsule as a musculocapsular flap (Figure 7).

A braided nonabsorbable stay suture is weaved through this musculocapsular flap, which includes the OE, QF, and hip joint capsule. Author A.J. Timperley prefers a single #5 ethibond, and author W.A. Leone uses a double-stranded #2 ethibond. These sutures are utilized for the transosseous posterior repair at the end of the procedure (Figure 8).

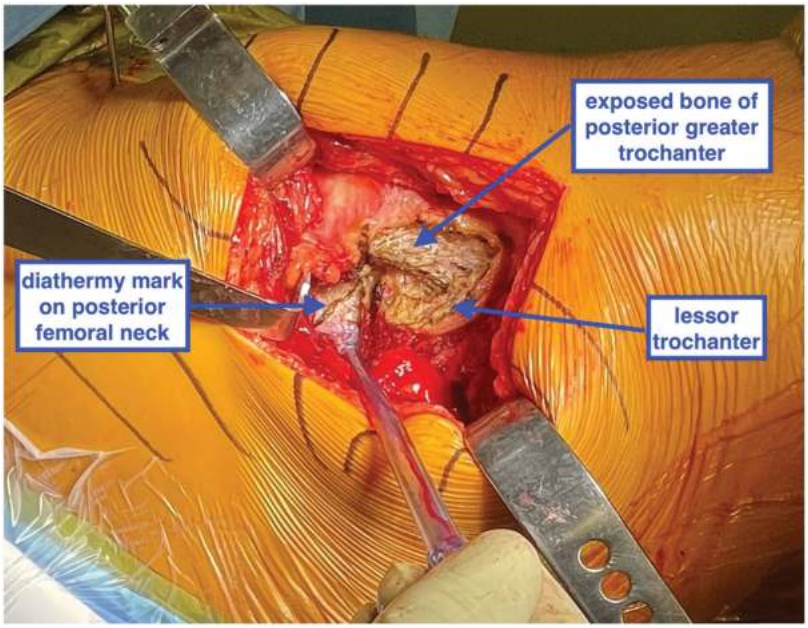

Figure 7: The capsulotomy is completed with the posterior myocapsular flap consisting of the OE, QF, and capsule created. The proximal oblique limb of the capsulotomy is created, extending to the femoral head-acetabular junction. Observe that a diathermy mark is visible on the posterior femoral neck created during a capsular incision. The skeletalized posterior GT is visible, having released the QF, OE, and hip joint capsule.

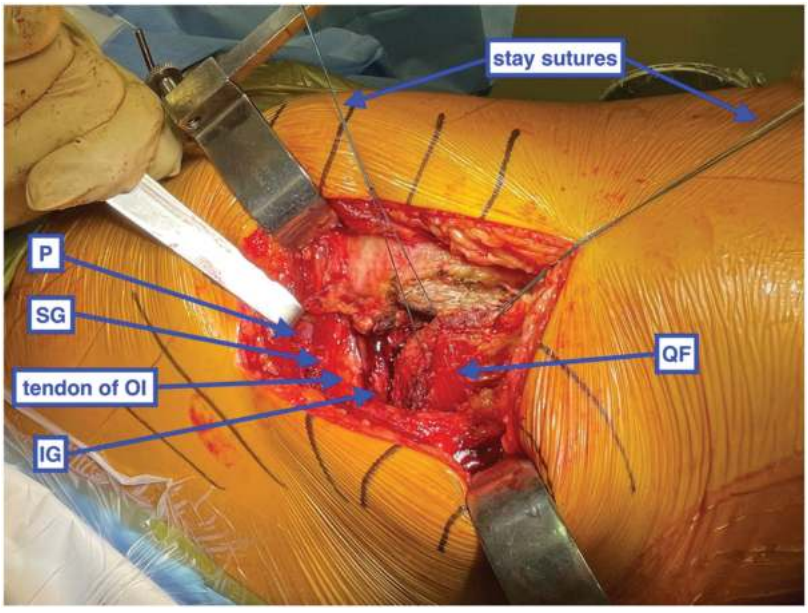

Figure 8: Stay sutures placed through the posterior myocapsular flap ready for repair after reconstruction and closure. Observe the intact QC (P, SG, OI, and IG).

Note: Occasionally, there is a tight inferior constriction of the capsule that prevents easy dislocation. If tight, the capsule can be released distally to the transverse acetabular ligament.

Note: In patients with decreased femoral offset, coxa profunda, or protrusio, the authors have recognized the need to release the proximal 1–1.5 cm of the femoral insertion of the gluteus maximus to allow posterior displacement, thereby protecting the sciatic nerve during acetabular preparation. This step is best performed prior to the initial dislocation if anticipated from preoperative planning.

Femoral Head Dislocation and Resection

The femoral head is dislocated beneath the intact QC with full flexion, adduction, and internal rotation. If the hip does not dislocate easily, check that the capsule has been fully released to the rim of the acetabulum and there are no inferior restrictions. The maneuver of dislocation should be no more difficult than with a conventional posterior approach.

The limb is repositioned for femoral head resection, typical for a conventional posterior approach: hip flexion, adduction, and 90° internal rotation. The level of the femoral neck osteotomy is based on preoperative planning, making sure that the lateral extent of the osteotomy does not enter the GT.

Hint: At this point, surgeon A.J. Timperley goes through the steps to expose the proximal end of the femur as if to commence a femoral preparation (see below). Occasionally, fibers of P are released from the inside of the trochanter to create the femoral slot. Similarly, surgeon W.A. Leone will enter the posterior lateral femoral neck with a starter reamer and then lateralize into the GT. This is a necessary step to implant the stem aligned with the axis of the femur. Performing these steps at this point may help with acetabular exposure.

Soft Tissue Retraction to Expose the Acetabulum

The limb is again repositioned, now for acetabular preparation and implantation. Flex the hip approximately 60–70° while maintaining neutral abduction/adduction and neutral or slight internal rotation. This novel position of the limb takes the tension off from both the abductor mechanism and the QC. Rotation of the thigh also has a slight effect on the tension within the QC and can be adjusted to optimize visualization depending on individual anatomy. By adjusting the position of the limb and the pull on the retractor, a "balance" is found that optimally de-tensions the QF in a position proximal to the acetabular rim. This is a key point of difference to the position of the limb with a standard posterior approach. Author A.J. Timperley uses a support attached to the table to rest the limb in this balanced position of flexion and neutral abduction. Author W.A. Leone positions a foam bolster under the thigh while supporting the foot on a padded Mayo stand to support this position.

A Hohmann or anterior retractor is slid up the anterior wall of the acetabulum at about the 2 o'clock position for a right hip and 10 o'clock position for a left hip between the labrum and capsule. An assistant applies pressure or alternatively a chain can be used to hold the retractor under appropriate tension. The chain is

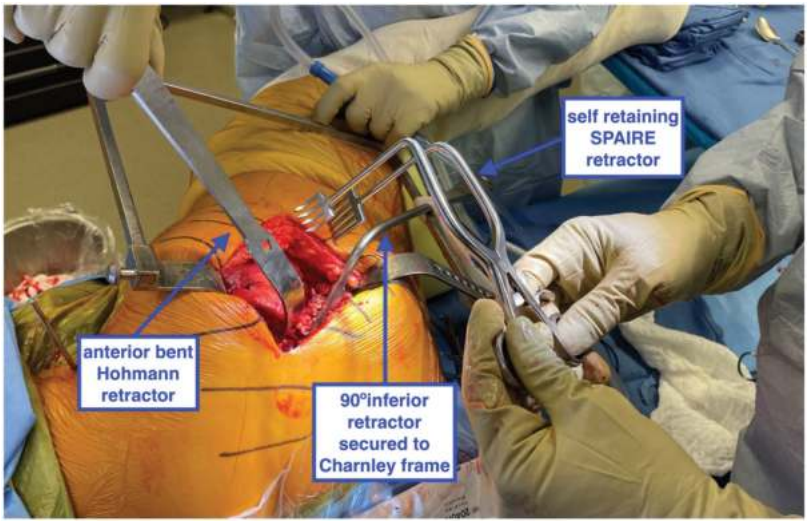

Figure 9: Acetabular exposure. The leg is flexed, 60–70° with neutral abductor/adduction and slight internal rotation. Author W.A. Leone supports the leg with a foam bolster while supporting the foot on a padded Mayo stand. Observe the anterior retractor (curved Hohmann) placed over the anterior rim of the acetabulum, and inferior 90° retractor placed under a transverse ligament and secured to the Charnley frame. A dedicated SPAIRE retractor (Platts & Nisbett) will retract against the medial great trochanter and anterior capsule with a larger, deeper posterior paddle, retracting the posterior capsule just over the posterior rim of the acetabulum.

hooked through the handle of the retractor and passes around a support that was attached to the table prior to draping.

An inferior retractor is placed under the transverse acetabular ligament. Occasionally, the inferior capsule must first be released down onto the transverse acetabular ligament at the 6 o'clock position by using a diathermy. The inferior retractor can be secured with a weight or to an external frame.

Finally, slide the long arm of the SPAIRE self-retaining retractor up the posterior wall and retract between the posterior capsule and the trochanter/QC complex (Figure 9).

Hint: It is important that exposure of the acetabular rim with excision of the labrum is carried out under direct vision as it is easy to mistake the tendon of OI for a capsule or labrum as it passes over the back of the acetabulum. An angled SPAIRE Trethowan-type retractor is used to retract and protect the OI.

Hint: In more slender patients, the self-retaining SPAIRE may angulate into an awkward position. Prevent this by pulling the underlying drape through a finger hole of the retractor to hold it in a flat position by clipping the drape.

Hint: If the acetabular opening is tight, the reamer basket can be introduced by hand between the retractors and then assembled on the driving shaft. Alternately, the reamers can "slide" down the posterior paddle of the self-retaining SPAIRE retractor. Regardless, it is often necessary to move the shaft of the reamer between the retractors or even remove the inferior retractor to allow sequential reaming and cup implantation (Figures 10 and 11).

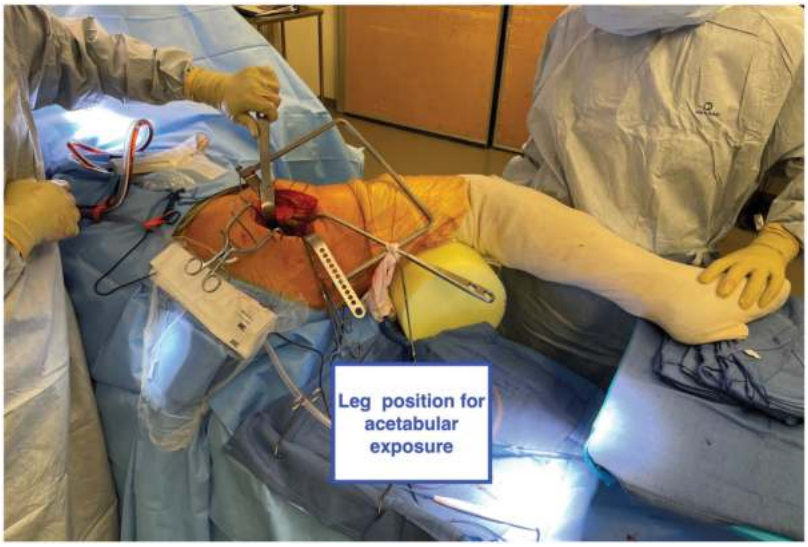

Figure 10: Acetabular exposure and leg positioning.

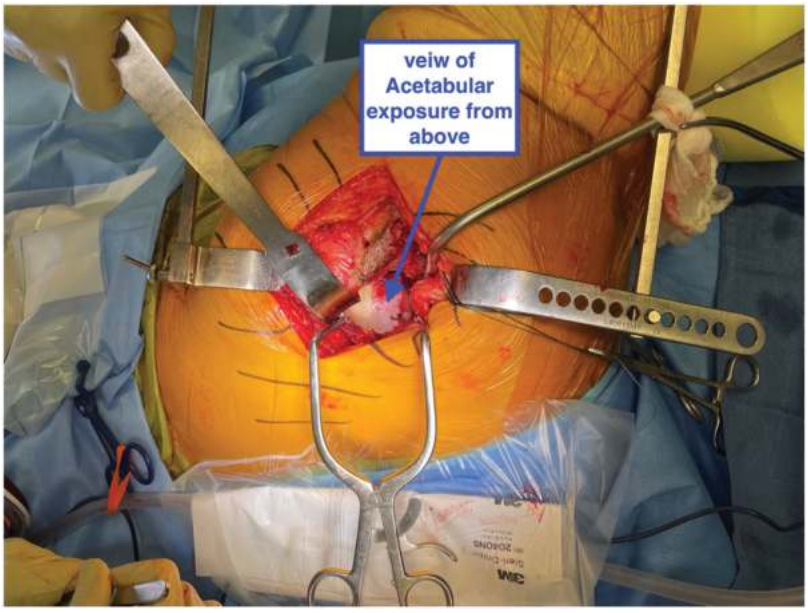

Figure 11: Acetabular exposure with retractors in position.

Preparation of the Femur

Femoral preparation is typical for a conventional posterior approach. Femoral preparation or implantation is not impeded by the insertion of the QC (piriformis plus conjoined tendon of OI and gemelli) into the anterior medial surface of the great trochanter. A posterior lateral entry point is required to implant a femoral

component centrally down the upper femur in both AP and lateral planes. Author A.J. Timperley routinely uses a high-speed burr to develop an accurate slot into the GT, which is positioned posterior to OI and distal to the posterior fibers of P. If the morphology of the femur or GT blocks a posterolateral entry, then posterior fibers of the QC (usually only fibers of P) can be reflected safely from within the GT. Fascial connections with the posterior capsule and more anterior terminal insertion of the conjoined tendon maintain the integrity of the musculotendinous complex and prevent retraction, even if partial release is necessary.

Trial Reduction

The trial prosthetic head is rotated beneath the OI and intact QC. The OI tendon traverses the femoral head anatomically in relationship to the center of rotation. Usually, this results in the tendon crossing the prosthetic head at or inferior to its center. The femoral offset and leg length created are assessed with the degree of QC tightness and length of the posterior capsule. Trial dislocation invariably requires a bone hook around the femoral neck with lateral and axial traction indicative of the stability afforded by the preservation of the QC complex (Figure 12).

Hint: To prevent capsular or synovial invagination into the articulation, have an assistant gently pull on the nonabsorbable stay sutures holding the posterior musculocapsular flap. If the inferior synovium tissue is redundant, an additional temporary stay suture is placed through this tissue and also retracted and then removed after the final reduction.

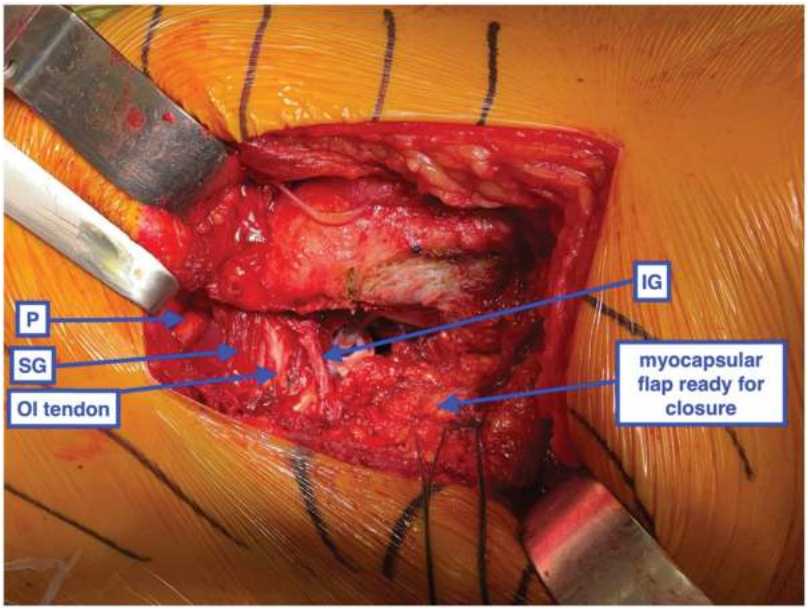

Figure 12: Reduced femoral head prior to capsular closure and repair of posterior myocapsular flap. Observe that QC (P, SG, OI, and IG) extends well below the hip joint center.

Note: It has been the author's experience that over-lengthening a limb following a THR implant using the SPAIRE is extremely infrequent, which is in contradistinction to when using a conventional posterior approach.

Capsular Closure and Transosseous Repair

After the final reduction, the hip capsule is closed with a nonabsorbable suture. Two drill holes are made through the posterior trochanter (Figure 13). Stay sutures that were placed through the posterior musculocapsular flap, which includes the hip joint capsule, OE, and QF, are passed through these holes. The sutures are tied to each other, creating a near anatomical and strong repair. The superiormost drill hole is directed through the obturator fossa that is adjacent to the medial surface of the GT and posterior femoral neck and is where the OE reliably inserts. By repairing the OE tendon to its anatomic footprint, the repair and function are optimized (Figure 14).

Note: During a conventional posterior approach, the QC is often repaired through drill holes placed through the posterior GT. This is a necessary compromise because it is not possible to reattach this muscle group to its anatomic footprint. Therefore, the assessment of soft tissue tension, including femoral offset and leg length, may be misleading with the conventional approach and is more easily estimated with the SPAIRE technique.

Each step of the SPAIRE technique may be viewed on VuMedi at the following locations:

https://www.vumedi.com/video/2-spaire-approach-and-hip-dislocation/

https://www.vumedi.com/video/posterior-spaire-technique-best-of-both-worlds-2/

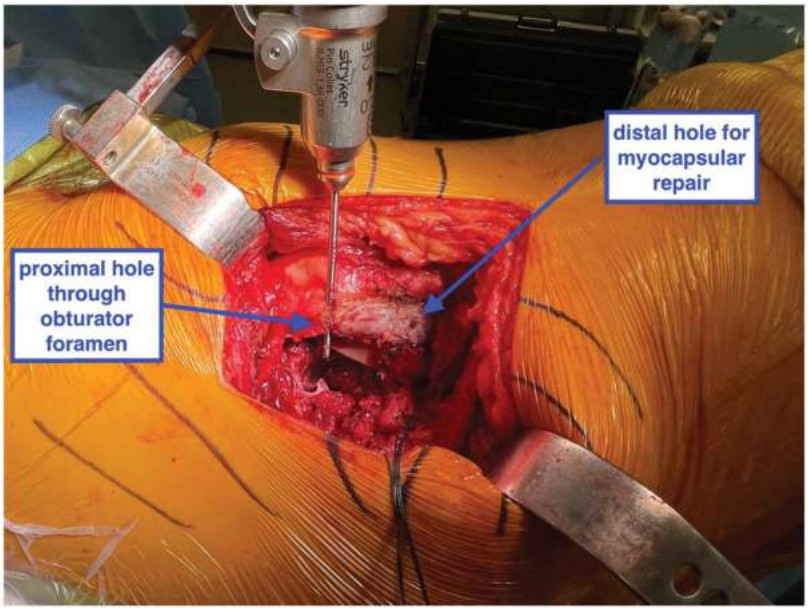

Figure 13: Proximal drill hole through posterior GT existing though the obturator fossa.

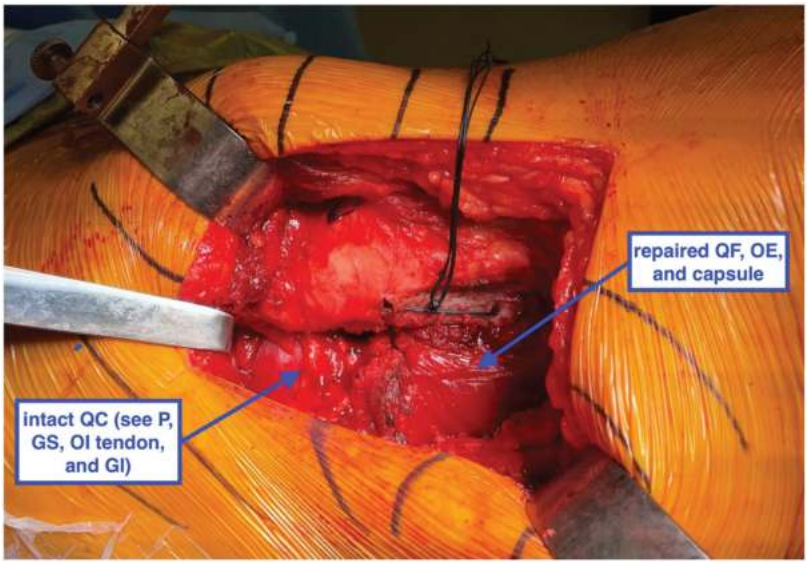

Figure 14: Closure of posterior myocapsular flap. Observe the intact QC.

Conclusion

We believe the SPAIRE is a safe, reproducible approach that results in a faster, more confident recovery with improved early gait, stability, and without the need for postoperative restrictions or special postoperative equipment. Importantly, it can easily be converted to a more extensile approach if the surgeon is at all concerned that the quality of surgery may be compromised. Randomized prospective studies are ongoing to prove these advantages, including a decreased incidence of dislocation and higher patient satisfaction scores.

References

1. Ito Y, Matsushita I, Watanabe H, Kimura T. Anatomic mapping of short external rotators shows the limit of their preservation during total hip arthroplasty. Clin Orthop Relat Res 2012, Jun;470(6):1690–5.
2. Vaarbakken K, Steen H, Samuelsen G, Dahl HA, Leergaard TB, Nordsletten L, Stuge B. Lengths of the external hip rotators in mobilized cadavers indicate the quadriceps coxa as a primary abductor and extensor of the flexed hip. Clin Biomech (Bristol, Avon) 2014, Aug;29(7):794–802.
3. Kim YS, Kwon SY, Sun DH, Han SK, Maloney WJ. Modified posterior approach to total hip arthroplasty to enhance joint stability. Clin Orthop Relat Res 2008, Feb;466(2):294–9.
4. Han S-K, Kim Y-S, Kang S-H. Treatment of femoral neck fractures with bipolar hemiarthroplasty using a modified minimally invasive posterior approach in patients with neurological disorders. Orthopedics 2012, May;35(5):e635–40.
5. Hanly RJ, Sokolowski S, Timperley AJ. The SPAIRE technique allows sparing of the piriformis and obturator internus in a modified posterior approach to the hip. Hip Int 2017, Feb 8:0.