THE REHABILITATION OF A RUNNER WITH ILIOPSOAS TENDINOPATHY USING AN ECCENTRIC-BIASED EXERCISE-A CASE REPORT

Carla Rauseo, DPT, CSCS¹

ABSTRACT

Background and Purpose: While there is much discussion about tendinopathy in the literature, there is little reference to the less common condition of iliopsoas tendinopathy, and no documentation of the condition in runners. The iliopsoas is a major decelerator of the hip and eccentric loading of the iliopsoas is an important component of energy transfer during running. Eccentric training is a thoroughly researched method of treating tendinopathy but has shown mixed results. The purpose of this case report is to describe the rehabilitation of a runner with iliopsoas tendinopathy, and demonstrate in a creative eccentric-biased technique to assist with treatment. A secondary objective is to illustrate how evidence on intervention for other tendinopathies was used to guide rehabilitation of this seldom described condition.

Case Description: The subject was a 39-year-old female middle distance runner diagnosed with iliopsoas tendinopathy via ultrasound, after sudden onset of left anterior groin pain. Symptoms began after a significant increase in running load, and persisted, despite rest, for three months. The intervention consisted of an eccentric-biased hip flexor exercise, with supportive kinetic chain exercises and progressive loading in a return to running program.

Outcomes: The Copenhagen Hip and Groin Outcome Score, the Visual Analogue Scale, the Global Rating of Change Scale and manual muscle testing scores all improved after 12 weeks of intervention with further improvement at the five-year follow up. After 12 weeks of intervention, the subject was running without restriction and had returned to her pre-injury running mileage at the five-year follow up.

Discussion: The eccentric-biased exercise in conjunction with exercises addressing the kinetic chain and a progressive tendon loading program, were successful in the rehabilitation of this subject with iliopsoas tendinopathy. This case report is the first to provide a description on the rehabilitation of iliopsoas tendinopathy, and offers clinicians suggestions and guidance for treatment and exercise choice in the clinical environment.

Level of Evidence: 5

Keywords: running, tendon, tendon pathology, tendon loading

CORRESPONDING AUTHOR

Carla Rauseo, DPT, CSCS
Total Rehabilitation Centre
60A Boundary Road Extension
San Juan, Trinidad and Tobago
E-mail: carla@totalrehabtt.com
Phone: (868)-389-5768

¹ Total Rehabilitation Centre, San Juan, Trinidad and Tobago

INTRODUCTION

Tendinopathy is the term used to describe the clinical condition of tendon pain, swelling, impaired tendon performance and dysfunction, independent of pathology within the tendon that has developed as a result of acute or chronic overload.¹⁻³ While tendinopathy is a common condition in the athletic population,⁴ its pathophysiology is still not fully understood.⁵ Tendinopathy is generally considered to encompass both inflammatory and degenerative processes.^{6,7,8} However, although inflammatory markers may be present, tendinopathy does not have a typical inflammation response, and expression of these markers occurs in response to cyclic load.⁵ In addition, the relationship between tendon pathology, pain and function is unclear.⁵ These mixed characteristics of tendinopathy present a challenge to clinicians, as understanding the timeline and sequence of pathology is important in determining the proper treatment. For example, it has been suggested that the most important aspect of a tendinopathy rehabilitation program is appropriate loading and progression to prepare the tendon to meet the demands of sport.⁹ According to the donut theory,⁵ an area of cell degeneration within a tendon is usually surrounded by healthy tissue, and rehabilitation should focus on increasing the tolerance of this healthy tissue to loading.^{5,9,10} However, concern has been raised as to when and how that load should be applied to the tendon^{4,5,9,11} given the risk of exacerbating the pathological state of the tendon.

A few models of tendon pathology have been proposed.¹¹⁻¹³ The most recent model by Cook and Purdam,^{5,11} relates the stage of pathology to the corresponding clinical presentation. Although the relationship between pain, structure and function is unclear, this model is still useful as it provides the clinician with a framework within which to determine timing and type of interventions. It is interesting to note that clinical tendon staging in this model is based heavily on loading history, clinical presentation and age of the individual, which can easily be determined in the clinical setting.

Cook and Purdam^{5,11} caution against eccentric loading in the early stages of tendinopathy when the tendon is already being significantly loaded from acute bouts of athletic activity, and tendon cells

are already upregulated. Rather, they suggest that eccentric exercise can have a positive effect in the degenerative stage when tendons are less irritable. It has also been recommended that during this stage, the athlete avoid the offending activity,¹⁴ or can perform walking/jogging once there is minimal pain.^{15,16} Exercise to address the kinetic chain and contralateral deficits may be performed throughout the continuum of tendon pathology as this will help to unload the tendon, improving success of rehabilitation.^{9,11}

Eccentric exercise as a method of rehabilitation for tendinopathy has been heavily investigated in the literature, but has yielded conflicting results.¹⁵⁻³³ Norregaard et al²⁵ found no differences in improvement between eccentric and stretching exercises over a one year period. In a recent review Coupee et al³⁴ concluded that eccentric exercises were not superior to other forms of exercise loading applied to patellar and Achilles tendons, and suggested that the direction of movement may not be as important as the load applied to the tendon. Other reviews, while reporting positive outcomes using eccentric exercise, were unable to establish its superiority over other forms of exercise.^{14,28,33}

In contrast, Roos et al³⁵ reported superior pain reduction in mid-portion Achilles tendinopathy and return to sport after 12 weeks of eccentric work when compared to splinting. A number of other studies have also shown positive results from eccentric exercise when compared to other forms of treatment.^{15,18,24,26,32} Two systematic reviews have reported eccentric exercise to demonstrate superior outcomes compared to other interventions in patients suffering from patella tendinopathy³⁶ and Achilles tendinopathy.³⁷

Although there is considerable literature investigating the effects of eccentric exercise on Achilles, wrist extensor, posterior tibialis, and patellar tendinopathies, there seems to be no studies that have investigated its effect on iliopsoas tendinopathy. This condition is rarely described in the literature. Blankenbaker et al³⁸ found one case of iliopsoas tendinopathy in a cohort of 40 patients with snapping hips. Other reports of iliopsoas tendinopathy have been documented in patients with total hip replacements^{39,40} with an incidence of 4.3%.⁴⁰ The author

of this study found no cases of reports in runners, whose prevalence of groin pain is as high as 18 percent.⁴¹ Whether it is a rare condition, or under- or misdiagnosed under different names such as tendinitis, bursitis, or snapping hip syndrome, seems unknown.

Eccentric exercise may be an appropriate method to use in the rehabilitation of iliopsoas tendinopathy in runners, given the role of the iliopsoas tendon in energy transfer during running. During stance phase in running, the hip is rapidly extending. The iliopsoas contracts eccentrically to decelerate the hip, and in doing so, gathers potential energy as it elongates. This energy is then released during swing as the leg slingshots forward.⁴² Because of this action, it makes sense to train the muscle with an eccentric component in order to prepare the muscle for the demands it faces in running.

The rehabilitation program for a runner with iliopsoas tendinopathy should consider the pathophysiology of the tendon, the biomechanics of the kinetic chain during running, and the characteristics of the load placed upon the iliopsoas tendon. The purpose of this case report is to describe the rehabilitation of a runner with the rarely described condition of iliopsoas tendinopathy, and demonstrate a creative eccentric-biased technique to assist with treatment. A secondary objective is to illustrate how evidence on intervention for other tendinopathies was used to guide rehabilitation of this condition. The subject of this report was informed that her case would be submitted for publication, and agreed to the submission.

CASE DESCRIPTION

The subject was a 39-year-old female runner who ran an average of 17-20 miles per week. She was 5 feet 4 inches tall and weighed 110 pounds. She had no significant medical history. At the time of the initial examination, the patient had been running consistently three to four times per week for over 15 years with no cross training.

At the initial examination, the subject presented with complaints of left inguinal pain that began after a self-perceived difficult hill run in new shoes after not running for two weeks. After this incident, she described stiffness in the groin when starting a

run, but had no pain once warmed up. She therefore continued to train and run. The pain would present after running and she occasionally could not lift her leg to get out of her car upon returning home after a run. The subject reported that pain was worse after faster runs and after runs on hills.

Initially, she had no pain at rest, but as she continued running she began experiencing pain during the day after prolonged periods of sitting, the onset of snapping in the groin at night while turning in bed, and sharp pain when rising in the morning. The pain eventually affected her ability to walk after being stationary for prolonged periods, but would decrease as she continued to walk. Beserol®, a muscle relaxer with an analgesic component, would decrease her pain when present, but would not prevent further episodes. Three months after the initial injury, she sought the services of a physician, received a diagnosis of iliopsoas tendinopathy confirmed by diagnostic ultrasound, and was referred to physical therapy. The subject's primary goal was to return to running without pain.

Detailed hip and functional assessments were performed. A clinical running analysis on the treadmill was also done to observe technique. Asymmetries in postural alignment were observed in standing and during the running analysis. Significant findings are reported in Table 1. Physical findings of particular note include excessive anterior pelvic tilt, positive left Thomas and Ober tests for iliopsoas and iliotibial band tightness respectively, pain to palpation of the belly of the iliopsoas, and weakness in bilateral hip extension and abduction, left greater than right. Her running analysis revealed a bilateral over-stride with decreased hip extension and anterior pelvic tilt. A right Trendelenberg sign was also noted, with poor lumbo-pelvic-hip control in the transverse plane and an asymmetrical and decreased arm swing.

Outcome Measures

The following outcome measures were assessed at the initial evaluation, after 12 weeks of eccentric training and at the 5-year follow up (Tables 2 and 3, Figure 1).

Pain Assessment. The subject's pain after a run was documented using a 10-point visual analog scale.

Table 1. *Symptoms and physical exam findings.*

Symptoms	Physical Exam Findings	Running Analysis
Localized left groin pain after running and prolonged sitting	Positive left Thomas test for iliopsoas tightness	Significant left hip drop during right stance (right Trendelenberg)
Pain worse after fast runs and hill running	Positive left Ober test for ITB tightness	Initial contact on extended tibia bilaterally, overstriding
Pain decreased once warmed up	Significant weakness (see Table 2 for MMT scores) of all hip musculature with left groin pain on resisted right and left hip abduction	Poor transverse plane control of lumbo-pelvic-hip complex with asymmetrical arm-swing
Snapping left hip	Excessive anterior pelvic tilt	Posterior placement of arms with decreased arm swing
Localized left groin pain when rolling in bed at night	S-curve scoliosis-convex right in T-spine and convex left in L-spine	Decreased hip extension in terminal stance bilaterally
	Pain in left psoas muscle belly to deep palpation	Anterior pelvic tilt

Table 2. *VAS and GROC Scores.*

Outcome Measure	Initial Assessment	12 weeks	5-year follow up
Visual Analogue Scale	6/10	2/10	1/10
Global Rating of Change Scale	—	+6 (a great deal better)	+7 (a very great deal better)

Table 3. *Manual muscle testing results.*

Movement Tested	Initial Assessment		After 12 weeks		5 Year Follow-up	
	Right	Left	Right	Left	Right	Left
Hip Flexion	4-	4-	4	4	5	5
Hip Abduction	4- pain	3 pain	4 pain	4 pain	5	5
Hip Adduction	4+	4+	4+	4+	5	5
Hip Extension (knee extended)	4-	4-	4+	4	5	5
Hip Extension (knee flexed)	4-	3+	4-	4-	5	5

This is a 100mm line anchored by 0 (no pain) on the left and 10 (pain as bad as it could be) on the right.⁴³ This has been found to be a valid, reliable and responsive assessment with a minimal clinically important difference of 2cm.^{43–45}

The Global Rating of Change Scale (GROC). The subject's perception of overall improvement was measured using the GROC. This is a 15 point Likert scale that measures the patient's impression of her progress after a period of treatment. The scores range

Figure 1. HAGOS Scores.

from “a very great deal worse” (-7) to “a very great deal better” (+7). Zero indicates no change. The minimal clinically important difference has been established at three points.⁴⁶

Hip and Groin Outcome Score (HAGOS). The HAGOS was used to measure six dimensions (subscales): Symptoms; Pain; Function in daily living (ADL); Function in sport and recreation; Participation in physical activities; and hip and/or groin-related quality of life. Each sub scale is normalized to give a score out of 100, where 100 indicates no problems and 0 indicates extreme problems. It has been shown to be a valid, reliable and responsive tool with a minimal clinically important change of between 10 and 15 for the subscales in young to middle-aged patients with hip and groin pain.⁴⁷

Manual Muscle Testing (MMT). MMT as described by Kendall⁴⁸ was used to assess strength. The subject moved to a position in the direction of the movement to be tested (ex. hip abduction) and attempted to hold the position against gradually increasing pressure exerted by the clinician. The point at which the subject breaks the hold position determines the score of the strength test. The strength of the muscle is scored out of 5, where 0 means that there is no evidence of any muscle contraction and 5 indicates that the subject's strength is normal and able to hold against

strong pressure. A study by Aitkens⁴⁹ found a significant correlation between quantitative isometric testing and MMT, although another study⁵⁰ found good specificity but only moderate sensitivity (<75%) and diagnostic accuracy (<78%) of MMT. Yet, in the absence of more robust isokinetic/isometric dynamometers, MMT may still provide a reasonable representation of a subject's strength in the clinic.

Assessment and Staging of Tendinopathy- Clinical Impression 1

No ultrasound was available to visualize the tendon in the physical therapy clinic, and the physician did not provide sufficient detail to stage the tendinopathy. Using the clinical presentation proposed by Cook et al,¹¹ it was established that the subject was in the tendon degenerative stage, and possibly had some reactive characteristics as well. This was determined based upon the chronicity of the subject's problem (> 3 months), the length of time she had been running which could indicate chronic strain (>15 years), and the fact that she had repeated bouts of tendon pain, that subsided with rest, but returned with loading again. In addition, palpation revealed a painful and thickened left iliopsoas tendon compared to the right side. These signs are consistent with reactive on degenerative tendinopathy based on the continuum of tendon pathology.¹⁰

Intervention

Phase I-Load management and eccentric exercise

The subject was instructed to stop running, as running, even short distances (less than one mile) in the initial phases of rehabilitation, was the primary aggravating factor, possibly creating acute reactivity within the tendon.¹¹ The cessation of the offending activity is in accordance with recommendations by Wasjelewski.¹⁴

As it was determined that the tendinopathy was in the degenerative stage, the subject was placed on an eccentric program for the iliopsoas tendon. Because she had stopped running, pain had subsided, likely indicating reduced reactivity, so loading could be introduced. She was also prescribed exercises to address the asymmetries, muscle length deficits of the hip flexors, weakness of the hip abductors and hip extensors as well as lumbo-pelvic-hip control. Studies support concomitant strengthening and lumbo-pelvic stability work in runners to improve kinetic chain biomechanics and unload the affected tendon.^{9,51,52} Table 4 shows the specific exercises that were done for three sets of ten to fifteen repetitions performed twice weekly throughout the 12 weeks of therapy.

The eccentric-biased program consisted of one exercise, designed by the author to limit the amount of core control needed by the subject. This side-lying position was chosen because she was unable to safely perform supine or standing eccentric hip flexion without excessively extending her spine. In addition, the exercise had to be performed at home on a daily basis without the need for clinic/gym equipment.

To perform the novel eccentric-biased exercise, the subject assumed the right side lying position with a Perform Better® black monster band secured around the left ankle and the other end attached to a sturdy object behind her at about knee height. Her left hip was maximally flexed with the knee flexed as well. This start position (Figure 2) is similar to a running position. To start the exercise, the subject slowly extended the hip, controlling against the pull into hip extension provided by the monster band for a count of “3” while keeping the knee flexed, until the hip was fully extended (Figure 3). This was to allow isolation of the iliopsoas and place the rectus

Figure 2. Start position for eccentric-biased exercise.

Figure 3. End position for eccentric-biased exercise.

femoris at a mechanical disadvantage. In addition, this placed stretch on the iliopsoas at end range hip extension, which was appropriate for the subject, given her hip extension limitations per the Thomas test and running analysis (Table 1). Once at the end position (Figure 3), the subject made a quick concentric contraction to the count of “1” as she quickly flexed the hip against the resistance of the band to move the left hip into full hip flexion to the start position. The subject was cued not to arch her back and to keep her abdominals engaged in order to stabilize the spine against the wall. She was allowed to hold onto a sturdy object to increase her stability. The exercise simulated the energy transferring function of the iliopsoas during running⁴² in a semi running-specific position.

Table 4. Rehabilitation exercise progression over three months.	
Weeks	Exercises
1-4	<ol style="list-style-type: none"> 1. Hip stretches (iliopsoas, piriformis, hamstring, gluteals) 2. Eccentric hip flexion sets of 15 reps (Figures 2 and 3) 3. Lumbo-pelvic dissociation on Swiss ball (pelvic tilting anterior-posterior, medial-lateral, clockwise/counter clockwise) 4. Prone and supine core stability exercises with Chattanooga stabilizer as per Chattanooga instruction manual (3 sets of 20 repetitions for each arm and leg movement for endurance and control) 5. Single leg bridging with opposite leg extension 6. Resisted lateral walks with resistance band placed around knees, progressing over time to ankles as tolerated 7. Forward lunges 8. Squats 9. Single leg stance with opposite leg at 90 degrees of hip and knee flexion 30 seconds x5 reps
5-8	<ol style="list-style-type: none"> 1. Hip stretches (iliopsoas, piriformis, hamstring, gluteals) 2. Eccentric hip flexion (as in weeks 1-4) 3. Prone and supine exercises with Chattanooga stabilizer (weighted 3 sets of 20 repetitions) 4. Quadruped pointer progressed by addition of weights to arms and legs 5. Cook hip lift/single limb bridge 6. Squats on unstable surface such as a Bosu ball for lumbo-pelvic-hip control 7. Single leg Romanian dead lifts (unweighted) 8. Lateral and forward lunges 9. Single leg stance on unstable surface 30 seconds x 5 reps 10. Gait training during running to decrease stride length
9-12	<ol style="list-style-type: none"> 1. Eccentric hip flexion (as in weeks 1-8) 2. Bridging progression (marching and on unstable surface) 3. Hamstring bicycles with hip lift on TRX for posterior chain strength 4. Multi-directional lunges (progressed to holding weight) 5. Weighted single leg Romanian dead lifts 6. Squatting on foam roller (control, balance and movement quality) 7. Multi-directional planks 8. Gait training during running to decrease stride length

Table 5. Protocol for eccentric-biased exercise.

- 3 sets of 15 repetitions
- Slow, controlled movements
- Exercise should elicit moderate but not disabling pain
- Increase load when pain is minor or absent
- Perform exercises 2x/day
- Avoid any offending physical activity during the first 4-6 weeks of eccentric exercise

The subject was instructed to perform 3 sets of 15 repetitions of this eccentric exercise twice per day over the course of 12 weeks (Table 5). She was informed that this should reproduce her tendon pain to no more than 5/10 (moderate pain) on the VAS.^{10,14,26,53,54} This protocol is based upon research by Alfredson et al¹⁶ who showed improvements in pain and function with this dosage and it is a frequently used dosage in the literature.^{14,33} The strength of the band was increased as the exercise became less painful,^{16,18,25} taking care not to cause an exacerbation of the pathological state⁹ or pain greater than 5/10. The subject reported good compliance with this exercise at home.

Phase II: Reintroduction of loading/Cross-training

Two weeks after starting the eccentric program, the subject reported an improvement in symptoms. As her pain was now minimal, the subject was allowed to start a walking program provided there was no further increase in pain^{18,34,51} to help start to increase the load on the iliopsoas tendon. During this time, she also performed deep-water running once a week for forty-five minutes in order to help maintain her fitness, and 100m sideways hill repeats ranging from 5-8 repetitions on each side once a week to assist with gluteal strength, pelvic stability and fitness. No pain was experienced during these activities.

Table 6. Running intervals and associated symptoms.		
WEEK (after starting eccentric training)	WALK-RUN-WALK INTERVALS (mins)	SYMPTOMS
5	10-10-10	Bilateral groin pain
10	8-14-8	No groin pain. +Low back pain
11	5-20-5	Mild left groin pain only at night when turning in bed
12	25 min run	Mild left pain in groin and back
13	30 min run	No groin pain. +Back stiffness
15	5-hour hike	No pain
17	Unrestricted	Left groin pain with increased speed

Phase III: Return to Running

Silbernagel et al⁵⁴ used a pain monitoring model to assist with return to sport activities. As recommended, the subject in this case study began to re-introduce running when her ADLs produced no more than 2/10 pain. This occurred five weeks after starting her eccentric work. She began a walk-run interval program (Table 6) once to twice a week with no fewer than three days in between sessions to allow for recovery of the tendon.¹⁰ She did this in combination with continued water running and sideways hill repeats during the non-run days. She experienced some increased groin pain and stiffness after her runs. Running time was progressed only when the pain was less than 2/10. During this time, she continued her rehabilitation program to address her other deficits (Table 4).

At the end of 17 weeks, the subject was running without restrictions and would only experience groin pain with increased pace faster than a 9-minute mile. Speed places increased load on the ilio-psoas tendon. At this point, she was discharged to a strength and conditioning coach with instructions to use the pain model to help guide her progression of speed, and continue her lumbo-pelvic-hip strengthening and stability training. At five years post discharge from physical therapy, the subject returned for a follow-up visit and the outcome variables were re-assessed (Tables 2 and 3, Figure 1).

OUTCOMES

Results of outcome measures at the initial assessment, after 12 weeks of eccentric training and at a

five-year follow-up are presented in Tables 2 and 3 and Figure 1. After 12 weeks of eccentric training using the technique described, the subject reported her worst pain to be 2/10 down from 6/10 at initial assessment, a clinically meaningful change. This further decreased to 1/10 at the five-year follow up although this was not significant. The subject also reported that the pain she did get at the 12-week mark was less frequent after running and appeared primarily only after increasing speed and/or distance for the first time. This pain continued to decrease in frequency at the five-year follow-up and was at that time, quite infrequent, occurring only about once monthly. She had returned to the mileage she was running at prior to the injury.

The HAGOS scores increased as well during this time frame, with the exception of the physical activity subscale, which showed a decrease in performance at the 12-week mark. This is likely because she was not running at the distance she was when she was initially assessed due to her cessation of running and gradual return to running protocol. However, at the five-year follow up, all sub scales showed improvement from the initial assessment and the 12-week mark. Clinically significant changes were found in the symptoms, sport/recreational and quality of life categories at the 12-week follow up. The improvement from initial assessment to the five-year follow up was clinically significant in all of the subscales. The improvement in pain and function were also reflected in the GROC scores.

DISCUSSION

Iliopsoas tendinopathy has not been well described in the literature. This case provides an example of the rehabilitation of a runner with this diagnosis and presents a novel eccentric-biased exercise for treating the condition. The subject in this study actually showed improvement in pain within two weeks after beginning the eccentric exercise. Tendinopathies can take 6-12 weeks to show improvement.^{16,55,56} However, this short time to improvement is similar to the time reported by Cushman⁵¹ in his study of eccentric training in rehabilitating hamstring tendinopathy, and is possibly due to neural changes at this early period.^{33,57} The subject was also performing exercises to improve the kinetic chain. However, the speed with which the subject reported pain reduction makes it unlikely that the improvement could be attributable to kinetic chain changes as these usually take a longer period to become apparent. Further improvement in this subject was achieved by the end of 12 weeks of eccentric training. This improvement indicated that the technique and dosage used were probably appropriate.

The subject attempted resisted eccentric hip flexion in both supine and standing, but was unable to maintain a neutral spine, which could increase the risk of back injury and decrease the effectiveness of the exercise. Therefore, the eccentric-biased exercise chosen was designed to limit the amount of lumbo-pelvic stability required to perform the exercise, as this subject had deficits in lumbo-pelvic control and strength. In addition, the psoas is a spinal stabilizer as well as a hip flexor,⁵⁸ and it was thought that the tendon could be loaded with greater resistance if the stability role of the muscle was reduced. The focus on the eccentric component was purposely done to increase the time under eccentric tension to take advantage of the neural benefits of eccentric contractions.⁵⁷

Although this was an eccentric-biased exercise, with the focus on the higher time under tension during the eccentric phase, it also had a concentric component. True eccentric strength training usually involves very high loads that can usually only be moved eccentrically, as higher loads are needed to capitalize on the neural efficiency of eccentric exercise.⁵⁷ There may be concern that this eccentric-biased exercise with

a concentric component may not eccentrically load the tendon enough to achieve gains.

As there is no literature on iliopsoas tendinopathy, an attempt to apply recommendations from other lower extremity tendinopathies was helpful. A systematic review by Malliaras et al^{33 p283} concluded that there is "limited (Achilles) and conflicting (patellar) evidence that clinical outcomes are superior with eccentric-only loading compared with other loading programs..." Therefore, as other programs, such as the Silbernagel-combined loading program,^{10,59} use both eccentric and concentric loading, it is possible that loads heavy enough to be only eccentrically tolerated, may not be necessary to elicit gains. Furthermore, in the clinical setting, when the patient's symptoms are highly irritable, high load may not be tolerated.

Malliaras et al^{33 p282} also stated that "clinical improvement is not dependent on isolated eccentric loading in Achilles and patellar tendinopathy rehabilitation." They also suggest that there is potential for benefit even with lower load eccentric training, given the possible neural and metabolic mechanisms of lower-load eccentric exercise. The review also recommended eccentric-concentric over isolated eccentric exercise, which therefore makes the technique proposed in this study a rational choice. In addition, some studies suggest that the important stimulus is that a load is placed upon the tendon, not the type of contraction.^{14,19,34} In fact, procollagen (a precursor to collagen) is upregulated, and therefore tendon protein synthesis is stimulated, regardless of contraction type.⁶⁰

Specificity of training muscle contractions is important, and in eccentric-only programs, there is a resulting problem of concentric weakness.³³ Furthermore, there is discussion that all tendons are unique to their function and position and therefore may not respond equally to particular loading protocols.⁶¹ Each tendon's loading environment should be considered, as they are each unique in their loading patterns.⁹ Running involves both concentric and eccentric contraction of the iliopsoas,⁴² and therefore training of the iliopsoas should include both types of muscle contractions. The exercise suggested in this study is performed in a semi-running-specific

position that reflects the concentric and eccentric hip flexion that occurs in running. Although research on other tendinopathies has been applied to this case report, it is important to consider the unique loading environment of the iliopsoas. It is for these reasons that the author believes that this technique was appropriate for this patient.

Although the subject had stopped eccentric training after 12 weeks, further improvement was noted at the five-year follow up in her HAGOS scores. This is similar to the results obtained by van de Plas et al³² five years after eccentric training for Achilles tendinopathy. The continued improvement of the patient in this case study could be attributed to the addition of strength and conditioning sessions which focused on improving asymmetries, and strength and stability of her lumbo-pelvic-hip complex. This outcome also supports the need to address the kinetic chain as discussed in recent literature.^{9,11,51,52} A holistic approach that includes the entire kinetic chain ensures that further unloading of the tendon may occur, as other structures, such as the gluteal muscles, may contribute more to running.^{62,63} This highlights the importance of continued load management in the long term, particularly since a decrease in pain is not necessarily reflective of tendon healing^{5,53,64} and therefore load management and improvement in load tolerance must continue throughout the patient's athletic career.

Gains may also have occurred because the progressive return to running, gradually increased the load tolerance of the tendon, allowing the subject to continuously improve her activity. This is supported by the donut theory⁵ of strengthening the healthy tissue around the degenerative zones within the tendon with gradual exposure to load.

The eccentric-biased exercise was chosen as the intervention based on the staging of the tendinopathy on the continuum of tendon pathology proposed by Cook and Purdam.¹¹ As the physician did not document the stage of the tendinopathy, this continuum was extremely helpful in determining the appropriate treatment based on the clinical presentation of this subject and her history of tendon load. Although, tendon pathophysiology is still unclear,^{2,5,6,13,65,66} this continuum can be a vital tool for the clinician who does not have access to imaging techniques.

Furthermore, imaging does not correlate well with pain, so it is important to attend to clinical symptoms in defining the stage of tendinopathy.¹

The dosage of the eccentric-biased exercise was based on the Alfredson protocol which is widely used in the literature.^{10,18,25,26,67} The subject was instructed to exercise into moderate pain, 5/10 on VAS which she tolerated well without increase in the reactivity of the tendon. However, she experienced increased groin pain upon re-introduction of running. Progression, therefore, was based upon pain response to help guide the return to running and avoid tendon re-injury. The pain monitoring model proposed by Silbernagel^{10,54} was useful in helping the subject progress her running safely without fear of re-injury, and can be a tool for clinicians progressing an athlete through rehabilitation and return to play. The pain monitoring model was also helpful in guiding recovery intervals. Using the recommendation that pain the morning after running should not exceed 5/10, she was able to increase her running time and frequency post discharge, and manage her symptoms. This speaks to the importance of patient education in the management of tendinopathy.

The subject experienced rare flare-ups post discharge. These occasional symptoms for this length of time at the five-year follow-up reflects the degenerative stage on the tendon pathology continuum.^{5,11} Despite the continued tendon pathology, the subject's low pain level (1/10) at five years is not necessarily reflective of the structure of the tendon. This supports recent research showing that pain does not correlate well with tendon histology.^{1,5,68,69} According to Cook et al,⁵ the subject has moved sideways along the continuum from a painful state with poor function to a pain-free state with good function, although degenerative changes are still present.

The research used to support this case study has come from studies on Achilles, patellar, rotator cuff and medial/lateral epicondyle tendinopathies. No empirical studies were found on subjects with iliopsoas tendinopathy. However, given the response of the subject to the treatment, it is possible that iliopsoas tendinopathy responds similarly to other lower limb tendinopathies. Nonetheless, attention should be given to the specific loading environment of the tendon during athletic performance.

A case report has several weaknesses that limit the strength of the results. This report is only on one individual's condition and response to treatment and therefore cannot be generalized to the general population. This subject was exceptionally compliant and patient with her program. This was a lengthy program that also relied heavily on the subject understanding the process and being receptive to education, and performing activities and load management interventions on her own. This may not be appropriate for all patients with this condition. This case report was also written retrospectively, and therefore may be subject to recall bias. Further research on this condition in a larger population is recommended before such treatment is implemented in a broader scope. In addition, while this case report supports the use of eccentric-biased training (with a small concentric component) in the treatment of this patient with iliopsoas tendinopathy, it did not investigate or compare the use of other forms of loading to the iliopsoas tendon.

CONCLUSION

The results of this case report indicate that iliopsoas tendinopathy can improve with a multi-modal approach to load management to allow recovery of the tendon. This includes appropriate staging of tendon pathology to help drive the timing and choice of treatment. This report demonstrates that in the correct stages of pathology, eccentric-biased isolated exercise, kinetic chain improvements and subject education with a return to sport program that considers tendon load and recovery are components that can lead to a successful outcome. This is a case report on one subject with iliopsoas tendinopathy, and there is a paucity of literature on this condition. Therefore, further studies on iliopsoas tendinopathy are recommended.

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