HIP
ISSN 1120-7000

Hip Int 2017; 00 (00): 000-000
DOI: 10.5301/hipint.5000490

SURGICAL TECHNIQUE

The SPAIRE technique allows sparing of the piriformis and obturator internus in a modified posterior approach to the hip

Richard J. Hanly[1], Sabrina Sokolowski[1], Andrew John Timperley[1,2]

[1] Princess Elizabeth Orthopaedic Centre, Royal Devon and Exeter NHS Foundation Trust, Exeter - UK
[2] College of Engineering, Maths and Physical Science, University of Exeter, Exeter - UK

ABSTRACT

Introduction: The Sparing Piriformis and Internus, Repair Externus (SPAIRE) technique allows a muscle sparing mini-posterior approach to the hip.

Method: We present in this article a description of an adaptation of the familiar posterior approach (PA) in which the only tendon released is obturator externus. Termed SPAIRE, this muscle sparing technique enables preservation of the piriformis tendon and conjoint insertion of obturator internus and the gemelli. The technical description allows for safe and reliable replication by any surgeon familiar with the posterior approach (PA) to the hip without reliance on additional equipment, and without compromising the ability to convert into a more extensile approach.

Conclusions: This technical description and brief discussion of rationale outlines the ongoing work of the authors in developing the SPAIRE technique as part of the spectrum of the posterior approach to the hip. The senior author now uses this technique routinely for total hip replacements and hemiarthroplasty. Patients are mobilised with no postoperative restrictions whatsoever. Other potential advantages include improved gait, more anatomical restoration of hip function, and enhanced stability. Projects have been initiated in our unit to objectively assess the possible clinical advantages relating to use of the SPAIRE technique using gait analysis, objective measurement of muscle power and studies of hip stability.

Keywords: Approach, Arthroplasty, Minimally invasive, Total hip replacement

Introduction

The success of total hip arthroplasty (THA) stems from its ability to alleviate pain, restore function, and correct biomechanics associated with pathology of the hip. There are a myriad surgical approaches described to access the hip joint (1-3). Various iterations have been described purporting inherent advantages, however, an approach must always allow for adequate exposure for the surgeon to reliably and reproducibly place prosthetic components to restore anatomy and function for the patient, whilst minimising associated surgical complications (4).

Accepted: December 9, 2016
Published online: February 8, 2017

Corresponding author:
Andrew John Timperley
Consultant Orthopaedic Surgeon
Hip Unit, Princess Elizabeth Orthopaedic Centre
Royal Devon and Exeter NHS Foundation Trust
Barrack Road
Exeter, EX2 5DW, UK
jtimperley@mac.com

Descriptions of “minimally invasive surgery” (MIS) in THA have fostered a renewed interest in surgical approaches to the hip (5). In 2010 Solomon et al (4) suggested that the lack of discernible clinical superiority of MIS relates to unappreciated soft tissue damage. Stratifying MIS into muscle sparing approaches, and mini-incision approaches, affords easier comparison of patient outcomes and between groups analyses (5). Muscle sparing approaches potentially allow more physiological soft-tissue balancing of prosthetic hip replacement, decreased dislocation rates and an accelerated recovery period without the need for postoperative precautions, thus promising to deliver the goals of improved patient satisfaction and a “forgotten joint replacement” (1, 4-6).

We present in this article a description of an adaptation of the familiar posterior approach (PA) in which only obturator externus tendon is released. Termed SPAIRE (Spare Piriformis and Internus, Repair Externus), this muscle sparing technique enables preservation of the piriformis tendon and conjoint insertion of obturator internus and the gemelli. Functionally complex, piriformis and obturator internus are synergists and have been termed the quadriceps coxae (QC) by Vaarbakken et al (7). This technique represents what the authors feel is a safe adaptation of the familiar posterior approach, which we increasingly view as a spectrum from least invasive SPAIRE to

Fig. 1 - Patient position. The hip is supported in slightly greater than neutral abduction by the padded limb support indicated by the arrow.

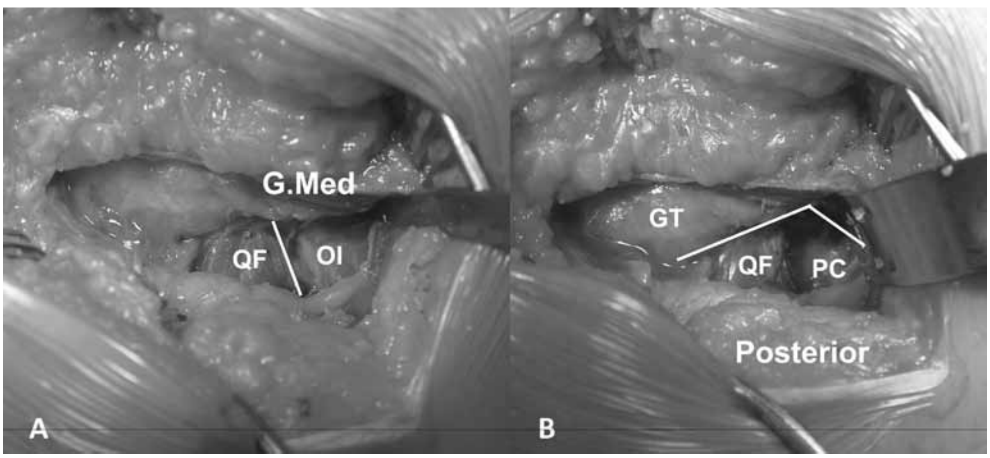

Fig. 2 - Short external rotator (SER) and capsular exposure. (**A**) The line indicates the interval for capsular exposure between quadratus femoris (QF) and obturator internus (OI) with its conjoined gemelli. (**B**) The lines indicate the intended capsulotomy of the posterior capsule (PC) subjacent to the retracted quadriceps coxae.

maximally extensile inclusive of extended trochanteric osteotomy (ETO).

Method

Additional equipment to that routinely used for posterior approach THA is not a necessity. The patient is positioned in the lateral decubitus position. The authors use sacral and iliac padded bolsters to allow for stable pelvic referencing.

A routine incision based on the posterolateral tip of the greater trochanter (GT) is made with conventional dissection through fascia lata and blunt splitting of gluteus maximus fibres. The posterolateral GT and posterior edge of gluteus medius are exposed by internal rotation of the hip by 15°-20°. The trochanteric bursa is incised as it overlies the posterior edge of the GT and soft tissues swept posteriorly with a swab to reveal the course of the short external rotators (SERs) as they traverse the posterior hip capsule. The sciatic nerve course is identifiable as a result of this manoeuvre and its position checked at all stages of acetabular preparation.

Exposure and dissection of posterior capsule

At this point it is critical to identify the tendon of obturator internus (OI), and the trochanteric branch of the deep medial circumflex femoral artery (8). This vessel is cauterised as it runs anteriorly at the superior edge of quadratus femoris toward the cruciate anastomosis (8).

Dissection from inferior to superior is now carried out to define the plane between OI, the gemelli, and piriformis from the posterior capsule. At the posterior extent of this dissection, close to the rim of the acetabulum, the sciatic nerve must be protected. Abduction of the hip past the neutral position by lifting the knee (Fig. 1), de-tensions OI and piriformis to allow passage of a cobb elevator deep to the quadriceps coxae (Fig. 2A) thus dividing any capsular attachments (4, 7, 9). The terminal muscle fibres of inferior gemellus may optionally be sharply released from their insertion onto the conjoint tendon with obturator internus (Fig. 2A). If they are not released these inferior muscle fibres are likely to subsequently stretch and become detached.

A posterior capsulotomy is performed in an L-shape with a proximal oblique limb (at 10 o’clock for right hip, 2 o’clock for left hip) starting subjacent to the preserved QC tendons. The authors use Trethowan bone levers placed deep to the QC to protect and lever them superiorly (Fig. 2B). The capsule is released with long diathermy needle along the femoral neck with final release through labrum and capsule at the acetabular rim. By cutting from inside-out there is no danger to structures posterior to the acetabular rim. The distal longitudinal extension of the capsulotomy is raised as a musculocapsular flap with release of quadratus femoris (QF) and obturator externus (OE).

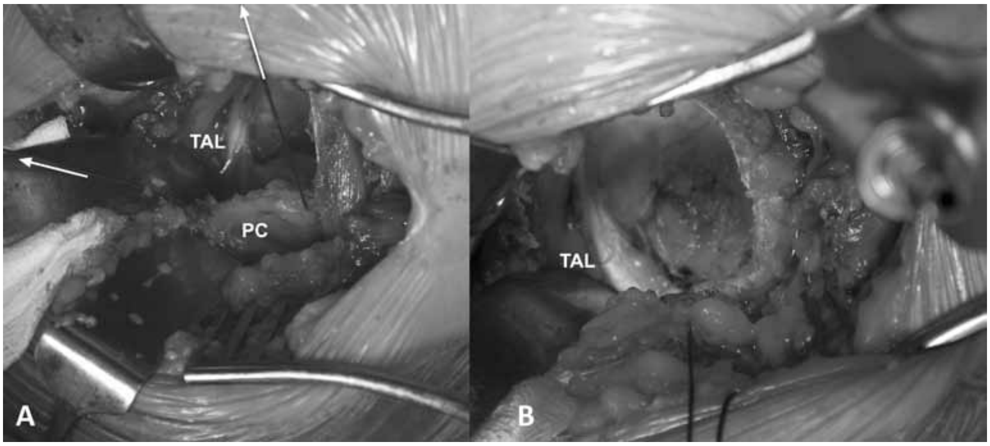

Fig. 3 - Acetabular exposure. (**A**) The posterior capsule (PC) and obturator externus tendon are secured with braided non-absorbable sutures indicated by the arrows. (**B**) The acetabulum is exposed in readiness for preparation with a clear view of the transverse acetabular ligament (TAL) and bony margin for anatomical referencing.

The authors use braided nonabsorbable stay sutures in the obturator externus and posterior capsule to optimise retraction of the posterior musculocapsular flap as demonstrated in Figure 3A. These sutures are utilised for the transosseous posterior repair at the conclusion of the procedure.

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

Soft tissue retraction to expose acetabulum

Acetabular preparation follows initial dislocation by adducting and rotating the hip in a position of full flexion with femoral neck resection based on the preoperative template. Of note, the preservation of QC can make initial dislocation more difficult, and occasionally a neck cut in situ may be a safer option. To best visualise the acetabulum the thigh should be positioned in a position of between 45° and 60° of flexion and abducted to neutral. This is a key point of difference to the position of the limb in the standard posterior approach. The novel position of the limb, as demonstrated in Figure 1, takes the tension off both the abductor mechanism and QC (7). Rotation of the thigh in this position will have little effect on the lengthening of QC and can be safely adjusted to optimise visualisation of the acetabulum dependent on the individual anatomy (7). The authors have utilised an articulated limb positioning system attached to the rail of the operating table to simplify positioning, however this is not essential.

Superior acetabular rim exposure is optimised by the combination of selective release of the iliofemoral capsular condensation and/or excision of superior capsule. The authors use a cannulated pin (Exeter, Stryker) placed under QC and the abductors, hammered into the supra-acetabular ilium, to act as a retractor and facilitate cement penetration. The inferior capsule is released radially down onto the transverse acetabular ligament (TAL) to allow an inferior retractor to be placed immediately inferior to TAL. Finally, a deep, narrow, self-retaining retractor is positioned between the femur anteriorly and posterior capsular flap (Fig. 3B). If access to the acetabulum is tight it may be necessary to remove either the inferior retractor, the self-retaining retractor, or both during some parts of acetabular preparation and implant insertion. Acetabular preparation can now be achieved safely for the surgeon's preferred implant of choice.

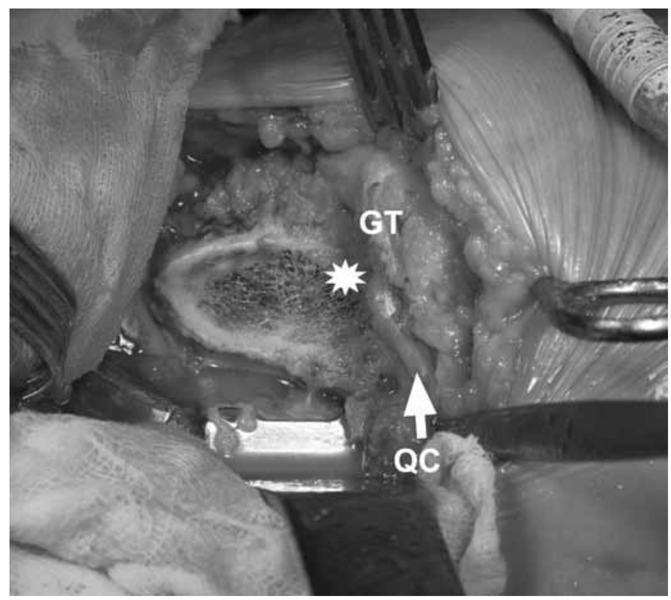

Fig. 4 - Femoral exposure. The insertion of the quadriceps coxae (QC) on the medial surface of the greater trochanter (GT) doesn't impede the intended posterolateral femoral entry point marked by the star.

Preparation of the femur

Femoral preparation is not impeded due to the insertion of the QC into the anterior aspect of the medial surface of the GT (4, 9-11). Should the morphology of the proximal femur or GT mean that establishment of a posterolateral entry point for broach insertion is obstructed, the posterior fibres of the QC insertion can be reflected from the inside of the GT safely as indicated in Figure 4. Fascial interconnections with the posterior capsule and more anterior terminal insertion of the conjoint tendon maintain the integrity of the musculotendinous complex and prevent retraction if partial reflection is necessitated

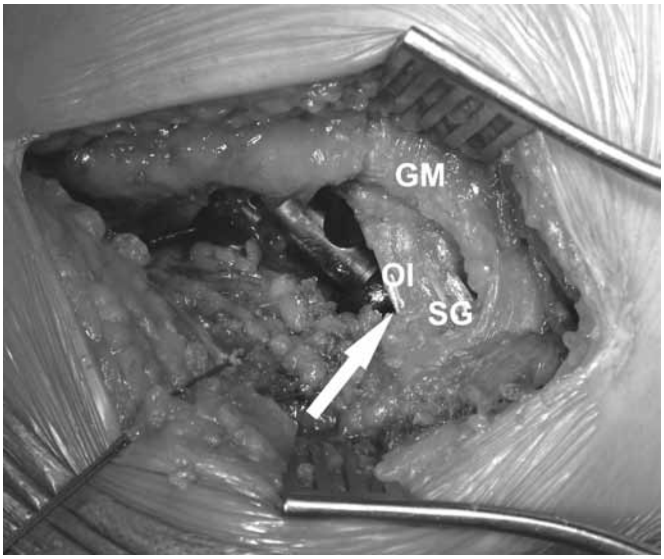

Fig. 5 - Trial reduction. Anatomical restoration of the centre of rotation (approximated by the arrow), underlying the retensioned intact obturator internus (OI) and superior gemellus (SG). Terminal fibres of the inferior gemellus were released in this case to aid exposure.

(4, 10). The authors use an Exeter V40 stem (Stryker) and have not found that component position or cementing technique is compromised with preservation of the QC. The technique for femoral preparation can be safely achieved for the surgeon's preferred implant of choice.

Trial reduction

At trial reduction, the prosthetic head is rotated beneath the QC tendon. It will be noted that the OI tendon traverses with an anatomically restored vector in relation to the centre of rotation of the hip (Fig. 5). Dislocation can often only be effected with a bone hook around the femoral neck and lateral and caudal traction indicative of the stability afforded with preservation of the QC complex. Adequacy of reconstruction of the offset of the joint will be obvious by the tightness of the QC and the length of the posterior capsular flap.

On final reduction, a transosseous repair of posterior capsule and OE into an anatomical position is carried out.

Discussion

To have merit, technical advancement in THA must demonstrate a realistic improvement in the fundamental aims of the procedure to relieve pain, restore anatomy, and improve function. The SPAIRE technique represents the highest degree of muscle sparing achievable through a familiar posterior approach to the hip. Restoration of anatomy and function with the SPAIRE technique is enhanced by preservation of the quadriceps coxae which has a complex functional role in hip movement (7, 12). From primary THA to revision THA, this technique remains versatile, allowing for sequential releases to the point of ETO affording exposure from the posterior column of the innominate to the distal femur.

Contemporary analyses of tendinous insertion and length-tension plots have elegantly given insight into form and function of these muscles (4, 7, 9-12). The piriformis tendon inserts superiorly on the medial surface of the greater trochanter with the most anterior point of its insertion between 42.1% and 76.9% of the total trochanteric AP distance (9-11). The conjoint tendon of the obturator internus and gemelli inserts inferior to that of piriformis, however, passes further anteriorly with its most anterior margin between 18.8% and 43.2% of the trochanteric AP distance (9-11). In contradistinction to the variability of the insertion of the QC, obturator externus is reported to reliably insert in the obturator fossa adjacent the junction of the posterior femoral neck and the medial surface of the greater trochanter (9-11). Minimal release of anatomical structures, whilst still safely affording adequate exposure to reliably place prosthetic components is the ideal scenario (4, 13). When release is necessitated, tendon repair should be made as near to the anatomical footprint as possible in order to optimise repair integrity and function (14). This can be reproducibly performed when repairing obturator externus due to its reliable insertion (9-11). Repair of the completely released QC using transosseous closure through the posterior edge of the GT represents a surrogate at best, and makes assessment of soft tissue tension when restoring lateral femoral offset potentially misleading due to diversion from the anatomical footprint.

The evidence that SERs act as primary movement generators has corrected previously held assumptions that they function as stabilisers, proprioceptive organs or vestigial capsular thickenings (7, 12). Vaarbakken et al (7) reported the QC as an extensor and abductor of the flexed hip with peak force generation between 90° and 60° of hip flexion. Further, their use of movement-lengthening curves reveals the lesser function of external rotation by QC converts to an internal rotation moment for piriformis at 65° degrees of flexion and for OI at 95° of flexion (7). Further discussion outlines the mechanical advantage that QC, with a 9% higher cross-sectional area and more favourable angle of fibre pennation, holds over gluteus medius such that it might be the primary generator of abduction of the hip in 90° of flexion or higher (7). The clinical implication of this is threefold: (i) release of the QC de-functions an important synergist of hip extension and abduction with MRI identifiable atrophy (13); (ii) repair of such a release needs to be into an anatomical position, and subsequently there needs to be suitable protection to ensure integrity; (iii) preservation of QC potentiates enhanced rehabilitation programmes. Similar work by the same group demonstrated minimal capacity for external rotation generated by QF and OE, and that the primary function of OE was as a flexor and adductor of the extended hip with demonstrable muscle shortening in positions of increased flexion (12). The clinical caveat of this being that release and repair of the OE tendon will be relatively protected in positions of flexion and should have no impact on an enhanced recovery protocol. In adopting the SPAIRE technique, the authors ongoing work involves quantifying the functional differences associated with preservation or repair of the SERs using dynamometry and 3-D gait analysis.

The Direct Anterior Approach (DAA) has had a resurgence of interest and is touted as the archetypal muscle sparing and mini-incision approach. There is a growing body of evidence showing no significant difference in dislocation rate, component position, and postoperative gait recovery (15-17). One significant limitation of the DAA is the need for release of the superior capsule to facilitate femoral delivery. This is performed from intra-capsular, usually compromises the QC, and it is impossible to perform a robust repair (10, 18, 19). This potentially could explain the equivocal functional outcomes discussed by Wesseling et al (17) when comparing the DAA and PA, with unappreciated damage to the QC being contributory to a lack of superior performance in comparative gait analyses. The advantage of the SPAIRE technique, in contrast, is the ability to preserve structures as able, or selectively release and perform a robust repair under direct vision with quantifiable effects on the force required to dislocate (20).

This technical description and brief discussion of rationale outlines the ongoing work of the authors in further developing the SPAIRE technique as part of the spectrum of the posterior approach to the hip. Since developing this technique the authors have been made aware of unpublished work reporting a dislocation rate of 0.3% in a series of patients operated on through a similar interval by Dr. Song in South Korea (personal communication with Mr. G.A. Gie; June 2016) and a further paper presented at a closed meeting of the International Hip Society also advocating this approach to reduce hip instability in predominantly osteonecrotic hips (21). The senior author has been using the technique for the last 18 months and for the last 6 months all primary hip arthroplasties have been inserted via this technique. Over 100 operations have been performed. All cases have been closely monitored and there has been no recorded complication or readmission within 30 days in any case. Initial examination of baseline data indicates similar radiological appearances and equivalent recovery compared with the conventional posterior approach; detailed studies are ongoing. Anticipated future work will include quantification of effect of the preservation of the QC using 3-D gait-analysis, MRI, and contemporary outcome measures such as the "forgotten joint score" (6). The SPAIRE technique represents the zenith of muscle and function preservation in a familiar posterior approach to the hip, and the utility to convert sequentially to an increasingly extensile approach ensures its utility.

Acknowledgement

The authors would like to thank Mrs. Sophie Kolowska for taking the original clinical photographs and for her assistance with editing the graphics.

Disclosures

Financial support: None.
Conflict of interest: AJT receives royalties and research support from Stryker Orthopaedics in relation to the Exeter Hip. No conflicts related to this study.

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