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CASE REPORT

TREATMENT OF HAMSTRING STRAIN IN A COLLEGIATE POLE-VAULTER INTEGRATING DRY NEEDLING WITH AN ECCENTRIC TRAINING PROGRAM: A RESIDENT'S CASE REPORT

Scott C. Dembowski, PT, MPT, OCS[1]
Richard B. Westrick, PT, DSc, OCS, SCS[2]
Edo Zylstra, PT, DPT, OCS[3]
Michael R. Johnson, PT, DSc, OCS, SCS[4]

ABSTRACT

Background: Hamstring strain injuries are among the most common injuries seen in sports. Management is made difficult by the high recurrence rates. Typical time to return to sport varies but can be prolonged with recurrence. Eccentric strength deficits remain post-injury, contributing to reinjury. Eccentric training has shown to be an effective method at prevention of hamstring injury in multiple systematic reviews and prospective RCTs but limited prospective rehabilitation literature. Functional dry needling is a technique that has been reported to be beneficial in the management of pain and dysfunction after muscle strains, but there is limited published literature on its effects on rehabilitation or recurrence of injury.

Purpose: The purpose of this case report is to present the management and outcomes of a patient with hamstring strain, treated with functional dry needling and eccentric exercise.

Case Description: The subject was an 18-year-old collegiate pole-vaulter who presented to physical therapy with an acute hamstring strain and history of multiple strains on uninvolved extremity. He was treated in Physical Therapy three times per week for 3 weeks with progressive eccentric training and 3 sessions of functional dry needling.

Outcomes: By day 12, his eccentric strength on the involved extremity was greater than the uninvolved extremity and he reported clinically meaningful improvement in outcome scores. By Day 20, he was able to return to full sports participation without pain or lingering strength deficits.

Discussion: The patient in this case report was able to return to sport within 20 days and without recurrence. He demonstrated significant decreases in pain and dysfunction with dry needling. He had greater strength on the injured extremity compared to contra-lateral previously injured extremity.

Conclusions: This case illustrates the use of functional dry needling and eccentric exercise leading to a favorable outcome in a patient with hamstring strain.

Key words: Functional Dry Needling, Hamstring, Eccentric Exercise

Level of Evidence: Level 4

[1] Resident, U.S. Military-Baylor University Post-Professional Doctoral Residency in Sports Physical Therapy, Keller Army Community Hospital, West Point, NY, USA
[2] U.S. Military-Baylor University Post-Professional Doctoral Residency in Sports Physical Therapy, Keller Army Community Hospital, West Point, NY, USA
[3] Kinetacore Physical Therapy, Brighton, CO, USA
[4] Director, U.S. Military-Baylor University Post-Professional Doctoral Residency in Sports Physical Therapy, Keller Army Community Hospital, West Point, NY, USA

The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or reflecting the views of Baylor University, the US Military, Department of Defense or the US Government.

CORRESPONDING AUTHOR
Scott C. Dembowski, PT, MPT, OCS
United States Military Academy
Arvin Cadet Physical Therapy Clinic
900 Washington Road
West Point, NY 10996-1197
Phone: 845-938-3067
Fax: 845-938-8114
Email: scott.dembowski@us.army.mil

BACKGROUND AND PURPOSE

Hamstring injuries are among the most common injuries seen in athletes and can be challenging to effectively manage, often leading to significant time away from sports. Management of these injuries is complicated by recurrence rates of up to 34% in sports involving high velocity running such as football, soccer, rugby, and track.[1-9] A review of the literature regarding hamstring injuries reveals there is no clear consensus related to mechanism of injury or risk factors for injury and re-injury.[1,4,10-14] A growing body of evidence indicates that muscular imbalance (unilateral differences as well as quadriceps-to-hamstring ratios) may be a significant risk factor for HSI.[4,6,15-19] Several authors have reported higher injury rates occur in the later stages of sports competition, suggesting fatigue may be another significant factor in injury.[4,7,20] Flexibility restrictions have also been described as a risk factor for HSI.[1,4,21-23] Additionally, prior hamstring injury appears to be a major risk factor for future HSI, leading authors to suspect that inadequate rehabilitation is a significant contributor to recurrence.[4,14,24,25]

Methods used to diagnose HSI are not consistent across the literature. The inconsistency regarding establishment of the diagnosis may be a contributing factor regarding variability in rehabilitation and the high recurrence of injury. Diagnostic ultrasound imaging is a potentially promising method of identifying and grading HSI, but is highly dependent on the skill of the clinician using it.[4,26] Magnetic resonance imaging (MRI) to grade severity of HSI is well documented throughout the literature. [2,3,14,26-30] However, due to high costs associated with MRI, clinical tests may be more economically feasible for most clinicians to use when grading injury severity. Assessment of knee active range of motion deficits has demonstrated positive correlation with degree of strain and return to sport time.[14,29,31] Additionally, previous authors have reported identifying and grading hamstring strain injuries with palpation, painful active or passive straight leg raise, and weakness.[2,4,14,23,29,31-34]

Few prospective studies address effective rehabilitation for athletes following hamstring strain.[35-37] Favorable outcomes have been reported for reducing recurrence rates with an eccentric based program integrating trunk stabilization.[25,38,39] Eccentric programs with various trunk stabilization exercises are believed to promote neuromuscular control of the lumbopelvic region and facilitate optimal hamstring activation.[9] Sherry and colleagues compared a "Progressive Agility Trunk Stabilization" (PATS) protocol to a static stretching, isolated progressive resistance protocol (STST) in 24 recreational athletes with acute hamstring strains.[39] The PATS protocol consisted of neuromuscular control exercises, initially focusing on movements in the frontal and transverse planes (Appendix). Exercises incorporating sagittal plane movements are added as the program progresses.[25,39] The PATS group returned to sport in a shorter time period than the STST group and only 1 re-injury in the year following return to sport was reported.[39] Similar findings have been reported throughout the literature.[5,16,17,22,40-46]

The use of eccentric training appears to be an essential component to any rehabilitation or preventive program, especially when returning to high speed running activities.[47] Eccentric strength imbalances assessed in professional soccer players during preseason, contributed to an increased risk of hamstring injury in players with untreated strength imbalances.[16] Significant reductions in initial and recurrent HSI have been reported for elite soccer athletes following a 10-week progressive eccentric training program and a weekly in-season program.[17]

Pain associated with hamstring strains may be amplified by areas of focal muscle dysfunction related to the strain injury. Changes surrounding the injured muscle tissue can include areas of muscle dysfunction commonly referred to as "trigger points".[48] There is no universally accepted treatment method for targeting pain associated with muscle dysfunction. Interventions vary from stretching, massage, and ischemic compression to ultrasound and laser therapy.[49] The variability of techniques used to address muscle dysfunction associated with HSI may be a contributor to inadequate treatment.

Dry needling is used in the treatment of athletes with chronic and acute musculoskeletal injury[48] and has recently been described for the treatment of several neuromuscular conditions.[50-52] Functional dry needling (FDN) is a form of dry needling used by healthcare providers worldwide in the management of musculoskeletal pain and injury, specifically in order to improve function.[49,53] FDN is believed to mechanically disrupt taut bands of muscle tissue found in areas of muscle dysfunction, allowing for normalized range of motion.[54] FDN of trigger points (MTrPs) in areas of pain and dysfunction is commonly associated with reduced local and referred pain, improved range of motion, and decreased MTrP irritability both locally and remotely.[55] Some evidence suggests that excessive muscle tension may be alleviated with FDN.[55] Although the exact mechanism of action is not completely understood, there is evidence indicating favorable local biomechanical changes may occur and the sensitivity of local muscle dysfunction can be altered in areas of muscle with MTrPs.[56-58] It has been reported that FDN is most effective when local twitch responses (LTR) are elicited.[59]

The purpose of this case report is to describe outcomes using FDN in conjunction with an eccentric based exercise program in a Division I collegiate athlete with recurrent hamstring strain injuries.

CASE DESCRIPTION

Patient History

The subject was an 18-year-old male collegiate pole-vaulter referred to physical therapy by his athletic trainer (ATC) for evaluation and treatment for a right HSI. The athlete reported injuring his right hamstring while performing sprint drills one week prior, stating he was unable to continue practice due to pain. Prior to this injury, he reported experiencing multiple hamstring injuries on the contralateral extremity (4 episodes over previous 12 months). He had been working regularly with the ATC on hamstring strengthening exercises and participated in conditioning activities daily. The patient was otherwise healthy without significant past medical history.

Examination

During the initial examination he reported his resting pain as 60/100 (100 mm visual analog scale) and pain during sport activities as 78/100. He completed several self-reported outcomes measures, including the Lower Extremity Functional Scale (LEFS), the Single Assessment Numeric Evaluation (SANE) and a Patient Specific Functional Scale (PSFS). These outcome measures are used in the authors' facility for all patients with lower extremity injuries. The LEFS is a reliable tool for assessing outcomes in the lower extremity[60,61] and the SANE has been validated for multiple conditions.[62] Both have recently been validated in patients with hamstring injuries.[63] The PSFS provides meaningful information regarding activities specific to individual patients, which may not be captured by other measures. The PSFS has been validated for various injuries[64-66] including the lower extremity.[67] This athletes initial outcomes scores are presented in Table 1.

Table 1. *Outocme Measures from Initial Evaluation. (A) PSFS with activity breakdown. (B) Other outcome measures collected initial evaluation included lower extremity functional scale (LEFS), visual analog scale (VAS) and single assessment numerical evaluation (SANE).*

Patient Specific Functional Scale (MDC for average score=2)

Activity	Score
Sprinting	0
Jumping	2
Squatting	5
Up/Down Stairs	2
Leg Swings	3
Average Score	2.40

Outcome Measure	Score
LEFS (MCID=9)	49/80
VAS (MDC=12mm)	60
SANE	50

MDC: Minimal Detectable Change; PSFS: Patient Specific Functional Scale; LEFS: Lower Extremity Functional Scale; SANE: Single Assessment Numerical Evaluation; VAS: Visual Analog Scale

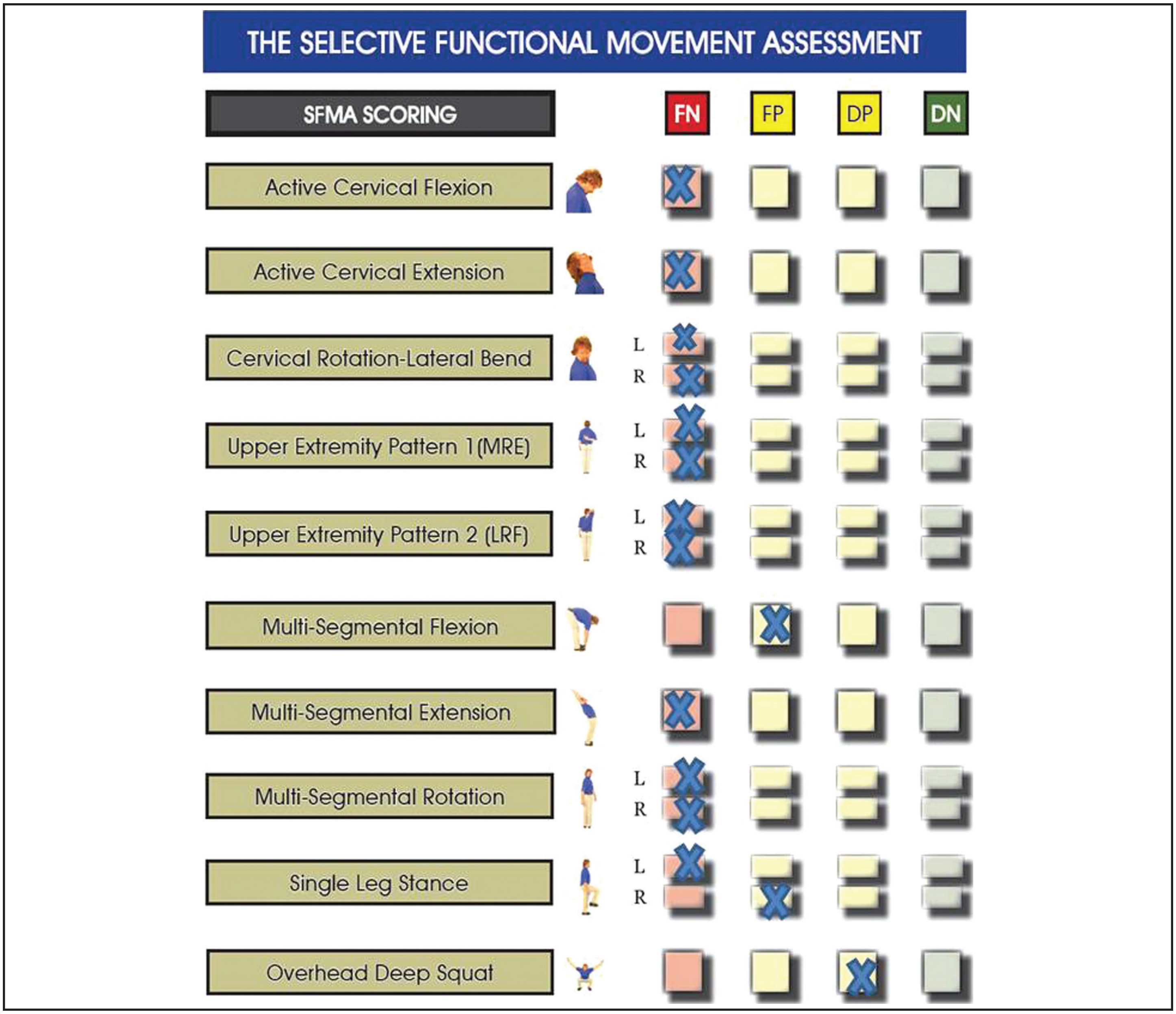


Figure 1. *Selective Functional Movement Assessment (SFMA) Top Tier Assessments: FN = Functional and Non-painful, FP = Functional with Pain, DP = Dysfunctional and Painful, DN = Dysfunctional, non-painful. [SFMA table used with permission of SFMA, LLC]*

The initial physical examination included the Selective Functional Movement Assessment (SFMA) to assess movement patterns and identify areas of movement dysfunction.[68,69] The SFMA scoring system categorizes movement patterns by function and pain. For each SFMA assessment the scoring options include: Functional and Non-Painful (FN), Functional and Painful (FP), Dysfunctional and Painful (DP), or Dysfunctional and Non-Painful (DN).[69] To be considered "functional" the movement pattern must be unrestricted or unlimited. When asymmetry, a lack of mobility, or a lack of stability is present the movement pattern is considered "dysfunctional".[68,69] His initial SFMA findings and grading criteria are presented in Figure 1. The identified areas of functional painful (FP) or dysfunctional painful (DP) were consistent with hamstring involvement, including: Multi-segmental Flexion, single leg stance on the right and the Overhead Squat. He was able to perform a single leg squat with subjective discomfort, which was graded as dysfunctional relative to the unaffected side.

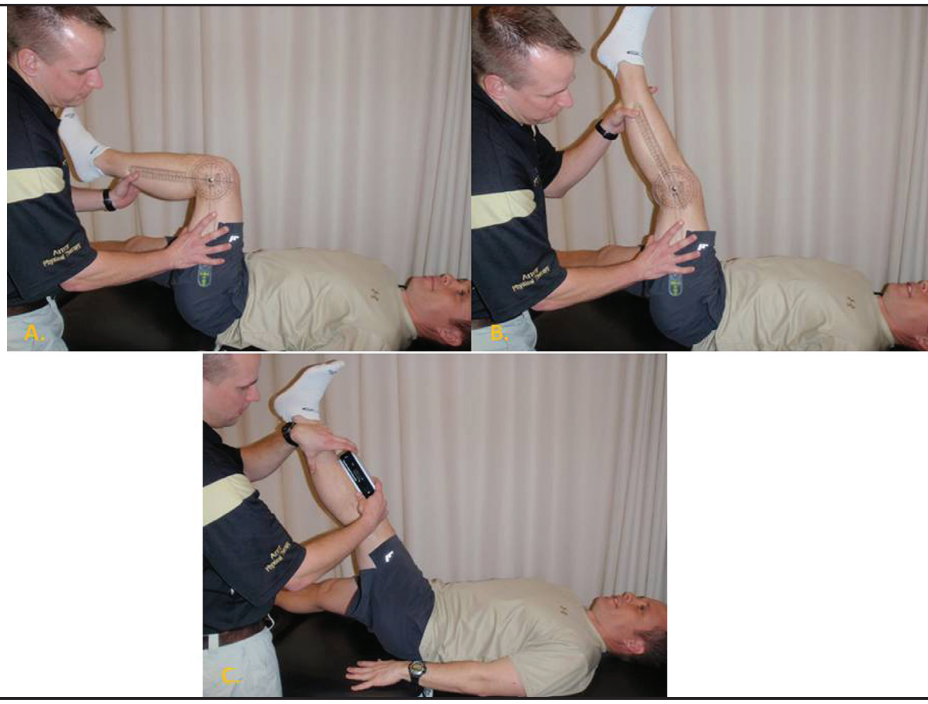


Figure 2. *(A) Start position for knee AROM measurement. Patient actively extends knee with hip flexed to 90°. (B) Measurement is recorded at first report of pain or stretch/tension. (C) Active straight leg raise performed with electronic goniometer placed on anterior lower leg in-line with tibial tubercle. Patient actively raises leg until pain, stretch, or opposite knee/hip flexion.*

The patient demonstrated a deficit in knee active range of motion (AROM), measured in supine with the hip flexed to 90 degrees (Figure 2).[29] The difference between the involved and uninvolved extremity was 18 degrees, which is indicative of a Grade 2 strain.[14,29] He also had an active straight leg raise (ASLR) difference, with 54 degrees of motion, limited by pain on the involved extremity as compared to 64 degrees on the uninvolved extremity (Figure 2). Hamstring strength was assessed with a hand-held dynamometer (HHD) using the break method (Figure 3).[70-73] HHD is consistently used in our facility for objective assessment of strength. His involved extremity was weak compared to the uninvolved extremity (Table 2). Flat palpation revealed tenderness along the proximal aspect of the biceps femoris long head (BFLH), semitendinosis (ST) and semimembranosus (SM), including multiple hypersensitive bands consistent with the description of trigger points. There was no evidence of lumbar spine involvement or other dysfunction in the hip on palpation or clearing examination.

ASSESSMENT

The patient's symptoms were consistent with a grade 2 hamstring strain.[1,15,17] The goal of rehabilitation was to return him to sport when he met specific functional criteria, particularly eccentric strength within 10% of the uninvolved extremity, single leg triple hop within 10% bilaterally and Illinois Agility Test (IAT) (Figure 4) without pain. A passing time on the IAT was 18.4 seconds from normative data published by Reiman.[74]

INTERVENTION

A rehabilitation program was initiated using the PATS program described by Sherry[39], including modifications described by Heiderscheit and colleagues (Appendix).[25] Given the athlete's examination findings, particularly the presence of multiple trigger points, the treating therapist decided to include FDN to address his muscle dysfunction. He returned for therapy three times per week to perform the exercise program in a supervised environment. He was also instructed to perform the exercises daily as a home exercise program on his own, at the same volume as performed in-clinic. He was allowed to use a stationary bike for cardiovascular conditioning at a pain-free pace, for 30-45 minutes daily. The volume of exercise in the PATS protocol was increased to his tolerance, with symptoms used to guide for appropriate volume. Once he met the program progression criteria, he was re-evaluated to assess progress.

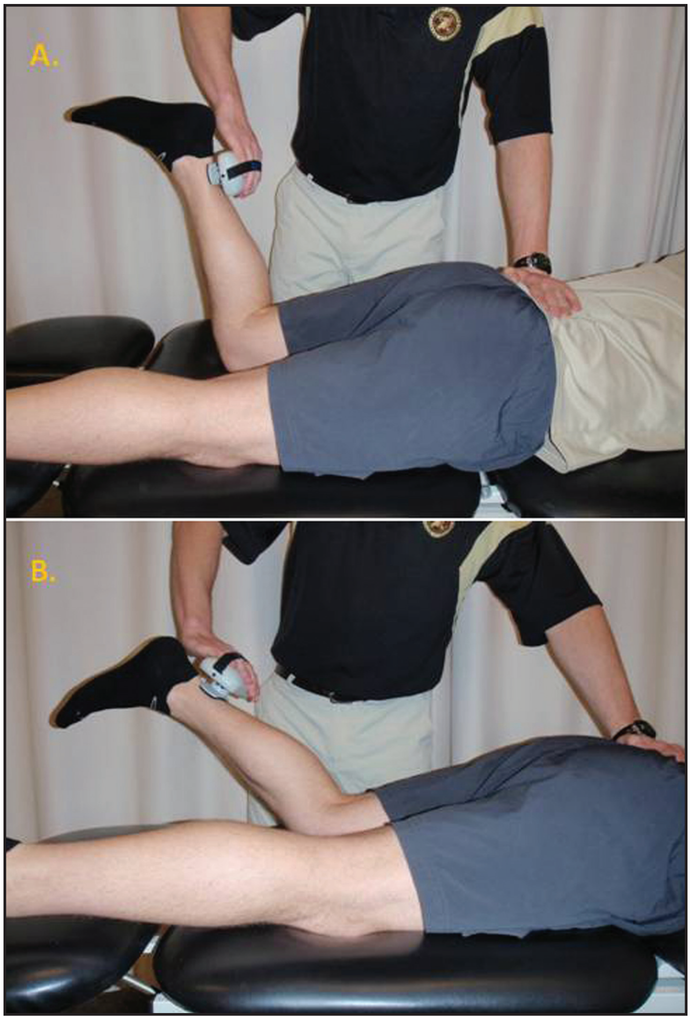


Figure 3. *Strength assessment testing positions with knee at 90° using a hand-held dynamometer (A) and 15° (B) using break method. Patient was asked to contract eccentrically once resistance was applied. Contraction was held for 3 seconds. 3 trials were conducted with the average recorded.*

FDN was integrated into the treatment plan once per week, after rehabilitation exercises were completed for that day. FDN was performed with the patient positioned in prone with his knee supported in 15-30 degrees of flexion. The focal areas of muscle dysfunction consistent with "trigger points" in the hamstring musculature were treated (Figure 5). The majority of trigger points were noted in the BFLH muscle, with additional locations in the SM and ST. The needling treatment was performed using 0.30 × 60mm solid filament needles, which were manipulated by pistoning the needles to elicit LTRs. The needles were then left in place and additional areas of muscle dysfunction were treated. The quantity of needles used per session ranged from three to six. Once all areas of muscle dysfunction were deemed to have been located, the needles remained in situ for 5 minutes. His ASLR pre and post FDN were recorded and are shown in Table 2.

Re-assessments were performed once he achieved the specific progression criteria for each rehabilitation phase of the PATS protocol. He was progressed from phase 1 after 5 days, Phase 2 at day 12 and Phase 3 at day 20. Once he completed phase 3, a series of functional tests were performed. Testing including the single leg triple hop and IAT (Table 3).[74,75] A passing score for the triple hop required the average of three trials on the involved extremity to be within 10% of the uninvolved and the IAT to be completed in less than 18.4 seconds.[74]

OUTCOMES

The patient was seen for a total of 9 visits over 3-weeks, including three FDN treatment visits. There were no observed adverse reactions during or after treatment for any of the FDN sessions. He demonstrated continuous progress with each consecutive visit, with improvements in outcome scores and overall progress (Table 4). The first progression occurred after 5 days, at which time his SFMA multi-segmental flexion had improved to FN, the overhead squat and single-leg squat were DN, and his ASLR was nearly equal with a minimal AROM deficit of 3

Table 2. *Functional dry needling Pre and Post active straight leg raise (ASLR) and visual analog scale (VAS) by treatment session*

Functional dry needling (FDN) treatment	Pre-Rx ASLR	Post- Rx ASLR	(+/-)Change	Pre-Rx VAS	Post-Rx VAS	(+/-) Change
FDN Treatment #1	54°	53°	-1°	60	40	-20
FDN Treatment #2	56°	64°	+8°	24	24	0
FDN Treatment #3	62°	67°	+5°	12	10	-2

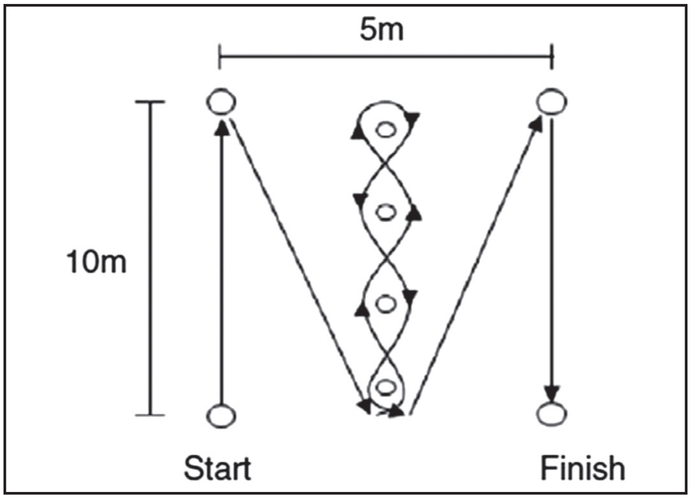
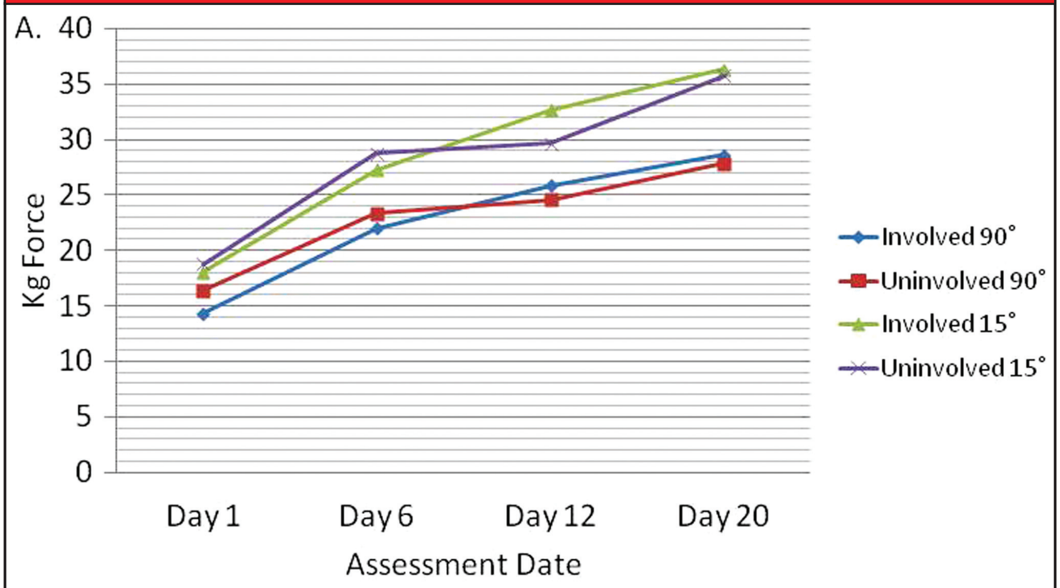


Figure 4. *Illinois Agility Test layout. There is 2.5 meters between cones in center portion. The participant begins in the prone position; on "go" the press-up to a sprint and complete the course. Time ends once crossed finish point. Passing for males is in less than 18.4 seconds.*

Figure 5. *Functional dry needling technique for hamstring musculature with patient prone and knees resting at 15-30 degrees of flexion.*

Table 3. *(A) Strength assessments according to assessment day. At Day 12, strength assessments on the involved extremity were greater than uninvolved at both 15° and 90°. (B) Return to sport assessment scores for Illinois Agility Test recorded in seconds and Single Leg (SL) Hop Test recorded in meters.*

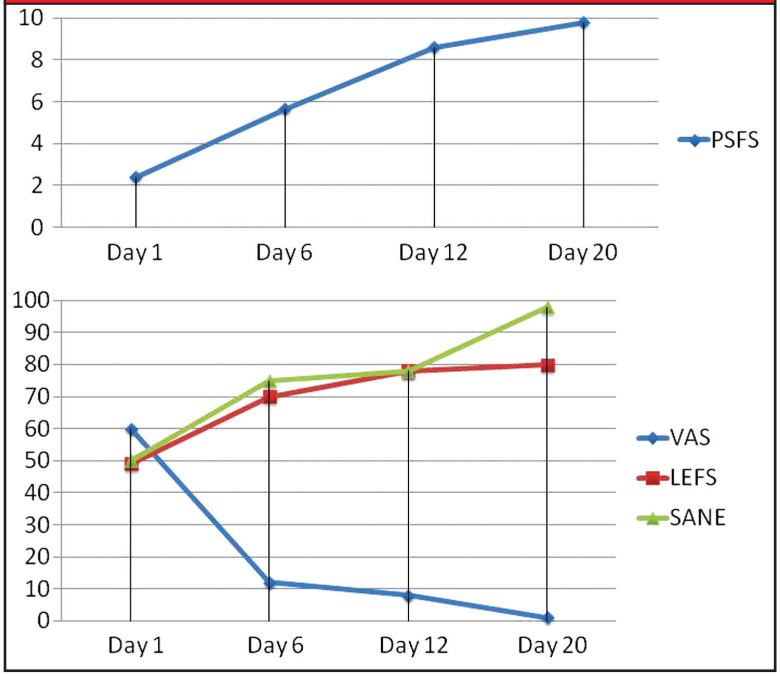
A.



B.

	Trial 1	Trial 2	Trial 3	Average
Uninvolved SL Hop	6.72	6.86	6.55	6.81
Involved SL Hop	6.80	7.00	6.85	6.90
Illinois Agility Test	16.6	16.8	16.3	16.57

Table 4. *Patient subjective outcome measures throughout the course of treatment. All outcome measures exceeded respective MDC's from baseline throughout course of treatment.*



degrees compared to the unaffected side. At the second progression period (Day 12), he demonstrated an equal ASLR and no AROM deficit. Also noted at this time, his strength at 15 and 90 degrees on the involved extremity exceeded that of the uninvolved extremity. At the time of his return to sport assessment on day 20, his self-reported outcome scores were near normal and the physical examination was unremarkable. A follow-up evaluation was conducted 10 days after the return to sport assessment, with no reported injury recurrence and no deficits with sports participation. At follow-up, 4-months post-injury, he reported no new injuries and was fully participating in pole vaulting.

DISCUSSION

Many modifiable and non-modifiable risk factors have been identified as contributing to HSI recurrence rates.[1,4,6,21,23,24,34] Incomplete rehabilitation from initial strain and eccentric-to-concentric strength ratio imbalances appear to be significant modifiable risk factors. Premature return to sports participation may increase the risk of re-injury from incomplete rehabilitation. The implementation of eccentric training programs for prevention of initial HSI has shown promise for athletes in multiple sports.[16,17,41,43,76,77] Despite the addition of eccentric training in rehabilitation and preventive programs, the incidence of recurrent hamstring strain injuries in athletics has not decreased and in some cases has continued to rise.[1,4]

Recently, authors have reported that altered muscle activation patterns in the injured hamstring compared to the uninjured side may last for six to twelve months post-injury.[18,78,79] The presence of scar tissue on follow-up MRI is reported as far out as 6 months[30,78,80] and may contribute to altered mechanics as well as strength deficits that remain after return to sport. Early hamstring activation of the injured extremity during preparation for single-leg stance suggests an alteration in motor control to these muscles.[18,30,78-81] The combination of motor control changes and the presence of scar tissue following injury may explain the higher recurrence rates and lingering strength deficits in HSI despite increased emphasis on eccentric training.

In this case, the patient had experienced multiple recurrent HSI's on the uninjured limb over a 12 month period. He returned to full participation in sports without re-injury at the final follow-up visit.

There is sufficient evidence to support that re-injury is most likely to occur within 2-3 weeks after return to sport.[4,19] The authors initially anticipated that his rehabilitation period might have been prolonged given his past history of HSI.

FDN treatments were incorporated with an eccentric training program, which may have contributed to this athletes recovery process. High quality evidence evaluating the effectiveness of FDN is limited and drawing definitive conclusions from the current literature is not possible. To the authors' knowledge there is no medical literature regarding the use of dry needling to assist with recovery from HSI. One study in subjects with posterior thigh pain demonstrated improvements in subjective outcomes measures following dry needling intervention.[82] It is unknown if the greater strength increase on the involved extremity was facilitated by the FDN treatment or another factor. Findings from previous studies suggest his strength should be less than or equal to the uninjured extremity given the history of recurrent injury on that extremity.[18,78,83] Consistent with this case, the authors have anecdotally noted functional recovery of strength in other regions when FDN has been applied as an adjunct to evidence-based rehabilitation programs.

CONCLUSION

This case report illustrates the use of dry needling and eccentric exercises to facilitate a favorable outcome in an athlete following a hamstring injury. These results indicate that dry needling could be a useful adjunct therapy to an eccentric based training program allowing athletes to return to sport quickly. It is unknown what effect this combination of therapeutic intervention might have regarding HSI recurrence and if there is a neuromuscular benefit with the use of functional dry needling. Further research is warranted to determine utility of FDN techniques in the treatment of hamstring strains.

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