IJSPT

ORIGINAL RESEARCH

THE EFFECTS OF INSTRUMENT ASSISTED SOFT TISSUE MOBILIZATION ON LOWER EXTREMITY MUSCLE PERFORMANCE: A RANDOMIZED CONTROLLED TRIAL

Nicole MacDonald, DrPH, ATC, CSCS[1]
Russell Baker, DAT, ATC[2]
Scott W. Cheatham, PhD, DPT, PT, OCS, ATC, CSCS[3]

ABSTRACT

Background: Instrument-Assisted Soft Tissue Mobilization (IASTM) is a non-invasive therapeutic technique used to theoretically aid in scar tissue breakdown and absorption, fascial mobilization, and improved tissue healing. Researchers have hypothesized that utilizing IASTM will improve muscular efficiency and performance; yet previous Investigations has been focused on treating injury.

Objective: The purpose of this investigation was to explore the effects of IASTM on muscle performance to assess if typical treatment application affected measures of muscular performance.

Design: A pretest-posttest randomized control design.

Participants: A convenience sample of 48 physically active adults (mean age 24 ± 4 years), randomly assigned to one of three groups: quadriceps treatment group, triceps surae treatment group, or control group.

Interventions: Participants performed a five-minute warm-up on a Monark bicycle ergometer before performing three countermovement vertical jumps (CMJ). Immediately after, the IASTM treatment was applied by one researcher for three minutes on each leg at the specified site (e.g., quadriceps) for those assigned to the treatment groups, while the control group rested for six minutes. Immediately following treatment, participants performed three additional CMJs. Pre- and post-testing included measures of vertical jump height (JH), peak power (PP) and peak velocity (PV).

Results: There were no statistically significant differences found between treatment groups in JH, PP, or PV or across pre- and post-test trials.

Conclusions: These preliminary findings suggest that standard treatment times of IASTM do not produce an immediate effect in muscular performance in healthy participants. This may help clinicians determine the optimal sequencing of IASTM when it is part of a pre-performance warm-up program. Future research should be conducted to determine the muscle performance effects of IASTM in individuals with known myofascial restriction and to determine optimal treatment parameters, such as instrument type, amount of pressure, and treatment time necessary to affect muscular performance.

Level of Evidence: 1b

Keywords: Massage, myofascial release, instrument-assisted

CORRESPONDING AUTHOR
Nicole MacDonald
California Baptist University
8432 Magnolia Ave.
Riverside, CA 92504
(951) 343-4379
E-mail: nmacdona@calbaptist.edu

[1] California Baptist University, Riverside, CA, USA
[2] University of Idaho, Moscow, ID, USA
[3] California State University Dominguez Hills, Carson, CA, USA

INTRODUCTION

The myofascial system is a complex network of muscles and related fascia. Fascia is comprised of elastin and collagen connective tissue fibers that form sheets or bands beneath the skin that serves to attach, stabilize, enclose, and separate muscles, internal organs, and bones.[1,2] The fascial network runs continuously throughout the body and consists of three layers: superficial, deep, and subserous. Each layer has its own unique properties that contribute to the overall function of the myofascial system.[2] The myofascial system is thought to aid in force transmission of muscles, fibroblastic activity, proprioception, nociception, and reducing compartmental friction during movement through sliding of the fascial layers.[1,2] Restriction within the myofascial system may occur due to injury, poor posture, or lack of full range of joint motion.[1]

The use of Instrument Assisted Soft Tissue Mobilization (IASTM) has become common by sports medicine professionals for treatment of myofascial restrictions. IASTM is a soft-tissue treatment technique where an instrument is used to provide a mobilizing stimulus to positively affect scar tissue and myofascial adhesion.[11, 12] The use of the instruments, as opposed to a clinician's hands, is theorized to provide a mechanical advantage to the clinician by allowing deeper penetration and possibly increasing specificity of treatment application,[13] while also reducing imposed stress of treatments on the clinician's hands.[14,15] Application of IASTM is theorized to stimulate connective tissue remodeling through resorption of excessive fibrosis, along with inducing repair and regeneration of collagen secondary to fibroblast recruitment.[11,16] In turn, this may result in breakdown of scar tissue, the release of adhesions, and improvement in fascial restrictions.[3,4,11,12,14,17]

There are several different approaches to IASTM, each of which provide their own tools and certification or training programs. Two of the more popular approaches are the Graston® Technique and Técnica Gavilán®. The body of literature on IASTM is still emerging, with the bulk of the research being case reports and case studies[5-17] and a few controlled trials.[14,18-21] IASTM has been found to be effective in improving range of motion and patient function in patients with chronic musculoskeletal pathology;[7,14,21-23] however, only a single study has been conducted that assesses the effects of IASTM on muscle performance (i.e., muscular force production and activation). The authors of that study found that IASTM application could improve muscular performance of the quadriceps muscle group when measured isometrically.[24] Unlike other myofascial interventions, such as self-myofascial release, there is a gap in the knowledge about the effects of IASTM on muscle performance (e.g., power) and any potential detrimental effects that may occur if applied to the lower extremity pre-performance. Based on the literature and proposed mechanism of IASTM, it is hypothesized that the intervention will not have a detrimental effect on muscle performance and may actually promote improvements if applied to the quadriceps and triceps surae muscle groups. The purpose of this investigation was to explore the effects of IASTM on muscle performance to determine if typical treatment application affected measures of muscular performance.

METHODS

This study was approved by California Baptist University's Institutional Review Board (IRB# 12-49). Eligible participants read and signed an informed consent prior to enrollment in this study. The present study utilized a pretest-posttest randomized control study design.

Subjects

A convenience sample of 48 physically active adults was recruited for this investigation. The participants ranged in age from 19-39 (mean = 24 ± 4 years), 58.3% (n = 28) female and 42% (n = 20) male. Most participants engaged in occasional vigorous exercise (47.9%), defined as "work or recreation, less than 4x/week for 30 minutes," and were not considered obese (mean Body Mass Index = 24.9 kg/m^2)[25] (Table 1). Only participants classified as low to moderate risk were included in the study as determined by the *Par Q and You*.[26] Participants were excluded if they had any current injuries that affected their integument or soft-tissue structures in the regions of treatment, dizziness, chest pain, or known heart conditions.

Participants were randomly assigned to one of three groups using a random number generator to ensure equal numbers in each group: IASTM Quadriceps treatment group (QG) (n = 16), IASTM Triceps Surae treatment group (TS) (n = 16), or control group (CG)

Table 1. *Summary of Participant Demographics*

Characteristic	Group I: Quadriceps (QG)	Group II: Triceps Surae (TS)	Group III: Control Group (CG)	Aggregate Totals
Number	16	16	16	48
Gender				
Male	5	7	8	20
Female	11	9	8	28
Age (yr)*	23.69 ± 3.77	23.75 ± 2.65	24.5 ± 5.03	23.98 ± 3.87
Height (cm)*	168.59 ± 10.0	170.74 ± 9.4	172.96 ± 10.4	170.76 ± 9.89
Weight (kg)*	68.04 ± 11.21	76.79 ± 16.68	74.45 ± 13.74	73.09 ± 14.25
Body Fat %*	19.73 ± 9.22	21.73 ± 7.56	21.24 ± 14.68	20.89 ± 10.71
BMI*	23.96 ± 3.68	26.09 ± 3.79	24.88 ± 4.09	24.98 ± 3.88
BMI Category				
Healthy (18.5-24.9)	11	8	10	29
Overweight (24.9-29.9)	4	5	4	13
Obese (30+)	1	3	2	6
Level of Physical Activity#				
Sedentary	1	1	0	2
Mild Exercise	1	4	4	9
Occasional Vigorous	7	9	7	23
Regular Vigorous	7	2	5	14

*Age, Height, Weight, Body Fat %, and BMI reported as mean ± standard deviation.

#Physical Activity Level Definitions:
Sedentary = no exercise
Mild exercise = i.e., climb stairs, walk 3 blocks, golf
Occasional vigorous exercise = i.e., work or recreation, less than 4x/week for 30 min.
Regular vigorous exercise = i.e., work or recreation 4x/week for 30 minutes

(n = 16). It was not possible to blind the participants or the practitioner applying the IASTM treatments, however, the researcher collecting the vertical jump data was blinded to which group the participant was assigned. Each participant completed a short demographic questionnaire and biometric measurements were taken before beginning the study.

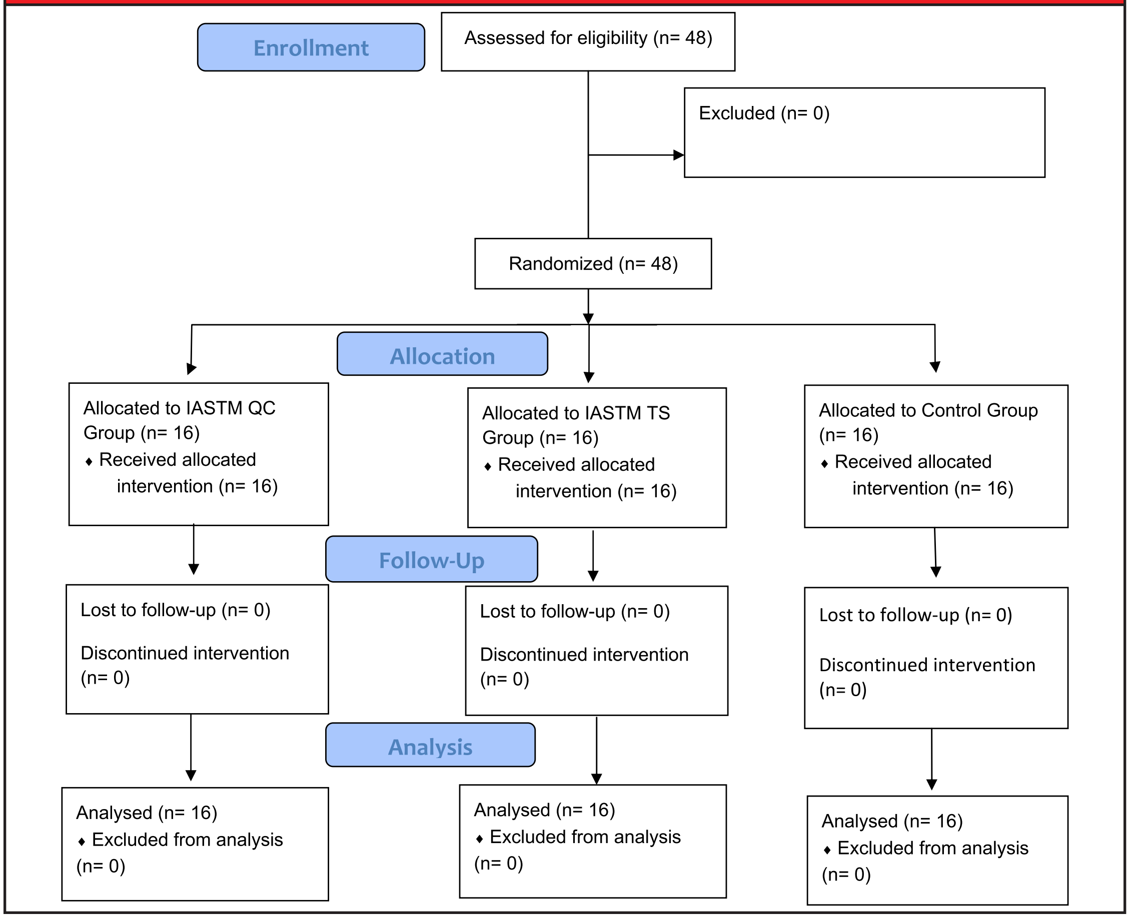
Instruments

The IASTM treatment was applied using Técnica Gavilán instruments (Tracy, CA) by one practitioner (RB) certified by Técnica Gavilán and with 10 years' experience treating patients with the instruments. The practitioner was blinded to the results of the study. Another blinded rater (AC) measured standing vertical jumps with the Tendo power analyzer (Tendo Sport Machines, Slovak Republic) and Vertec Vertical Jump Training system (Jump USA, Sunnyvale, CA). Both the Tendo power analyzer (test-retest reliability = 0.97) and Vertec system (test-retest reliability = 0.91)[27] are reliable measures. Another researcher (NM) ensured blinding of the treating and rating researchers, collected all in-take data (e.g., activity level, BMI, etc.), and analyzed the data.

Procedures

All participants underwent pre-test measures, IASTM or control intervention, and post-test measures in one session (Table 2). Prior to testing, participants performed a five-minute warm-up on a Monark bicycle ergometer. Pre and post-intervention testing consisted of three standing vertical jumps measured by a Tendo

Table 2. *Consort Flow Chart*



power analyzer attached to the participant while performing a countermovement vertical jump with the Vertec Vertical Jump Training system. The participant's standing height was first measured using the Vertec by recording the highest vane touched by their raised right hand (Figure 1). After the standing height value was recorded, the Tendo power analyzer cable and belt were attached to the participant, who was then asked to jump and hit the highest target vane possible on the Vertec with their right hand (Figure 2). The participant completed three consecutive jumps resting no more than 10 seconds in between, and the height of each jump, the peak power (PP), and peak velocity (PV) were recorded as baseline. Maximum jump height was recorded as the highest vane moved (cm) by the participant on the Vertec, and PP(watts) and PV(m/sec) were measured using the Tendo power analyzer. Only the best attempt of the three was taken for data analysis.

Immediately after obtaining baseline measures, the IASTM treatment was applied bilaterally, left leg first for each participant, for three minutes on each leg at the specified site (i.e., quadriceps or triceps surae) for those assigned to the treatment groups. The quadriceps group received direct IASTM treatment to the rectus femoris, vastus lateralis and vastus medialis, with indirect treatment to the vastus intermedius (Figure 3). The triceps surae group received direct IASTM treatment to the gastrocnemius, with indirect treatment to the soleus and plantaris (Figure 4). The IASTM application began with ultrasound gel application to the treatment area and included general "sweeping" strokes from origin or insertion of each muscle group, without specific treatment strokes to any specific area in the muscle group. Each muscle group was treated with the participant in a resting position (i.e., quadriceps group in a long sitting position and triceps surae group in prone position with foot in slight plantarflexion). The practitioner attempted to maintain consistent instrument angle (~45°) and pressure (~250g) throughout the treatment. The control group rested

Figure 1. *Standing Height Measurement with the Vertec Standing Vertical Jump Training System (Jump USA, Sunnyvale, CA)*

Figure 2. *Standing Vertical Jump Analysis using Vertec Vertical Jump Training System (Jump USA, Sunnyvale, CA) and Tendo Power Analyzer (Tendo Sport Machines, Slovak Republic)*

Figure 3. *IASTM (Tecnica Gavilan, Tracy, CA) Treatment to Quadriceps*

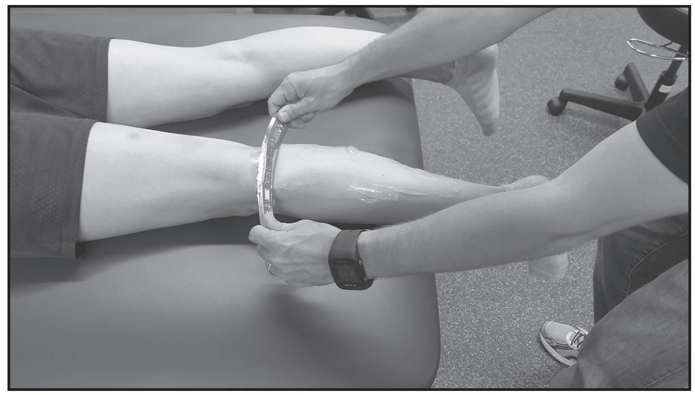


Figure 4. *IASTM (Tecnica Gavilan, Tracy, CA) Treatment to the Triceps Surae Group*

for six minutes between testing periods by sitting in a chair. Immediately following the IASTM treatment, participants performed three additional standing vertical jumps following the same procedure from the baseline measurement.

Statistical Analysis

All participants that were deemed eligible to participate completed the study and all data were analyzed utilizing SPSS (v. 22, Chicago Ill.) using a repeated measures design. The analysis used to test the primary hypothesis was an Analysis of Variance with three groups. As previous research did not exist to guide effect size selection for a power analysis, Cohen's[26] guidelines of an estimation of a large effect size (f = 0.4), 80% power, and $\alpha = 0.05$ were utilized; it was concluded that 21 participants were needed in each group for a total of 63 participants. Descriptive statistics included means and standard deviations for continuous data (age, height, weight, BMI, and body fat percentage) and frequencies for categori-

Table 3. *Comparison between mean scores for pre and post measurements by treatment group. Values are represented as mean ± SD*

Treatment Group	Jump Height (cm)	Peak Power (Watts)	Peak Velocity (m/sec)
Quadriceps			
Pre	43.18 ± 9.9	422.3 ± 70.9	2.5 ± 0.4
Post	43.89 ± 8.9	423.7 ± 62.6	2.5 ± 0.38
Triceps Surae			
Pre	48.33 ± 15.1	426.8 ± 72	2.6 ± 0.4
Post	48.10 ± 14.7	425.3 ± 66	2.6 ± 0.40
Control			
Pre	49.69 ± 12.7	459.6 ± 68	2.8 ± 0.4
Post	49.53 ± 11.8	455.9 ± 78.1	2.7 ± 0.47
Interaction effects p-values	p=0.478	p=0.885	p=0.865
p-value considered significant p < 0.05			

cal data (gender and level of physical activity) were calculated (Table 1). Differences between group variables were calculated with an ANOVA. Vertical jump height (JH) was calculated by subtracting the participant's standing height from the best of the three jumps before and after treatment. A between-subject factorial ANOVA was conducted to compare the effects of IASTM (QG, TS, and CG) on JH, PP, and PV before and after treatment. The p-value was considered significant at $p < 0.05$.

RESULTS

No statistically significant differences ($p < 0.05$) between groups for JH, PP, or PV at baseline were identified [JH: $F(2,45) = 1.065$, $p = 0.323$, $\eta^2 = 0.045$; PP: $F(2,45) = 1.277$, $p = 0.289$, $\eta^2 = 0.054$; PV: $F(2,45) = 1.221$, $p = 0.305$, $\eta^2 = 0.051$.] There were no significant main effects for time [JH : $F(1,45) = 0.09$, $p = 0.765$, partial $\eta^2 = 0.002$; PP: $F(1,45) = 0.092$, $p = 0.763$, partial $\eta^2 = 0.002$; PV: $F(1,45) = 0.241$, $p = 0.626$, partial $\eta^2 = 0.005$], nor any significant interaction effects for time*group [JH: $F(2,45) = 0.751$, $p = 0.478$, partial $\eta^2 = 0.032$; PP: $F(2,45) = 0.123$, $p = 0.885$, partial $\eta^2 = 0.005$; PV: $F(2,45) = 0.146$, $p = 0.865$, partial $\eta^2 = 0.006$] (Table 3).

DISCUSSION

The effects of IASTM on muscle performance measured by vertical jump height, peak power, and peak velocity were examined in this study. No significant differences between treatment groups were found when using the current IASTM treatment parameters. The IASTM treatment in this study was applied for three-minutes to reflect current IASTM protocols which typically include short treatment times (e.g., one to five minutes) per treatment location.[12,16-19]

Donahue[24] previously found that IASTM application on the quadriceps muscle group increased isometric force production, while also decreasing muscle activation (percent maximal voluntary isometric contraction) in healthy, college-aged students. Participants were treated with four one-hour IASTM treatments over a one-week period (Days 1, 3, 5, and 7); improvements in muscular contraction efficacy were found between treatment sessions (e.g., pre-treatment Day 1 post-treatments Day 3, 5, and 7) and over the full course of treatment for the quadriceps muscles (i.e., rectus femoris, vastus lateralis, and vastus medialis oblique). While it is possible that the differences in instruments (e.g., instrument weight, angle of instrument edge, surface area, etc.) or treatment administration (e.g., force application) may have resulted in the different findings, the most obvious difference in this study was treatment duration and the length of the assessment period.[24] To produce meaningful change in muscle performance it may be necessary to provide longer IASTM treatment times. Given the different findings, it may be that a longer treatment time, increased pressure during application, or multiple treatments are needed to improve muscle performance enough to significantly change vertical jump performance or other measures of muscular performance. Drawing accurate conclusions on this topic is difficult and more research is needed to determine the effect of IASTM on muscular performance.

Limitations

This investigation contains several limitations that warrant discussion. First, this investigation used a convenience sample of healthy participants and did not reach the estimated sample size. It is possible the lack of statistical significance is a result of the sample size or a smaller treatment effect than expected. The results of this study, however, serve as a useful guide for designing follow-up studies and calculating an appropriate sample size. Second, the participant group ranged from 19-39 (mean = 24 $\pm$ 4 years) years of age; the results of this study can only be generalized to healthy participants within this age group. Third, this study utilized more global measures of lower extremity muscle performance (e.g., vertical jump) and did not measure performance of specific lower extremity muscles; it is possible that treating more than one muscle group may be necessary to improve these measures. The additional use of isokinetic dynamometry or electromyography may have provided further insight into the performance of specific muscles.[26] Both global and isolated measures should be considered in future research to obtain a more comprehensive understanding of the effects of the intervention.

Clinical Implications

Despite these limitations, these data suggest that standard treatment times of IASTM do not affect muscle performance. For the clinician, this data provides some preliminary evidence that may help in determining the optimal sequencing of IASTM when it is part of a comprehensive rehabilitation program for individuals with myofascial dysfunction. Clinicians may want to include IASTM as part of their treatment regime; IASTM is a skilled intervention provided by the clinician. Based on the current evidence, it does not appear that IASTM will negatively impact muscular performance if utilized prior to athletic performance; however, the paucity of evidence makes it difficult to suggest that this intervention may be beneficial to measures of muscular performance.

CONCLUSIONS

IASTM is a popular myofascial intervention that is incompletely described with regard to its effects on muscle performance. The purpose of this research was to determine the effect of an IASTM treatment on lower extremity muscle performance, and no significant differences were found among groups suggesting such intervention will not detrimentally affect lower extremity muscle performance when used as a pre-exercise intervention. Future research should focus on determining the muscle performance effects of IASTM on individuals with a known myofascial pathology. Future research should also seek to determine the optimal treatment parameters such as type of instrument, amount of pressure, and treatment time for different pathologies.

REFERENCES

1. Kwong EH, Findley TW. Fascia--Current knowledge and future directions in physiatry: narrative review. *J Rehabil Res Dev.* 2014;51(6):875-884.

2. Kumka M, Bonar J. Fascia: a morphological description and classification system based on a literature review. *J Can Chiropr Assoc.* 2012;56(3):179-191.

3. Gehlsen GM, Ganion LR, Helfst R. Fibroblast responses to variation in soft tissue mobilization pressure. *Med Sci Sports Exerc.* 1999;31(4):531-535.

4. Loghmani MT, Warden SJ. Instrument-assisted cross-fiber massage accelerates knee ligament healing. *J Orthop Sports Phys Ther.* 2009;39(7):506-514.

5. Aspegren D, Hyde T, Miller M. Conservative treatment of a female collegiate volleyball player with costochondritis. *J Manipulative Physiol Ther.* 2007;30(4):321-325.

6. Bayliss AJ, Klene FJ, Gundeck EL, Loghmani MT. Treatment of a patient with post-natal chronic calf pain utilizing instrument-assisted soft tissue mobilization: a case study. *J Man Manip Ther.* 2011;19(3):127-134.

7. 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.

8. Daniels CJ, Morrell AP. Chiropractic management of pediatric plantar fasciitis: a case report. *J Chiropr Med.* 2012;11(1):58-63.
9. 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.
10. Howitt S, Jung S, Hammonds N. Conservative treatment of a tibialis posterior strain in a novice triathlete: a case report. *J Can Chiropr Assoc.* 2009;53(1):23-31.
11. Papa JA. Conservative management of Achilles Tendinopathy: a case report. *J Can Chiropr Assoc.* 2012;56(3):216-224.
12. Papa JA. Two cases of work-related lateral epicondylopathy treated with Graston Technique(R) and conservative rehabilitation. *J Can Chiropr Assoc.* 2012;56(3):192-200.
13. Papa JA. Conservative management of De Quervain's stenosing tenosynovitis: a case report. *J Can Chiropr Assoc.* 2012;56(2):112-120.
14. Sevier TL, Stegink-Jansen CW. Astym treatment vs. eccentric exercise for lateral elbow tendinopathy: a randomized controlled clinical trial. *PeerJ.* 2015;3:e967.
15. Strunk RG, Pfefer MT, Dube D. Multimodal chiropractic care of pain and disability for a patient diagnosed with benign joint hypermobility syndrome: a case report. *J Chiropr Med.* 2014;13(1):35-42.
16. Lee JJ, Lee JJ, Kim do H, You SJ. Inhibitory effects of instrument-assisted neuromobilization on hyperactive gastrocnemius in a hemiparetic stroke patient. *Biomed Mater Eng.* 2014;24(6):2389-2394.
17. White KE. High hamstring tendinopathy in 3 female long distance runners. *J Chiropr Med.* 2011;10(2):93-99.
18. Braun M, Schwickert M, Nielsen A, et al. Effectiveness of traditional Chinese "gua sha" therapy in patients with chronic neck pain: a randomized controlled trial. *Pain Med.* 2011;12(3):362-369.
19. Laudner K, Compton BD, McLoda TA, Walters CM. Acute effects of instrument assisted soft tissue mobilization for improving posterior shoulder range of motion in collegiate baseball players. *Int J Sports Phys Ther.* 2014;9(1):1-7.
20. Markovic G. Acute effects of instrument assisted soft tissue mobilization vs. foam rolling on knee and hip range of motion in soccer players. *J Bodyw Mov Ther.* 2015;19(4):690-696.
21. Schaefer JL, Sandrey MA. Effects of a 4-week dynamic-balance-training program supplemented with Graston instrument-assisted soft-tissue mobilization for chronic ankle instability. *J Sport Rehabil.* 2012;21(4):313-326.
22. Baker RT, Nasypany A, Seegmiller JG, Baker JG. Instrument-Assisted Soft Tissue Mobilization Treatment for Tissue Extensibility Dysfunction. *Int J Athl Ther Train.* 2013;18(5):16-21.
23. Wilson JK, Sevier TK, Helfts R, Honing EW, Thomann A. Comparison of Rehabilitation methods in the Treatment of Patellar Tendinitis. *Journal of Sport Rehabilitation.* 2000;9(4):304.
24. Donahue M. *The Effect of the Graston Technique on Quadracieps [i.e. Quadriceps] Muscle Activation and Force Production.* Indiana University, Department of Kinesiology; 2008.
25. Garber CE, Blissmer B, Deschenes MR, et al. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. *Med Sci Sports Exerc.* 2011;43(7):1334-1359.
26. Bennett DR, Blackburn JT, Boling MC, McGrath M, Walusz H, Padua DA. The relationship between anterior tibial shear force during a jump landing task and quadriceps and hamstring strength. *Clin Biomech (Bristol, Avon).* 2008;23(9):1165-1171.