The Modified Resisted Internal Rotation Test for Detection of Gluteal Tendon Tears

Rafael Walker-Santiago, M.D., Victor Ortiz-Declet, M.D., David R. Maldonado, M.D., Natalia M. Wojnowski, B.S., and Benjamin G. Domb, M.D.

Abstract: Greater trochanteric pain syndrome (GTPS) has received increasing attention in recent years. Most patients with GTPS present with trochanteric bursitis and respond to nonoperative treatment. However, a subset of patients may have persistent lateral hip pain or recalcitrant GTPS resulting from an undiagnosed gluteal tendon tear. Recalcitrant GTPS may be a debilitating condition in this patient subset. There is a need for an accurate and evidence-based physical examination maneuver to aid in earlier diagnosis of gluteal tendon tears and timely intervention in these patients. Most studies evaluating gluteal tendinopathy fail to assess surgical indications and instead focus on identifying trochanteric bursitis, which may or may not require surgical treatment. The modified resisted internal rotation test has been used in our practice to detect gluteus medius tendon tears in the recalcitrant GTPS patient population. Fundamental anatomic, biomechanical, electromyographic, and clinical data have been reviewed to make this an evidence-based clinical test for early detection of this pathology.

Greater trochanteric pain syndrome (GTPS) has received increasing attention in recent years.[1-3] A better understanding of lateral hip pathology, recent publications on the anatomy and biomechanics of the peritrochanteric area,[4,5] and advances in sonographic and magnetic resonance imaging have provided the grounds for improved characterization of GTPS. An improved understanding of the posterior tendon of the gluteus medius has been key to a more targeted approach to treating patients with GTPS.[6] Within the spectrum of gluteal pathology, cases of recalcitrant GTPS may be difficult to diagnose in a timely manner, thus resulting in increased patient morbidity. Gluteus medius tendon tears are thought to be responsible for a large number of recalcitrant cases. When standard interventions such as corticosteroid infiltrations and shock wave therapy fail to provide relief, surgical treatment may be warranted.[7]

Recalcitrant GTPS is more difficult to manage than conventional trochanteric bursitis. This condition may result from gluteal tendinopathy, including tendinosis or insertional tendinitis, and gluteus medius tears. Gluteal tears are more prevalent in women than in men, with a peak incidence in the fourth to sixth decade of life (25% of women and 10% of men in this age group).[1] Tendon tears may be partial, complete, or intrasubstance tears and are most commonly degenerative in origin. Magnetic resonance imaging is the study of choice to confirm this diagnosis.

From the American Hip Institute (R.W-S., D.R.M., N.M.W., B.G.D.), Westmont, Illinois; and Kayal Orthopaedic Center, P.C. (V.O-D.), Franklin Lakes, New Jersey, U.S.A.

The authors report the following potential conflicts of interest or sources of funding: V.O-D. receives support in form of food and beverage from Abbvie, Arthrex, Bioventus, Ferring Pharmaceuticals, Horizon Pharma, Johnson & Johnson, Medacta, Smith and Nephew, Stryker, Vericel, and Vertical Pharmaceuticals; education from SeaPearl; and food and beverage, travel, and lodging from Tornier. B.G.D. receives support from the following: grants to the American Orthopedic Foundation from Arthrex, Medacta, and Stryker; staff and expenses related to all research paid by the American Orthopedic Foundation; consulting fees from Adventist Hinsdale Hospital and Amplitude; research support, education support, consulting fees, royalties, and speaking fees from Arthrex; royalties from DJO Global and Orthomerica; research support from Kaufman Foundation; research support and consulting fees from Medacta and Pacira Pharmaceuticals; research support, consulting fees, and royalties from Stryker; and education support from Breg. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

Received October 15, 2018; accepted November 6, 2018.

Address correspondence to Benjamin G. Domb, M.D., American Hip Institute, 1010 Executive Ct, Ste 250, Westmont, IL 60559, U.S.A. E-mail: DrDomb@americanhipinstitute.org

2212-6287/181255

https://doi.org/10.1016/j.eats.2018.11.006

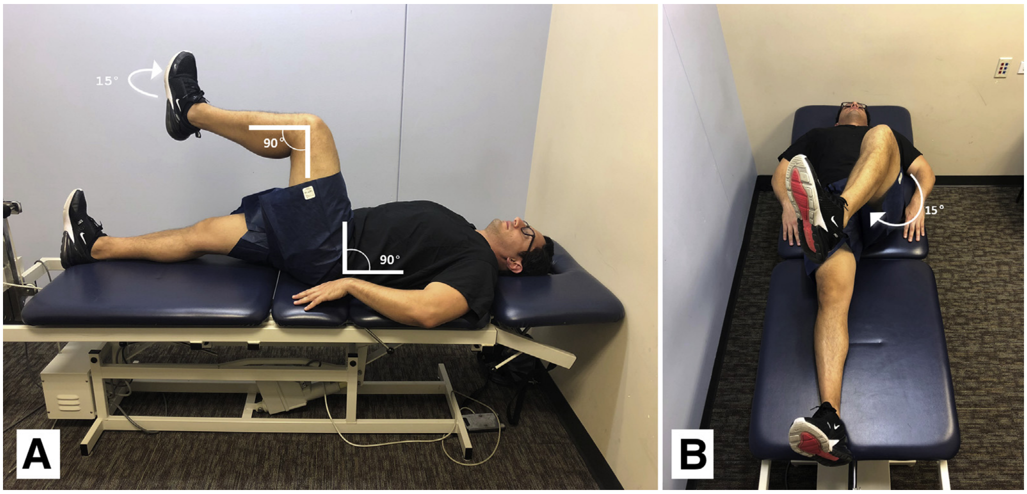

Fig 1. (A) While the patient is in the supine position, the affected left hip and knee are positioned at 90° of flexion. The affected hip is then externally rotated 15° while the contralateral right hip and knee remain in full extension. (B) Positioning of the patient with 15° of external rotation of the left hip for the starting position of the maneuver. This femoral derotational positioning is important to increase tension on the internal rotators of the hip and increase the accuracy of the test.

The Trendelenburg test and the abduction test are commonly used to assess hip abductor pathology on examination; however, their sensitivity and specificity show only moderate accuracy.[8] In a recent study by Ganderton et al.,[3] the 4 most valuable clinical tests were found to be palpation of the greater trochanter, flexion−abduction−external rotation, resisted hip abduction, and resisted external derotation, with sensitivities of 85.7%, 50.0%, 50.0%, and 42.3%, respectively, and specificities of 61.1%, 83%, 97.3%, and 95.0%, respectively. However, most publications on this topic have focused on detecting a nonspecific pathology, such as GTPS, and not necessarily a surgical diagnosis of a gluteus medius tear. More attention has been given to a physical examination maneuver that involves resisted internal rotation of the hip. This maneuver has been shown to activate the gluteus minimus and the posterior compartment of the gluteus medius in clinical and electromyographic studies,[4,5,9,10] and in cases of recalcitrant GTPS, it is thought to be provocative in nature. We believe that performing this test at 90° of hip flexion and 15° to 20° of external rotation achieves maximal tension on the gluteus medius tendons, allowing for the detection of tears that manifest as weakness in hip abduction and lateral-sided hip pain. To our knowledge, no studies have proposed the resisted internal rotation test as a sole means of diagnosing gluteus medius tendon tears. The purpose of this publication was (1) to describe a modified resistive internal rotation test; (2) to provide the anatomic, biomechanical, electromyographic, and clinical data that support its role in the detection of gluteus medius tears; and (3) to propose its routine use in the evaluation of patients presenting with lateral hip pain for earlier detection of gluteus medius tears.

Technique

While in the supine position, the patient is asked to flex the affected hip and knee to 90° while maintaining the contralateral hip and knee in full extension. The clinician assists in positioning the affected hip in 15° to 20° of external rotation, the starting position of the maneuver (Fig 1). Adequate knee and ankle stabilization is key at this point, with the clinician placing one hand on the medial aspect of the knee and placing the other hand on the lateral aspect of the ankle to resist adduction and internal rotation, respectively. The patient must exert an internal rotation force by moving the knee toward the midline and simultaneously moving the foot away from the midline (Fig 2, Video 1). The clinician's hands provide resistance against these movements. A positive test consists of the reproduction of pain, with or without associated weakness. Table 1 shows pearls and pitfalls for this technique.

Discussion

The hip abductor muscle anatomy and tendon arrangement have been described in detail.[4,5] In a recent publication, Flack et al.[4] described the fascicular arrangement of the gluteus medius, gluteus minimus, and tensor fascia lata based on dissection of 12 cadavers. The superior gluteal nerve branching was used to define 4 compartments in the gluteus medius: anterior, midanterior, midposterior, and posterior. The anterior compartment originates anterior to the greater trochanter and has a posteroinferior direction toward the proximal femur. The middle compartments have a central location relative to the greater trochanter and a vertical orientation of its fascicles, whereas the posterior compartment has an anteroinferior direction. The

Fig 2. The examiner should place one hand on the medial aspect of the knee while the other hand is placed on the lateral aspect of the ankle to provide a resistive force, as shown here for the left lower extremity. Then, the patient is asked to simultaneously internally rotate (a) and adduct (b) the hip. In this manner, hip flexion decreases the contribution of the tensor fascia lata, whereas 15° of external rotation increases the tension on the gluteus medius to favor detection of gluteal tendinopathy.

direction of the posterior compartment is anteroinferior toward the anterior aspect of the greater trochanter and horizontal and parallel to the femoral neck.[4,5]

The gluteus medius muscle forms 2 distal tendinous attachments: 1 flat tendon with a lateral insertion, as well as a cordlike tendon with a posterior insertion on the proximal femur. The lateral tendon inserts along an anteroinferior oblique line measuring 31 mm at the lateral aspect of the greater trochanter. Its main contribution is from the anterior compartment of the gluteus medius muscle. The posterior tendon has a cordlike arrangement with fascicle contributions from the midanterior, midposterior, and posterior compartments. It inserts into the posterosuperior facet of the greater trochanter,[11] and has a mean anteroposterior attachment width of 16 mm.[4] In all specimens, the tendons for the gluteus medius and gluteus minimus fuse when approaching the anterior greater trochanter

Table 1. Pearls and Pitfalls of Modified Resisted Internal Rotation Test

Pearls
Hip flexion to 90° will shorten the tensor fascia lata and effectively isolate gluteus medius tendon function.
Hip external rotation to 15° to 20° optimizes lengthening and tension on the gluteus medius to facilitate reproduction of symptoms with the resistive maneuver.
The contralateral extremity should always be tested for baseline comparison of strength because weakness may be the only finding.
Pitfalls
Failing to ask the patient to simultaneously adduct while internally rotating the hip can produce inadvertent hip abduction, which can confound the findings of the described test.

insertion site. Despite a detailed and updated description of the hip abductor muscle complex, Flack et al.[4] argued that the functional significance of its fascicular organization is not fully understood.

The gluteus medius and gluteus minimus are dynamic hip stabilizers and pelvic rotators.[5] The posterior compartment of the gluteus medius pulls the femoral head against the acetabulum, whereas the middle and anterior compartments participate in initiation of abduction and pelvic rotation, respectively. With the gluteus medius acting as a dynamic stabilizer and initiator of hip abduction, it is now more commonly accepted that the tensor fascia lata acts as the main hip abductor analogous to the rotator cuff and deltoid in shoulder abduction.[5] This role of the tensor fascia lata has also been suggested in the literature by reports on the iatrogenic Trendelenburg sign that results from iliotibial band release used to treat abduction contracture of the hip.

Hip positioning in the sagittal plane during abduction or rotation has significant effects on muscle activation with documented increases in gluteus medius moment capacity with hip flexion and internal rotation.[12] Elerian et al.[9] assessed the electromyographic activity of the gluteus medius muscle during hip abduction in the lateral decubitus position. They compared hip abduction with flexion at 0°, 45°, and 90° and in neutral, internal, and external rotation positions. Gluteus medius activation was greatest with hip flexion at 90° and internal rotation. Lee et al.[10] observed that gluteus medius activity was significantly greater when hip abduction was performed with internal rotation versus in a neutral position. The gluteus maximus and the tensor fascia lata showed decreased levels of activity with increasing hip flexion, which suggests gluteus medius dominance within this range. Differences in activation of the abductor muscles during ambulation have been identified in patients with gluteal tendinosis, warranting further studies.[13]

The accuracy of physical examination maneuvers for the detection of GTPS and gluteal tears has been

Table 2. Advantages and Disadvantages of Modified Resisted Internal Rotation Test

Advantages	
	Noninvasive and inexpensive test
	Easy to incorporate into routine hip physical examination
	Minimized tensor fascia lata confounding during hip abduction
	May be cost-effective in ruling out gluteus medius tears
	May be helpful in avoiding delays in diagnosis
Disadvantages	
	Accuracy of test not yet determined
	Difficulty in distinguishing full or high-grade tear from partial tear

reported in the literature. Bird et al.[8] compared the accuracy of 3 physical examination maneuvers in predicting hip abductor tendon tears that were later confirmed with magnetic resonance imaging. The Trendelenburg sign was found to be the most accurate test (sensitivity and specificity of 72.7% and 76.9%, respectively). Resisted abduction, performed with the patient supine and starting at 45° of abduction, showed sensitivity and specificity of 72.7% and 46.2%, respectively. Resisted internal rotation was performed with the patient supine, hip flexion at 45°, and maximal external rotation. Sensitivity and specificity (with a starting position in neutral rotation) was 54.5% and 69.2%, respectively. In a similar study, Lequesne et al.[2] reported sensitivity and specificity of 100% and 97.3%, respectively, for the single-leg stance test and 88% and 97.3%, respectively, for the resisted external derotation test in the supine position. They noted that accuracy for resisted internal rotation tests improved as a function of increasing hip and knee flexion that can be explained by increased tendon stretching in the starting position. However, their accuracy analysis consisted of identifying trochanteric tendino-bursitis and not gluteus medius tears.

It is important to note that what makes our modified resisted internal rotation test unique—and possibly more accurate—is the effective isolation of active internal rotation that results from the clinician's hand placement and encouraging the patient to adduct against resistance simultaneously with resisted internal rotation. Advantages and disadvantages of this test are detailed in Table 2. Lequesne et al.[2] stated that some studies lack a detailed description of the clinical examination maneuvers, which in some cases is critical in determining the accuracy of the test. The described precise limb position reduces tension on the tensor fascia lata with the hip at 90° of flexion, stretches the lateral and posterior insertions of the gluteus medius tendon with 15° to 20° of hip external rotation, and further isolates internal rotation during active motion with simultaneous adduction of the hip. The modified resisted internal rotation test, as described in this article, can be used for early detection of gluteus medius tears in cases of recalcitrant GTPS. Anatomic, biomechanical, electromyographic, and clinical data support the use of this test in the diagnosis of gluteus medius tears, allowing for earlier detection and treatment in these patients.

References

1. Redmond JM, Chen AW, Domb BG. Greater trochanteric pain syndrome. *J Am Acad Orthop Surg* 2016;24:231-240.
2. 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;59:241-246.
3. Ganderton C, Cook J, Pizzari T, Semciw A. Demystifying the clinical diagnosis of greater trochanteric pain syndrome in women. *J Womens Health (Larchmt)* 2017;26:633-643.
4. Flack NA, Nicholson HD, Woodley SJ. The anatomy of the hip abductor muscles. *Clin Anat* 2014;27:241-253.
5. Gottschalk F, Kourosh S, Leveau B. The functional anatomy of tensor fasciae latae and gluteus medius and minimus. *J Anat* 1989;166:179-189.
6. Hoffman DF, Smith J. Sonoanatomy and pathology of the posterior band of the gluteus medius tendon. *J Ultrasound Med* 2017;36:389-399.
7. 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.
8. 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;44:2138-2145.
9. Elerian AE, Ewida MM, Aboelelaa NA. Comparison between the different hip rotation positions on hip abduction exercise. *Int J Ther Rehabil Res* 2016;5:23-36.
10. Lee J-H, Cynn H-S, Kwon O-Y, et al. Different hip rotations influence hip abductor muscles activity during isometric side-lying hip abduction in subjects with gluteus medius weakness. *J Electromyogr Kinesiol* 2014;24:318-324.
11. Robertson WJ, Gardner MJ, Barker JU, Boraiah S, Lorich DG, Kelly BT. Anatomy and dimensions of the gluteus medius tendon insertion. *Arthroscopy* 2008;24:130-136.
12. Ward SR, Winters TM, Blemker SS. The architectural design of the gluteal muscle group: Implications for movement and rehabilitation. *J Orthop Sports Phys Ther* 2010;40:95-102.
13. Allison K, Salomoni SE, Bennell KL, et al. Hip abductor muscle activity during walking in individuals with gluteal tendinopathy. *Scand J Med Sci Sports* 2018;28:686-695.