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Therapeutic Exercise In The Treatment Of Greater Trochanteric Pain Syndrome S/P Lumbar Discectomy: A Case Report

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TITLE PAGE

Therapeutic Exercise in the Treatment of Greater Trochanteric Pain Syndrome s/p Lumbar Discectomy: A Case Report.

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ABSTRACT

Background and Purpose

Greater trochanteric pain syndrome (GTPS) is a multifactorial cause of lateral hip pain, affecting between 1.8 and 5.6 patients per 1000 per year. The prevalence of GTPS is more common in patients with coexisting low back pain.[1] Though discectomy is effective in the treatment of prolapsed lumbar intervertebral discs, it does not correct concurrent hip pathology. As GTPS in the setting of discectomy rehabilitation lacks defined treatment guidelines, the purpose of this case report is to display physical therapy (PT) treatment of GTPS in conjunction with simultaneous rehab from lumbar microdiscectomy.

Case Description

A 56-year-old male was referred to PT for treatment of lateral hip pain two weeks after successful lumbar microdiscectomy of L4/L5. He reported hip and back stiffness with sleeping and prolonged sitting. He experienced a steady decrease in tolerance for sitting (15 - 20 minutes maximum) and recreational activity (bicycling 20 minutes per day), despite a significant daily walking routine (15,000 steps per day). An exercise program was created that centered around lumbar stabilization and gluteal recruitment, while maintaining a neutral lumbar spine.

Outcomes

Hip range of motion was improved to within normal limits in all planes. Improvements in core stability and reduction of hip pain were achieved. These manifested in increased tolerance for sitting (2 hours) and recreational activity (bicycling 20 miles). However, reports of hip stiffness with inactivity remained at discharge.

Discussion

The concurrent treatment of GTPS and rehab post lumbar discectomy requires a balance of intervention selection. Care must be taken to avoid exacerbating symptoms of one site while

treating the other. Further research is needed to develop clinical guidelines in the treatment of GTPS and rehab from discectomy.

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BACKGROUND and PURPOSE

Greater trochanteric pain syndrome (GTPS) is a common cause of lateral hip pain. GTPS affects between 1.8 and 5.6 patients per 1000 per year, most frequently between age 40 and 60, predominantly female, and is possibly related to pelvic biomechanics.[1] After osteoarthritis, GTPS is the second most common cause of lateral hip pain.[2] Previously, it was believed this condition was caused by trochanteric bursitis, with treatments targeting the bursitis. Recently, gluteal tendinopathy and tears have been proposed as potential causes.[3] Radiological findings for patients with GTPS report variable incidence, with bursitis incidence ranging from 4% to 46% and gluteal tendinopathy ranging from 18% to 50%.[6] The likely cause of GTPS is by repetitive friction between the greater trochanter and iliotibial band, causing repetitive microtrauma of the gluteal tendons that insert into the greater trochanter.[3] Greater trochanteric pain syndrome encompasses trochanteric bursitis, external coxa saltans (snapping hip), and abductor tendinopathy.[4] The preferred clinical term for lateral hip pain is therefore GTPS.[1]

The most common examination finding is reproduction of the pain on palpation of the greater trochanter.[5] Typically with GTPS, the patient will have pain at end-range hip range of motion (ROM), pain with resisted hip abduction, and tenderness over the greater trochanter.[1] At present there is no defined treatment protocol for GTPS.[6] Patients historically have been treated with nonsteroidal anti-inflammatory medications, corticosteroid injections, and physical therapy.[4] Most cases resolve with conservative measures, with success rates of over 90%.[7]

Approximately two thirds of individuals with GTPS have co-existing hip joint osteoarthritis or low back pain,[8] although back pain and GTPS are typically not directly related.[9]

Because the iliotibial tract and the lumbar dermatomes have an anatomic overlap, symptoms of GTPS may mimic those of lumbar radiculopathy.[10] The appearance of pathology in the lumbar spine, such as a previous episode of low disc herniation, may contribute to improper activation of the hip muscles.[11]

Often, microdiscectomy is used successfully to treat prolapsed lumbar intervertebral disc. Microdiscectomy can bring about significant improvements in pain, disability, and mobility of hip and lumbar spine in patients with sciatica.[12] Current best practices promote the use of postoperative rehabilitation following lumbar disc surgery. Though there are no widely accepted criteria as to what constitutes an optimal rehabilitation program, clinical trials that emphasized lumbar stabilization exercise and initiated treatment sooner in the postoperative period demonstrated improved outcomes.[13] Surgery does not correct back muscle dysfunction and may make it worse. A 4-week postoperative exercise program designed predominantly to strengthen back and abdominal muscles was shown to have brought about further significant improvements in spinal function. The improvements in spinal function were associated with improvements in pain and disability that were maintained or further enhanced 12 months after surgery.[12]

As the prevalence of GTPS is more common in patients with coexisting low back pain,[1] and both GTPS and discectomy rehabilitation lack defined treatment protocols, the purpose of this case report is to display PT treatment of GTPS in conjunction with simultaneous rehab from lumbar microdiscectomy.

CASE DESCRIPTION

Patient History and Systems Review

A 56-year-old male was referred to physical therapy for treatment of left hip pain. He reported eight years of lumbar radiculopathy from lumbar disc degeneration, which included two to three exacerbations of hip pain. He reported an acute exacerbation of lumbar symptoms six

months ago. PT treatment was attempted, but was ultimately unsuccessful at reducing his pain. After magnetic resonance imaging showed a large lumbar disc herniation, he elected microdiscectomy of L4/L5 six week ago, resulting in resolution of his sciatica symptoms.

Two weeks later, however, his left hip began to feel tight and painful in the morning. In an effort to rehabilitate himself, he walked approximately 15,000 steps a day, including hills. He reported that his back also "tightened up" when sitting for over an hour. He said that he felt his hip loosen after walking and he found ice beneficial for pain control. The subject stated that prior to injury he was biking 20 miles a day. Over the winter he rode his stationary bicycle 30 minutes a day, but was now only able to ride for 20 minutes per day. His goals were to gain hip flexibility and to be able to return to recreational activities, including biking, kayaking, and skiing. He requested the creation of a regular exercise program.

Clinical Impression 1

The subject presented with symptoms consistent with left GTPS, post lumbar microdiscectomy. A systems review was performed to screen the patient for impairments. (Table 1) Planned testing included active range of motion (AROM) of the trunk and hip, as well as observation of gait and functional strength. Deep tendon reflexes (DTR) and functional myotomal strength was tested to rule out neurological dysfunction. Differential diagnoses include lumbosacral radiculopathy, iliotibial band syndrome, , myofascial pain, and degenerative joint disease.[1] GTPS was previously known as trochanteric bursitis, but has expanded the diagnosis to describe chronic peritrochanteric pain caused by disorders to the trochanteric bursa, the iliotibial band, and the gluteus medius and gluteus minimus tendons.[14] GTPS is characterized by chronic lateral hip pain exacerbated by active abduction or passive adduction, and direct palpation of the greater trochanter.[6] The subject denied paresthesia, radiculopathy, groin pain, or trauma.

This subject was an interesting case in that he presented with a reoccurrence of symptoms at the hip, following apparently successful lumbar surgery. PT treatment required careful consideration of lumbar impairment while selecting treatment interventions, not only of the back but of the hip as well.[15] Long periods of sitting at work and poor mechanics may have contributed to both disc herniation as well as aggravation of the lateral hip or trochanteric bursa. However, the patient was only able to distinguish the symptoms separately following discectomy. It is possible the pain from his disc herniation caused a protective posture and gait, resulting in overuse injury to his hip. The large amount of walking he was doing after surgery may have contributed to overuse of hip musculature and irritation of the bursa.

Examination – Tests and Measures

Passive range of motion, manual muscle testing, and other special tests were not performed in accordance with instruction of clinical instructor. Common practice at the clinic was to avoid aggravating patient symptoms when diagnosis could be offered with the information readily presented. Therefore, strength testing was not performed initially due to patient irritability. Strength was determined by later assessment of functional resistance exercise capability. Tenderness to palpation was the primary factor to rule in GTPS.[6]

Clinical Impression 2

Diagnosis of GTPS was supported by localization of pain to the left greater trochanter with hip internal rotation, extension, adduction, and abduction in concert with the patient's history of symptoms. Diagnosis of GTPS requires that the patient must present with aching pain in the lateral hip and distinct tenderness in the proximity of the greater trochanter. Additionally, diagnosis requires a non-radicular pattern of pain extending down the lateral thigh or pain at the end range of motion for hip abduction/adduction or internal/external rotation.[16] The patient's medical diagnosis using the International Classification of Disease (ICD) 10 code was M70.62

trochanteric bursitis, left hip. Other issues were ruled out due to the tenderness to palpation at the greater trochanter, intact myotomal strength, and lack of trauma or reported radiculopathy. Generally, pain worsens upon weight bearing or inactivity for intra-articular pain, and worsens with compression or stretching in extra-articular conditions such as GTPS.[17] Palpation is the greatest tool for ruling in or out GTPS.[17]

Simultaneous therapeutic treatment of GTPS required careful application with concurrent rehabilitation following lumbar discectomy. Treatment of each condition required coordination to avoid aggravating the other. Care had to be taken to maintain a neutral lumbar spine with all exercises, even those targeting the hip.

Hip mobility limitations and pain limited the patient's ability to sit at work and participate in recreational activity. He also presented with gait deficits (table 2), related to an excessive toe-out and posteriorly rotated pelvis. PT treatment of GTPS has been shown to be effective at reducing pain and returning patients to activity.[6] However, many patients will experience repeated episodes of symptom exacerbation.[18] Supervised exercise after microdiscectomy has been shown to reduce pain, improved function, and increase activity tolerance over the short term without increased risk of complications.[19] Standard practice of the clinic dictated restoration of proper mechanical function in order to lessen future insult to damaged tissue. The patient's prognosis for improvement with PT was good considering his flexible workspace (home office / standing desk), active lifestyle, and commitment to therapy.

The plan of care was for treatment three times a week for five weeks. No need for referral or consultation was immediately present. Subjective statements of daily activity, objective measurements of progress, and functional assessment of quality of movement were taken at every treatment session.

Interventions consisted of preparatory soft tissue mobilization to the left glute

maximus and medius, a stretching program to increase hip range of motion,[17] and a therapeutic exercise program to improve postural control and increase hip, glute, and core strength. Core exercises have been shown to have a positive effect on reducing lower back pain.[20] Inadequate core stability and gluteal weakness contribute to the probability of developing GTPS.[16]

It was standard practice at the clinic to prepare tissues for exercise with myofascial rolling. Rolling the tissue desensitized the patient to the localized pain, reduced the tone of hypertonic muscle fibers, and relieved myofascial tension.[21]

Exercise, especially eccentric strengthening, reduces pain and may lead to normalization of tendon structures. Though there were no studies identified that directly related eccentric exercise (EE) to gluteal tendinopathy, studies have shown good results with eccentric exercise in other tendinopathies, including patellar tendinopathy and Achilles tendinopathy. EE could therefore be considered a potential component of GTPS rehabilitation.[22]

Short term goals were to increase left hip abduction by ten degrees, reduce reported pain with hip adduction, extension, and internal rotation by 50 percent (according to the self-reported pain scale), and for patient demonstration of a normalized gait pattern to reduce excessive toe-out and pelvic posterior rotation. Long term goals were to increase all hip motion in all planes to within normal limits, facilitate 20-mile bicycle rides without pain, and increase sitting tolerance to two hours.

Intervention

Interventions were focused on reducing pain, increasing flexibility about the hip, increasing gluteal recruitment and strength, and stabilization of the lumbar spine.

Each treatment session began with rolling hip and gluteal musculature and fascia by trapping a lacrosse ball between the patient's tissue and the wall. The patient moved his body in

slow vertical and horizontal oscillations in order to prepare the tissue for exercise by reducing muscle soreness and increasing ROM.[23]

Following rolling, a stretching routine was performed to increase hip flexibility,[24] beginning with a kneeling hip flexor stretch (contralateral hip elevated on box to preserve neutral lumbar spine). Hip flexor stretching has implications to gait and injury prevention.[25] This was followed by a kneeling quadriceps stretch (utilizing a 55 cm inflatable exercise ball to support the shank and prevent lumbar lordosis), supine piriformis stretch (contralateral foot on wall, ipsilateral figure four hip external rotation), and supine adductor stretch (legs supported on the wall in a "V" shape). (Table 3) A neutral lumbar spine was emphasized to avoid narrowing of the intervertebral foramina to prevent reaggravation of radiculopathy.[26]

More demanding strengthening exercised were preceded by activation exercises for the purpose of preparing the muscles for the work ahead.[29,30] This included hip knee extension (HKE), in which the hip and knee began at 90 degrees, then the leg drove a weighted cable to the floor, activating glutes and lower extremity musculature. Resisted terminal knee extension (TKE) was performed initially for the same purpose. (Table 4)

The patient also activated hip musculature in multiple planes by way of mini band boxes. With a small miniband loop stretched above the knees, the patient took five large steps forward, five large steps left, five large steps backwards, and five large steps to the right. This pattern was repeated for two minutes.

Other activation exercises performed were the 90-90 abdominal brace (90-90 Ab Brace), in which the patient was positioned in supine with his feet on the wall, hips and knees at 90 degrees, and a small foam roller squeezed between the knees. The patient was instructed to brace his abdominals while applying downward pressure on the wall through the lower extremity for the purpose of teaching active abdominal bracing.

Hip pendulums were performed in order to disassociate hip extension from lumbar extension. The patient began in a quadruped position and was instructed to extend his hip while maintaining a neutral lumbar spine, requiring core stabilization while simultaneously activating glutes and hamstrings.

Strengthening exercises were selected with two primary goals: 1) increase glute strength to improve gait mechanics,[31] balance forces on the hip, and improve standing posture, and 2) increase trunk and abdominal stability to protect the surgical repair of the lumbar spine and prevent further insult. The ability to maintain a neutral spine with daily activity was especially important considering the history of disc pathology.[32]

Once the patient demonstrated independent ability to brace his abdominals, 90-90 abdominal bracing was replaced by more dynamic core strength exercises, including forearm planks (for core strength and endurance) and bird-dogs and dual cable push-pulls, which demand trunk rotational stability. Planks and bird-dogs were progressed to achieve three minutes total time under tension each, which the clinic subscribes to as ideal for strengthening static muscle stability.

Bridges, as with all therapeutic movements, were limited to pain free range. As this range grew to be completely pain free, single leg hip lifts (SLHL) were added to the exercise program. In order to maintain a neutral pelvis and prevent excess lumbar extension, a tennis ball was squeezed between the contralateral proximal thigh and the ASIS. SLHLs were also limited to the pain free range, which improved gradually until complete hip extension without pain was achieved. (Table 5)

During treatment session ten, reports of contralateral glute tightness during SLHLs led to palpation of a hypertonic muscle knot (figure 1) in the left proximal gluteus medius. Manual

massage to the area, including cross friction massage was performed for 10 minutes this session only, resulting in resolution of muscle hypertrophy.

Pallof presses (figure 2) consisted of extending a cable, weighted laterally, with both arms in a posterior to anterior direction out from the sternum. This position was held for 10 seconds followed by a 10 second rest where the cable was returned to the chest. Pallofs strengthen rotational core stability by requiring rotational deceleration.[33]

Overhead Pallof presses (figure 3) were added to strengthen anterior core musculature in order to improve trunk extension deceleration. Excessive lumbar extension can be provocative for patients with lower back disc pathology, as trunk extension narrows the intervertebral foramen and can compress the nerve roots, causing radiculopathy.[34]

Single leg Romanian deadlifts replaced the initial single leg balance in order to increase the demand on lower extremity stabilization. This dynamic exercise also contributes to increasing glute strength, trunk stabilization, and balance.[35] The patient struggled with execution of this movement, and so was regressed to performing the exercise over a table. The presence of the table allowed the patient some assistance with the balance portion of the movement. At discharge, the patient had progressed to performing the movement with only lightly gripping a vertical wooden dowel as assistance.

The patient complimented PT by performing the floor exercises four times a week at home between treatments. He began each day with a warm up at home on his Arc Trainer (Cybex International, Owatonna, MN). Additionally, he rode 25 minutes a day on a stationary bicycle at home. The subject attended therapy two to three times a week for five weeks, totaling 15 sessions, at which time the patient requested discharge to a home exercise program.

OUTCOME

When goals were met, the patient was discharged home with a home exercise program

utilizing the equipment and space he had available to him. Tolerance for exercise had improved steadily over the course of treatment (Table 5). Objectively, hip ROM was improved (Table 6) to within normal limits and pain free in all planes, though extension remained somewhat limited. The subject was no longer tender to palpation, but did report dulled sensation at the right greater trochanter. Toe-out severity in standing was decreased, but a posterior pelvic tilt posture remained, which may have also affected functional hip extension ROM.

The subject reported feeling a plateau of improvement in waking hip stiffness, which resolved with activity, especially walking. There was improvement in sitting tolerance, from 15 – 20 minutes at evaluation to greater than one hour at discharge.. While he reported stiffness with prolonged sitting, the subject was able to reach his functional long term goals of sitting for two hours and bicycling 20 miles.

DISCUSSION

Interventions focused on restoring motion, movement, and strength to the hip while training lumbar stabilization. As the literature suggests, core stabilization is beneficial following lumbar surgery.[13] Through resistance exercise, the subject greatly improved his core stability; by discharge he was able to withstand significant time under tension in core stabilization exercises (table 4). Some exercises (SLRDL, bird dog, plank, hip pendulum) were selected because they target lumbar stabilization and gluteal recruitment concurrently. Functionally, he demonstrated improved single leg and hip mechanics through improved balance, motor control, and strength with performance of SLHL and SLRDL exercises.

In patients with concurrent hip and lumbar impairment, therapists must take care in treatment selection to avoid exacerbating one issue while treating the other. All hip exercises were selected or modified in order to preserve a neutral lumbar spine, as some exercises designed for hip extension may also extend the lumbar spine. Yet, excessive lumbar motion must be

avoided in this patient population.[13] The hip pendulum exercise was selected for this very reason, to teach independence of hip extension motor movement from lumbar extension. The subject's ability to stabilize the lumbar spine therefore becomes crucial before progressing supine hip strengthening exercises.

All hip stretches were modified to ensure the maintenance of a neutral lumbar spine. The hip rotator stretch and hip rotator stretch were performed in supine to support the spine in neutral. Quadriceps and hip flexor stretches were performed in a high kneel with supportive objects used to bring the floor up to the foot, to avoid gliding forward and increasing lumbar extension.

This case details the results of a course of therapy treating GTPS pain in a subject recovering from lumbar discectomy. Cause and effect of intervention cannot be truly inferred due to the nature of a case study. However, strength training is an effective and safe method to build stability and to support proper mechanical movement.[4,7,13] Future research should focus on the establishment of clinical guidelines for GTPS and for lumbar discectomy rehabilitation, while acknowledging the commonality of coexisting hip and low back pathology.[8]

REFERENCES

1. Williams B, Cohen S. Greater trochanteric pain syndrome: a review of anatomy, diagnosis and treatment. Anesth Analg. 2009;108:1662-70. doi: 10.1213/ane.0b013e31819d6562.

2. Reid D. The management of greater trochanteric pain syndrome: A systematic literature review.
J Orthop. 2016;13(1):15-28. doi: 10.1016/j.jor.2015.12.006.

3. Jones D, Erhard R. Diagnosis of trochanteric bursitis versus femoral neck stress fracture. Phys Ther. 1997;77:58-67. http://ptjournal.apta.org.une.idm.oclc.org/content/77/1/58. Accessed 7/21/2016.

4. Redmond J, Chen A, Domb B. Greater Trochanteric Pain Syndrome. J Am Acad Orthop Surg. 2016;24(4):231-40. doi: 10.5435/JAAOS-D-14-00406.

5. Segal N, Felson D, Torner J, et al. Greater trochanteric pain syndrome: epidemiology and

associated factors. Arch Phys Med Rehabil. 2007;88(8):988-92. http://ac.els-cdn.com.une.idm.oclc.org/S0003999307003024/1-s2.0-S0003999307003024-main.pdf?_tid=a15f9c14-842d-11e6-ad62-00000aacb360&acdnat=1474924400_2ab4440d8fa5c977d5d0b50f2bbb050d Accessed September 21, 2016.

6. Lustenberger D, Ng V, Best T, Ellis T. Efficacy of treatment of trochanteric bursitis: a systematic review. Clin J Sport Med. 2011;21:447-53. doi: 10.1097/JSM.0b013e318221299c.

7. Brooker A. The surgical approach to refractory trochanteric bursitis. Johns Hopkins Med J. 1979;145(3):98-100. http://www-ncbi-nlm-nih-gov.une.idm.oclc.org/pubmed/?term=The+surgical+approach+to+refractory+trochanteric+bursitis Accessed September 21, 2016.

8. Collee G. Greater trochanteric pain syndrome (trochanteric bursitis) in low back pain. Scand J Rheumatol. 1991;20:262-66. http://qa3nq3jm4u.search.serialssolutions.com.une.idm.oclc.org/?V=1.0&sid=PubMed:LinkOut&pmid=26686241 Accessed September 21, 2016.

9. Lauder T. Musculoskeletal disorder that frequently mimic radiculopathy. Phys Med Rehabil Clin N Am. 2002;13:469-85. http://qa3nq3jm4u.search.serialssolutions.com.une.idm.oclc.org/?V=1.0&sid=PubMed:LinkOut&pmid=12380546 Accessed September 21, 2016.

10. Swezey, R. Pseudo-radiculopathy in subacute trochanteric bursitis of the subgluteus maximus bursa. Arch Phys Med Rehabil. 1976;57(8):387-90. http://www-ncbi-nlm-nih-gov.une.idm.oclc.org/pubmed/?term=Pseudo-radiculopathy+in+subacute+trochanteric+bursitis+of+the+subgluteus+maximus+bursa. Accessed September 21, 2016.

11. Ciesielska J, Lisiński P, Bandosz A, Huber J, Kulczyk A, Lipiec J. Hip strategy alterations in patients with history of low disc herniation and non-specific low back pain measured by surface electromyography and balance platform. Acta Bioeng Biomech. 2015;17(3):103-8. http://qa3nq3jm4u.search.serialssolutions.com.une.idm.oclc.org/?V=1.0&sid=PubMed:LinkOut&pmid=26686241 Accessed September 21, 2016.

12. Dolan P, Greenfield K, Nelson R, Nelson I. Can exercise therapy improve the outcome of microdiscectomy? Spine. 25(12):1523-32. http://qa3nq3jm4u.search.serialssolutions.com.une.idm.oclc.org/?V=1.0&sid=PubMed:LinkOut&pmid=10851101 Accessed September 21, 2016.

13. Hebert J, Marcus R, Koppenhaver S, Fritz J. Postoperative rehabilitation following lumbar discectomy with quantification of trunk muscle morphology and function: a case report and review of the literature. J Orthop Sports Phys Ther. 2010 Jul;40(7):402-12. doi: 10.2519/jospt.2010.3332.

14. Velden K, Thomas E. Greater trochanteric pain syndrome. Physiopedia. http://www.physio-

pedia.com/Greater_Trochanteric_Pain_Syndrome#References. Accessed July 26, 2016.

15. Esene I, Meher A, Elzoghby M, Kotb A, El-Hakim A. Diagnostic performance of the medial hamstring reflex in L5 radiculopathy. Surg Neurol Int. 2012;3:104. doi: 10.4103/2152-7806.100862.

16. Mulligan E, Middleton E, Brunette M. Evaluation and management of greater trochanter pain syndrome. Phys Ther Sport. 2015;16(3):205-14. doi: 10.1016/j.ptsp.2014.11.002.

17. Cook C. Orthopedic Manual Therapy: An Evidence-Based Approach, 2nd Edition. Pearson Health Science; 2012.

18. Mallow M, Nazarian L. Greater trochanteric pain syndrome diagnosis and treatment. Phys Med Rehabil Clin N Am. 2014;25:279-89. doi: 10.1016/j.pmr.2014.01.009

19. Kulig K, et al. An intensive, progressive exercise program reduces disability and improves functional performance in patients after single-level lumbar microdiskectomy. Phys Ther. 2009 Nov;89(11):1145-57. doi: 10.2522/ptj.20080052.

20. Miyake Y, Kobayashi R, Kelepecz D, Nakajima M. Core exercises elevate trunk stability to facilitate skilled motor behavior of the upper extremities. J Bodyw Mov Ther. 2013;17:259-65. doi: 10.1016/j.jbmt.2012.06.003

21. Schroeder A, Best T. Is self myofascial release an effective preexercise and recovery strategy? A literature review. Curr Sports Med Rep. 2015;14:200-8. doi: 10.1249/JSR.0000000000000148.

22. Rees J, Maffulli N, and Cook J. Management of tendinopathy. Am J Sports Med. 2009;37:1855-1867. doi: 10.1177/0363546508324283.

23. Cheatham S, Kolber M, Cain M, Lee M. The effects of self-myofascial release using a foal roll or roller massager on joint range of motion, muscle recovery, and performance: a systematic review. Int J Sports Phys Ther. 2015;10:827-38. http://www-ncbi-nlm-nih-gov.une.idm.oclc.org/pubmed/26618062 Accessed July 26, 2016.

24. Choi J, Yoo K, An H, Choi W, Koo J, Kim J, Kim N. The effects of taping, stretching, and joint exercise on hip joint flexibility and range of motion. J Phys Ther Sci. 2016;28:1665-8. doi: 10.1589/jpts.28.1665.

25. Rodacki A, Souza R, Ugrinowitsch C, Cristopoliski F, Fowler N. Transient effects of stretching exercises on gait parameters of elderly women. Man Ther. 2009;14:167-172. doi: 10.1016/j.math.2008.01.006.

26. Govind J. Lumbar radicular pain. Aust Fam Physician. 2004;33:409-12. http://www-ncbi-nlm-nih-gov.une.idm.oclc.org/pubmed/15253601 Accessed July 26, 2016.

27. Takahata T, A biomechanical study of the lumbar intervertebral disc by the finite element

method. 1988;62:665-78 http://www-ncbi-nlm-nih-gov.une.idm.oclc.org/pubmed/3225494 Accessed July 26, 2016.

28. Tang S, Rebholz B. Does lumbar microdiscectomy affect adjacent segmental disc degeneration? A finite element study. J Surg Res. 2013 Jun 1;182(1):62-7. doi: 10.1016/j.jss.2012.09.012.

29. McGowan C, Pyne D, Thompson K, Rattray B. Warm-Up Strategies for Sport and Exercise: Mechanisms and Applications. Sports Med. 2015 Nov;45(11):1523-46. doi: 10.1007/s40279-015-0376-x.

30. Barnes M, Petterson A, Cochrane D. Effects of different warm-up modalities on power output during the high pull. J Sports Sci. 2016:1-6. doi: 10.1080/02640414.2016.1206665

31. Stanek J, McLoda T, Csiszer V, Hansen A. Hip and trunk muscle activation patterns during perturbed gait. J Sport Rehabil. 2011;20:287-95. http://www-ncbi-nlm-nih-gov.une.idm.oclc.org/pubmed/21828381 Accessed July 12, 2016.

32. Poppert E, Kulig K. Rehabilitation following lumbar diskectomy. Phys Ther. 2013;93:591-6. doi: 10.2522/ptj.20120087.

33. Mark Watts. An in-season training guide for baseball pitchers. Elitefts. Published June 12, 2014. Accessed July 26, 2016.

34. Orita S, Inage K, Eguchi Y, Kubota G, Aoki Y, Nakamura J, Matsuura Y, Furuya T, Koda M, Ohtori S. Lumbar foraminal stenosis, the hidden stenosis including at L5/S1. Eur J Orthop Surg Traumatol. 2016. doi: 10.1007/s00590-016-1806-7

35. Fisher J, Bruce-Low S, Smith D. A randomized trial to consider the effect of Romanian deadlift exercise on the development of lumbar extension strength. Phys Ther Sport. 2013;14:139-45. doi: 10.1016/j.ptsp.2012.04.001

36. Agency for Health Care Policy and Research. Acute Low Back Pain Problems in Adults: Assessment and Treatment. Chirobase. http://www.chirobase.org/07Strategy/AHCPR/ahcprclinician.html. Published 1994. Accessed June 14, 2016.

37. Wikimedia Commons. File:Gluteus medius muscle01.png. Wikimedia Foundation. https://commons.wikimedia.org/wiki/File:Gluteus_medius_muscle01.png Published 2013. Accessed July 12, 2016.

TABLES and FIGURES

Table 1. Systems Review

System	Results
Cardiovascular/Pulmonary	Hypertension (medically controlled)
Musculoskeletal	AROM impaired

Neuromuscular	Unimpaired
Integumentary	Incision scar along lumbar spine well healed
Communication	Normal
Affect, Cognition, Language, Learning Style	Alert and oriented x4

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Table 2. Tests and Measures

Tests & Measures	**Initial Evaluation Results**	
Deep tendon reflexes at medial hamstrings (L5 nerve root),[15] Achilles (S1 nerve root),[36] patella tendons (L4 nerve root)[36]	Normal and intact (2/5)	
Gait observation	Toe-out, externally rotated hips, posterior pelvic tilt	
Lumbar spine flexion, extension, side-bending AROM	Within normal limits (WNL) and pain free	
Heel walk (L5 and L4 nerve roots)[36]	Normal	
Toe walk (S1 nerve root)[36]	Normal	
Palpation[6]	Tenderness to palpation above left greater trochanter	
Hip AROM	**Left**	**Right**
Abduction	20 degrees	40 degrees
Adduction	WNL	limited with pain reported at trochanteric bursa
Internal Rotation	24 degrees with pain reported at trochanteric bursa	WNL
External Rotation	WNL bilaterally	
Extension	Limited bilaterally with pain reported at trochanteric bursa	
Flexion	WNL bilaterally	
Manual Muscle Testing and Other Special Tests	Deferred secondary to patient's pain	

Table 3. Tissue Preparation Activities Performed at Every Treatment Session

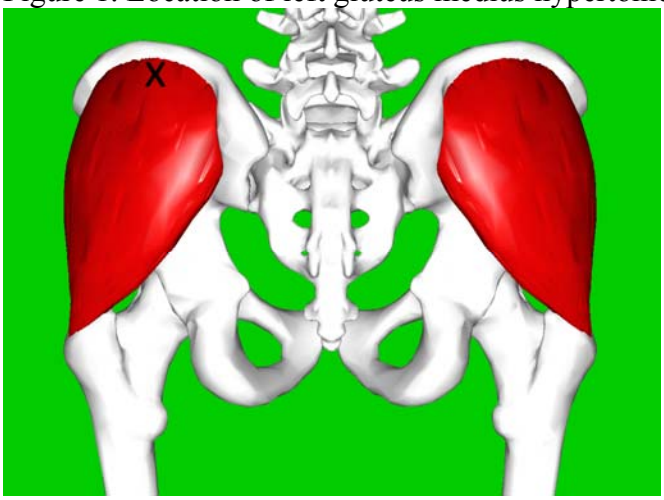
Treatment	**Duration**
Lacrosse ball roll	1 minute
Hip flexor stretch	3x30 sec
Quadricep stretch	3x30 sec
Piriformis stretch	3x30 sec
Adductor Stretch	3x30 sec

Table 4. Therapeutic Exercise Progression

Treatment	1	2 - 4	5 - 7	8 - 15
Miniband Boxes				2 minutes
HKE		3x10x10 - 3x15x15	3x17.5-22.5x15	3x25-42.5x15
TKE		3x10x10 - 3x15x10		
Hip Pendulum	3x10	3x10	3x10	3x10
Bridge	4x5	5x5 - 3x10	3x10	3x10 - 3x6x10
SLHL			3x5	4x5 - 3x8”x10
90-90 Ab Brace		5x10 sec		
Plank			3x20-40 sec	3 x 40-60 sec
Bird-dog			5x5 10 sec arms only - 3x10 5 secs	10x10 10 sec - 7x7 30 sec
Pallof		5x7.5x5 - 2x12.5x4	2x15-19x4	2x22.5-27.5x4
OH Pallof				2x15-25x4
Push-Pulls			3x7.5x8-12	3x7.5x15 - 3x22.5x10
Balance		Tandem head turns 6x30 sec - tandem head turns 2x30 sec, single leg 4x30 sec	Single leg on mat 6x30 sec	
SLRDL				1x10 table assist - 3x10 dowel assist

Legend: exercises are listed in the following form: sets x weight (pounds) x repetitions (i.e. 3x12x8 is 3 sets, 12 lbs., 8 reps). Abbreviations: Hip Knee Extension (HKE), Terminal Knee Extension (TKE), Single Leg Hip Lift (SLHL), Single Leg Romanian Dead Lift (SLRDL)

Figure 1. Location of left gluteus medius hypertonicity[37]



APPENDICES

Table 5. Timeline of notable dates of pain reduction in relation to hip extension exercises

Session 1	Terminal hip extension painful with bridges
Session 5	Hip flexor stretch completely pain free. Bridge pain free range increased.
Session 6	Bridge pain free range expanded further.
Session 7	Bridges pain free. SLHL pain free range increased.
Session 8	HKE and hip pendulums completely pain free. Patient reports multiple planes of motion as painless.
Session 9	Patient reports SLHL irritates left hip bursa at end range.
Session 11	Hip pain reported with attempted increase of resistance to bridges.
Session 14	SLHL peformed at full range, pain free

Table 6. Pre and post treatment hip AROM in degrees

Motion	**Pre Right**	**Post Right**	**Pre Left**	**Post Left**
External Rotation	WNL	45	WNL	50
Internal Rotation	WNL	55	24, pain	58
Flexion	WNL	144	WNL	142
Abduction	40	42	20	34
Adduction	Limited by pain	15	WNL	14
Extension	Limited by pain	7	Limited by pain	7

Figure 2. Pallof Press

Figure 3. Overhead Pallof Press