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Clinical approach

Gluteus medius strengthening and the use of the Donatelli Drop Leg Test in the athlete

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ABSTRACT

Objectives: To evaluate and strengthen the posterior segment of the gluteus medius.
Design: A technical description of a novel examination and rehabilitation protocol.
Setting: The gluteus medius, primarily a hip abductor, serves several important functions in the athlete. Weakness of the gluteus medius has been linked to injuries in the shoulder and iliotibial band, as well as ankle instability. Though previously treated as a homogenous muscle, recent studies of the gluteus medius show three segments with distinct function and activation – the anterior, middle, and posterior. Current rehabilitation protocol focuses primarily on the anterior and middle segments, neglecting the posterior.
Conclusion: We propose a three-stage protocol for strengthening and rehabilitation of the injured athlete and the Drop Leg Test, which can be used to identify weakness in the posterior segment of the gluteus medius.

1. Introduction

The gluteus medius serves as an integral component in the kinetic chain of the athlete (Stodden, Langendorfer, Fleisig, & Andrews, 2006), and is now commonly described separately and as having several anatomic subdivisions (Neumann, 2002). Gottschalk et al. previously reported three separate segments – anterior, middle and posterior – based on cadaveric dissection and biomechanical studies (Gottschalk, Kourosh, & Leveau, 1989). The anterior and middle segments of the gluteus medius contain fibers running vertically from the anterior iliac crest to the greater trochanter. The posterior segment contains fibers running horizontally in line with the femoral neck. The posterior fibers have been described to function as the primary segment active in stabilizing the femoral head in the acetabulum during weight transfer (Gottschalk et al., 1989), and to contribute to external rotation of the femur relative to the stable pelvis (Neumann, 2002; Powers, 2010).

Neumann reported the importance of the posterior segment of the gluteus medius in lunging and jumping by showing that the gluteus maximus produced less external hip rotational torque at hip flexion angles greater than 60°. With greater hip flexion a shift of the anterior fibers of the gluteus maximus anterior to the hip joint axis of rotation turns the anterior gluteus maximus into an internal rotator rather a femur stabilizer (Neumann, 2002). In this situation, the posterior fibers of the gluteus medius act with the deep external rotators to provide control (Powers, 2010).

Through EMG analysis, O'Dwyer et al. have shown differing activation of the various segments of the gluteus medius during isometric contraction (O'Dwyer, Sainsbury, & O'Sullivan, 2011). O'Sullivan et al. furthered the analysis and suggested a need for variation in rehabilitation protocols by showing differing segmental activation with various weight bearing exercises (O'Sullivan, Smith, & Sainsbury, 2010).

Compromise of the gluteus medius has been linked most commonly to ankle inversion and knee injuries including patellofemoral tendonitis, iliotibial band syndrome, anterior cruciate ligament tears, and medial collateral ligament tears (Beckman & Buchanan, 1995; Earl, Hertel, & Denegar, 2005; Fredericson, Cookingham, Chaudhari, Dowdell, Oestreicher, & Sahrmann, 2000; Friel, McLean, Myers, & Caceres, 2006; Powers, 2010; Schmitz, Riemann, & Thompson, 2002). Powers et al. described an increased knee valgus posture and a shift of the center of mass as a means of biomechanical compensation for hip abductor weakness (Powers, 2010).

The majority of current gluteus medius rehabilitation protocols utilize exercises with the hip in slight flexion, including the clam, closed chain lateral lunges, and side lying abduction without

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extension. A shortened lever arm with hip extension changes the gluteus medius angle of pull, thus requiring the abductor muscle to develop greater force and recruit all segments to counterbalance the effect of gravity (Neumann, 2002). Additionally, Philippon reported significant gluteus medius weakness and concurrent iliopsoas tendonitis in patients undergoing flexion rehabilitation activities (Philippon, Decker, Giphart, Torry, Wahoff, & LaPrade, 2011).

The purpose of the Drop Leg Test is to establish a manual muscle test more specific for the inclusion of posterior fibers of the gluteus medius. The authors propose that the Drop Leg Test isolates weakness of the posterior fibers of the gluteus medius because of the emphasis on extension and abduction with the leg in neutral position. As the gluteus maximus is a primary external rotator of the femur with the leg in neutral position, hip abduction with extension reduces the gluteus maximus role as an external rotator and thus emphasizes the posterior fibers of the gluteus medius.

Here we propose a three-stage protocol with emphasis on the posterior fibers of the gluteus medius. In order to evaluate these fibers, we propose the Drop Leg Test.

2. Materials and methods

The Drop Leg Test (Fig. 1) is performed from the side lying position. The clinician passively abducts the leg to the end of the hip abduction range of motion and then extends the hip 20°. While holding the leg in the abducted and extended position, the patient is asked to maintain this leg position while the clinician lets go. A shortened lever arm with hip extension changes the gluteus medius angle of pull, thus requiring the abductor muscle to develop greater force, recruiting more fibers to counterbalance the effect of gravity (Neumann, 2002). The senior author of this paper has performed the Drop Leg Test on hundreds of patients that expose significant muscle deficits that would have been missed by testing in flexion or neutral position. With weakness of the posterior segment of the muscle, the patient will be unable to hold the leg in the abducted and extended position and the leg will drop 2–12 inches until the muscle lever arm is elongated and the muscle is capable of developing enough strength to stop the fall of the leg. If the limb drops several inches and the patient is able to hold the leg in abduction and extension, a manual muscle test may be performed to further determine the muscle deficits.

Maximum voluntary isometric contraction (MVC) has been determined for a variety of common hip rehabilitation exercises (Ekstrom, Donatelli, & Carp, 2007; Philippon et al., 2011). We propose a three-phase protocol (Table 1) based on MVC of the gluteus medius muscle with emphasis on the posterior segment. Phase one produces 20–35% gluteus medius MVC, phase two produces 40–45% gluteus medius MVC, and phase three produces 45–74% gluteus medius MVC.

Fig. 1. Demonstrating the Drop Leg Test, performed from the side lying position. The leg is passively abducted to the end of its range and then extended 20°, after which it is dropped.

The phased exercise program below is unique in that the exercises emphasize external rotation in order to strengthen the posterior fibers of the gluteus medius, the deep rotators, and also the gluteus maximus, while de-emphasizing hip flexion. The authors of this paper have noted irritation of the iliopsoas muscle in many patients that complain of hip dysfunction, an observation also made by Philippon et al. (2011), which the proposed protocol seeks to minimize. Running and plyometric exercise should not be initiated until the patient demonstrates a stable trunk and a strong base (hips and lower extremities). Traditionally, running and plyometrics constitute the final stage of rehabilitation before returning to sport.

2.1. Phase one

Exercises are initiated with phase one (Fig. 2) and include the double leg bridge, external rotation while kneeling on a stool, single leg stance, and resisted hip extension while prone. Double leg bridge, an isometric hold, is performed for 5–15 s and is repeated five to ten times once to twice daily. Remaining phase one exercises are performed with appropriate resistance to allow for six to eight repetitions in two sets, with the goal of fifteen repetitions in three sets. Once this goal is achieved weight can be added and commenced with six to eight repetitions. Progression out of this phase occurs when the patient is able to hold the double leg bridge for 60 s without pain with the hip in extension.

2.2. Phase two

Phase two (Fig. 3) includes strengthening with the quadrupled four arm/leg lift, lateral step ups, two-way hip standing on a step, and external rotation standing with pulleys. The quadrupled four arm/leg lift is performed for 5–15 s and repeated five to ten times once to twice daily. Remaining phase two exercises are performed with an amount of resistance to allow for six to eight repetitions in two sets with the goal of fifteen repetitions in three sets. Once this goal is achieved weight can be added and commenced with six to eight repetitions.

2.3. Phase three

Phase three exercises (Fig. 4) include the single leg bridge, wall slides, and side bridges. Exercises are performed with an amount of resistance to allow for six to eight repetitions in two sets with the

Table 1
Rehabilitation protocol.

Phase one
- Double leg bridge
- External rotation kneeling on stool
- Single leg stance
- Resisted hip extension while prone
Phase two
- Quadruped fours arm/leg lift
- Lateral step up
- 2-Way hip standing on step with abduction/external rotation
- External rotation standing with pulleys
Phase three
- Signal leg bridge
- Wall slides with abduction/extension/internal rotation
- Side bridge

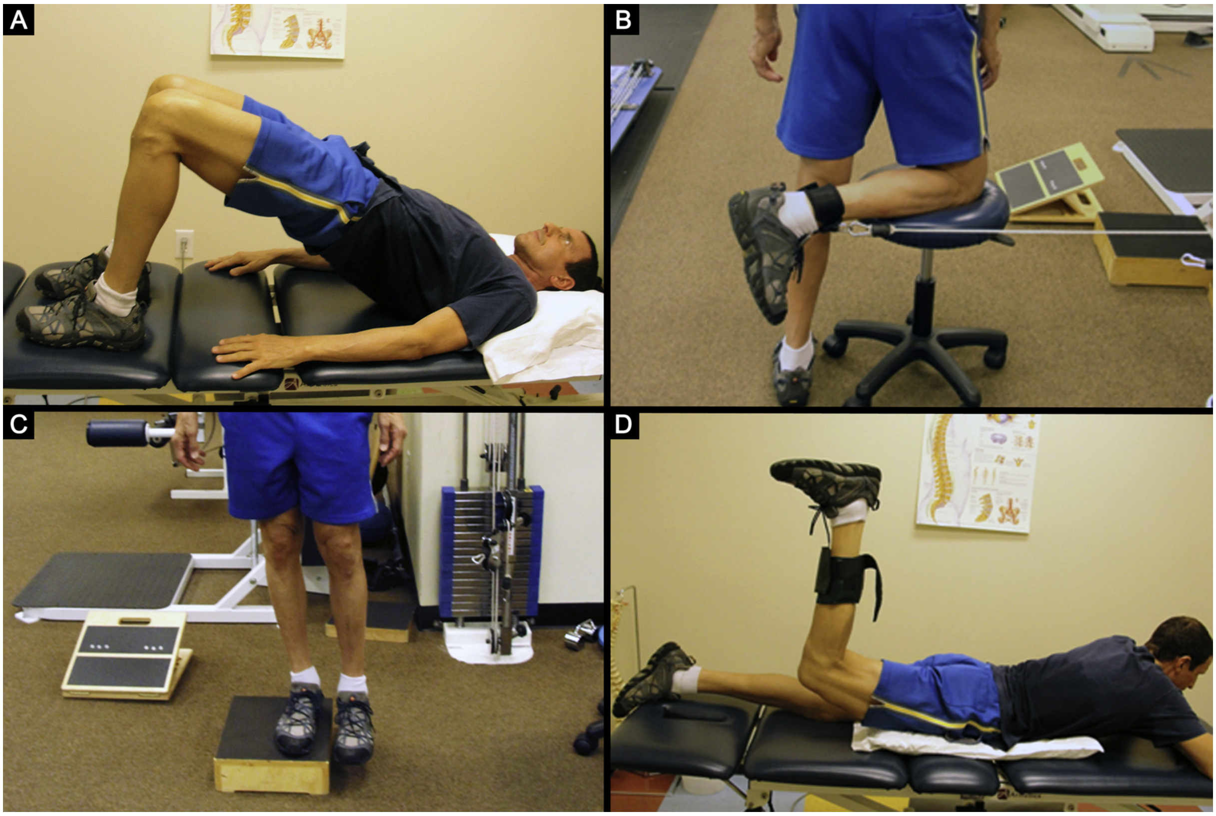

Fig. 2. Phase one exercises include the double leg bridge (A), external rotation while kneeling on a stool (B), single leg stance (C) and resisted hip extension while prone (D).

Fig. 3. Phase two exercises include quadrupled four arm/leg lift (A), lateral step up (B), two-way hip standing on a step (C) and external rotation standing with pulleys (D).

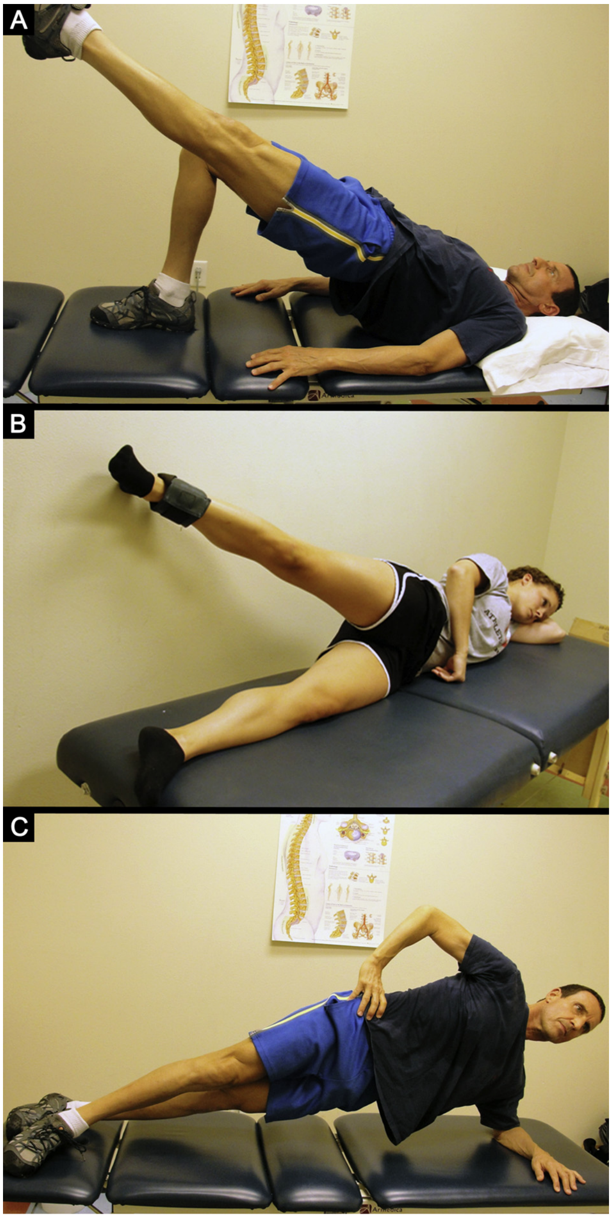

Fig. 4. Phase three exercises include single leg bridge (A), wall slides with abduction/extension/internal rotation (B) and side bridges (C).

goal of fifteen repetitions in three sets. Once this goal is achieved weight can be added and commenced with six to eight repetitions.

3. Discussion

Injuries to the knee, ankle, shoulder, and iliotibial band have been linked to gluteus medius weakness. Nicholas, Strizak, and Veras (1976) retrospectively studied patients with foot and ankle injuries and found consistent decreases in gluteus medius strength on Cybex testing. Beckman and Buchanan (1995) noted that patients classified as having hypermobile ankles presented with gluteus medius weakness. A lack of dynamic hip stabilizers thus may not allow for normal compensation of small sudden ankle alterations.

In the overhead athlete the importance of the gluteus medius is noted in several phases of pitch. During the wind up phase, gluteus medius strength is needed to maintain pelvic position during maximum lead leg knee flexion (Wilk, Meister, Fleisig, & Andrews, 2000; Yamanouchi, 1998). In the cocking phase, the abduction moment initiates forward movement and lengthens stride (Wilk et al., 2000). During normal pitching motion activation of the lower extremity is known to influence the velocity of the upper extremity (MacWilliams, Choi, Perezous, Chao, & McFarland, 1998) and a reduction in lower extremity recruitment thus leads to more stress on the upper extremity (Burkhart, Morgan, & Kibler, 2003) increasing the likelihood of injury.

In the running athlete, iliotibial band tendonitis has been implicated as an imbalance of the gluteus medius and iliotibial band. The gluteus medius acts primarily as an abductor and external rotator while the iliotibial band acts as an abductor and internal rotator. With weakness of the gluteus medius, internal rotation from the pull of the iliotibial band increases the valgus angle of the femur, placing more tension on the iliotibial band and causing it to be more prone to impingement on the distal lateral femur (Fredericson et al., 2000).

Neumann reported dynamic control of the hip and pelvis may be compromised during tasks that require greater hip and knee flexion angles, including lunges and jumping, both key movements in most sporting activities (Neumann, 2002).

The authors have observed a large number of patients with weakness of the posterior fibers of the gluteus medius using this test. In addition, the authors have observed that patients with lower limb injuries and hip dysplasia have excellent results after progressing through the above described phased exercise program which places emphasis on restoring strength to the posterior fibers of the gluteus medius. In our experience, significant increases in posterior segmental strength have been achieved using the two-way hip exercise with pulleys and wall slides. External rotation exercises over the side of the table have been shown to provide the best results but are the most difficult to perform, thus making them a less desirable option. The standing pulley rotation exercise is effective but currently is a device not widely available. Rehabilitation through this described protocol allows a stepwise increase in gluteus medius activation resulting in increased recruitment as strength increases. This rehabilitation protocol thus theoretically allows for improving strength of all segments while minimizing the risk of injury.

The Drop Leg Test described here offers a specific manual muscle test for weakness of the posterior fibers of the gluteus medius muscle. Compared to the commonly utilized Trendelenburg test, the Drop Leg Test is a more specific test for weakness of the posterior fibers of the gluteus medius since it elicits weakness that may be masked by the larger anterior and middle segments. This focus on the posterior segment differentiates the Drop Leg Test and provides supplementation to the Trendelenburg test by isolating zone specific weakness. With the Drop Leg Test, a combination of hip abduction and extension reduces the lever arm of the gluteus medius, changing its angle of pull and recruiting the posterior fibers.

Bolgla et al. determined that the commonly used weight bearing rehabilitation exercise with contralateral hip abduction and ipsilateral hip and knee flexion of 20° provided the best weight bearing gluteus medius activation (Bolgla & Uhl, 2005). While many patients may achieve excellent results with this commonly used weight bearing exercise, iliopsoas tendonitis may pose a problem (Philippon et al., 2011). The proposed rehabilitation protocol takes into account anatomic considerations of the posterior fibers of the gluteus medius (Gottschalk et al., 1989) while minimizing the risk of iliopsoas tendonitis (Philippon et al., 2011), utilizing exercises that achieve maximal gluteus medius recruitment (Bolgla & Uhl, 2005; Ekstrom et al., 2007). By reducing the chance of iliopsoas tendonitis, increasing the recruitment of the gluteus medius, and including the posterior fibers, current rehabilitation protocols can be improved.

4. Conclusion

Strengthening of the gluteus medius improves lower extremity power, reduces future risk in the uninjured athlete, and improves rehabilitation in the injured athlete. Knowledge of the differing segments of the gluteus medius and their positions of greatest activation as well as rehabilitation protocol that emphasizes the individual action of these segments improves outcomes and limits sequelae. Though currently rarely targeted in rehabilitation protocol, the posterior fibers of the gluteus medius are unique and contribute to overall performance of the muscle. The Drop Leg Test offers a means by which to easily evaluate these fibers and supplements the commonly used Trendelenburg Test.

Conflict of interest

No conflicts of interest exist.

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