23 Gluteus Medius and Minimus Tears Open Repair/Reconstruction

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23.1 Introduction

The pathology of abductors' tendons is the most common cause of lateral thigh pain or greater trochanteric pain syndrome (GTPS) both in native and in prosthetic hips [1]. The spectrum of GTPS pathology ranges from tendinosis to complete tendon rupture, retraction and fatty atrophy of the gluteal muscles. The popularization of imaging facilities and the greater awareness of physicians subsequently led to a higher reported incidence rate of the syndrome [2]. GTPS is more prevalent in women than in men with a peak prevalence found between the fourth and sixth decade of life [3]. It is often misdiagnosed with trochanteric bursitis; however, no ultrasound detected bursitis could be confirmed in 80% of patients suffering from GTPS. On the other hand, trochanteric bursitis is usually combined with abductor tendon or fascia lata pathology; only 8% of patients suffer from bursitis in the absence of other pathology [1].

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23.2 Anatomy of Gluteal Muscles

23.2.1 Gluteal Muscle Origin

The gluteus medius (GMed) originates from the anterior superior iliac spine and the outer edge of the iliac crest back to the posterior superior iliac spine. The GMed is composed of three separate parts the anterior, the middle and the posterior, all innervated by the superior gluteal nerve [4]. The muscle fibres of the anterior and middle portions of the GMed are vertically oriented and have a critical role in initiating the hip abduction [5]. The gluteus minimus (GMin) initiates from the anterior–inferior iliac spine back to the posterior inferior iliac spine between the inferior and anterior gluteal lines. Both the GMin and the posterior portion of GMed are horizontally oriented and parallel to the femoral neck, stabilizing the hip joint in different phases of the gait cycle [5].

23.2.2 Gluteal Muscles Insertion

Recent cadaveric studies further sorted out the complex anatomy of gluteal muscles [6] highlighting the two different attachment sites of the GMed into the greater trochanter (Fig. 23.1). The posterior and part of the middle portion of GMed are inserted separately on the posterosuperior facet of the greater trochanter; this facet

N. Bonin et al. (eds.), *Hip Preservation Surgery*, https://doi.org/10.1007/978-3-662-61186-9_23

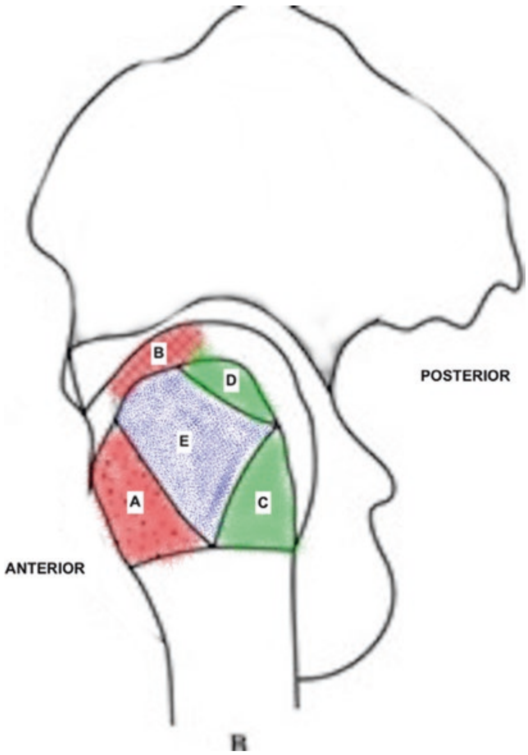


Fig. 23.1 Insertion sites of the Gluteus Medius and Minimus into the greater trochanter; *A*: trochanteric attachment of GMin, *B*: Capsular attachment of GMin, *C*: Posterosuperior facet of GMed, *D*: Lateral Facet of GMed, *E*: "bold area"

has a roughly circular shape with a radius of 8.5 mm. The rest of the middle and the anterior part of GMed are inserted on the lateral trochanteric facet, which is almost trapezoidal and has a greater surface area. In a cadaveric study of eight femora, the insertional footprint of the lateral facet of GMed demonstrated a mean length of 35 mm and an angle of 37° to the axis of the femur. It was wider proximally and narrower distally, the width being around 12 mm at the midpoint [6]. GMin has fascicular attachments to the anterior hip capsule but also inserts to the anterior and lateral facets of the greater trochanter. An area bare of tendon attachments separates the insertional facets of GMed and GMin; this so-called bald spot serves as an anatomic landmark, particularly in the endoscopic approach to the hip [6].

23.3 Epidemiology and Aetiopathogenesis of Gluteal Tendon Pathology

23.3.1 Epidemiology

Almost half of the patients suffering from GTPS demonstrate gluteal tendinosis or ruptures. The rate of gluteal tendinosis and ruptures increases with age. The incidence of gluteal ruptures raises from 10% lower than 60 years to 50% over 70 years of age [7].

23.3.2 Aetiopathogenesis

The aetiopathogenesis of abductor insufficiency is mainly attributed to the altered lower limb biomechanics, especially in the setting of hip osteoarthritis. Ruptures of gluteal tendons have been reported up to 20% of patients suffering from hip OA and 25% of patients undergoing total hip arthroplasty (THA) for end-stage hip osteoarthritis [8, 9].

23.3.3 Clinical Scenarios

Three distinct clinical scenarios have been described for the tears of the hip abductor muscles. The so-called rotator cuff of the hip [10] may suffer from atraumatic chronic tears of the anterior part of GMed, tears found unexpectedly during hip arthroplasty surgery for femoral neck or osteoarthritis and avulsion tears of abductor tendons resulting from hip arthroplasty through a transgluteal approach [4]. Iatrogenic damage to the abductors' tendons following a transgluteal hip approach is often reported due to deficient healing of the disruption site [11]. However, abductor insufficiency is also met in abductor sparing approaches, highlighting also the role of altered hip mechanics in the tear pathogenesis. Both abductor fatigue and inflammatory process seen in THA patients including excessive wear and osteolysis and especially metallosis can lead to excessive abductor tendon damage, rendering direct repair impossible and possibly necessitating more complex reconstructive options [12].

23.4 Clinical Presentation

The chief complaint of abductor tendon pathology is lateral thigh pain that is usually aggravated by lying on the affected limb, walking or climbing stairs [4].Tenderness over the site of abductor insertion and the superior and lateral facets of the greater trochanter is also a typical clinical finding. Anterior groin pain is also described; however, it is less common, and when reported other potential sources of pain should be ruled out [13]. The pain worsened over the fascia lata may also suggest abductor tendon pathology.

23.5 Clinical Examination

The patient often demonstrates a slight or moderate limping. A positive Trendelenburg sign often indicates abductor tendon tears; it is defined as a truncal sway to the contralateral side on stance phase on the affected limb. The sensitivity and specificity of the Trendelenburg sign for abductor tear are reported to be 73% and 76%, respectively [14].

23.5.1 Specific Tests

The hip lag sign is another useful test in diagnosing abductor insufficiency with a reported sensitivity of 89% and specificity of 96%. It is performed with the patient in the lateral position with the affected side up. The clinician passively extends the hip 10°, abducts 20°, and then maximally internally rotates the hip with the knee in 45° of flexion. The leg is then released, and the patient is asked to hold it in the upright position; if the leg drops more than 10 cm, the test is considered positive [15]. Additional useful tests are the 30-s single leg stance and the external derotation tests. In the former, the patient is asked to perform a 30-s single leg stance and no trunk deviation; the arrival of lateral thigh pain is considered a positive result [16]. The passive hip range of motion is not limited, but the force of hip abduction may be weakened. Besides, a thorough clinical examination should be performed including the evaluation of muscle strength, neurologic status, lumbar spine, and hip or fascia lata pathology; in patients that underwent THA, the integrity of the prosthetic joint must also be checked.

23.6 Imaging Studies

23.6.1 Magnetic Resonance Imaging (MRI)

MRI is the gold-standard examination of the anatomy and pathology of the abductor muscles and tendons [3]. The reported sensitivity and specificity of MRI to predict GMed tendon tears is 73% and 95%, respectively [17]. Advanced MRI protocols, as the metal artefact reduction sequences (MARS) and multiple acquisitions with variable-resonance image combinations MRI (MAVRIC), facilitates the study of abductors in the setting of prosthetic hips. Information regarding the size and shape of gluteal muscles and tendons, tendinosis, partial or complete tendon defects or fatty infiltration of the muscles can be obtained. Several MRI findings have been related to tears of abductors' tendons as a high sign superior or lateral to the greater trochanter, GMed tendon elongation or discontinuity [17]. TFL hypertrophy is also an indirect sign of abductor tendon tears [18].

23.6.2 Evaluation of Fatty Infiltration Using MRI

The Goutallier-Fuchs classification rates the degree of fatty infiltration of abductors on MRI, that ranges from 0 to 4 grades. Grade 1 is related to some fatty streaks of the muscle, grade 2 has fatty infiltration but more muscle than fat, grade 3 fatty infiltration with equal fat and muscle and grade 4 more fat than muscle on MRI [19]. It is supported that the extent of abductor muscle fatty infiltration is predictive of repair outcomes, with a high grade (>2) being linked to inferior results

[19]. Bogunovic et al. demonstrated that the greater the fatty infiltration of the muscle, the higher the postoperative pain level and lower the functional outcomes of the patients, highlighting the prognostic role of this classification [19].

23.6.3 Standard Radiographs

Standard hip and pelvic radiographs should be performed. Greater trochanter enthesophytes or surface irregularity greater than 2 mm have been associated with abductor tendon pathology, especially in the chronic setting (Fig. 23.2). Steinert et al. showed that 90% of the hips having greater trochanteric irregularities larger than 2 mm also demonstrated GMed or GMin tendon abnormalities [20]. In patients with prosthetic hips, the radiologic evaluation is more than necessary to rule out concomitant THA pathology. Additional views such as Dunn or false profile views are performed as needed; the presence and extent of osteolysis, especially around the greater trochanter, should be carefully evaluated.

23.6.4 Ultrasound

Ultrasound may be beneficial, especially in the setting of THA or the absence of advanced MRI protocols for artefact reduction. It can accurately diagnose tendinopathy and tears; however, it is user-dependent, and inferior to MRI in classifying the degree of fatty atrophy.

Fig. 23.2 Standard anteroposterior pelvic radiographs demonstrating greater trochanter enthesophytes greater than 2 mm

23.7 Treatment

(a) *Conservative*

The treatment of GTPS syndrome usually starts conservatively including short-term use of nonsteroidal anti-inflammatory medication, activity modification, physical therapy and prudent use of corticosteroid plus local anaesthetic injection into the tender trochanteric bursa. If conservative management fails to relieve the symptoms following at least 3 months of therapy, surgical treatment usually follows [21].

(b) *Surgical*

Surgical management is mainly indicated for full or partial gluteal tendon ruptures that are nonresponsive to conservative treatment, eliciting pain and disability to the patient. The main goals of the surgical treatment of gluteal tears are the preservation of the function and quality of life of the patients and the reduction of pain.

23.8 Preoperative Evaluation

The patients that are scheduled to undergo surgical repair of gluteal tendon tears must undergo a thorough preoperative evaluation, including clinical and radiological evaluation. Special care is needed preoperatively concerning the following:

(a) *Neurologic Evaluation*

A neurologically intact abductor muscle is a prerequisite for any attempt to directly repair an abductor tear. A detailed screening for lumbar spine pathology or other types of neurologic impairment of gluteal muscles must be routinely performed preoperatively. In cases of neurologically impaired gluteal muscle, the direct repair of a tear predominantly fails and other reconstruction techniques as synthetic grafts or muscle transfers may be required.

(b) *Fatty Infiltration of Gluteal Muscles*

It has been recognized that extensive fatty infiltration of abductors muscles is a predictive factor of inferior repair outcomes. A Goutallier classification grade >2 is highly predictive of more inferior results [19]; in such cases, other more complex reconstruction techniques as muscle flaps or grafts may be needed.

(c) *Presence of THA*

In the setting of an existing THA, the joint should be thoroughly evaluated preoperatively to exclude aseptic loosening or any other pathology that could potentially necessitate a concurrent revision of the prosthesis. Special care should be given to the radiologic appearance of the greater trochanter, as excessive osteolysis can render fixation of the tendon on cancellous bone risky or even insufficient. In cases of a previous infected THA or excessive wear following a failed metal on metal THA, the quality of tendon is often unreliable and augmented repair or transfer of local muscles may be needed.

(d) *Fascia Lata or Iliotibial Band Tightness*

Preoperative and intraoperative evaluation of the tightness of iliotibial band or fascia lata should be performed, and appropriate corrections should be made concurrently with the abductor repair. One of the main advantages of the open approaches is the easy and precise lengthening of iliotibial band or fascia lata that can be performed when needed with a V-Y technique.

23.9 Surgical Techniques

The standard patient positioning is the lateral decubitus with the involved extremity on the top. Standard sterile prepping and draping is performed keeping in mind to drape from the iliac crest to the knee, especially in the setting of reconstructive surgery. A Mayo table or similar device is necessary to facilitate the leg abduction during the tensioning of the repair.

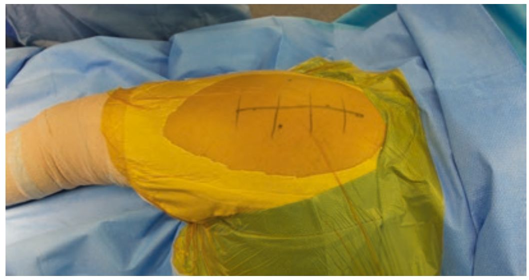


Fig. 23.3 A standard straight incision centred over the greater trochanter along the femoral axis usually performed for direct open repair of hip abductor tendons

A straight incision centred over the greater trochanter along the femoral axis extending proximally and distally as needed is usually performed (Fig. 23.3). A 10–15 cm incision length enables adequate visualization of the involved anatomic structures in the majority of patients. In case of simultaneous revision THA or more complex abductor tendon reconstructions, the incision should be modified accordingly.

Various types of open procedures for the management of abductor tears have been reported; the following three categories of direct open methods are further discussed.

(a) Nonaugmented direct repair
(b) Augmented direct repair
(c) Reconstruction techniques

23.10 Direct Open Nonaugmented Repair Using Bone Tunnels or Suture Anchors

A prerequisite for direct open repair of abductor's tendon is the neurologic integrity of the muscle and fatty infiltration level Goutallier <2. The patient is positioned usually in lateral position. Following a standard incision of skin and division of the fascia lata, the trochanteric bursa and glutei attachment are exposed. Once bursectomy is performed, the surgeon can evaluate the quality, type and extent of the rupture of the gluteal tendon (Fig. 23.4a, b). Sometimes the rupture is not evident at first sight. Injection of saline under the insertion of gluteal tendons can cause

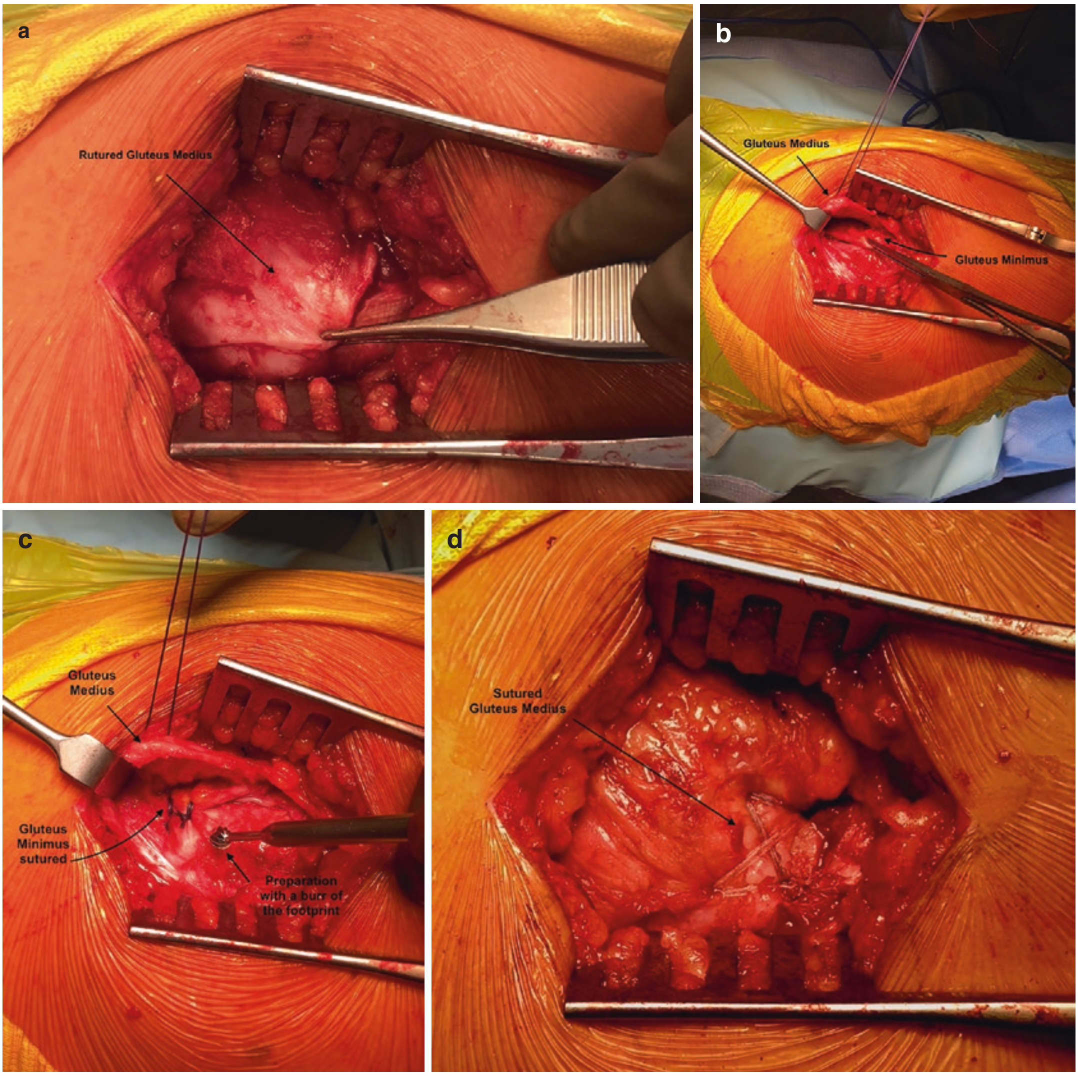


Fig. 23.4 Direct open nonaugmented abductor tendon repair. (**a**) Gluteus medius tendon rupture, (**b**) gluteus minimus tendon rupture, (**c**) preparation of the footprint for tendon attachment, (**d**) final result of both tendon attachment with anchors

elevation of the tendinous insertion; this is the so-called bubble sign indicating an undersurface rupture. In cases of doubtful tendon tears, one may split GMed fibres in line to gain access to the undersurface of the tendon and evaluate the extent of rupture. Before splitting the muscle, sutures must be placed on the opposite tendon sides to help with the anatomic repair. In cases of severe tendinosis, an aggressive debridement should be avoided to preserve the maximal tendon length and width, preventing also tensioning or nonanatomic repair [22]. Once the tendon tears have been recognized, the bone bed area should be prepared with a burr or nibbler, making sure not to remove excessive bone, particularly in the setting of an existing THA with osteolysis. Microfractures can be performed; however, caution should be taken not to over weaken bone adjacent to anchor holes.

If possible, four pairs of bone tunnels should be drilled on the lateral facet for full ruptures of the GMed. In partial ruptures, the number of tunnels can be modified accordingly; however, a minimum of two tunnels is required to ensure adequate contact of the tendon to the repair site. In cases of GMin tears, an additional pair of tunnels should be drilled on the anterior tubercle of the greater trochanter [23]. The bone tunnels for GMed reattachment should be performed perpendicularly to the long axis of the footprint, parallel to the long axis of the femur, whereas tunnel(s) for GMin reattachment should be done in an oblique plane. Thick nonabsorbable pull sutures should be used in a Bunnel, Krakow or similar locking type technique, passing through the tendon ends and bone tunnels and tied down under maximum tension to reapproximate the tendons to their footprint. Additional thin sutures are usually needed, passing through the tendon to enhance the repair.

In the case of a native hip, aiming not to disturb the vascular supply of the femoral head, suture anchors can be used instead of bone tunnels. Two to three proximal anchors are usually placed in a proximal row and other two distally to serve for the double row effect. The size of the anchors should be adjusted depending on the bone area and the presence of a femoral stem [24]. Anchors of 5–6.5 mm diameter are often preferred to overcome the pulling stress due to the underlying cancellous bone of the greater trochanter. Following bone preparation of the abductors' footprint, the proximal anchor holes are drilled and anchors placed (Fig. 23.4c, d). The sutures were then passed through the GM flap and tightened, transferring the flap on the major trochanter with the hip in abduction of 15–20°. Suture placement should account for final tendon positioning and row width, usually 5–10 mm from the tendon edge. After tendon approximation and proximal row suturing, the distal-row anchors are placed and the new sutures increase tendon compression on the bone. A similar approach is used for GMin tears; however, due to the smaller insertion site and capsular attachments of the muscle, one or two anchors can be maximally used [25].

The appropriate tensioning of the repair is checked with the leg in abduction of about 20–30°. When needed, a blunt release of the glutei is performed taking care to avoid the superior gluteal nerve. Besides, the fascia lata can be elongated via a V-Y technique.

Postoperatively, the patient is educated to walk with nonweight or partial weight bearing for 6 weeks with two scratches avoiding active hip abduction; then, hip abductor strengthening and active physiotherapy can be commenced [22–25].

The direct open nonaugmented repair with sutures passing from bony tunnels is a straightforward technique; however, the inadequate mechanics and substantial delay of the repair ends to a high reported failure rate up to 25% [26]. In a retrospective study, 18 patients underwent open repair of abductor tears following THA with lateral approach, using sutures passing through bone tunnels; only half of them have substantial improvement of both limp and pain at 38-month follow-up [24]. A high failure rate was also reported in other studies where suture anchors were used to managing chronic abductor tears. Davies et al. reported five failures of 16 patients that underwent surgical repair using multiple soft tissue anchors inserted into the greater trochanter of the hip to reattach the abductors [27].

23.11 Direct Open Augmented Repair with Synthetic Grafts or Allografts

In cases where the functional quality or the anatomic integrity of gluteal muscleis compromised, the tendon can be augmented with synthetic grafts or allografts. Prerequisite for an adequate augmented repair is the functioning glutei with a low-grade fatty infiltration (Goutallier grade <2) [28].

The standard positioning, approach and evaluation of the rupture are performed as previously described. Either a standard transosseous or suture anchor repair is performed. In case of short tendon length, a slightly proximal position and single-row technique could be used to avoid over tensioning of the repair. The synthetic graft or allograft is utilized to cover the repair site, ensuring the holding on healthy tendon proximally and healthy tendon or bone distally. Different types of synthetic grafts or allografts have been proposed:

(a) Synthetic Ligament

Following bursectomy, Y-iliotibial band release, debridement of the diseased tendon and decortication of the trochanteric footprint, the flattened portion of the synthetic ligament is sutured onto the undersurface of medius or reflected minimus, if involved. The GMed augmented with the synthetic ligament is reattached through a transosseous tunnel, together with suture anchors [29]. Bucher et al. [29] reported on the 1-year clinical and functional results of 22 patients with GMed and GMin tears that were augmented with Ligament Augmentation and Reconstruction System (LARS) synthetic ligament. All patients had failure of conservative treatment previously. There was a significant improvement at 12 postoperative months in the Oxford Hip Score, Short-Form Health Survey (SF-36) and a visual analogue pain scale (VAS) compared to the preoperative values. There was a minimal complication rate. All patients were at least satisfied with the procedure at the end of the first postop year.

(b) Collagen Patch

Following the repair of an abductor tear with transosseous tunnels or anchors, an appropriately sized nonabsorbable collagen patch can be secured over the repair with a running nonabsorbable suture [30]. In cases, with questionable distal fixation, the patch could be partly secured on the vastus lateralis tendon to enhance mechanical integrity.

Fink et al. [30] evaluated the postoperative outcomes of 30 patients with a mean age of 76 years suffering from large tears of the GMed. The patients were treated with osseous fixation using a modified Mason-Allen technique that was additionally secured by a nonresorbable collagen patch (Covidien, Trèvoux, France). Nine patients had a spontaneous tear of the gluteal muscle, and 21 had suffered tearing following hip replacement surgery using a transgluteal approach. At a mean of 24 months, the VAS, HHS and the GMed muscle force were significantly improved and 25 patients had mild or no limb at all. A degree of fatty degeneration of the muscle greater than 50% was related to suboptimal functional results.

(c) Achilles Tendon Allograft

In this technique, the fresh-frozen Achilles tendon with attached calcaneal bone allograft is used. The calcaneal bone block measuring 2 × 1.5 × 0.5–1 cm is fashioned with a saw appropriately with the most proximal edge bevelled to dovetail into a trough of the greater trochanter that was outlined to match the size of the allograft [31]. The fibrous remnants of the tendon insertion are cleaned to create a vascularized bed to increase integration. The GMed and GMin are then mobilized, and the interval between them is developed to allow inferior translation of the muscles. The tendinous part of the allograft is passing through the intact GMed almost 3 cm proximal to the ruptured end and then looped back on itself. Following maximum abduction of the leg, the bone block is placed into the trough of greater trochanter with a press-fit technique and secured with 16-gauge wire or cable placed around the bone block and the proximal part of the femur. Nonabsorbable sutures are used to secure the tendinous portion of the allograft to the GMin and the capsule anteriorly and the intact area of the GMed tendon in a similar fashion posteriorly [31]. Hip abduction brace (10 abuction-30 flexion) for 6 weeks with partial weight bearing is required.

Fehm et al. reported the functional results of seven patients that underwent reconstruction of a deficient abductor mechanism following THA with the aforementioned surgical technique. At a mean follow-up of 24 months, all but one patient had substantial improvements in both the Harris Hip and the pain score.

23.12 Reconstruction for Chronic End-Stage Abductor Tears Using Muscle Transfer

These are salvage techniques described to manage chronic end-stage abductor tears with remarkable tendon insufficiency or gluteal atrophy. Two main surgical techniques have been proposed using either gluteus maximus (GMax) [32–34] or vastus lateralis (VL) muscle transfer [35, 36].

(a) Reconstruction with Gluteus Maximus Transfer Flap

The original technique using the anterior part of the GMax to replace the deficient abductor was described and evolved by L. Whiteside [32, 33]. Whiteside recommended the use of the anterior half of GM alone or combined with Tensor Fascia Lata (TFL) sutured under the VL to manage abductor insufficiency in a native hip; a supplementary posterior flap from GM could be also used to treat THA instability [32, 33]. Whiteside showed the vast improvement of limping and pain in five patients with irreparable tears of hip abductors, using the previously mentioned method; however, this study did not report on functional scores and muscle strength. Chandrasekaran et al. demonstrated a simpler modification of the previous technique [34]; they transferred the anterior third of GM and the posterior third of TFL in a flap to the greater trochanter to manage irreparable abductor tears in three patients with satisfactory outcomes.

The authors' preferred technique is a more straightforward modification of the aforementioned surgical techniques and is described as follows:

The patient is placed in the lateral decubitus position. An incision 12–15 cm long centred over the greater trochanter is performed following the anatomic axis of the femur distally, slanting slightly posteriorly proximally. Following the dissection and retraction of the subcutaneous tissue, the conjoint aponeurosis of the GMax muscle and the fascia lata are exposed. A triangular flap including the anterior third of the GMax muscle is sharply divided anteriorly from the fascia lata and posteriorly in line with GMax fibres; this flap extends 12–15 cm roughly to the half of the length of the muscle (Fig. 23.5). The VL muscle is then incised

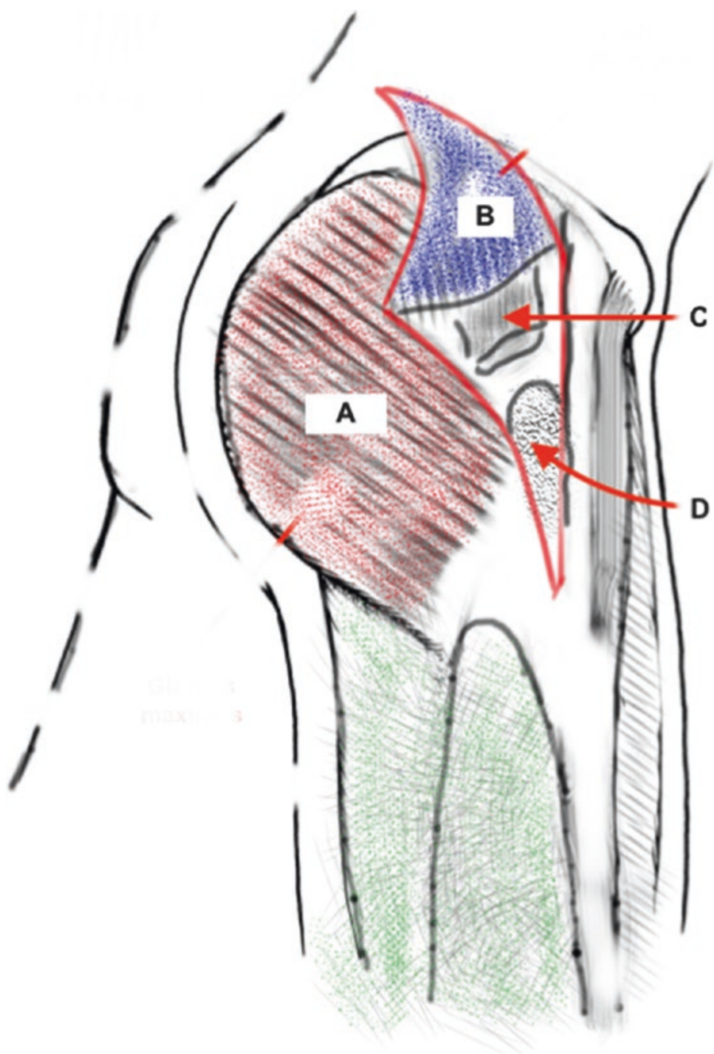


Fig. 23.5 Schematic representation of the lateral part of the gluteal and femoral region demonstrating the lifted triangular flap of the anterior third of the gluteus maximus muscle that uncovers the tear of gluteus medius and greater trochanter

off the vastus lateralis ridge, and the proximal part of VL is mobilized for 2–4 cm in length. The footprint of re-insertion of the GMax on the lateral side of the greater trochanter is then prepared using a round burr aiming to reveal cancellous bone to facilitate healing of the flaps. In case of a patient with THA, six 1.8-mm-diameter drill holes were made at the anterior and posterior margins of the footprint. Large nonabsorbable sutures are passed through the holes in a direction from inside-outside-inside and then through the GM flap where tightened, transferring the flap on the major trochanter with the hip in the abduction of 15–20°. When no hip implant is present, trying not to disturb the vascular supply of the femoral head, three 2.6 mm bio-composite corkscrew suture anchors double loaded with high strength sutures row are used at the anterior and posterior margins of the footprint to transfer and tightening of the flap to the greater trochanter (Figs. 23.6 and 23.7). Once the limb is reduced to a neutral position, pie crust incisions can be performed on the flap to obtain the proper tension. In the end, the upper part of VL muscle is slightly mobilized and sutured over the distal end of the flap of

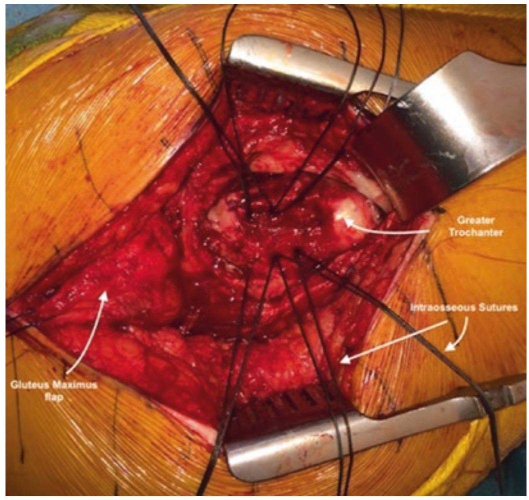
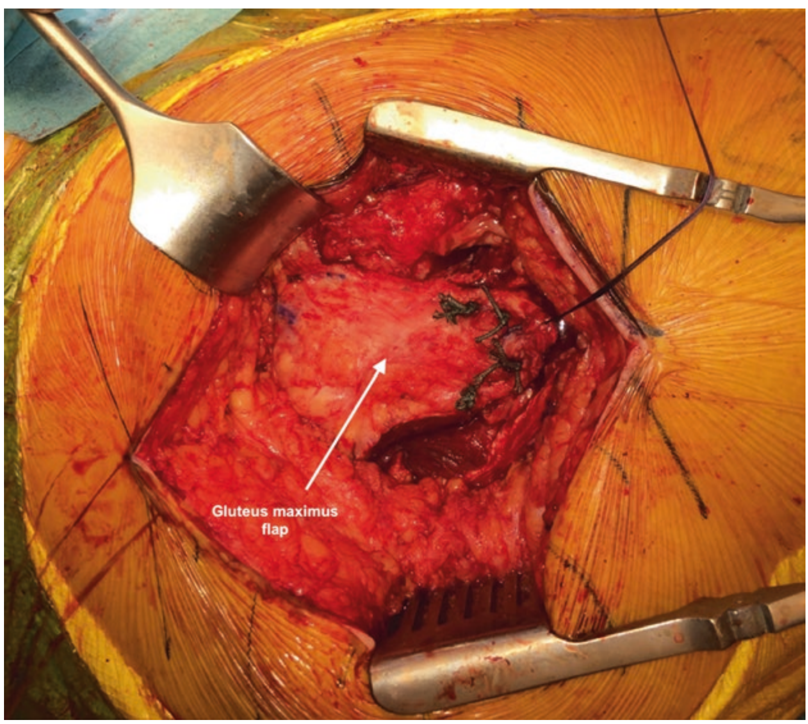


Fig. 23.6 Intraoperative picture displaying the prepared footprint of the greater trochanter, sutures in position and the lifted flap of gluteus maximus

Fig. 23.7 Intraoperative picture showing the gluteus maximus flap that is stitched on the footprint of major trochanter



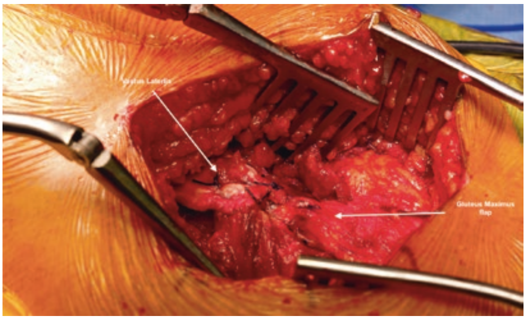


Fig. 23.8 An intraoperative picture illustrating the mobilized part of vastus lateralis covering the lower part of the transfer red gluteus maximus

GMax with absorbable sutures to form a united flap (Fig. 23.8). Postoperatively, the patient walks with partial weight bearing and two crutches for the first 8 postoperative weeks and no active abduction is allowed for 8 weeks. Physiotherapy initiates at 2 months postoperatively.

The authors retrospectively evaluated 38 patients with a mean age of 70.2 years who were surgically managed for chronic abductor insufficiency with the technique mentioned above. All patients had Trendelenburg sign, impaired muscle strength of abduction (≤M4) and fatty degeneration of muscles (Goutallier ≥3). Ten patients received the tendon transfer on a native hip, six following primary THA and 22 after revision THA. The mean VAS, HHS and the median abductor strength were significantly improved compared to the preoperative values. Two-thirds of the patients had a negative Trendelenburg sign at twelve postoperative months. No serious complications were reported.

(b) Reconstruction with VL Flap

This is the other salvage technique to manage nonreparable chronic end-stage abductor tears [35, 36]. Following a lateral incision across the whole length of the thigh, the iliotibial band is incised in line. Once the interval between rectus femoris and VL is developed, the entire VL is prepared taking care not to injure the neurovascular pedicle of the muscle. The muscle is best mobilized from proximal to distal. The plane between VL and the underlying vastus intermedius must be dissected carefully, and the nerve supply to the vastus intermedius must be preserved. Once the insertion of VL into the quadriceps tendon is divided, the muscle is mobilized, the neurovascular pedicle is followed to the femoral nerve, but left within the surrounding fatty tissue to protect it. The leg is abducted approximately 30°, and the VL is sutured proximally to the remaining abductors and with transosseous sutures to the proximal femur and the lateral intermuscular septum [35]. The patient postoperatively needs an orthosis for 6 weeks, and full weight bearing and abductor exercises are then allowed.

In a small series of 11 patients, the VL transfer demonstrated the moderate improvement of functional scores, pain and strength at 2-year follow-up [35]. The advantages of the method include the partial restriction of hip flexion, the separate neurovascular pedicle and the activation of VL in the same part of the gait cycle as hip abductors. However, the complex procedure, the decreased quadriceps muscle strength and the potential neurovascular damage due to overstretching of the neurovascular bundles are the main drawbacks [35, 36].

A proposed treatment algorithm for the management of abductor tendon tears is depicted in Fig. 23.9.

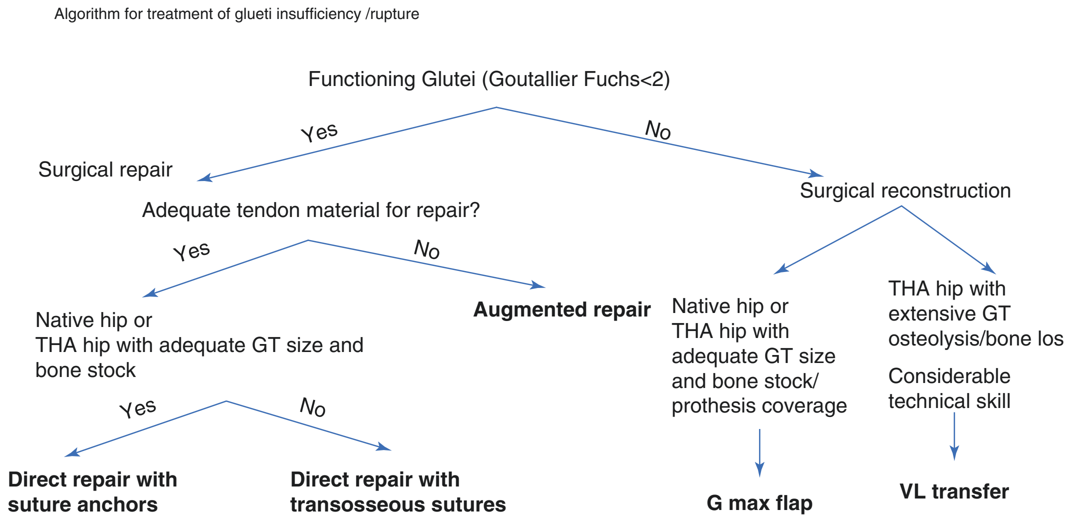


Fig. 23.9 A proposed treatment algorithm of abductor tendon tears

Tips and Tricks

Reinsertion

1. Do not reinsert neurologically nonintact muscles or fatty infiltrated gluteal muscles (Goutallier >2)
2. The lateral position of the patient is preferable.
3. A standard incision is advised to understand the pathology of tendons
4. When rupture is not evident at first sight then inject of saline under the insertion of gluteal tendons or split GMed fibres in line to gain access to the undersurface of the tendon and evaluate the extent of the rupture. Before splitting the muscle, place sutures into the opposite tendon sides to help with the anatomic repair.
5. Avoid an aggressive debridement in cases of severe tendinosis to preserve the maximal tendon length and width.
6. Do not remove excessive bone from the bone bed area of major trochanter to avoid microfractures and weakening of bone adjacent to anchor holes.
7. Use anchors instead of tunnels in case of a native hip aiming not to disturb the vascular supply of the femoral head.
8. Use four pairs of bone tunnels on the lateral facet for full ruptures of the GMed, perpendicularly to the long axis of the footprint.
9. Perform an additional pair of tunnels for GMin tears on the anterior tubercle of the greater trochanter, obliquely to the long axis of the femur.
10. Prefer thick nonabsorbable pull sutures
11. Place two to three proximal anchors in a proximal row and other two distally to serve for the double row effect.
12. Check the tension of the repair with the leg in the abduction of about 20–30°.
13. Perform blunt release of the glutei taking care to avoid the superior gluteal nerve or fascia lata elongation when necessary.
14. Postoperatively avoid full weight-bearing and active hip abduction for 6 weeks

Transfer

1. Transfer muscles to manage chronic end-stage abductor tears with remarkable tendon insufficiency or gluteal atrophy

2. Gluteus maximus transfer is considered less complicated technique than vastus lateralis muscle transfer
3. For the author's preferred technique of gluteus maximus
   (a) Place the patient in the lateral decubitus position
   (b) Perform an incision 12–15 cm long centred over the greater trochanter following the anatomic axis of the femur distally, slanting slightly posteriorly proximally.
   (c) Do not extend the flap of Gluteus maximus more than the half of the muscle (roughly 12–15 cm)
   (d) Do not mobilize vastus lateralis more than 2–4 cm in order not to risk the nerve supply of the muscle
   (e) Use anchors instead of tunnels in case of a native hip aiming not to disturb the vascular supply of the femoral head.
   (f) Pie-crust the flap to achieve the proper tension of the flap with the leg in neutral position
   (g) Try to achieve a united flap between gluteus maximus and vastus lateralis
   (h) Postoperatively avoid full weight-bearing and active hip abduction for 8 weeks

References

1. Long S, Surrey DE, Nazarian LN. Sonography of greater trochanteric pain syndrome and the rarity of primary bursitis. AJR Am J Roentgenol. 2013;201(5):1083–6.
2. Albers IS, Zwerver J, Diercks RL, Dekker JH, Van den Akker-Scheek I. Incidence and prevalence of lower extremity tendinopathy in a Dutch general practice population: a cross sectional study. BMC Musculoskelet Disord. 2016;17:16.
3. Pierce TP, Issa K, Kurowicki J, Festa A, McInerney VK, Scillia A. Abductor tendon tears of the hip. JBJS Rev. 2018;6(3):e6. https://doi.org/10.2106/JBJS.
4. Lachiewicz PF. Abductor tendon tears of the hip: evaluation and management. J Am Acad Orthop Surg. 2011;19(7):385–91.
5. Gottschalk F, Kourosh S, Leveau B. The functional anatomy of tensor fasciae latae and gluteus medius and minimus. J Anat. 1989;166:179–89.
6. Robertson WJ, Gardner MJ, Barker JU, Boraiah S, Lorich DG, Kelly BT. Anatomy and dimensions of the gluteus medius tendon insertion. Arthroscopy. 2008;24(2):130–6.
7. Chi AS, Long SS, Zoga AC, Read PJ, Deely DM, Parker L, Morrison WB. Prevalence and pattern of gluteus medius and minimus tendon pathology and muscle atrophy in older individuals using MRI. Skeletal Radiol. 2015;44(12):1727–33.
8. Howell G, Biggs RE, Bourne RB. Prevalence of abductor mechanism tears of the hips in patients with osteoarthritis. J Arthroplasty. 2001;16(1):121–3.
9. Hendry J, Biant LC, Breusch SJ. Abductor mechanism tears in primary total hip arthroplasty. Arch Orthop Trauma Surg. 2012;132:1619–23.
10. Kagan A II. Rotator cuff tears of the hip. Clin Orthop Relat Res. 1999;368:135–40.
11. Svensson O, Sköld S, Blomgren G. Integrity of the gluteus medius after the transgluteal approach in total hip arthroplasty. J Arthroplasty. 1990;5(1):57–60.
12. Fearon AM, Cook JL, Scarvell JM, Neeman T, Cormick W, Smith PN. Greater trochanteric pain syndrome negatively affects work, physical activity and quality of life: a case control study. J Arthroplasty. 2014;29(2):383–6.
13. Lindner D, Shohat N, Botser I, Agar G, Domb BG. Clinical presentation and imaging results of patients with symptomatic gluteus medius tears. J Hip Preserv Surg. 2015;2(3):310–5.
14. Bird PA, Oakley SP, Shnier R, Kirkham BW. Prospective evaluation of magnetic resonance imaging and physical examination findings in patients with greater trochanteric pain syndrome. Arthritis Rheum. 2001;44(9):2138–45.
15. Kaltenborn A, Bourg CM, Gutzeit A, Kalberer F. The hip lag sign - prospective blinded trial of a new clinical sign to predict hip abductor damage. PLoS One. 2014;9(3):e91560.
16. Lequesne M, Mathieu P, Vuillemin-Bodaghi V, Bard H, Djian P. Gluteal tendinopathy in refractory greater trochanter pain syndrome: diagnostic value of two clinical tests. Arthritis Rheum. 2008;59(2):241–6.
17. Cvitanic O, Henzie G, Skezas N, Lyons J, Minter J. MRI diagnosis of tears of the hip abductor tendons (gluteus medius and gluteus minimus). AJR Am J Roentgenol. 2004;182(1):137–43.
18. Sutter R, Kalberer F, Binkert CA, Graf N, Pfirrmann CW, Gutzeit A. Abductor tendon tears are associated with hypertrophy of the tensor fasciae latae muscle. Skeletal Radiol. 2013;42(5):627–33.
19. Bogunovic L, Lee SX, Haro MS, Frank JM, Mather RC 3rd, Bush-Joseph CA, Nho SJ. Application of the Goutallier/Fuchs rotator cuff classification to the evaluation of hip abductor tendon tears and the clinical correlation with outcome after repair. Arthroscopy. 2015;31(11):2145–51.
20. Steinert L, Zanetti M, Hodler J, Pfirrmann CW, Dora C, Saupe N. Are radiographic trochanteric surface

irregularities associated with abductor tendon abnormalities? Radiology. 2010;257(3):754–63.
21. Pfirrmann CW, Notzli HP, Dora C, Hodler J, Zanetti M. Abductor tendons and muscles assessed at MR imaging after total hip arthroplasty in asymptomatic and symptomatic patients. Radiology. 2005;235(3):969–76.
22. Davies JF, Stiehl JB, Davies JA, Geiger PB. Surgical treatment of hip abductor tendon tears. J Bone Joint Surg Am. 2013;95(15):1420–5.
23. Walsh MJ, Walton JR, Walsh NA. Surgical repair of the gluteal tendons: a report of 72 cases. J Arthroplasty. 2011;26(8):1514–9.
24. Lübbeke A, Kampfen S, Stern R, Hoffmeyer P. Results of surgical repair of abductor avulsion after primary total hip arthroplasty. J Arthroplasty. 2008;23(5):694–8.
25. Schröder JH, Geßlein M, Schütz M, Perka C, Krüger D. Open repair of gluteus medius and minimus tendons tears with double-row technique: clinical and radiological results. Orthopade. 2018;47(3):238–45.
26. Miozzari HH, Dora C, Clark JM, Nötzli HP. Late repair of abductor avulsion after the transgluteal approach for hip arthroplasty. J Arthroplasty. 2010;25(3):450–457.e1.
27. Davies H, Zhaeentan S, Tavakkolizadeh A, et al. Surgical repair of chronic tears of the hip abductor mechanism. Hip Int. 2009;19:372–6.
28. Rao BM, Kamal TT, Vafaye J, Taylor L. Surgical repair of hip abductors. A new technique using Graft Jacket allograft acellular human dermal matrix. Int Orthop. 2012;36(10):2049–53. https://doi.org/10.1007/s00264-012-1630-6. Epub 2012 Aug 8.
29. Bucher TA, Darcy P, Ebert JR, Smith A, Janes G. Gluteal tendon repair augmented with a synthetic ligament: surgical technique and a case series. Hip Int. 2014;24(2):187–93.
30. Fink B, Braun L. Treatment of extensive gluteus muscle tears with trans-osseous fixation and a non- resorbable collagen patch. J Arthroplasty. 2018;33(2):555–9.
31. Fehm MN, Huddleston JI, Burke DW, Geller JA, Malchau H. Repair of a deficient abductor mechanism with Achilles tendon allograft after total hip replacement. J Bone Joint Surg Am. 2010;92(13):2305–11. https://doi.org/10.2106/JBJS.I.01011.
32. Whiteside LA, Nayfeh T, Katerberg BJ. Gluteus maximus flap transfer for greater trochanter reconstruction in revision THA. Clin Orthop Relat Res. 2006;453:203–10.
33. Whiteside LA. Surgical technique: gluteus maximus and tensor fascia lata transfer for primary deficiency of the abductors of the hip. Clin Orthop Relat Res. 2014;472(2):645–53. https://doi.org/10.1007/s11999-013-3161-x.
34. Chandrasekaran S, Darwish N, Vemula SP, Lodhia P, Suarez-Ahedo C, Domb BG. Outcomes of gluteus maximus and tensor fascia lata transfer for primary deficiency of the abductors of the hip. Hip Int. 2017;27(6):567–72.
35. Kohl S, Evangelopoulos DS, Siebenrock KA, Beck M. Hip abductor defect repair by means of a vastus lateralis muscle shift. J Arthroplasty. 2012;27(4):625–9. https://doi.org/10.1016/j.arth.2011.06.034. Epub 2011 Sep 9.
36. Grob K, Monahan R, Gilbey H, Ackland T, Kuster MS. Limitations of the vastus lateralis muscle as a substitute for lost abductor muscle function: an anatomical study. J Arthroplasty. 2015;30(12):2338–42. https://doi.org/10.1016/j.arth.2015.06.047. Epub 2015 Jul 17.