Rehabilitation of proximal hamstring tendinopathy utilizing eccentric training, lumbopelvic stabilization, and trigger point dry needling: 2 case reports

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STUDY DESIGN: Case report.

BACKGROUND: Proximal hamstring tendinopathy is a relatively uncommon overuse injury seen in runners. In contrast to the significant amount of literature guiding the evaluation and treatment of hamstring strains, there is little literature about the physical therapy management of proximal hamstring tendinopathy other than the general recommendations to increase strength and flexibility.

CASE DESCRIPTION: Two runners were treated in physical therapy for proximal hamstring tendinopathy. Each presented with buttock pain with running and sitting, as well as tenderness to palpation at the ischial tuberosity. Each patient was prescribed a specific exercise program focusing on eccentric loading of the hamstrings and lumbopelvic stabilization exercises. Trigger point dry needling was also used with both runners to facilitate improved joint motion and decrease pain.

OUTCOMES: Both patients were seen between 8 and 9 visits over 8 to 10 weeks. Clinically significant improvements were seen in pain, tenderness, and function in each case. Each patient returned to running and sitting without symptoms. **DISCUSSION**: Proximal hamstring tendinopathy can be difficult to treat. In these 2 runners, eccentric loading of the hamstrings, lumbopelvic stabilization exercises, and trigger point dry needling provided short and long term pain reduction and functional benefits. Further research is needed to determine the effectiveness of this cluster of interventions for this condition.

LEVEL OF EVIDENCE: Therapy, level 4

KEY WORDS: dry needling, pain, running, tendinopathy

Tendon overuse injuries have been reported to account for 30 to 50% of injuries in sports along with 30% of all general practitioner consultations for musculoskeletal injuries.[27] In the lower extremity, chronic tendon overuse accounts for 30% of all running related injuries typically involving the patellar or Achilles tendons.[31,34] Proximal hamstring tendinopathy is a relatively uncommon overuse injury seen among middle and long-distance runners and less commonly in other running athletes.[18] The literature on physical therapy management of proximal hamstring tendinopathy is limited to general recommendations to improve hamstring strength and flexibility, address trunk stability, and correct muscle imbalances.

The mechanism of injury is not particularly clear; however is likely related to repetitive microtrauma, typically resulting from non-optimal gait mechanics, muscular imbalances, or improper training. Proximal hamstring tendinopathy risk factors have not been specifically described, and the pathology can easily be missed clinically, as a number of tissues can generate posterior hip/buttock pain.[18,44] Individuals with proximal hamstring tendinopathy present to physical therapy with complaints of a deep ache in the gluteal region often exacerbated with running and sitting.[18,41,51,53] Magnetic resonance imaging (MRI) can assist with diagnostic accuracy[8,11] but is not always performed due to expense and time required.

Eccentric training has been well documented as a potentially successful conservative treatment option in the rehabilitation of chronic tendinopathic dysfunction.[26] Controlled eccentric loading has been shown to normalize the disorganized tendon structure seen in tendinopathy which in turn has been associated with decreased pain and improved function.[39]

Lumbopelvic stability is crucial as it relates to running. When running, individuals are required to quickly achieve, maintain and progress through single limb stance, which may be controlled by proximal segments.[40] By achieving proximal stability, athletes are able to maintain proper distal mobility, allowing for decreased risk of compensation and injury.[17,28]

Trigger point dry needling (TDN) is a technique that involves the application of a fine filiform needle to soft tissues to treat tendon and joint dysfunction (**FIGURE 1**).[3,15,29] A trigger point (TrP) is a hyperirritable area in a taut band of skeletal muscle that is painful on compression and can produce a characteristic referred pain pattern.[46] While painful themselves, TrPs can also alter the function of the entire muscle and its attachments. Treating TrPs in the hamstrings can reduce pain associated with their typical referral pattern, which includes the lower buttock and posterior knee region. Another benefit from TDN comes from eliciting a local twitch response (LTR) which involves a quick contraction and relaxation of the TrP fibers. This is associated with neuromuscular and biochemical benefits and can improve flexibility of the muscle/tendon unit.[3,12,16,19-21,38,42,43]

The purpose of this manuscript is to describe the physical rehabilitation of 2 active individuals with suspected proximal hamstring tendinopathy using eccentric training, lumbopelvic stability exercises, and TDN.

CASE DESCRIPTION

Two patients were seen in physical therapy for proximal hamstring tendinopathy and both provided verbal consent for their data to be used for publication. As fewer than

4 patients were described, and standard of care clinical services were provided, the George Washington University Medical Center required no formal Institutional Review Board approval.

History

Patient #1 was a 70 year-old, retired male, referred from his orthopedic surgeon with a diagnosis of right hamstring strain. The patient had proximal thigh/buttock pain on the right side for the previous 7 months. He described his pain as a deep ache which was exacerbated with running and sitting on firm surfaces for 30 minutes or more. Using an 11-point numeric pain rating scale (NPRS) where 0 is no pain and 10 is maximum tolerable pain, the pain was rated 1/10 at best, 4/10 at time of evaluation, and 7/10 at worst. No neural symptoms were reported, and the patient reported no pain distal to the ischial tuberosity. The patient did not recall any specific injury; however he recalled an increase in his running mileage around the same time. The patient was active, running 40 to 48 kilometers (km) and biking 80 km on average each week; however he discontinued running when he started having pain. Past medical history revealed a history a prostate cancer 3 years prior, which was successfully treated with surgery and radiation, with annual bone scans showing no abnormalities. He reported no other orthopedic problems. The patient's primary goal was to decrease pain to return to recreational running and biking symptom free.

Patient #2 was a 69 year-old male with symptoms of left proximal thigh/buttock pain for the previous 5 months who was referred to physical therapy by his primary care physician with a diagnosis of left hip pain. Pain, based on the NPRS, was rated as 4/10 at best, 6/10 at time of the evaluation, and 10/10 at worst and was described as a nagging ache. No neural symptoms were reported and no pain along the midportion or distal aspect of the posterior thigh was reported. The patient reported no traumatic injury. Exacerbating activities included running and sitting at work for extended periods of time. Symptoms were gradually getting worse and prevented him from running more than 8 km without pain. At the time of evaluation the patient was training for a triathlon and continued to run despite pain. Past medical history was unremarkable. The patient's primary goal was to be able to participate in an upcoming triathlon without limitations.

Examination

A thorough global and regional examination was performed on each patient by the same therapist, with notable findings presented in **TABLE 1**. Posture was examined in standing, followed by lumbar active range of motion (ROM) testing in all planes including quadrant tests with overpressure at end ranges. A bilateral and unilateral squat were performed without reproduction of symptoms, however a combination of excessive femoral adduction and internal rotation motion was noted on the involved side with single leg squats. Hip examination included active and passive ROM, as well as the scour, flexion abduction external rotation (FABER), flexion adduction internal rotation (FAIR), and impingement tests, which were negative. The sacroiliac joint was assessed using a provocation test cluster[30] which was negative as well. Manual muscle testing for the hamstrings and gluteus maximus was performed with the patient in prone, and for the gluteus medius in side-lying. Both patients demonstrated gluteus medius weakness, however only Patient # 1 had pain and weakness with hamstring muscle testing. A neurological assessment including myotomal and dermatomal assessment, lower quarter reflexes, and the straight leg raise and slump tests was negative. An observational running gait analysis was also performed. No symptoms were reproduced while running however slight gait deviations were noted with both patients. Patient # 1 demonstrated decreased knee flexion of the involved limb through the swing phase of gait. Patient # 2 demonstrated decreased hip extension of the involved limb through mid and terminal stance.

A number of pathologies can refer pain into the posterior thigh, including: piriformis syndrome, ischiogluteal bursitis, ischiofemoral impingement, lumbar disc or facet dysfunction, sacroiliac joint dysfunction, and spondylogenic lesions.[18,44] Also, given the proximity to the lumbosacral plexus, patients presenting with posterior hip pain should be screened for neural entrapments. Patients with referred pain into the posterior hip often complain of variable diffuse symptoms proximal to the ischial tuberosity or distal to the knee. These symptoms are often described as muscle cramping and tightness, numbness, tingling, and shooting pain.[6,18,44] In both patients, no symptoms of numbness, tingling, burning, or loss of sensation was expressed. With the examination tests and measures being negative for reproduction of symptoms, the possibility of these pathologies causing posterior hip or thigh pain was considered unlikely.

Both patients had tenderness to palpation at the ischial tuberosity (proximal hamstring origin) as well as a positive bent knee stretch and modified bent knee stretch tests on the affected side.[7] The bent knee stretch test is performed with the patient supine. The hip and knee are maximally flexed and the examiner slowly straightens the knee, with pain reproduction being considered a positive test.[18] The modified version of this test differs only in the velocity, as the examiner rapidly extends the patient's knee in the latter rather than slowly in the former, again looking for pain reproduction.[8] These special tests have demonstrated moderate to high validity for the diagnosis of proximal hamstring tendinopathy.[7] The results of these tests combined with pain to palpation at the ischial tuberosity and subjective history pointed to proximal hamstring tendinopathy as the likely diagnosis.

Self-report outcome measures included the lower extremity functional scale (LEFS), NPRS, and the global rating of change (GROC). The LEFS is a validated outcome measure of self-reported function for individuals with lower extremity dysfunction. It contains 20 questions on a scale of 0 (extreme difficulty) to 4 (no difficulty) that assess a person's ability to perform everyday tasks, with a higher score representing higher levels of function. The minimal clinically important difference (MCID), representing a clinically meaningful change, is 9 points.[5] The GROC provides a measure of self-perceived change over time. It is a 15-point Likert type scale from -7 (a great deal worse) to +7 (a great deal better), with 0 being no change. A change of 3 or more points is needed to be considered a clinically important improvement.[49]

Treatment

Both patients were treated by the same therapist who evaluated them, using a 3 stage impairment driven eccentric loading rehabilitation program and lumbopelvic stability exercises. With chronic tendon dysfunction, progressive eccentric loading of the involved tendon has been shown to be beneficial at normalizing tendon structure which in turn can decrease pain.[39] With runners, lumbopelvic stability is beneficial in preventing abnormal length-tension or force-velocity relationships of the hamstring muscles, thereby decreasing potential stresses on the proximal hamstring complex.[45]

Previous reports have shown a combination of eccentric and lumbopelvic exercises to be beneficial in decreasing pain and improving function in those with similar clinical presentations.[18]

TDN was added to this exercise program in an attempt to provide greater pain reduction to facilitate improved function. Needling was performed by a separate therapist with advanced training in TDN. The treatment goal was to progress through each phase as rapidly as tolerated, using pain with exacerbating activities as a main marker of progress, to facilitate a return to running. Each patient's clinic visit time frame and phase progression can be seen in **TABLE 2**.

Phase 1 Phase 1 included eccentric loading of the hamstrings, lumbopelvic stabilization exercises, and patient education. Eccentric loading is expected to be painful as it promotes tendon structure reorganization through active overload. Patients were educated on eccentric training principles and performance based on Alfredson's widely used Achilles tendinopathy protocol at the initial evaluation.[1] Using weight training equipment patients were educated to slowly lower the resistance during the eccentric phase, as the knee is extending, using the involved leg only, and assist the weight back to the starting position through the concentric phase using the contralateral limb to help with knee flexion. The patient was educated to maintain proper form and add resistance as needed to ensure that pain was present with the contraction but not disabling.

Eccentric exercises performed in phase 1 included a leg curl machine to isolate hamstring contraction, single leg deadlifts to facilitate eccentric loading, and single leg stance stability and supine bridge walk outs (**FIGURE 2**) to promote hamstring loading and trunk stabilization. To further train lumbopelvic stabilization, patients performed planks, side-planks, side-lying hip abduction (to increase gluteus medius recruitment, in turn improving stance limb stability) and bridges with a therapeutic inflated ball. Patients were to perform 3 sets of 10 to 15 repetitions of each of the eccentric hamstring and hip abduction exercises in addition to planks and side-planks as part of a daily home exercise plan (HEP). The number of repetitions and hold times varied depending on whether proper form could be maintained. Criteria for advancement included demonstrating proper form with 3 sets of 15 eccentric loading exercises, no compensatory motion with lumbopelvic stabilization exercises, a 25% or greater reduction in pain intensity with exacerbating activities and subjective reports of ease with exercise performance.

Phase 2 During phase 2, phase 1 exercises were continued with increased repetitions or weight to ensure consistent eccentric overloading of the proximal hamstring tendon. In addition, the intent of phase 2 was to place an increased focus on strengthening, weight bearing activities, and lumbopelvic co-contraction. To incorporate a more dynamic task, single leg windmills[22] were performed allowing for eccentric loading of the hamstring complex as well as promotion of single limb stance stability. Standing hip hikes and lunges were added to continue to facilitate lumbopelvic awareness and stability in weight bearing which is required with running.[52]

TDN was introduced during phase 2. Each patient was treated with 2 to 3 sessions of dry needling to trigger points in the medial and lateral hamstrings as well as the adductor magnus. The adductor magnus was included due to the fact that it shares an attachment site with the hamstrings at the infero-lateral aspect of the ischial tuberosity, as well as aiding in hip extension. Prior to TDN, the patient was positioned in prone with a towel roll placed under the foot of the involved limb to place the knee in slight flexion reducing tension on the hamstring complex. The hamstrings and adductor magnus were palpated to locate TrPs, which were identified as taut bands of muscle tissue that were painful to pinch palpation.

These TrPs were treated using a 0.30x0.50mm or 0.30x0.60mm solid filament needle depending on the size of the patient and the length of needle required to reach the TrP. A pistoning technique was utilized whereby the needle was directed at the TrP, partially withdrawn, and then redirected slightly toward the same TrP with the purpose of eliciting multiple LTRs in the same region. This technique was repeated until LTRs were no longer elicited, the TrP was no longer palpable, or the patient required a break in the treatment. This was repeated for all TrPs found in the hamstrings and adductor magnus muscle. On average, the overall sessions lasted 10-15 minutes and 3 to 5 TrPs were treated each session. After the treatment, patients were instructed to gently stretch the hamstrings and ice was applied. This treatment did not interfere with participating in other aspects of their therapy program. Risks and benefits were discussed explicitly with each patient, and verbal and signed consent was received prior to TDN as per the guidelines of the District of Columbia Department of Health.

The HEP was modified by having the patients perform longer hold times with planks and side-planks, as well as increasing weight with leg curl machine eccentric exercises to ensure that some discomfort/pain remained during the activity. Criteria for progression to the final phase was demonstrating proper form with all therapeutic exercises, subjective reports of ease with exercise, and a reported 50% or greater decrease in pain intensity with exacerbating activities.

Phase 3 The final phase included continued progressive eccentric loading and lumbopelvic stabilization exercise, with an additional focus on sport specific and plyometric activities. Previously performed exercises were continued, again with progression of weight or repetitions. Lumbopelvic stability and awareness has been shown to be important with runners[13,17,28,45,52] however distal impairments can also be correlated with proximal pathologies.[13,37] Because of this, the therapist placed an increased focus on performing the exercises while maintaining balance. Single leg deadlifts were performed on a half-foam roll to facilitate single limb stance stability on an unstable surface during a dynamic task which would be beneficial when running on trails or unstable surfaces. A 4-way hip exercise was also performed in standing on a half-foam roll, forcing the patient to maintain single leg balance while moving the contralateral limb into hip flexion, extension, abduction, and adduction against resistance provided by an elastic band. Other exercises added during this phase included walking lunges with weights to facilitate lumbopelvic stability during a motion similar to running and Nordic curls (**FIGURE 3**) to progress eccentric hamstring loading.

OUTCOMES

Outcomes for each patient can be seen in **TABLE 3**. Final evaluations and discharge were performed by the same therapist who performed the initial evaluations and oversaw each treatment session. Following a program utilizing eccentric training of the hamstrings, TDN, and lumbopelvic stabilization exercises, each patient improved functionally and returned to running without pain. Following TDN sessions, Patient # 1 reported significantly decreased pain with sitting in the following days, and both patients reported decreased pain with running. No more than 3 TDN sessions were necessary as improvements remained. Improvements were also seen in pain, tenderness, LEFS scores, and sitting was no longer an aggravating activity. Both patients met the MCID of 9 scale points for the LEFS and 3 points on the GROC, indicating significant functional improvements reported by the patients. Improvements in gluteal strength and hip motion control were seen both with manual muscle testing and when performing a single leg squat, with minimal or no dynamic femoral adduction or internal rotation noted.

Patient # 1 was treated in physical therapy for 9 visits over 8 weeks. At discharge, Patient #1 achieved his goal of running 8 to 10 km 5 times each week pain free. An email received 6 months following discharge noted that the patient remained symptom free with all activity and that he completed a triathlon symptom free.

Patient # 2 was seen in physical therapy for 8 visits over the course of 10 weeks. He was discharged after running 30 km without symptoms and reporting significant decrease in hamstring pain. The patient was seen 6 months later in physical therapy for unrelated right shoulder subacromial impingement, however reported no hamstring symptoms and that he participated pain free in a marathon.

DISCUSSION

Proximal hamstring tendinopathy can be a frustrating diagnosis to manage for patients and to treat in physical therapy. With proximal hamstring tendinopathy, there is often no traumatic incident to link the pathology to and there is a lack of literature available to guide rehabilitation programs. Aside from general recommendations, specific physical therapy management for proximal hamstring tendinopathy has not been well described. In the patients described here, significant improvements were noted with pain and function following eccentric loading of the hamstrings, lumbopelvic stabilization exercises, and the use of TDN. In addition to the interventions described, shockwave therapy and platelet-rich plasma injections appear to be promising conservative treatment options.[8,50] In cases where conservative treatment is ineffective, surgical management can be beneficial.[31,32]

Eccentric training has been shown to potentially result in positive changes in pain and function for patients with chronic tendinopathic changes.[39] Although research describing eccentric training for all tendons is not available, positive outcomes with minimal risk has been shown with other tendons in the upper and lower quarter.[1,4,9,10,23,25,36,47,48] Assuming a patient has symptomatic chronic tendinopathic changes without an active inflammatory component present,[2] eccentric training is a viable conservative treatment option for physical therapists to employ. This appears true regardless of whether the tendinopathy is insertional or in the midsubstance or body of the tendon.[33] Some studies have shown that modifying the performance of eccentric loading may be more beneficial for insertional tendinopathy.[24,35] For example, with chronic Achilles insertional tendinopathy, 1 study found that patients responded better to eccentric loading to neutral rather than into dorsiflexion (as Alfredson's original eccentric protocol suggests should be done), to prevent wrapping or irritation of the tendon on boney prominences or osteophytic growth.[24] Future studies investigating modified eccentrics of insertional proximal hamstring tendinopathy would be useful.

TDN may be a beneficial adjunct intervention in the rehabilitation of individuals with symptomatic tendinopathic changes. TDN can be used to help treat acute and chronic musculoskeletal pain to improve patient function.[3,15,29] TDN of TrPs can allow for reduced local and referred pain, improved ROM, and may alleviate excessive muscle tension, allowing for decreased stress on the tendon and related joint(s).[3] With these patients, it is speculated that TDN produced a decrease in pain and improvement in myofascial mobility allowing for decreased tension on the proximal hamstring tendon at the ischial tuberosity. TDN may be appropriate to use early in rehabilitation programs because of its potential for pain relief and minimal potential side effects.

It may be difficult to generalize the results from these 2 cases to other patients with chronic tendinopathic changes, as a specific treatment protocol was not used. In the protocol developed by Alfredson for Achilles tendinopathy, patients performed 3 sets of 15 repetitions, twice a day for 12 weeks.[12] Although the Achilles tendon eccentric loading protocol has been consistently beneficial in rehabilitating numerous tendinopathies, individuals with proximal hamstring tendinopathy may also have other impairments which can lead to a delayed or incomplete recovery if left unaddressed. The authors believed that eccentric hamstring loading (3 sets of 15 repetitions with multiple exercises) performed once daily, in addition to an impairment based rehabilitation program, would facilitate returning these patients to running. Accordingly, as both patients presented with hip weakness noted with strength and functional testing, specific exercises that require high level of gluteal muscle activition[14] were prescribed to facilitate lumbopelvic strengthening, which may have contributed to the improvement of the patients.

There are a number of limitations associated with this report. The authors arrived at a clinical diagnosis of proximal hamstring tendinopathy based on subjective and objective information, however, no imaging was performed to further confirm the diagnosis.[8,11] A number of pathologies may cause buttock pain worsened with running and sitting and should be considered in the clinician's differential diagnosis. Only 2 cases are reported here, making it difficult to generalize results. The same therapist who performed the initial evaluation, also performed the treatments and completed the final evaluation. In future studies, potential bias could be minimized by using a different and potentially blinded evaluator. Although both patients demonstrated subjective and objective functional improvements, it should be noted that the LEFS may not have been the most appropriate functional outcome measure for these high level runners as both patients had a high baseline score, indicating low disability. Although they both demonstrated improvements satisfying the MCID, the LEFS may provide a low ceiling for potential improvement. Other questionnaires that are more sport or running specific may be more applicable.

As there is a lack of evidence describing the rehabilitation of proximal hamstring tendinopathy using TDN, additional systematic research is needed to determine the exact contribution of TDN to the overall treatment approach provided to these patients. The findings from these case reports may be used to benefit clinicians with similar patient presentations, and drive future research into the use of these interventions in the treatment of proximal hamstring tendinopathy.

CONCLUSION

The authors present a multimodal approach to rehabilitation of 2 older high level runners with proximal hamstring tendinopathy. For both cases, progressive eccentric loading of the hamstrings was combined with lumbopelvic stabilization exercises and TDN to the hamstrings and adductor magnus. Both patients exhibited clinically significant improvements in pain, tenderness, and self reported outcome scores which were maintained 6 months after the end of the intervention. Both patients returned to symptom free running at a high level, with 1 patient participating in a marathon and the other a triathlon within the 6 month period after the intervention. The successful management of these individuals warrants further investigation into the effectiveness of this treatment approach for individuals with similar clinical presentations.

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FIGURE CAPTIONS

FIGURE 1. Trigger point dry needling of the hamstrings.

FIGURE 2. Supine bridge walk outs. In supine with knees bent, the patient performs hip extension to come into a bridge position (A). In a controlled fashion, the patient alternately walks their feet out (B) while maintaining the bridge position. Once the patient reaches the end of the range of motion (C), the patient returns to the starting position.

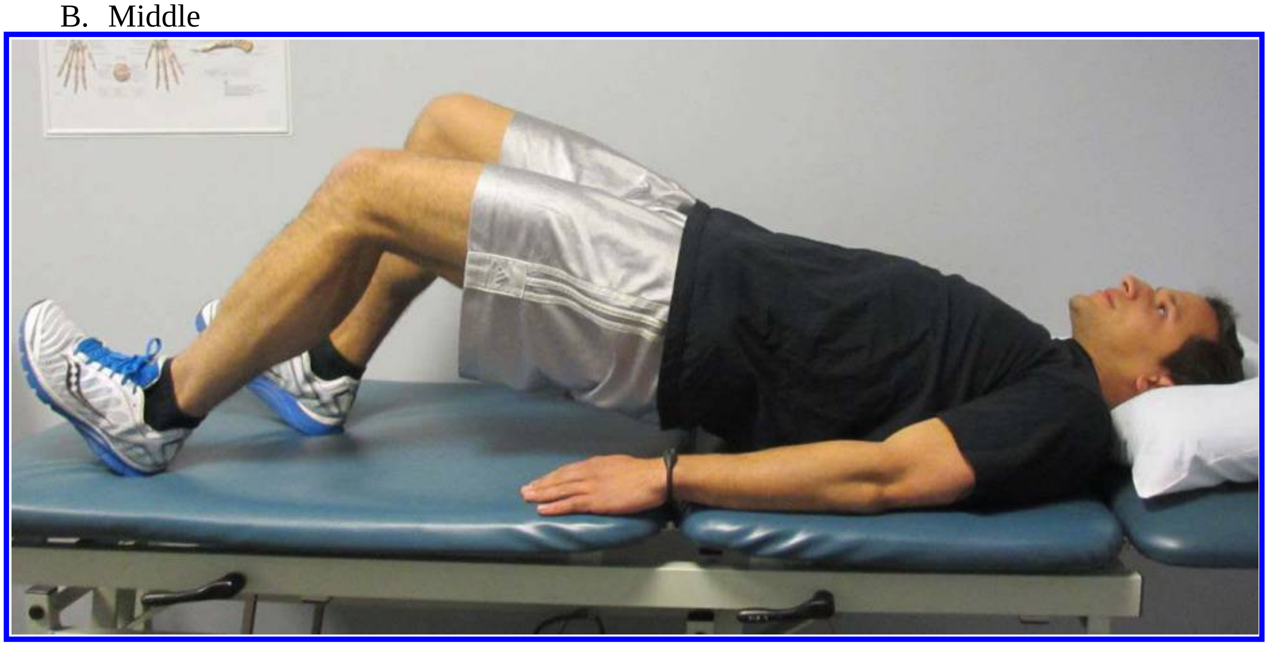
FIGURE 3. Nordic curls. In the kneeling position, with the therapist stabilizing the ankles, the patient slowly controls lowering of the trunk down towards the mat, to eccentrically load the hamstrings. The patient should use their arms to brace their fall once unable to control the movement eccentrically with the hamstrings.

FIGURE 1. Trigger point dry needling

FIGURE 2. Supine bridge walk outs

A. Starting position

B. Middle



C. Ending position

FIGURE 3. Nordic curl

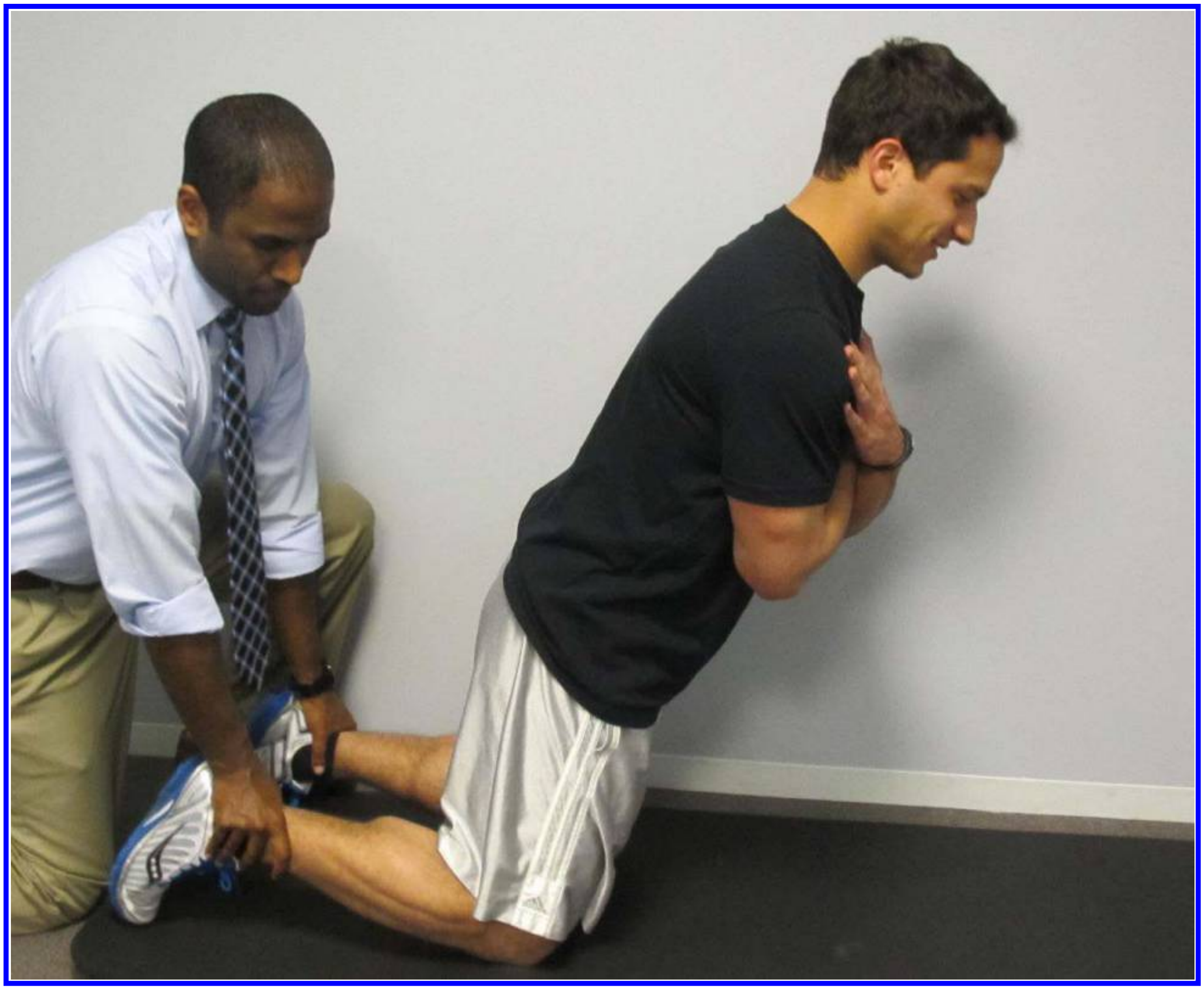


TABLE 1. Patient examination findings.

	Patient 1	Patient 2
Location of symptoms	Right proximal buttock	Left proximal buttock
Lumbopelvic screen	Negative	Negative
Neurological screen	Negative	Negative
Strength	4/5 right hamstring (with pain) 3+/5 right gluteus medius	5/5 hamstrings 4/5 left gluteus medius
Tenderness to palpation	Right ischial tuberosity	Left ischial tuberosity
Special tests	(+) bent knee stretch (+) modified bent knee stretch	(+) bent knee stretch (+) modified bent knee stretch
Running gait	Slight decreased knee flexion on right during swing	Decreased hip extension on left during mid and terminal stance
LEFS score	67/80	68/80

Abbreviation: LEFS, lower extremity functional scale.

TABLE 2. Patient visits and rehabilitation progression

	Visits (each week/total)		Phase of treatment	
Week	Patient 1	Patient 2	Patient 1	Patient 2
1	2(2)	1(1)	1	1
2	1(3)	1(2)	1	1
3	1(4)	1(3)	2	2
4	1(5)	1(4)	2	2
5	1(6)	0(4)*	2	2
6	1(7)	1(5)	3	2
7	1(8)	1(6)	3	3
8	1(9)	0(6)*	3	3
9	D/C	1(7)	D/C	3
10	D/C	1(8)	D/C	3

D/C- patient was already discharged from therapy

* - cancelled appointment due to scheduling conflict

TABLE 3. Outcome measures at initial evaluation and discharge

	Patient 1		Patient 2	
	Evaluation	Discharge	Evaluation	Discharge
Pain (0-10) at rest at worst	 4 7	 0 0	 6 10	 0 2
LEFS (0-80)	67/80	80/80	68/80	79/80
GROC*	N/A	+7	N/A	+7
Tenderness	Ischial tuberosity	Negative	Ischial tuberosity	Negative
Strength	4/5 right hamstring (with pain) 3+/5 right gluteus medius	5/5 right hamstring (pain free) 5/5 right gluteus medius	4/5 left gluteus medius	5/5 left gluteus medius

Abbreviations: GROC, Global Rating of Change; LEFS, Lower Extremity Functional Scale

* -7 to +7, 0 being no change, +7 A very great deal better