Instrument-Assisted Soft Tissue Mobilization Treatment for Tissue Extensibility Dysfunction

Russell T. Baker, DAT, ATC; Alan Nasypany, EdD, ATC, LAT; Jeff G. Seegmiller, EdD, ATC, LAT • University of Idaho; and Jayme G. Baker, DPT, ATC, PT • West Coast Spine Restoration Center

Optimal musculoskeletal function requires an adequate joint range of motion (ROM), which may be restricted by muscle tightness.[1] Inadequate muscle flexibility increases susceptibility to both overuse syndromes[2,3] and acute injuries.[4,5] Improvement of flexibility is often a goal of interventions for injury prevention, performance enhancement, and injury rehabilitation.[1,4,5] A variety of stretching techniques[1,4,5] and heating modalities[6] are used routinely to promote flexibility.

A theorized cause of apparent muscle tightness is tissue extensibility dysfunction (TED).[7] Musculoskeletal injury, even if microtraumatic, can produce scar tissue that alters the properties of collagenous tissues.[8,9] The term *neurodynamics* refers to peripheral nerve sliding and/or tension development that normally occurs without symptoms. Appropriate neurodynamic treatment strategies (i.e., "slides" or "tensioners") may alleviate neural symptoms that arise from TED.[10] Neuromuscular activation patterns may involve strong contractions that produce joint compression and excessive muscle tension.[7] When treating TED, clinicians need to identify its cause in order to implement an intervention that will be effective in producing long-term flexibility improvement.

Instrument-assisted soft tissue mobilization (IASTM) is a therapeutic technique that is based on the soft tissue mobilization rationale introduced by James Cyriax.[11-13] IASTM differs from traditional cross-friction or transverse friction massage. Specially designed instruments are used to apply longitudinal pressure along the course of muscle fibers,[11,14] and treatment typically includes application to more than the tissues at the isolated location of pain.[12] The instruments are thought to facilitate the clinician's ability to detect altered tissue properties, as well as facilitate the patient's awareness of altered sensations within the treated tissues.[15,16] Increased vibration within the instrument is believed to an indication of abnormal tissue properties.[9,17,18] Additionally, the instruments are believed to provide a mechanical advantage that allows the clinician to achieve greater depth of mechanical force transmission than that which can be produced with the hands,[13] while also reducing compressive stress on the clinician's hands.[16,17]

The clinical use of soft tissue mobilization instruments is purported to enhance treatment effectiveness,[19] particularly in areas of fibrosis.[9] The inducement of tissue microtrauma is believed to elicit a local inflammatory response that promotes breakdown of scar tissue, release of adhesions, synthesis of new collagen, and connective tissue remodeling.[9,17,19,20]

IASTM treatment of enzyme-induced tendinitis in rats has been shown to promote fibroblast proliferation, collagen synthesis, collagen maturation, and collagen alignment.[20,21] Functional benefits included increased stride length and stride frequency.[20] A study of ligament healing in rats following IASTM treatment documented greater cellularity, improved collagen alignment, fewer adhesions and granular tissue, and increased ligament strength and stiffness.[22] Clinical studies of IASTM administered to patients with tendinopathies have demonstrated pain resolution, improved ROM, and return to normal function at a faster rate than that observed for natural healing[18] and traditional therapeutic interventions.[23] Case studies have documented similar IASTM benefits, but other therapeutic interventions also were administered in those cases.[16,24-26]

The purpose of this investigation was to assess the effectiveness of IASTM for the treatment of hamstring TED in three consecutive patients. A method of IASTM administration developed by a proprietary entity (Técnica Gavilán, Tracy, CA) was utilized, which involves soft tissue mobilization with movement. All three patients were evaluated with the same processes, and all treatments followed a designed protocol.

Case Series

A summary of each patient's history is provided in Table 1. The patients were collegiate student-athletes who complained of chronic posterior tightness in the lower extremities and exhibited hamstring TED (i.e., ROM limitation on standing flexion test, sit and reach test, passive and active straight-leg hip flexion, and 90/90 active knee extension test), without signs of a lumbar spine or hip joint injury. Exclusionary criteria included history of surgery, bleeding disorders, use of anticoagulant medication, thrombophlebitis, skin disorders, diabetes, kidney disease, uncontrolled

Table 1: Summary of Initial Physical Examinations

Patient	Age (Years)	Sex	Sport	Physical Exam	DPA Scale Score
1	19	M	Cross-Country	Presented with complaints of chronic posterior leg tightness without a mechanism of trauma that had been constant over the past two weeks. Reported bilateral hamstring pain rated as a 5 while training and a 4 during initial examination using the NRS. Stated that stretching and cryotherapy self-treatments had not improved his symptoms. Goniometric measurement of active straight leg hip flexion revealed 38° of flexion on the right side and 20° on the left side. The patient also displayed positive signs (i.e., pain, decreased ROM) during the 90/90 active knee extension, Ober's, and Noble's compression tests bilaterally.	31
2	21	F	Swim	Presented with complaints of chronic posterior leg tightness for the past few months, but denied any mechanism of trauma, previous injury, or prior treatment. Reported a gradual increase in pain during this time period that had exacerbated with a recent increase in training. Rated her bilateral hamstring pain as an 8 while training and a 5 during initial examination using the NRS. Goniometric measurement of active straight leg hip flexion leg revealed 45° of flexion on the right side and 36° on the left side. The patient also displayed positive signs (i.e., pain, decreased ROM) during the 90/90 active knee extension test bilaterally.	41
3	22	M	Cross-Country	Presented with complaints of chronic posterior leg tightness for the past eight months, but denied any mechanism of trauma or previous injury. Previous treatment, applied by both an athletic trainer and a physical therapist, had failed to produce improvement despite the use of ultrasound, exercise, static and PNF stretching. He did not report any hamstring pain at the time of initial examination on the NRS. Goniometric measurement of active straight leg hip flexion revealed 74° of flexion on the right side and 54° on the left side. The patient also displayed positive signs (i.e., pain, decreased ROM) during the 90/90 active knee extension test bilaterally.	7

hypertension, infection, diffuse pain syndrome (e.g., fibromyalgia), rheumatoid arthritis, or corticosteroid injection within the previous 30 days. Three patients met the initial inclusion criteria to participate in the study, while three were excluded due to not meeting the TED classification of our study. The apparent muscular tightness of the excluded patients was addressed immediately with screening interventions used as part of the initial physical examination. Patients who met the inclusion criteria were instructed to avoid use of any analgesic medications and to not deviate from the prescribed therapeutic interventions.

Baseline measurements were obtained for active ROM (AROM), numerical rating scale (NRS) score for pain during activity, and disablement in the physically active (DPA) scale. All AROM measurements were recorded in 1° increments by the same clinician. AROM and NRS score were recorded during the initial examination, prior to each treatment, following the completion of each treatment, and at discharge. DPA scale score was recorded during the initial examination, at the end of each treatment week, and at discharge.

All IASTM treatments were administered by athletic trainers who were certified by Técnica Gavilán (Tracy, CA). Each patient received three IASTM treatments per week until discharge. Each treatment session included a 5-minute stationary cycling warm-up that was followed by IASTM with passive sagittal plane motion (i.e., hip flexion and extension) for five minutes on both extremities. Each therapy session concluded with administration of cryotherapy (i.e., 20-minute ice application with compression wrap). Each patient was discharged when AROM and DPA scale score had normalized.

Following the first week of treatment, both Patient 1 and Patient 2 exhibited a minimally clinically important difference (MCID) with a 2 point decrease for the NRS score (Figure 1).[27,28] By the end of the second week of treatment, all three patients demonstrated a MCID with a 6 point decrease in the DPA scale score (Figure 2).[29] Each patient maintained AROM measurements that were within normal limits for straight-leg hip flexion during the second week of treatment (Figures 3–5).

Patient 1 experienced a full resolution of pain with activity and improved AROM during the first week (Figure 1 and 3), but the DPA scale score did not indicate a MCID decrease until the second week of treatment (Figure 2). When questioned, the patient reported feeling anxious about an upcoming race. Subsequently, the DPA scale score continued to improve. At final examination, Patient 1 was able to perform active straight-leg hip flexion to 90°, and a follow-up examination one month later indicated maintenance of the therapeutic benefits.

Patient 2 exhibited a 2-point decrease in NRS rating for both of the first two weeks of treatment, which was followed by complete resolution of pain during the third week (Figure 1). The patient demonstrated consistent improvement in active ROM and reduction of pain, which corresponded to the DPA scale score improvements (Figures 1, 2, and 4). At final examination, Patient 2 was able to perform active straight-leg hip flexion beyond 100°, and follow-up examination one month later indicated maintenance of the therapeutic benefits.

Patient 3 reported a 0 pain rating for the NRS and demonstrated both a lower DPA score and lesser AROM deficiency than the other two patients. Over the first

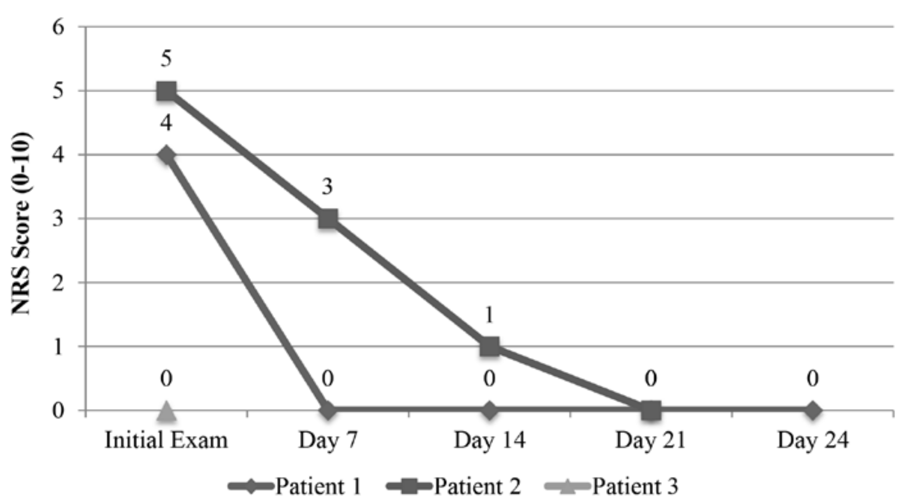

Figure 1 Changes in numeric rating scale (NRS) score for pain during physical activity.

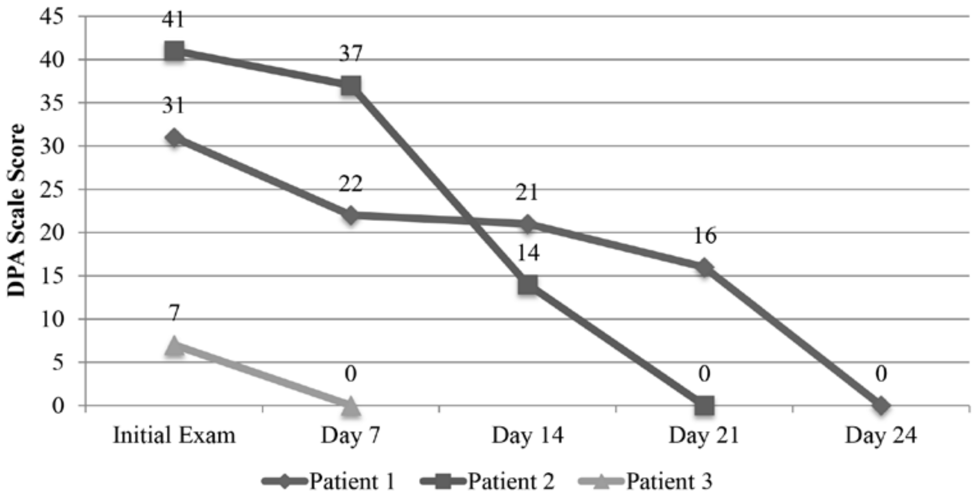

Figure 2 Changes in disablement in the physically active (DPA) rating.

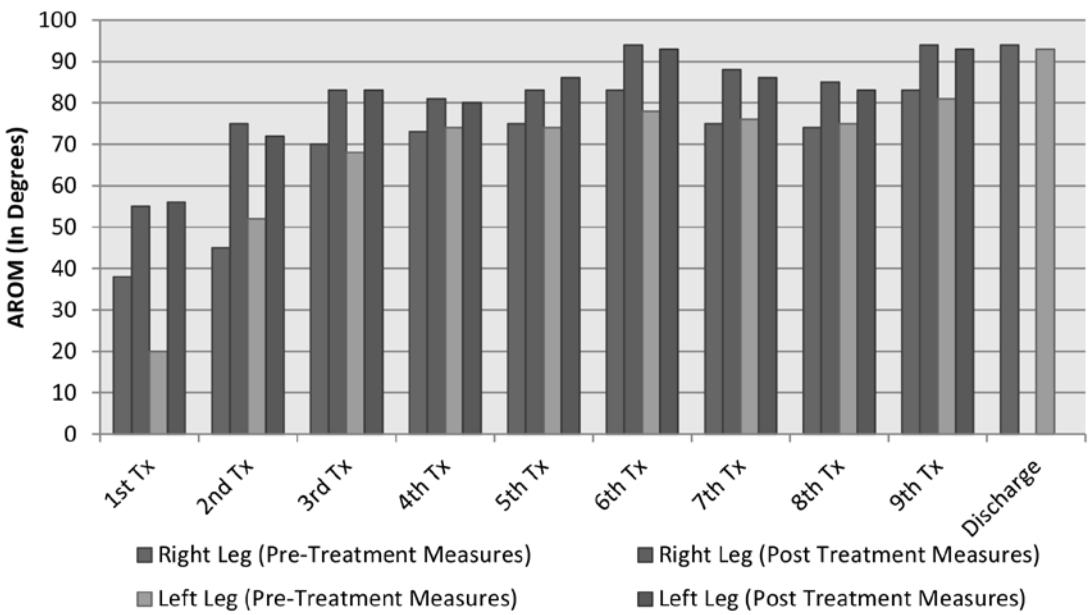

Figure 3 Increase in active straight-leg raise hip flexion for patient 1.

week of treatment, the patient demonstrated normalization of AROM that was maintained until the final examination (Figure 5). At final examination, Patient 3 was able to perform active straight-leg hip flexion beyond 85°.

Discussion

Each patient demonstrated a clinically significant change in NRS score for pain during each week of treatment until complete resolution of pain was achieved.[27,28] Weekly improvement in DPA scale score also exceeded MCID for each patient.[29] The treatment protocol was not modified for any patient from the initiation of treatment through discharge. Patient 1 demonstrated normalization of Ober's test and Noble's test results, which suggests that restoration of hamstring extensibility reduced hip dysfunction.

Recent studies of stretching protocols have documented an average increase in hip flexion of 16.6° over a 12-week period,[1] and an increase in knee extension of 12° over a 6-week period.[5] Our results far exceeded these reported range of motion improvements over a shorter period of time, which suggests that IASTM application with passive motion may be more effective than traditional stretching.

The primary limitation of this research was the lack of a comparison group of patients with a similar clinical presentation that received some other treatment approach. Future research should evaluate the relative

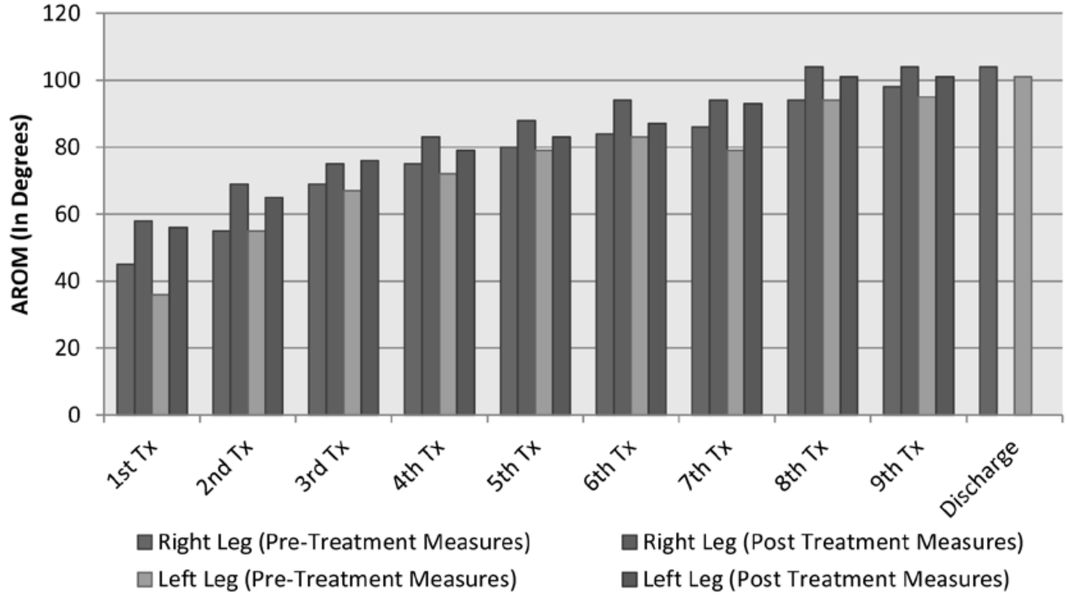

Figure 4 Increase in active straight-leg raise hip flexion for patient 2.

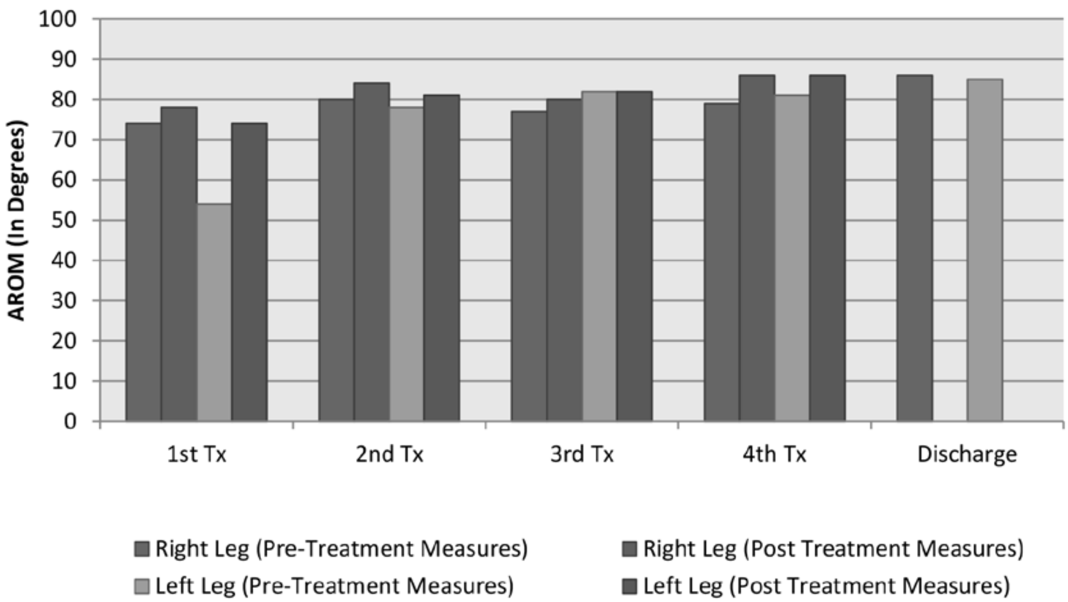

Figure 5 Increase in active straight-leg raise hip flexion for patient 3.

effectiveness of different IASTM application parameters (e.g., increased or decreased force, treatment duration, treatment frequency, etc.), and objective measures of change in physical function (e.g., muscle strength) should be documented.

Conclusion

The administration of IASTM was associated with clinically significant improvement in patient status. Each patient was able to maintain and increase participation in sport activity without a return of symptoms throughout the remainder of the competitive season. Each of the three patients demonstrated restoration of AROM, pain reduction, and improved function. Although our findings suggest that IASTM was effective, further research is needed to establish the physiological basis of the improvement in function that appears to result from the treatment. ▮

References

1. Sainz de Baranda P, Ayala F. Chronic flexibility improvement after 12 week of stretching program utilizing the ACSM recommendations: hamstring flexibility. *Int J Sports Med*. 2010;31:389-396.

2. Hreljac A, Marshall RN, Hume, PA. Evaluation of lower extremity overuse injury potential in runners. *Med Sci Sports Exerc*. 2000;32:1635-1641.
3. Davis DS, Ashby PE, McCale KL, McQuain JA, Wine JM. The effectiveness of 3 stretching techniques on hamstring flexibility using consistent stretching parameters. *Journal of Strength and Conditioning Research*. 2005;19(1):27-32.
4. DePino GM, Webright WG, Arnold BL. Duration of maintained hamstring flexibility after cessation of an acute static stretching protocol. *J Athl Train*. 2000;35(1):56-59.
5. Nelson RT, Bandy WD. Eccentric training and static stretching improve hamstring flexibility of high school males. *J Athl Train*. 2004;39(3):254-258.
6. Draper DO, Castro JL, Feland B, Schulthies S, Eggett D. Shortwave diathermy and prolonged stretching increase hamstring flexibility more than prolonged stretching alone. *J Orthop Sports Phys Ther*. 2004;34(1):13-20.
7. Cook G. *Movement: Functional Movement Systems: Screening, Assessment and Corrective Strategies*. Aptos, CA: On Target Publications; 2010.
8. Jarvinen T, Jarvinen T, Kaariainen M, Kalimo H, Jarvinen M. Muscle injuries: Biology and treatment. *Am J Sports Med*. 2005;33(5):745-766.
9. Melham TJ, Sevier TL, Malnofski MJ, Wilson JK, Helfst RH. Chronic ankle pain and fibrosis successfully treated with a new noninvasive augmented soft tissue mobilization technique (ATSM): A case report. *Med Sci Sports Exerc*. 1998;30(6):801-804
10. Butler D. *The Sensitive Nervous System*. Adelaide, Australia: Noigroup Publications; 2000.
11. Sevier TL, Wilson JK. Treating lateral epicondylitis. *Sports Med*. 1999;28(5):375-380.
12. Fowler S, Wilson JK, Sevier TL. Innovative approach for the treatment of cumulative trauma disorders. *Work*. 1999;15:9-14.
13. Hammer WI, Pfefer MT. Treatment of a case of subacute lumbar compartment syndrome using the Graston technique. *J Manipulative Physiol Ther*. 2005;28(3):199-204.
14. Sevier TL, Gehlsen GM, Wilson JK, Stover SA, Helfst RH. Traditional physical therapy vs. graston augmented soft tissue mobilization in the treatment of lateral epicondylitis. *Med Sci Sports Exerc*,. 1995;27(5):S52.
15. Carey MT. *Graston Technique Instruction Manual* (2nd ed.). Indianapolis, IN: TherapyCare Resources, Inc.; 2001.
16. Hammer WI. The effect of mechanical load on degenerated soft tissue. *J Bodyw Mov Ther*. 2008;12:246-256.
17. Burke J, Buchberger DJ, Carey-Loghmani, MT, Dougherty PE, Greco DS, Dishman JD. A pilot study comparing two manual therapy interventions for carpal tunnel syndrome. *J Manipulative Physiol Ther*. 2007;30(1):50-61.
18. Blanchette MA, Normand MC. Augmented soft tissue mobilization vs. natural history in the treatment of lateral epicondylitis: A pilot study. *J Manipulative Physiol Ther*. 2011;34(2):123-130.
19. Stow R. Instrument-assisted soft tissue mobilization. *Int JAthl Ther Train*. 2011;16(3):5-8.
20. Davidson CJ, Ganion LR, Gehlsen GM, Verhoestra B, Roepke JE, Sevier TL. Rat tendon morphologic and functional changes resulting from soft tissue mobilization. *Med Sci Sports Exerc*. 1997;29(3):313-319.
21. Gehlsen GM, Ganion LR, Helfst RH. Fibroblast responses to variation in soft tissue mobilization pressure. *Med Sci Sports Exerc*. 1999;31(4):531-535.
22. Loghmani MT, Warden SJ. Instrument-Assisted cross-fiber massage accelerates knee ligament healing. *J Orthop Sports Phys Ther*. 2009;39(7):506-514.
23. Wilson JK, Sevier TL, Helfst R, Honing EW, Thomann A. Comparison of rehabilitation methods in the treatment of patellar tendinitis. *J Sport Rehabil*. 2000;9(4):304-314.
24. White KE. High hamstring tendinopathy in 3 female long distance runners. *J Chiropr Med*. 2011;10:93-99.
25. Howitt S, Jung S, Hammonds H. Conservative treatment of a tibilais posterior strain in a novice triathlete: A care report. *J Can Chiropr Assoc*. 2009;53(1):23-31.
26. Howitt S, Wong J, Zabukovec S. The conservative treatment of trigger thumb using graston techniques and active release techniques. *J Can Chiropr Assoc*. 2006;50(4):249-254.
27. Farrar JT, Young JP, LaMoreaux L, Werth JL, Poole M. Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale. *Pain*. 2001;94:149-158.
28. Pool JJ, Ostelo RW, Hoving JL, Bouter LM, de Vet HC. Minimal clinically important change of the neck disability index and the numerical rating scale for patients with neck pain. *Spine*. 2007;32(26):3047-3051.
29. Vela LI, Denegar C. The disablement in the physically active scale, part II: the psychometric properties of an outcomes scale for musculoskeletal injuries. *J Athl Train*. 2010;45(6):630-641.

Russell Baker is the Clinical Education Coordinator of Athletic Training Education in the Department of Movement Sciences at the University of Idaho in Moscow, Idaho.

Alan Nasypany is the Director of Athletic Training Education in the Department of Movement Sciences at the University of Idaho in Moscow, Idaho.

Jeff Seegmiller is an Associate Professor and Musculoskeletal Anatomy Chair in WWAMI Medical Education and the Department of Movement Sciences at the University of Idaho in Moscow, Idaho.

Jayme Baker is an instructor in Athletic Training Education in the Department of Movement Sciences at the University of Idaho in Moscow, Idaho.

Lindsey Eberman, PhD, ATC, LAT, Indiana State University, is the report editor for this article.