Technical Note

Greater Trochanteric Pain Syndrome: An Intraoperative Endoscopic Classification System with Pearls to Surgical Techniques and Rehabilitation Protocols

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Abstract: Over the past decade, understanding of disorders compromising greater trochanteric pain syndrome (GTPS) has increased dramatically. Nonsurgical treatment options include physical rehabilitation and activity modification, anti-inflammatory as well as biologic injections into the peritrochanteric compartment, and administration of oral analgesics. Multiple open and endoscopic treatment options exist when nonsurgical management is unsuccessful in patients with refractory lateral-sided hip pain, with or without weakness. No true consensus exists within the literature regarding operative techniques of GTPS or postoperative rehabilitation protocols. We present an endoscopic classification system of GTPS with 5 distinct types, which seems to correlate well with preoperative diagnoses and postoperative rehabilitation protocols. The classification system is intuitive, and the corresponding surgical techniques are reproducible for surgeons treating peritrochanteric pathology. Level of Evidence: I (hip); II (extra-articular, impingement).

Historically, patients with lateral-sided hip pain have been diagnosed with trochanteric bursitis and treated with physical therapy, nonsteroidal anti-inflammatory drugs, and corticosteroid injections.[1-6] Advancements in magnetic resonance imaging (MRI) as well as experience with hip arthroscopy have led to an improved understanding of peritrochanteric pain etiology and its management.[7-12] Greater trochanteric pain syndrome (GTPS) has expanded to include disorders of the peritrochanteric space encompassing trochanteric bursitis, gluteus medius and minimus tendinopathy or tears, and external coxa saltans (i.e. snapping hip).[1,4]

Affecting 10% to 25% of the general population,[4] and frequently reported with pain and tenderness in the low back, buttocks, or lateral thigh, GTPS is often a difficult entity to diagnose for musculoskeletal clinicians practicing without an index of suspicion for peritrochanteric pathology.[13] Delay in diagnosis has been shown to lead to significant delays in management for this patient population.[14] Furthermore, once the diagnosis is made, there is a paucity of literature and lack of

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consensus detailing criteria for intraoperative management or postoperative rehabilitation protocols that may predict optimal patient-reported outcomes.

The purpose of this article is to provide an overview of anatomy, discuss relevant diagnostic workups, introduce an intraoperative GTPS endoscopic classification system with 5 distinct types, and describe detailed surgical techniques for each type. Additionally, we provide postoperative rehabilitation protocols that correspond to surgical management.

Anatomy

The anatomy of the peritrochanteric space has been well described in multiple previous reports.[1,13,15] The largest of the 3 main bursae, the subgluteus maximus, also known as the trochanteric bursa, is depicted in Figure 1.[9] The peritrochanteric space contains insertional footprints of the gluteus medius and gluteus minimus on the superoposterior and anterior greater trochanteric facets, respectively.

Diagnostic Workup

A thorough history and physical examination is necessary to diagnose GTPS. Clinical examination includes inspection of the peritrochanteric musculature, looking for signs of atrophy or neuromuscular weakness. Palpation for tenderness and measures of abductor strength should be performed routinely. Single-legged stance and Trendelenburg gait assess gait patterns and the flexion, abduction, and external rotation (FABER) and Ober tests look for signs of discomfort.[9,16,17] Preoperative physical examination variables should include greater trochanter (GT) tenderness (none, 1+, 2+), Trendelenburg gait (yes/no), and abductor strength (scale 0 to 5).

The most common imaging modalities used in the evaluation for GTPS are plain radiography, ultrasonography, and MRI, with MRI as the primary means of evaluating a patient for GTPS.[1,8,12]

Surgical Technique

The surgical technique for steps 1 to 11 are shown in Video 1.

Patient and Room Setup

1. Preoperative preparation begins with general anesthesia, with the patient positioned supine on an arthroscopic traction table with a well-padded perineal post. The following surgical instruments should be available during this case: 70° arthroscope, three 8.25 × 9-mm twist-in cannulas (Arthrex, Naples, FL), epinephrine (1 mg/3 L bag of fluid), 30° bird beak suture passer (Arthrex), and suture retriever (Arthrex).
2. The leg is placed in 15° to 30° of abduction to relax the iliotibial (IT) band and allow for working space in the peritrochanteric compartment.
3. Intraoperative fluoroscopy is used with the C-arm entering the surgical field from the contralateral side. The image is centered over the GT (Fig 2).

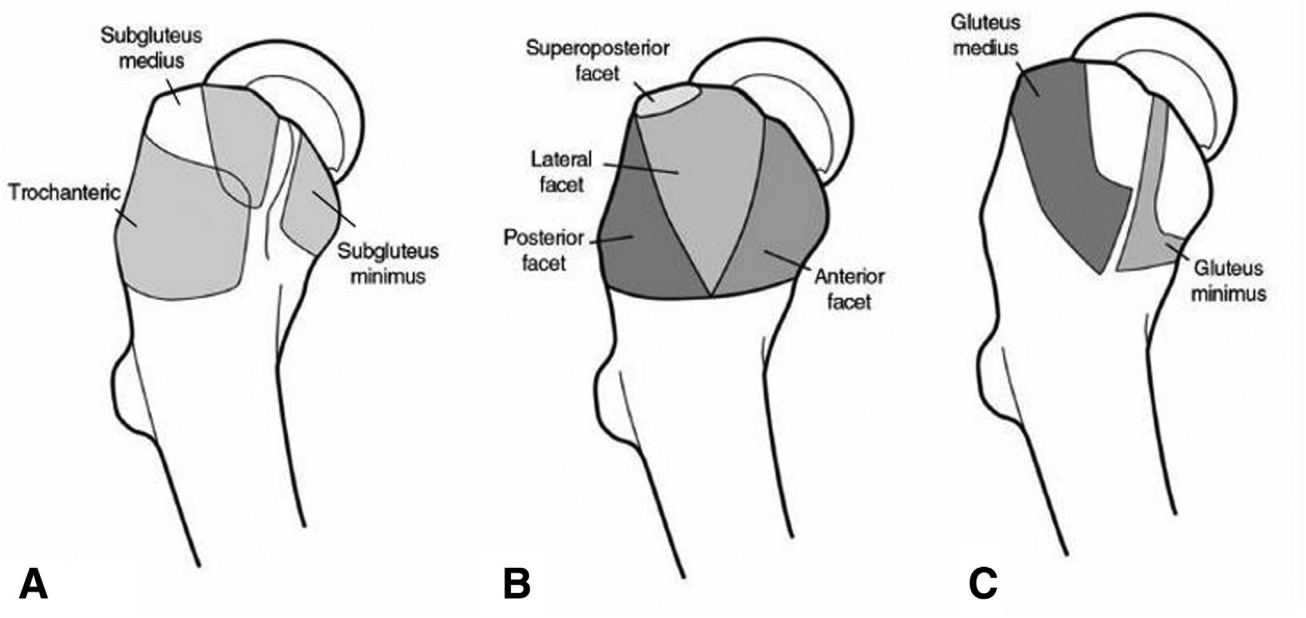

Fig 1. Illustrations depicting sagittal anatomy of the greater trochanter. (A) The 3 main bursae from anterior to posterior direction; subgluteus minimus, subgluteus medius, and trochanteric. (B) Facets of the greater trochanter from anterior to posterior direction; anterior, superoposterior, lateral, and posterior. (C) Insertion footprints of the gluteus medius and gluteus minimus tendons. (Reproduced with permission from Domb et al.[30])

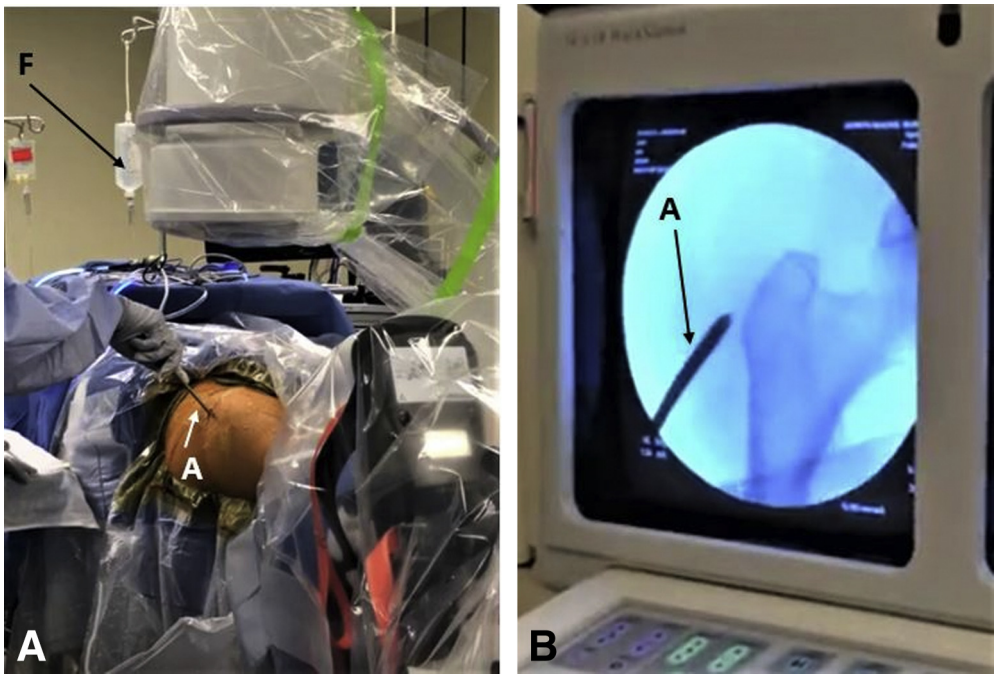

Fig 2. Operating room view of patient in the modified supine position. Right lower extremity is positioned with 30° of hip abduction. (A) Arthroscope positioned in DALA portal aiming toward vastus ridge with image intensifier superior to operative field. (B) Fluoroscopic image confirmation of arthroscope centered over the greater trochanter. A, arthroscope; DALA, distal anterolateral accessory portal; F, fluoroscope.

4. The portals necessary for this operation are the anterolateral (AL) portal, midanterior (MA) portal, distal anterolateral accessory portal (DALA), and superior posterolateral (PL) portal.

Diagnostic Endoscopy of the Peritrochanteric Space

5. Initial access to the peritrochanteric space is done through the DALA portal under fluoroscopic guidance with the image intensifier centered over the GT.
6. A 5.0-mm hip access cannula (Arthrex) is brought into the peritrochanteric space between the interval of the sartorius and tensor fascia lata.
7. Visualization of the shiny white vastus lateralis fascia confirms appropriate scope position.
8. The AL portal is created (or accessed), and a shaver is introduced anterior to the IT band.
9. Thorough trochanteric bursectomy is completed in every case to a) relieve symptomatic trochanteric bursitis and b) allow for visualization of the abductor complex.
10. With a probe, diagnostic endoscopy assesses the abductor complex, including superficial tendon tears and undersurface delamination, gluteus maximus tendon insertion, and undersurface of the IT band.
11. If injury to the abductor complex is identified, the surgeon should reference the presented GTPS endoscopic classification system (Table 1) to correlate findings with preoperative examination and MRI results. Once the GTPS type is diagnosed, appropriate surgical techniques are initiated.

Preparation for Surgical Treatment

12. The PL portal is localized ~2 to 4 cm proximal to the posterior edge of the GT. Under direct visualization, a spinal needle should be tested for correct trajectory of possible future suture anchor placement.
13. Three 8.25-mm flexible Trim-It Custom Hip Cannulas (Arthrex) are cut to the appropriate length. Using detachable Trim-It cannula obturators, cannulas are placed through the PL, AL, and MA portals.

GTPS Classification System

An underlying theme of our GTPS classification system is use of endoscopic diagnosis to guide management. Although multiple previous studies have shown good correlation with preoperative imaging and intraoperative findings in refractory GTPS, little consensus exists as to what to do with these findings.[9,18,19] As such, proper surgical indications and management are of utmost importance to optimize postoperative patient outcomes. In this section and in Table 1, we present the classification types, and respective subtypes, in increasing level of severity. Intraoperative findings ranging from isolated trochanteric bursitis to full-thickness abductor tendon tears with severe retraction will be discussed with corresponding preoperative

Table 1. Greater Trochanteric Pain Syndrome Classification System

Type	Intraoperative Finding	Examination	MRI	Surgical Technique	Rehabilitation Protocol (Week to Begin Crutches, Brace, PT)
I	Bursitis	None vs GT TTP	Trochanteric bursitis	Endoscopic bursectomy	2, 2, 0
II	Bursitis + fraying	GT TTP	Tendinosis	Endoscopic bursectomy, micropuncture	2, 2, 0
IIIA	Partial-thickness tear <25%	Mild abductor weakness	Partial tear low-grade	Endoscopic micropuncture, suture staple repair	2, 2, 0
IIIB	Partial-thickness tear >25%	Moderate abductor weakness	Partial tear high-grade	Endoscopic transtendinous repair (single row)	6, 6, 6
IV	Full-thickness tear	± Trendelenburg testing	Full-thickness tear	Endoscopic vs open repair (double row)	8, 8, 6
V	Full-thickness tear ± retraction (or revision surgical planning)	Severe abductor weakness, +Trendelenburg testing ± nonambulatory without assistance	Full-thickness tear, retracted ± fatty atrophy	Open repair (double row) vs gluteus maximus tendon transfer	8, 8, 6

GT, greater trochanter; MRI, magnetic resonance imaging; PT, physical therapy; TTP, tenderness to palpation.

physical examination and MRI findings, in addition to recommended surgical techniques and rehabilitation protocols. Of note, type V is often diagnosed preoperatively via clinical examination and advanced imaging. Surgical planning typically includes endoscopic versus open repair, versus definitively open tendon transfer for irreparable injuries.

Diagnosis: GTPS Type 1

Endoscopically, GTPS type I consists of isolated trochanteric bursitis without evidence of abductor injury. Clinically, preoperative physical examination consists of tenderness to palpation over the peritrochanteric space. MRI findings are consistent with trochanteric bursitis. Recommended surgical management consists of endoscopic trochanteric bursectomy.

Surgical Technique: Endoscopic Bursectomy

The 70° arthroscope is inserted into the peritrochanteric space through the DALA portal. Aiming just inferior to the vastus ridge under fluoroscopic visualization allows the surgeon to avoid iatrogenic damage to the gluteus medius insertion (Fig 3A). An arthroscopic shaver is then introduced through the AL portal, and trochanteric bursectomy with debridement is performed. The entire peritrochanteric space is examined, including the gluteus medius and maximus insertions, for signs of tearing or injury. A probe must be used to confirm tendon stability and to rule out undersurface tendon delamination injuries (Fig 3B).

Rehabilitation Protocol

- 20-lb flat-foot weightbearing restriction for 2 weeks
- Hip brace (Donjoy X-Act ROM Hip Brace; DJO Global, Vista, CA) to be worn for 2 weeks
- Rehabilitation to begin the day after surgery.

Diagnosis: GTPS Type II

GTPS type II consists of trochanteric bursitis and surface fraying of the gluteus medius or gluteus minimus tendons, respectively. Clinically, preoperative physical examination is consistent with tenderness to palpation over the peritrochanteric space with maintained abductor strength. MRI findings typically show insertional tendinosis of the gluteus medius or gluteus minimus tendons in addition to subgluteal inflammation. Recommended surgical management consists of endoscopic trochanteric bursectomy with trochanteric micropuncture.[1,4,8]

Surgical Technique: Endoscopic Trochanteric Micropuncture

A 70° arthroscope is used to view the peritrochanteric space through the DALA portal, and a 45° microfracture awl is introduced through the 8.25-mm cannula within the PL portal (Fig 4A). The limb can be rotated internally and externally to provide better access to the trochanteric region. To stimulate healing, a microfracture awl is used to create multiple holes within the lateral facet of the GT through the diseased gluteus medius tendon (Fig 4B). The awl is driven to a depth of 3 to 5 mm with a light mallet.

Rehabilitation Protocol

- 20-lb flat-foot weightbearing restriction for 2 weeks
- Hip brace to be worn for 2 weeks
- Rehabilitation to begin the day after surgery.

Diagnosis: GTPS Type IIIA

GTPS type IIIA consists of a partial-thickness (<25%) tear of the gluteus medius or gluteus minimus undersurface attachments to the lateral facet, indicated by

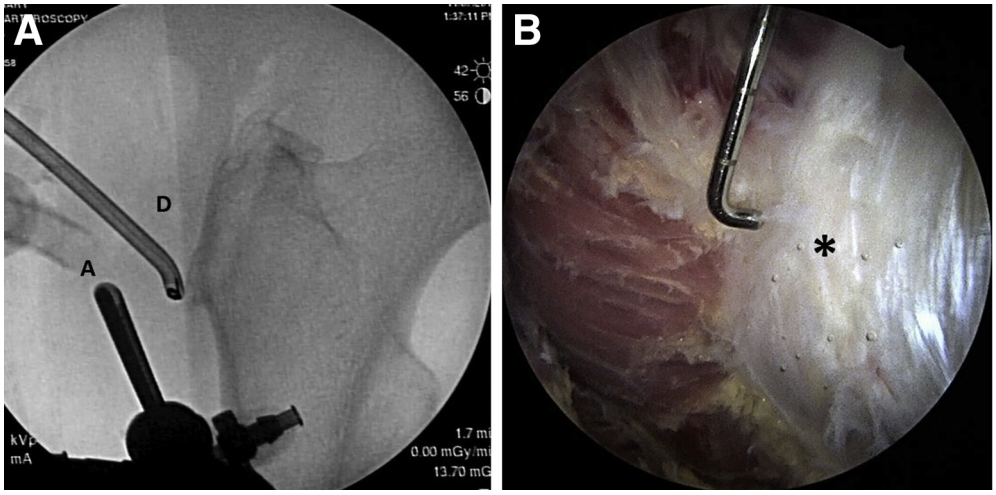

Fig 3. Right hip positioned supine with 30° of abduction. (A) Fluoroscopic view of peritrochanteric space with arthroscope positioned in DALA portal and shaver positioned in anterolateral portal. (B) Arthroscopic view from DALA portal, probe evaluation of intact gluteal tendon (tip of probe at muscle–tendon junction) after completion of endoscopic trochanteric bursectomy. A, anterolateral portal. D, DALA portal; DALA, distal anterolateral accessory portal. *Gluteus medius tendon.

focal destabilization when probed. Clinically, preoperative physical examination is consistent with mild abductor weakness in addition to peritrochanteric tenderness. MRI findings are consistent with low-grade partial-thickness tearing of the gluteus medius or gluteus minimus tendon footprints. Recommended surgical management consists of endoscopic trochanteric bursectomy and micropuncture[20] followed by abductor tendon repair using the suture staple technique.[21]

Surgical Technique: Endoscopic Gluteus Medius Repair, Suture Staple Technique

Viewing with a 70° arthroscope through the DALA portal, the gluteus medius insertion is probed and confirmed to be partially destabilized on its undersurface from its attachment to the lateral facet. A trochanteric micropuncture is completed before anchor placement, as previously described.[20] This sequence of surgical steps helps prevent poor anchor fixation. Next, a metal punch is introduced into the trochanteric facet, followed by placement of at least 1 pair of PEEK 3.0-mm Knotless SutureTak anchors (Arthrex). Care is taken to internally rotate the extremity while placing the posterior anchor and to maintain a neutral limb when placing the anterior anchor. The repair suture from each anchor is shuttled through the adjacent anchor looped shuttle stitch (A to B and B to A), to create a horizontal mattress suture staple configuration (Fig 5B). This technique allows for excellent compression of the tendon over the lateral facet (Fig 5C).

Rehabilitation Protocol

- 20-lb flat-foot weightbearing restriction for 2 weeks
- Hip brace to be worn for 2 weeks
- Rehabilitation to begin the day after surgery.

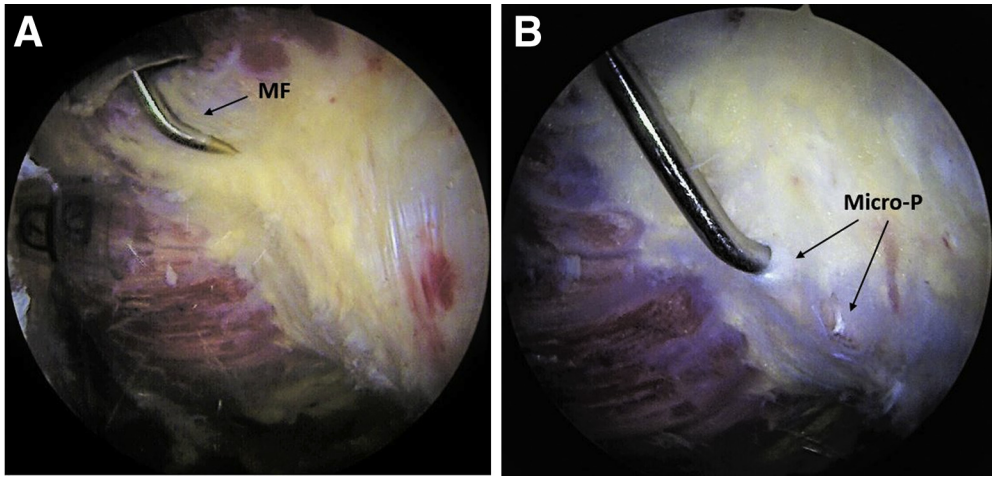

Fig 4. Right hip positioned supine with 30° of abduction; all arthroscopic views are from the DALA portal. (A) Microfracture awl positioned at a region of known undersurface abductor tendon injury, verified with probe evaluation. (B) Microfracture awl entering abductor tendon footprint using the micropuncture technique. DALA, distal anterolateral accessory portal; MF, microfracture awl; Micro-P, micropuncture holes within greater trochanter.

Diagnosis: GTPS Type IIIB

GTPS type IIIB consists of a partial-thickness (>25%) tear of the gluteus medius or gluteus minimus lateral facet insertion sites, confirmed by direct visualization of injured tendon and destabilization of footprint when probed. Clinically, preoperative physical examination is consistent with moderate abductor weakness. MRI findings are consistent with high-grade partial-thickness tearing of the gluteus medius or gluteus minimus tendinous footprints with associated subgluteal bursal inflammation. Recommended surgical management consists of diseased gluteus medius or minimus tendon debridement followed by tendon repair using the endoscopic transtendinous technique.[22]

Surgical Technique: Endoscopic Gluteus Medius Repair, Transtendinous Technique

Viewing with a 70° arthroscope through the DALA portal, after completing a trochanteric bursectomy and diseased tendinous debridement, a thorough diagnostic endoscopic examination of the peritrochanteric space is done. All structures are evaluated and probed, including the gluteus maximus, vastus lateralis, IT band, and torn gluteus medius. A beaver blade is inserted through a cannula within the AL portal, and a longitudinal split is made within the midsubstance of the gluteus medius tendon, along the lateral facet adjacent to the injured undersurface tissue (Fig 6A,B). The arthroscope is then inserted through this split within the gluteus medius bursal space, and undersurface tear of the diseased, pathologic tendon is viewed in its entirety. Torn fibers identified on the deep side of the gluteus medius tendon are debrided with a shaver positioned within this AL portal, exposing the lateral facet of the GT. The lateral facet is then decorticated with an arthroscopic burr to create a bleeding bed of bone for healing. Via the accessory PL portal, a double-loaded 5.5-mm PEEK Corkscrew anchor (Arthrex) is

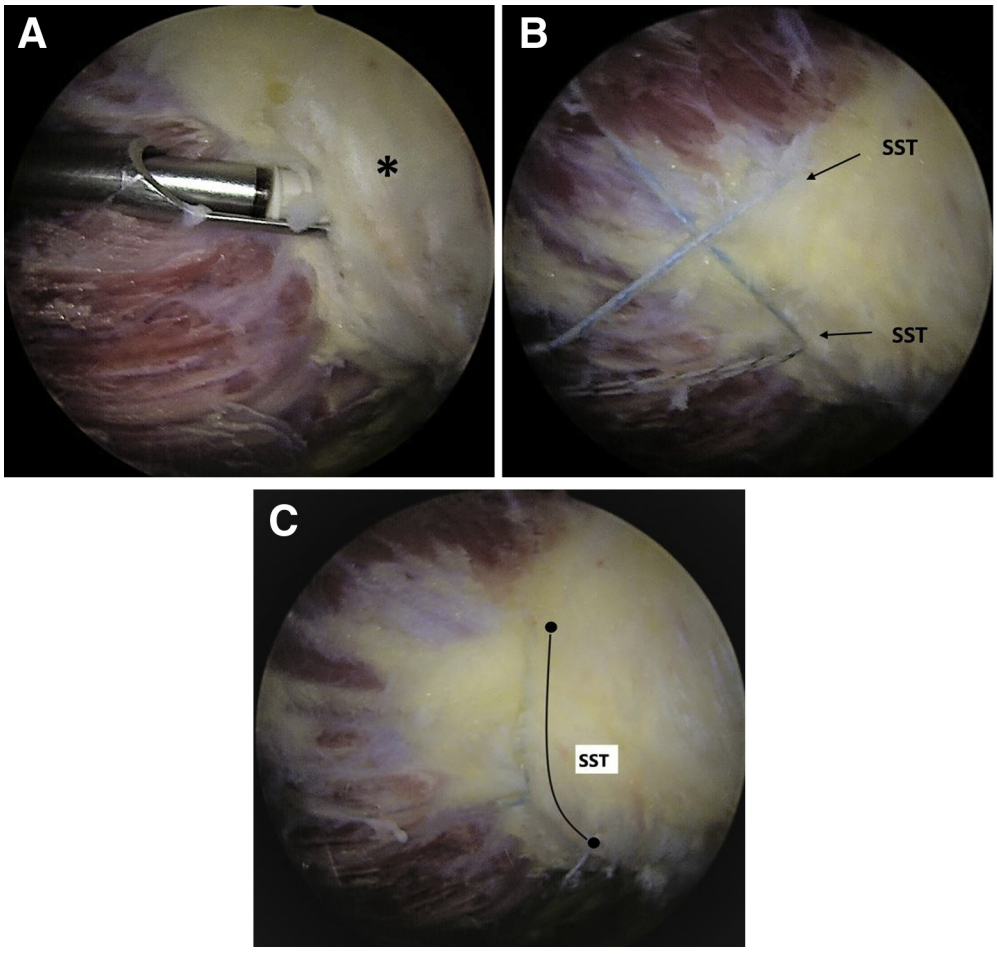

Fig 5. Right hip positioned supine with 30° of abduction; all arthroscopic views are from the DALA portal. (A) Placement of 3.0-mm PEEK Knotless SutueTak (Arthrex) anchor within gluteal tendon footprint at area of confirmed undersurface partial tear. *Gluteus medius tendon. (B) Crisscross configuration of 2 knotless repair anchors placed within the superoposterior facet. (C) Completed gluteus medius repair using suture staple technique. DALA, distal anterolateral accessory portal; SST, suture staple repair stitch.

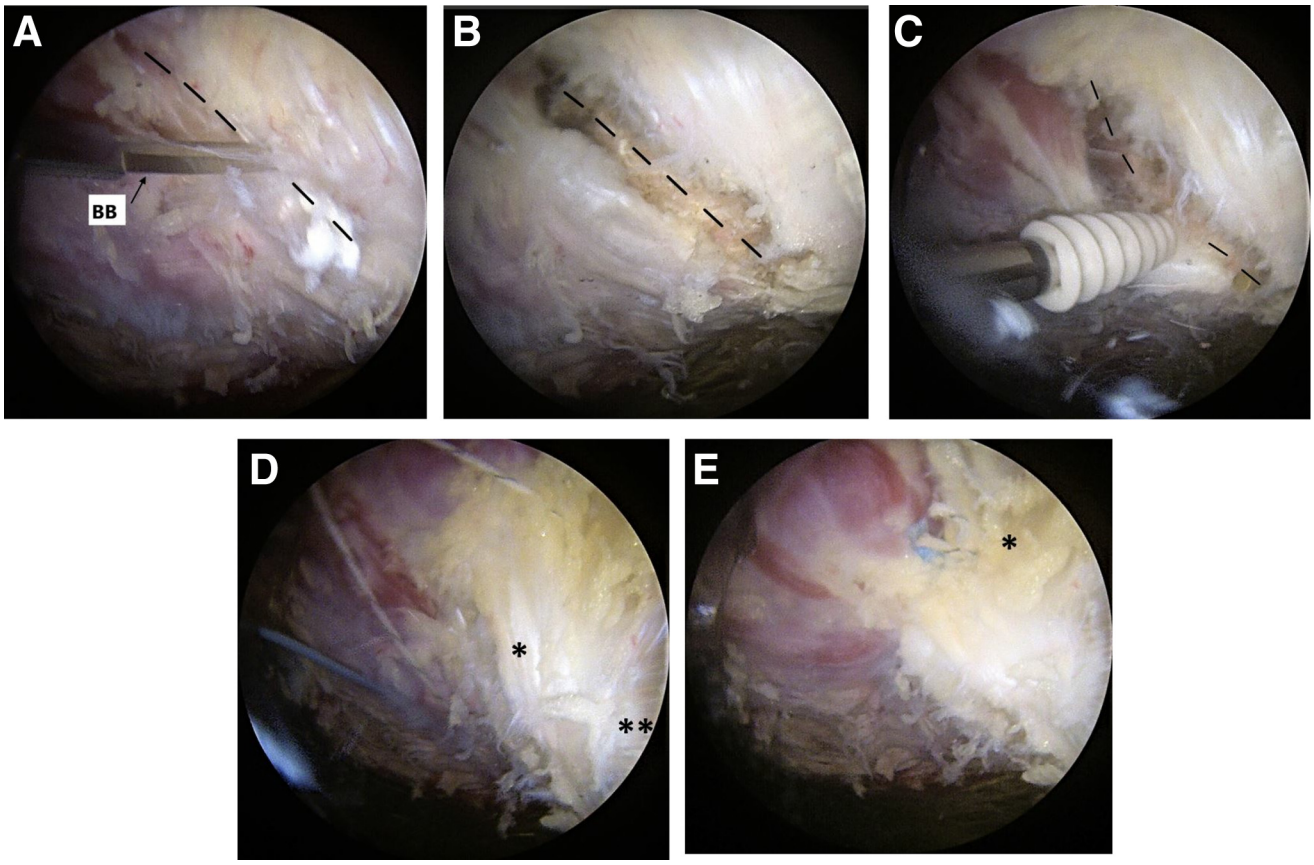

Fig 6. Right hip positioned supine with 30° of abduction; all arthroscopic views are from the DALA portal. (A) Arthroscopic beaver blade split into high-grade partial-thickness tearing of the abductor tendon. (B) Arthroscopic view of transtendinous access to greater trochanteric footprint. (C) After decortication of bony footprint, arthroscopic view of double-loaded corkscrew anchor (Arthrex) being placed at the superoposterior greater trochanteric facet. (D) Arthroscopic view of sutures tails being passed in a side-to-side configuration along transtendinous split, proximal to distal direction. (E) Arthroscopic view showing completed repair of gluteus medius tendon using the transtendinous technique. BB, arthroscopic beaver blade; DALA, distal anterolateral accessory portal. Dotted line, transtendinous window. *Gluteus medius tendon. **Vastus lateralis tendon.

placed through the tendon split in the distal part of the lateral facet footprint (Fig 6C). Next, a Birdbeak grasper (Arthrex) is used to pass 1 limb of each suture through the anterior and posterior tendon leaflets (Fig 6D). Both sets of sutures are then tied using an arthroscopic knot pusher. This technique results in debridement of nonviable tissue, side-to-side repair of the longitudinal tendon split, and firm approximation of the tendon to the footprint along the lateral facet (Fig 6E).

Rehabilitation Protocol

- 20-lb flat-foot weightbearing restriction for 6 weeks
- Hip brace to be worn for 6 weeks
- Rehabilitation to begin at 6 weeks postoperatively.

Diagnosis: GTPS Type IV

GTPS type IV consists of a full-thickness gluteus medius tear without significant retraction. Clinically, preoperative physical examination is consistent with moderate abductor weakness and often positive Trendelenburg testing, either weakness with single leg stance or gait pattern. MRI findings are consistent with a full-thickness gluteus medius tear pattern, possible tendon retraction, and moderate subgluteal bursal inflammation. Recommended surgical management consists of endoscopic versus open gluteus medius repair with double-row configuration.[23]

Surgical Technique: Endoscopic Gluteus Medius Repair, Full-Thickness Technique

The sequence of repair for full-thickness tendon tears is similar to partial-thickness repairs; however, a double-row suture anchor configuration is used. After entry in the peritrochanteric space, a 70° arthroscope is placed within the DALA portal for visualization (Fig 7A,B). After a thorough bursectomy is completed, a probe is inserted through the AL portal to palpate the gluteus medius tendon footprint. When a full-thickness tear is confirmed and deemed amenable to endoscopic

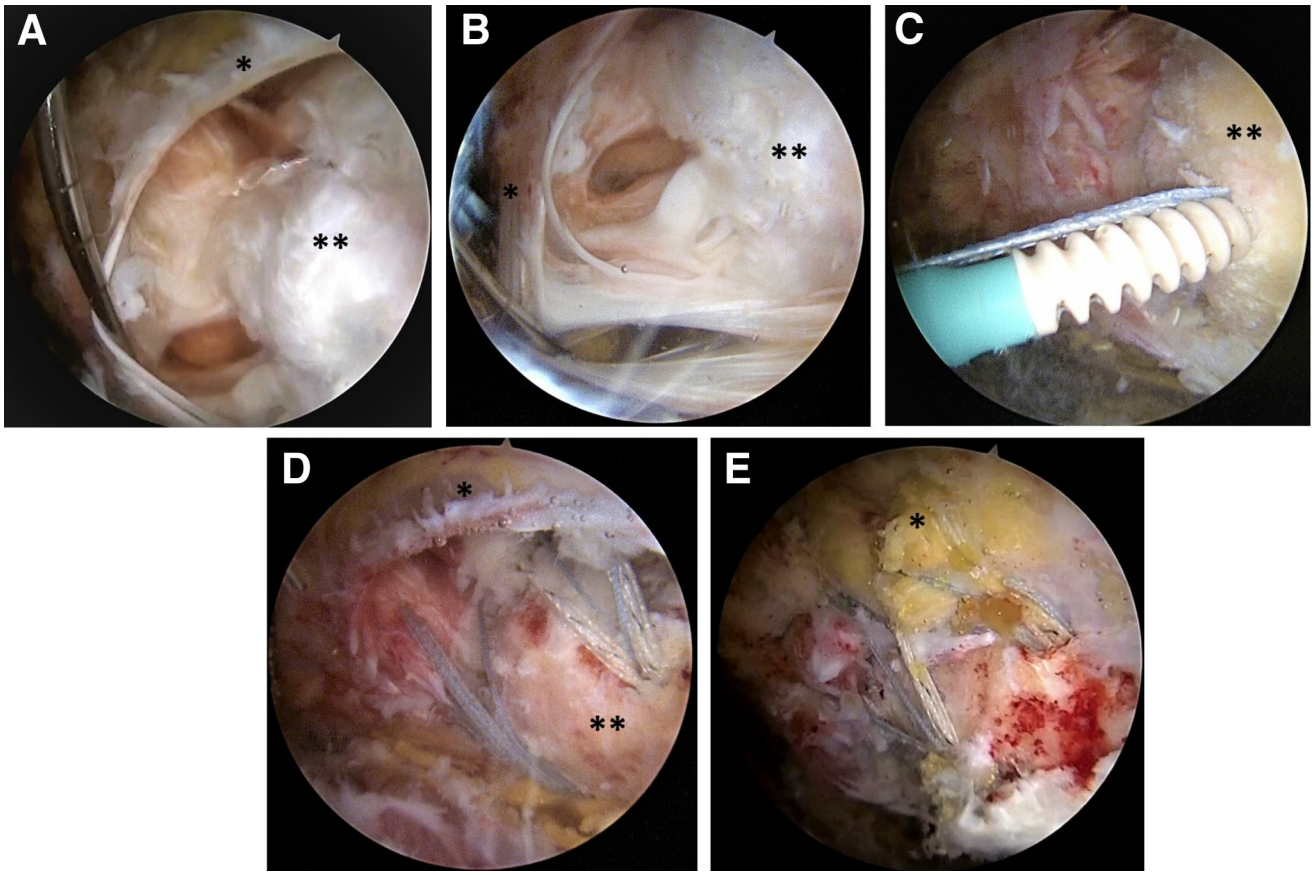

Fig 7. Right hip positioned supine with 30° of abduction; all arthroscopic views are from the DALA portal. (A,B) Full-thickness, retracted gluteus medius tear is identified and probed, exposing insertional facet of the greater trochanter. (C) After diseased tendon debridement and footprint decortication, shown here is placement of double-loaded corkscrew suture anchor (Arthrex) within superoposterior greater trochanteric facet. (D) Passage of suture tails in horizontal mattress fashion from anterior to posterior direction. (E) Arthroscopic view showing completed repair using a double-row suture-bridge configuration. DALA, distal anterolateral accessory portal. *Gluteus medius tendon. **Greater trochanter.

repair, diseased tendon is debrided, and the lateral facet is decorticated using an arthroscopic burr to create a bleeding bed of bone in preparation for suture anchor placement. The tendon repair is then performed with a double-row construct. Two versus 3 double-loaded SwiveLock suture anchors (Arthrex) are placed within the lateral facet proximally via access through the AL and PL portals, respectively. Of note, during placement of anterior anchors, single- or double-row technique, the foot should maintain in neutral rotation. When placing posteriorly based anchors, the lower extremity can be rotated internally, thereby providing better access to the trochanteric footprint (Fig 7C). Additionally, this position aids in directing the implant target away from the sciatic nerve, which lies posterior to the GT. Suture pairs are then passed in a horizontal mattress configuration through the debrided end of tendon using a Birdbeak passer (Arthrex) as seen in Figure 7D. Next, 4 versus 6 corresponding knots are tied with an arthroscopic knot pusher. A single limb of each proximal row suture anchor knot is then passed into 2 versus 3 additional knotless SwiveLock (Arthrex) suture anchors within the distal row. This completes a crisscross, suture-bridge configuration that provides added compression of the tendon against bone (Fig 7E,F).

Of note, when the tendinous injury is not amenable to endoscopic repair, the open double-row repair technique is used, as seen in Figure 8. A standard posterolateral approach to the left hip is performed with the patient in the lateral decubitus position. An incision is carried through the subcutaneous tissues to identify the fascia lata, which is incised in line with the GT distally and curved posteriorly. Blunt dissection of gluteus maximus fibers is completed. A trochanteric bursectomy is performed with electrocautery, removing inflamed tissue and providing excellent exposure of the gluteus medius tendon. Scar tissue from around the tendon stump is debrided sharply, and the healthy-appearing tendon is defined. The area of the GT is

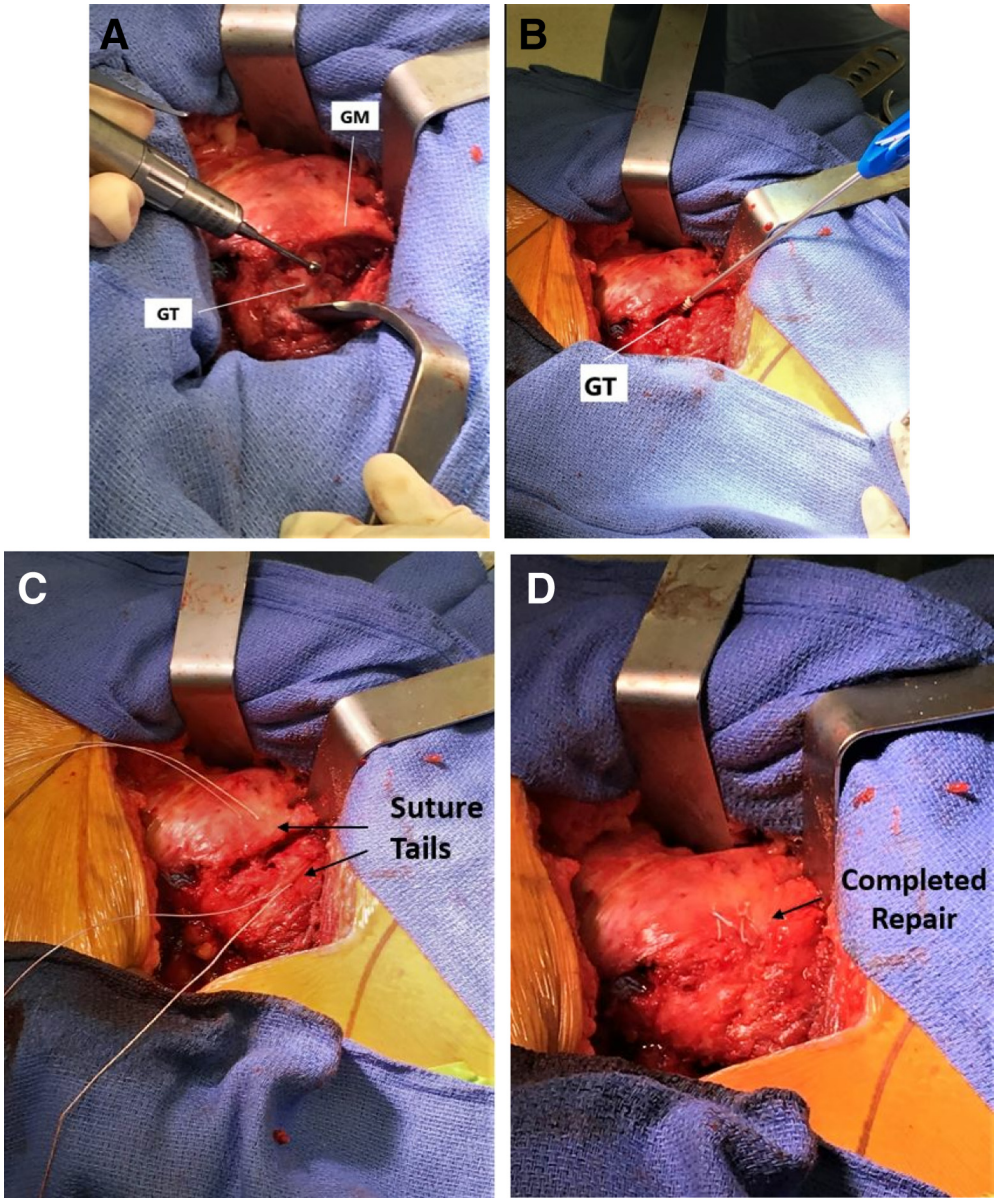

Fig 8. Open-procedure left hip with the patient positioned in the lateral decubitus position showing full-thickness tear of gluteus medius tendon. (A) Open decortication with round burr being performed to create a bleeding bone bed in preparation of tendon repair. (B) Double-loaded corkscrew suture anchor (Arthrex) placed within the greater trochanteric facet. (C) Passage of suture tails in horizontal mattress configuration. (D) Completion, open repair of gluteus medius tendon. GM, gluteus medius tendon; GT, greater trochanter.

decorticated with a handheld burr to create a bleeding bed of bone for tendon healing (Fig 8A). As previously described, a double-row suture bridge construct is created, first by placing double- versus triple-loaded corkscrew (Arthrex) suture anchors within the proximal aspect of the greater trochanteric footprint (Fig 8B). Next, corresponding suture limbs are passed through the tendon in horizontal mattress configuration and tied to complete fixation (Fig 8C). Next, a single limb from each proximal row knot is loaded distally into 2 versus 3 additional knotless SwiveLock anchors (Arthrex), completing double-row fixation (Fig 8D). Excellent repair construct is created in this fashion and reinforced with #1 Vicryl sutures through the tendon repair.

Rehabilitation Protocol

- 20-lb flat-foot weightbearing restriction for 8 weeks
- Hip brace to be worn for 8 weeks
- Rehabilitation to begin at 6 weeks postoperatively.

Diagnosis: GTPS Type V

GTPS type V consists of thickened inflammatory bursitis and full-thickness gluteus medius tear with significant retraction. Preoperative physical examination is typically consistent with severe abductor weakness and positive Trendelenburg testing, or even inability to ambulate without assistance. MRI findings are often consistent with a retracted, irreparable, full-thickness abductor tear pattern and significant subgluteal inflammation or edema due to increased

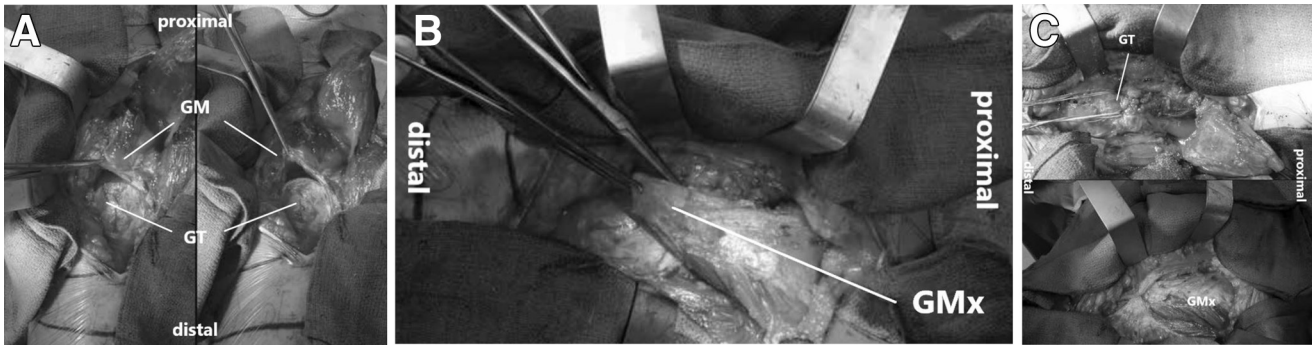

Fig 9. Open-procedure left hip with the patient positioned in the lateral decubitus position showing irreparable full-thickness tear of gluteus medius tendon with significant retraction. (A) Kocher clamp placed on end of retracted abductor tendon, which did not approximate to the level of the greater trochanter (GT), even after being mobilized via removal of adhesions. (B) Mobilization of the gluteus maximus flap with the anterior one-third released from its distal attachment to fascia lata. (A) Upper image, double-loaded corkscrew suture anchors (Arthrex) placed within the greater trochanteric footprint; gluteus maximus flap everted showing bare underlying facet. Lower image, completion of gluteus maximus flap attachment to the GT with suture anchors tensioned as the hip is placed in neutral abduction. GM, gluteus medius tendon; GMx, gluteus maximus tendon transfer flap; proximal, toward head of patient; distal, toward foot of patient.(Reproduced with permission from Chandrasekaran et al.[25])

potential space within the peritrochanteric region. Fatty atrophy is often between grades 3 or 4, according to Goutallier/Fuchs classification,[24] indicating significant fatty infiltration of the abductor musculature. Recommended surgical management consists of attempted open double-row gluteus medius repair versus open gluteus maximus and tensor fascia lata transfer, which is reserved for irreparable injuries.[25,26]

Surgical Technique: Open Gluteus Maximus and Tensor Fascia Lata Transfer

As previously described, a standard posterolateral approach to the hip is performed. At the level of the fascia lata, an incision made in line with the GT distally is curved sharply in the posterior direction, separating the anterior two-thirds of the gluteus maximus, along with its insertion on the fascia lata, and IT band from the posterior one-third. A plane is then developed between the IT band and the gluteus medius. In this manner, the entire IT band and fascia lata are separated from the gluteus medius and preserved for later gluteus maximus transfer. The gluteus medius is then closely inspected and often is found to have severe retraction, up to 4 to 5 cm, with severe atrophy (Fig 9A). An attempt to repair the gluteus medius can be undertaken as described in the aforementioned open repair technique. To augment difficult repairs, or in cases of irreparable injury because of poor tissue quality and retraction, the gluteus maximus and tensor fascia lata transfer may be used. The anterior third of the gluteus maximus is then separated from the posterior two-thirds, and this triangular flap is transferred to the GT, recreating the abductor mechanism (Fig 9B). This is secured to the GT with 3 double-loaded corkscrew anchors, each of which is used to pass 2 horizontal mattress suture configurations. After knots are tied, a single limb from each knot is passed in a suture bridge fashion and anchored distally to an additional 2 to 3 knotless SwivelLock suture anchors (Arthrex). After completion of the tendon transfer construct, additional No. 1 Vicryl sutures are then used to close the transferred gluteus maximus to the vastus lateralis fascia. Both the lateral femoral circumflex artery and the superior gluteal nerve should be identified and protected throughout this procedure.

Rehabilitation Protocol

- 20-lb flat-foot weightbearing restriction for 8 weeks
- Hip brace to be worn for 8 weeks
- Rehabilitation to begin at 6 weeks postoperatively.

Summary of Guidelines and Precautions after Surgery

Weightbearing/Hip Brace/Rehabilitation

A hip brace is used in all patients to facilitate healing and pain relief after a surgical procedure by providing support and restricting range of motion (ROM) of the operative extremity.

Type 1-IIIA

- 2 crutches (or rolling walker)
- 20-lb flat-foot weightbearing for the first 2 weeks postoperatively
- Hip brace worn for 2 weeks
- Rehabilitation protocol begins immediately postoperatively.

Type IIIB

- 2 crutches (or rolling walker)
- 20-lb flat-foot weightbearing for the first 6 weeks postoperatively

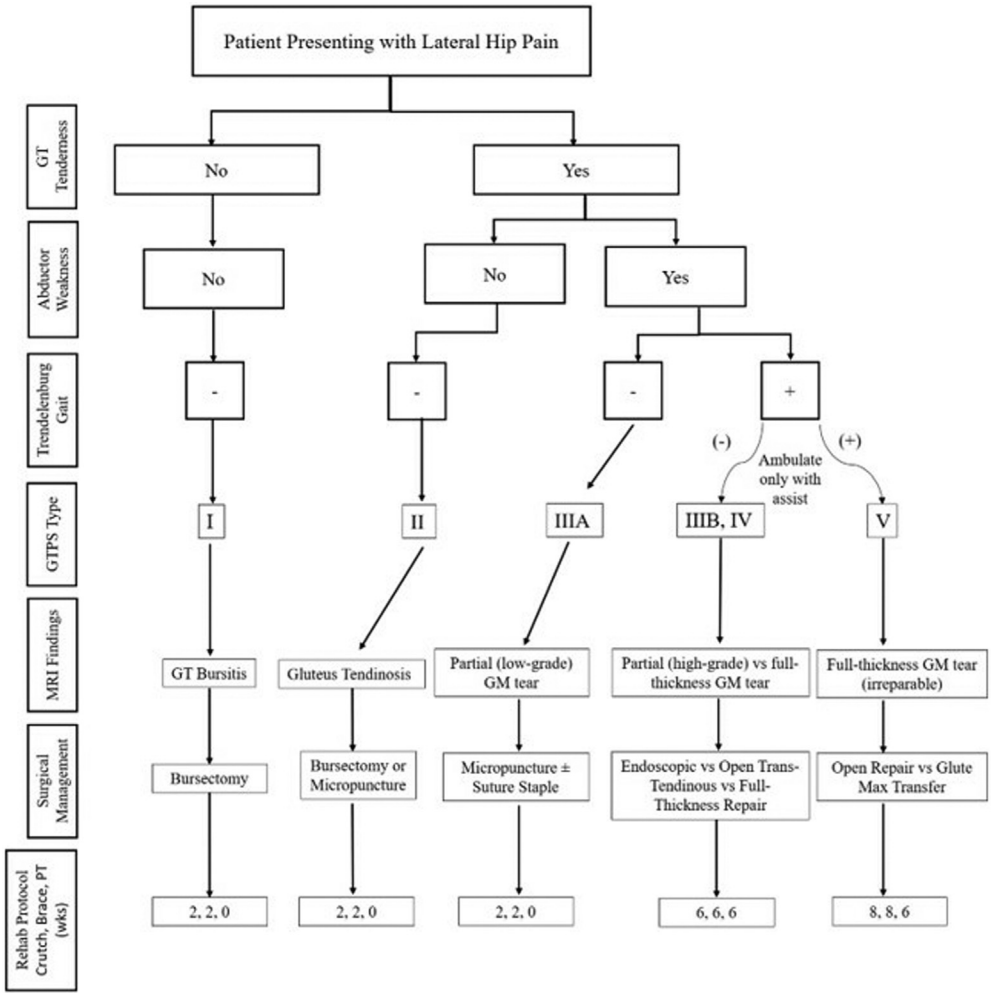

Fig 10. Greater trochanteric pain syndrome (GTPS) treatment algorithm. Crutch; duration of crutch use (wk). Brace; duration of abduction brace use (wk). PT; time point to begin physical therapy postoperatively (wks). GM, gluteus minimus or medius; GT, greater trochanter; MRI, magnetic resonance imaging; PT, physical therapy. *See Appendix for full rehabilitation protocol.

- Hip brace worn for 6 weeks
- Rehabilitation protocol begins 6 weeks postoperatively.

Type IV-V

- 2 crutches (or rolling walker)
- 20-lb flat-foot weightbearing for the first 8 weeks postoperatively
- Hip brace worn for 8 weeks
- Rehabilitation protocol begins 6 weeks postoperatively.

ROM

Type IIIB-V: For first 6 weeks postoperatively, no active hip abduction and IR; no passive hip ER and adduction. See Appendix for full rehabilitation protocol.

Discussion

Surgical management of GTPS has been reserved for patients with symptoms that have been present for a minimum of 6 to 12 months and in whom nonsurgical treatment has been unsuccessful. As such, various open or endoscopic techniques[1,9,27] have been described to treat GTPS depending on the etiology of the pain; however, to our knowledge, there is no consensus on recommended techniques based on intraoperative findings.

Our classification system relies on endoscopic confirmation of the pathological tissue, which may correlate with the preoperative diagnosis. Few studies have focused on the clinical presentation of patients with GTPS. Lindner et al.[11] found that 45 of 45 (100%) patients presenting with greater trochanteric tenderness to palpation or abductor weakness were diagnosed with a gluteus medius tear. In that same study, preoperative MRI findings were misdiagnosed 43% of the time by radiologists, which led the authors to conclude that physician experience with GTPS imaging is critical to accurate diagnosis. Ebert et al.[28] set out to describe the clinical, functional, and biomechanical presentation of patients with symptomatic abductor tears of the hip. Results of that study showed the difficulty in assessing

Table 2. Pearls and Pitfalls of the Endoscopic Greater Trochanteric Pain Syndrome Classification System and Associated Surgical Techniques

Pearls
Rapid intraoperative diagnostics and decision making
Concomitant described surgical techniques
Descriptive postoperative restrictions/rehabilitation protocols
Pitfalls
Misdiagnosis due to lack of visualization or unfamiliarity with anatomy
Deviation from recommended postoperative restrictions/protocols

patients with GTPS due to significantly reduced patient-reported outcomes, active hip ROM in all planes, and hip abduction strength compared to an age-matched control group with end-stage hip osteoarthritis.

In response to the aforementioned difficulties in diagnosis, and in an attempt to improve the accuracy of surgical indications, Chandrasekaran et al.[29] recently identified clinical features predicting the need for operative intervention in patients with gluteus medius tears. The authors identified reduced power of resisted hip abduction and the presence of gait deviation as factors which significantly increased the likelihood of surgical intervention.[29] The authors specifically noted the need for early diagnosis to avoid problems of tendon retraction and fatty infiltration, which can potentially improve surgical outcomes in an often missed or delayed diagnosis.

It is our hope that this article aids in early diagnosis of an often difficult-to-treat patient population with an evidence-based algorithmic approach, as illustrated in Figure 10. Identification of preoperative diagnostic variables such as greater trochanteric tenderness, abductor weakness, Trendelenburg gait, or pertinent MRI findings can help clinicians diagnose GTPS at early symptom onset (Tables 2 and 3). The endoscopic classification system, with corresponding surgical techniques, presented in this article will help surgeons with intraoperative diagnostic decision making. Additionally, the associated rehabilitation protocols will help aid in streamlining communication between treating providers, patients, and physical therapists.

Table 3. Advantages, Risks, and Limitations of the Greater Trochanteric Pain Syndrome Classification System

Advantages
Guided, evidence-based decision making algorithm
Iliotibial band sparing 70° arthroscopic techniques
Historically gold standard open management treatment options
Aid in communication of management between patients, surgical providers, and physical therapists.
Risk
Improper surgical technique can cause severe iatrogenic injury to the abductor complex and/or surrounding neurovascular structures.
Limitations
Steep surgical learning curve
Trained surgical team and staff
Patient compliance to restrictions/protocols.

References

1. Redmond JM, Chen AW, Domb BG. Greater trochanteric pain syndrome. *J Am Acad Orthop Surg* 2016;24:231-240.
2. Seidman AJ, Varacallo M. Trochanteric Bursitis. In: *StatPearls*. Treasure Island, FL: StatPearls Publishing, http://www.ncbi.nlm.nih.gov/books/NBK538503/. Accessed March 15, 2019.
3. LaPorte C, Vasaris M, Gossett L, Boykin R, Menge T. Gluteus medius tears of the hip: A comprehensive approach. *Phys Sportsmed* 2019;47:15-20.
4. Torres A, Fernández-Fairen M, Sueiro-Fernández J. Greater trochanteric pain syndrome and gluteus medius and minimus tendinosis: Nonsurgical treatment. *Pain Manage* 2018;8:45-55.
5. Barratt PA, Brookes N, Newson A. Conservative treatments for greater trochanteric pain syndrome: A systematic review. *Br J Sports Med* 2017;51:97-104.
6. Stephens G, O'Neill S, French HP, et al. A survey of physiotherapy practice (2018) in the United Kingdom for patients with greater trochanteric pain syndrome. *Musculoskelet Sci Pract* 2019;40:10-20.
7. Grimaldi A, Fearon A. Gluteal tendinopathy: Integrating pathomechanics and clinical features in its management. *J Orthop Sports Phys Ther* 2015;45:910-922.
8. Chowdhury R, Naaseri S, Lee J, Rajeswaran G. Imaging and management of greater trochanteric pain syndrome. *Postgrad Med J* 2014;90:576-581.
9. Speers CJ, Bhogal GS. Greater trochanteric pain syndrome: A review of diagnosis and management in general practice. *Br J Gen Pract* 2017;67:479-480.
10. Pozzi G, Lanza E, Parra CG, Merli I, Sconfienza LM, Zerbi A. Incidence of greater trochanteric pain syndrome in patients suspected for femoroacetabular impingement evaluated using magnetic resonance arthrography of the hip. *Radiol Med* 2017;122:208-214.
11. 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;2:310-315.
12. Docking SI, Cook J, Chen S, et al. Identification and differentiation of gluteus medius tendon pathology using ultrasound and magnetic resonance imaging. *Musculoskelet Sci Pract* 2019;41:1-5.
13. Reid D. The management of greater trochanteric pain syndrome: A systematic literature review. *J Orthop* 2016;13:15-28.
14. Tan LA, Benkli B, Tuchman A, et al. High prevalence of greater trochanteric pain syndrome among patients presenting to spine clinic for evaluation of degenerative lumbar pathologies. *J Clin Neurosci* 2018;53:89-91.
15. Byrd JWT. Disorders of the peritrochanteric and deep gluteal space: New frontiers for arthroscopy. *Sports Med Arthrosc Rev* 2015;23:221-231.
16. Ganderton C, Semciw A, Cook J, Pizzari T. Demystifying the clinical diagnosis of greater trochanteric pain syndrome in women. *J Womens Health (Larchmt)* 2017;26:633-643.

17. Allison K, Hall M, Hodges PW, et al. Gluteal tendinopathy and hip osteoarthritis: Different pathologies, different hip biomechanics. *Gait Posture* 2018;61:459-465.
18. Kidanu D, Rowbotham E, Grainger AJ, Robinson P, Bolton WS. Greater trochanteric pain syndrome. *InnovAiT* 2017;10:39-44.
19. Makridis KG, Lequesne M, Bard H, Djian P. Clinical and MRI results in 67 patients operated for gluteus medius and minimus tendon tears with a median follow-up of 4.6 years. *Orthop Traumatol Surg Res* 2014;100:849-853.
20. Redmond JM, Cregar WM, Gupta A, Hammarstedt JE, Martin TJ, Domb BG. Trochanteric micropuncture: treatment for gluteus medius tendinopathy. *Arthrosc Tech* 2015;4:e87-e90.
21. Hartigan DE, Mansor Y, Perets I, Walsh JP, Mohr MR, Domb BG. Knotless 'suture staple' technique for endoscopic partial thickness abductor tendon repair. *Arthrosc Tech* 2018;7:e975-e980.
22. Hartigan DE, Perets I, Ho SW, Walsh JP, Yuen LC, Domb BG. Endoscopic repair of partial-thickness undersurface tears of the abductor tendon: Clinical outcomes with minimum 2-year follow-up. *Arthroscopy* 2018;34:1193-1199.
23. Perets I, Mansor Y, Yuen LC, Chen AW, Chaharbakhshi EO, Domb BG. Endoscopic gluteus medius repair with concomitant arthroscopy for labral tears: A case series with minimum 5-year outcomes. *Arthroscopy* 2017;33:2159-2167.
24. Bogunovic L, Lee SX, Haro MS, et al. 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;31:2145-2151.
25. 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;27:567-572.
26. Chandrasekaran S, Lodhia P, Gui C, Vemula SP, Martin TJ, Domb BG. Outcomes of open versus endoscopic repair of abductor muscle tears of the hip: A systematic review. *Arthroscopy* 2015;31:2057-2067.e2.
27. Redmond JM, Cregar WM, Gupta A, Hammarstedt JE, Martin TJ, Domb BG. Trochanteric micropuncture: Treatment for gluteus medius tendinopathy. *Arthrosc Tech* 2015;4:e87-90.
28. Ebert JR, Retheesh T, Mutreja R, Janes GC. The clinical, functional and biomechanical presentation of patients with symptomatic hip abductor tendon tears. *Int J Sports Phys Ther* 2016;11:725-737.
29. Chandrasekaran S, Vemula SP, Gui C, Suarez-Ahedo C, Lodhia P, Domb BG. Clinical features that predict the need for operative intervention in gluteus medius tears. *Orthop J Sports Med* 2015;3. 2325967115571079.
30. Domb BG, Nasser RM, Botser IB. Partial-thickness tears of the gluteus medius: Rationale and technique for trans-tendinous endoscopic repair. *Arthroscopy* 2010;26:1697-1705.

Appendix

Rehabilitation Protocol

All phases are 2 weeks in duration. Start of protocol determined by GTPS type (Table 1). Hip brace is Donjoy X-Act ROM Hip Brace (DJO Global).

Phase 1

- ROM: PROM hip IR; AAROM: hip ER, abduction, adduction; AROM: hip flexion, extension
- Upright bike: No resistance (must be pain-free, begin half-circles, progress to full circles)
- Soft tissue mobilization: Gentle to scar and hip flexor, IT band
- Gait training: Weightbearing as tolerated for type I to III, continue 20-lb weightbearing for type IV to V
- Strength:
  - Hip isometrics:
    - (Begin at Phase 1): extension, adduction
    - (Begin at Phase 2): sub max pain free hip flexion
  - Quad sets, hamstring sets, lower abdominal activation
- Modalities for pain control, swelling

Phase 2

- Continue with previous exercises
- Gait training: Weightbearing as tolerated type I to V, work on symmetry
- ROM: Progress active/passive ROM in all directions
- Upright bike: Progress resistance as tolerated
- Soft tissue massage: PRN (scar, iliopsoas, tensor fasciae latae [TFL], IT band, piriformis, quadratus lumborum [QL], lumbar paraspinals, hip adductors)
- Strength:
  - Hip abduction: Isometrics to isotonics
  - Progress isometric resistance
  - Quad and hamstring isotonic exercise
  - Quadruped rocking
- Stretching:
  - Manual hip flexor stretching (gentle, no pain)
  - Modified Thomas position, or pillows under buttocks
- Modalities for pain control, swelling

Phase 3

- Gait: Work on symmetry
- Continue with previous exercises
- ROM: progress active/passive ROM in all directions
- Soft tissue massage: PRN (scar, iliopsoas, TFL, IT band, piriformis, QL, paraspinals, hip adductors, gluteus medius)
- Strength
  - Progress core strengthening
  - Initiate hip flexion and extension strengthening progression
  - Hip internal and external rotation (IR/ER) using stool under knee (make sure to hold onto object for support)
  - Upright bike with resistance
  - Begin elliptical training
- Stretching: Manual and self hip flexor stretching
- Modalities for pain control, swelling

Phase 4

- Gait: Normalize without assist device
- ROM: progress active/passive ROM all directions
- Soft tissue massage: PRN (scar, iliopsoas, TFL, ITB, piriformis, QL, paraspinals, hip adductors, gluteus medius)
- Strength:
  - Progress lower extremity and core strength and endurance as able
  - Begin proprioception/balance activity (2 legs to 1 leg, stable to unstable)
  - Begin closed-chain strengthening such as leg press
  - Side stepping with Theraband
  - Single leg squats, step-ups, lunges
- Stretching: Manual and self hip flexor stretching
- Modalities for pain control, swelling

Phase 5

- Gait: Normalize without assist device
- ROM: progress active/passive ROM all directions
- Soft tissue massage: PRN (scar, iliopsoas, TFL, ITB, piriformis, QL, paraspinals, hip adductors, gluteus medius)
- Strength:
  - Progress lower extremity and core strengthening
  - Increased emphasis on single leg strength moves
  - Unilateral leg press, hip hikes, eccentric step downs
  - Progress balance and proprioception
- Stretching: Manual and self (hip flexor, hip adductors, glute, piriformis, TFL, IT band)

Phase 6 (Advanced Rehabilitation)

- Criteria for progression to this level
  - Full ROM
  - Pain-free, normal gait pattern
  - Hip flexor strength 4/5 or better
  - Hip abductor, adductor, extremity and IR/ER strength of 4+/5 or better
- Strength:
  - Progress core, hip, lower extremity strength and endurance

- Lunges (multiangle)
- Plyometric progression (must have good control with all exercises first)
- Forward/backward running program (must have good control with all exercises first)
- Agility drills (must have good control with all exercises first)

- Stretching: Progress self and manual stretches

Precautions

- No contact activities until cleared by physician
- No forced (aggressive) stretching.