

APPENDIX | A08230526: Open surgical repair of hip abductor tendon tears

Table 1: Impairments, complaints and clinical findings in patients with hip abductor tendon ruptures.

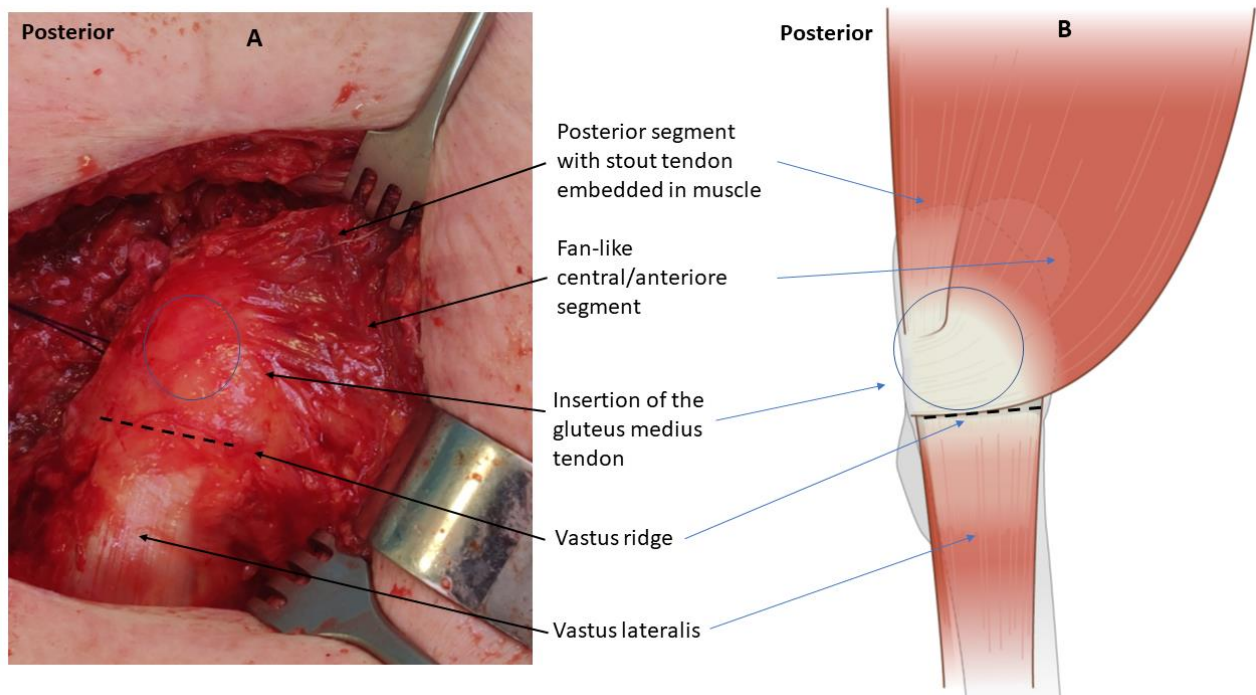
Lateral hip pain aggravated by*:	Clinical findings:	Consequence:
<ul style="list-style-type: none"> • Lying on the affected side • Walking: <ul style="list-style-type: none"> - for longer distances - uphill - on bumpy/rugged ground • climbing a staircase • Getting in and out of a car • Sitting for longer periods • Running 	<ul style="list-style-type: none"> ▪ Palpably tenderness over the Trochanter major (tested with patient in side-lying) ▪ 30 second one-leg stand test with - most often - immediately onset of known pain over the greater trochanter ▪ One leg stance (Trendelenburg test) positive - meaning patient not able to keep their pelvis horizontal/sink into adduction on affected side (NB. patients often complain about poor balance when standing on one leg) ▪ Trendelenburg walk ('limping' all the time or when tired (ask partner)) ▪ Reduced hip abductor strength against gravity (tested with patient in side-lying)** ▪ Internal Resistance Test positive (reduced muscle strength compared to unaffected side, provoke known pain) <p><u>Other complaints:</u></p> <ul style="list-style-type: none"> ▪ LHP¹ worsened by activity² ▪ Pain radiating into the buttock region or down the lateral thigh (not always present, only to knee level) ▪ Seldom problems when putting on socks and shoes 	<ul style="list-style-type: none"> ➤ Interrupted sleep pattern ➤ Reduced walking distance ➤ Difficulties in coping with work and leisure time activities ➤ Paucity or complete stop of exercise related activities ➤ Reduced Quality Of Life

*Same aggravating factors seen in patients with gluteal tendinopathy.

** NB. Be aware the patient do not 'cheat', ie. using their M. Tensor fascia lata primarily to do the hip abduction/lifting their leg in a more ventral direction. Ask the patients to 'pour water out their umbilicus' (positioned with their stomach slightly towards the bed) in order to perform hip abduction with the gluteal muscles.

¹LHP: Lateral hip pain, ²In many patients suffering from gluteal tendinopathy (i.e. overuse injury), LHP is reduced with activity.

Figure A: Insertional anatomy of the Gluteus medius muscle at the Greater Trochanter



A - Normal appearance of the superficial surface of the lateral hip structures in an 81-year-old female patient undergoing total hip arthroplasty. Any trochanteric bursae tissue has been removed with a cloth.

B - The gluteus medius depicted, as appearing in A, with trochanter and caput femoris visible profund, to illustrate the fan-like approach of the central and anterior segments. Gluteus minimus is not shown but is located deep to the anterior part of the gluteus medius.

Textbox 1: Surgical description of our open gluteus medius and minimus anatomical restoration.

- All procedures were performed in general anesthesia, with preoperative cefuroxime for infection prophylaxis and tranexamic acid for bleeding prophylaxis. No thrombosis prophylaxis was used. No drains or pain catheters were used.
- The patient was placed in the lateral decubitus position with the upper leg in slight hip flexion and the femur placed horizontally by use of a pillow.
- A straight longitudinal incision was centered over the greater trochanter. The incision was taken to the iliotibial band (ITB) and the ITB was incised longitudinal, with no detachment of subcutaneous tissue to the ITB.
- Any adherence deep to the ITB was loosened digitally, and the greater trochanteric bursa split to identify the vastus ridge. The vastus ridge was located as a secure landmark for the procedure in all cases, as chronic bursa tissue, scar tissue with adhesions to the GMM muscle and ITB, and the GMM tendons often made it difficult to differentiate the constitution of the different layers of tissue in more severe cases. Only in a few cases of severe adherence or acute inflammation was the bursa removed.
- The GMM tendons and muscles were identified and subsequently mobilized with care not to proceed too far cranially to risk damage to the superior gluteal nerve. At this point, the degree of damage to the GMM muscle/tendon insertion was evaluated. In cases with tendinous scar tissue, where the greater trochanter was not directly exposed (bald trochanter), a 5 cm straight, slightly anterior oriented, incision was made in the anterolateral corner in the insertion of the gluteus medius to gain sufficient access to the tendon-bone interface and to the gluteus minimus tendon. This incision was made in the transition area between the posterior segment and central/anterior segment and was performed as to allow for an anatomical restoration of the tendons in all cases.
- Attention was made to avoid bleeding by small branches of the circumflex femoral arteries.
- The greater trochanter was then prepared with a small osteotome and Lürer rongeur to ensure a bleeding bonebed, and one to five bone anchors, depending on the degree of muscle/tendon damage, were placed according to manufacturer's guidelines.
- The mobilized tendon complex was joined with the prepared footprint at the greater trochanter with sutures into the tendinous portion on the profund surface of the gluteus medius muscle. The adaption of the tendon to the bone was always done in neutral with no abduction to avoid tension of the construct. Anatomical restoration, as shown in , of the tendon complex was always a key element.
- The ITB was closed with looped suture, the subcutaneous tissue with standard resorbable single sutures, and the skin stapled. A standard wound dressing was applied.
- Staples were removed after two weeks at our institution.

Textbox 2: The Horsens classification system of gluteus medius and minimus used during open repairs.

Type:		Grade:
Gluteus medius pathology	Gluteus minimus pathology	“Hours” gluteus medius is affected
0 - No affection	A – No affection	0-4
1 - Partial low-grade	B – Partial tear	
2 - Partial high-grade	C – Complete tear	
3 - Full-thickness		
4 - Posterior tendon only		

Based on our 6 years’ experience of focused hip abductor tendon repairs, utilizing a lateral open approach, we have adapted two existing classifications of gluteal tendon tears, which combined gives us a surgical versatile classification system, which we now apply to all our cases to select the procedure of choice.

The peri-operative macroscopic evaluation is always combined with a pre-operative MRI to address relevant underlying pathologies. Our classification system is based on the Incavo system [1] addressing both partial and complete tendon pathologies in both the gluteus minimus (Gmin) and medius (Gmed) attachment and the Milwaukee grading system [2] addressing only complete Gmed tears. By combining these two classifications and adapting them based on our own surgical experiences we have created a system which can be readily applied by all surgeons and used in future reports to be able to uniformly describe cases surgically treated, and enable comparison across centers and surgical treatments.

By utilizing this classification structure, we will be able to compare treatments across of centers, and between procedures for individual classifications.

We are aware that this classification does not take muscular fat infiltration into account. But current knowledge on this is insufficient at the time.

Our thoughts behind our classification are as follows.

First, we believe a clockwise description as depicted in the Milwaukee system is an important aspect to incorporate. As such the extent of damage to the gluteus medius is always graded as 1-4 (the number of “hours on the clock” that is visually affected – in both full-thickness and partial thickness pathologies).

Second, it is important to evaluate whether the gluteus minimus is affected in cases of partial thickness Gmed tears. This needs to be clearly addressed on the pre-operative MRI scan. In most cases it is obvious on the MRI whether the Gmin tendon (which in structure and attachment resembles the Achilles tendon attachment on the calcaneus) is normal or pathological. In cases of pathology, the tendon needs to be evaluated during surgery.

Third, the assessment of the gluteus medius is described as either a full-thickness tear or a partial low-grade or high-grade tear based on combining the information from the pre-operative MRI evaluation and the visual appearance during surgery.

Fourth, the Gmin is not seldom the only site of pathology.

Fifth, in rare cases, the pathology is solely located in the posterior Gmed tendon. In these cases, the Gmin is never affected.

We utilize standardized surgical approaches, which can always be interchanged during the procedure according to the perioperative findings guided by the MRI.

- 1) Type 1A, grade 1-2: We use a suture staples technique with the knotless corkscrew anchors.
- 2) Type 0B/0C/4A and 1B/1C grade 1-2: We use a small incision centered at the bare-spot area of the greater trochanter to access the undersurface of the gluteus medius and/or the gluteus minimus. We use 1 bone anchor with 2 separate sutures with needles. One suture to Gmin and one to Gmed, or both for Gmed in case of normal Gmin.
- 3) Type 2x/3x all grades and 1x grade 3-4: In these cases, we do a rigorous detachment of the gluteus medius tendon to ensure an adequate reconstruction depending on the degree of damage to both the Gmed and

Gmin. This to allow for access to the bony surface of the trochanter, and the deep tendinous fibers of the Gmed and Gmin. The reconstruction is always aiming at restoring the anatomical and biomechanical aspects of the abductors. Tissue augmentation is used on a case-by-case decision.

References:

1. Incavo, S.J. and K.D. Harper, *Open Hip Abductor Tendon Repair into a Bone Trough: Improved Outcomes for Hip Abductor Tendon Avulsion*. JBJS Essent Surg Tech, 2020. **10**(2): p. e0042.
2. Davies, J.F. and D.M. Davies, *Surgical Technique for the Repair of Tears to the Gluteus Medius and Minimus Tendons of the Hip*. JBJS Essent Surg Tech, 2014. **4**(2): p. e11.