



Original Article

A quasi-experimental study on the effects of instrument assisted soft tissue mobilization on mechanosensitive neurons

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Abstract. [Purpose] Instrument Assisted Soft Tissue Mobilization (IASTM) is a form of manual therapy. Despite its growing popularity and an increasing number of patients receiving IASTM each year, there is a lack of high-level evidence to elucidate its therapeutic mechanisms and to support its clinical applications. The purpose of this research project was to determine the effects of IASTM on activities of mechanosensitive neurons in skin. [Subjects and Methods] Twenty-three subjects, 9 females and 14 males, mean age 25.7 (SD 6.4) years old were recruited through a convenience sampling on the university campus. The study design was a quasi-experimental study using single group pretest-posttest design. The activities of mechanosensitive neurons were measured before and after the application of IASTM. [Results] The mean 2-point discrimination was 40.2 (SD 9.4) mm before IASTM and increased to 44.9 (SD 12.0) mm after IASTM. The increase was statistically significant pre and post IASTM. The mean pain threshold was 18.2 (SD 6.6) lb and increased slightly to 18.7 (SD 6.8) lb after IASTM; however, no statistical significance was found pre and post IASTM. [Conclusion] The data indicates that IASTM changes the neural activities in 2-point discrimination but not in pain threshold.

Key words: IASTM, Pain, Strength

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INTRODUCTION

Instrument Assisted Soft Tissue Mobilization (IASTM) is a form of manual therapy involving instruments with various shapes and materials to locate and treat various soft tissue disorders^{1, 2)}. Over the years, the effectiveness of IASTM, used alone or in combination with other therapeutic approaches, has been demonstrated by multiple case reports in treating conditions such as finger joint injury³⁾, post-natal chronic calf pain⁴⁾, apparent hamstring tightness⁵⁾, hyperactive gastrocnemius⁶⁾, high hamstring tendinopathy⁷⁾, tibialis posterior strain⁸⁾, soft tissue degeneration⁹⁾, costochondritis¹⁰⁾, and subacute lumbar compartment syndrome¹¹⁾. The effectiveness of IASTM has also been demonstrated by research studies with a larger sample size in treating chronic ankle instability¹²⁾ and carpal tunnel syndrome¹³⁾. A recent systematical review initially identified a total of 261 articles in December 2015¹⁾. A total of 155 articles were screened by the reviewers where only 7 randomized controlled trials (RCTs) met the inclusion criteria for the systematical review. The results of 5 of the RCTs on a musculoskeletal pathology were found insignificant. Only 2 of the RCTs on the short term effects on joint range of motion (ROM), an impairment level measurement, of the shoulder¹⁴⁾ and knee¹⁵⁾ in healthy athletic subjects, did demonstrate significant increases. A more recent study, possibly a randomized controlled trial (randomization not specified in the article), demonstrated the effectiveness of IASTM on pain and ROM for patients with chronic low back pain¹⁶⁾.

So how does IASTM work? The answer to this question is critical for not only addressing the concerns raised by the patient, but also determining the optimal treatment dosage for the clinician. Despite its growing popularity and an increasing

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number of patients receiving IASTM each year, there is a lack of high-level evidence to elucidate its therapeutic mechanisms and to support its clinical applications¹). In addition to providing a mechanical advantage for the clinician for deeper penetration, it is theorized that IASTM increases vibration perception by the clinician's hands holding the instrument to detect altered tissue properties. For therapeutic effects, the current literature often emphasizes the mechanical effects of IASTM in the release and breakdown of scar tissue, adhesions, and fascial restrictions, but somehow overlooks the neurophysiological effects of IASTM.

Soft tissues including skin, muscle, and joint capsule have various mechanosensitive neurons, including mechanoreceptors and mechano-nociceptors, that respond to a variety of mechanical stimuli such as compression, stretch, and vibration. These different neurons encode compressive or tensile stress¹⁷⁻¹⁹). Stress is a terminology defined as the force per unit area in biomechanics²⁰). The responsiveness of muscle spindles (one of the mechanosensitive neurons in muscle) are affected by recent vibration²¹) and stretching (or shortening) history²²⁻²⁵).

Presumably, the mechanical load experienced by the superficial skin is higher than that by the deeper tissues under external mechanical loading. Compared to clinician's bare hands, the contact area of the instrument is significantly less which leads to increased compressive stress. The instrument can also stretch the skin more which leads to increased tensile stress. When the instrument is moved across the skin during IASTM intervention, the skin is compressed and then stretched with much more mechanical stress than soft tissue mobilization with hands only. The increased skin deformation is likely to alter the activities of the mechanosensitive neurons being compressed and stretched. We speculate that one of the two opposite effects may occur: first, IASTM may lead to increased neural activities of large fiber neurons and therefore decrease the pain perception based on gate control theory. Conversely, IASTM may lead to decreased neural activities of both large and small fiber neurons due to neural accommodation initiated by the increased deformation and mechanical stimulation. The purpose of this research project was to determine the effects of IASTM on activities of mechanosensitive neurons in skin. The results will provide insight to the understanding of the neurophysiological mechanisms of IASTM and future clinical research on the effects of IASTM on certain pathologies.

SUBJECTS AND METHODS

Subjects were recruited through a convenience sampling on the university campus through word of mouth and email. The inclusion criteria included males and females, age 18 to 65. The exclusion criteria included sensory impairments and conditions contraindicated to IASTM which include cancer, burn scars, kidney dysfunction, pregnancy, varicose veins, osteoporosis, body art, chronic regional pain syndrome, polyneuropathies, fractures, autoimmune disorders, diabetes, vitamin C & D/Calcium deficiencies, rheumatoid arthritis, ankylosing spondylitis, congestive heart failure, acute inflammation, lymphedema, flu or illness with flu-like symptoms, and medications (anticoagulant, steroids, hormone replacements, NSAIDs, fluoroquinolone antibiotics, herbal supplements). Ethics approval for this study was sought and obtained from the Institutional Review Board at Youngstown State University (Protocol number 177-15). Written informed consent has been obtained from each subject. Twenty-three subjects, 9 females and 14 males, mean age 25.7 (SD 6.4) years old were recruited. Body weight and height for each subject were not collected.

The study design was a quasi-experimental study using single group pretest-posttest design. The activities of mechanosensitive neurons were measured before and after the application of IASTM. Each subject received IASTM in supine position to the region of the anterior thigh. IASTM was performed using GT1 instrument (Graston Technique, Indianapolis, IN, USA) where the sweep technique was used. The duration of the treatment was 10 minutes. The principal investigator completed the M1 basic training from Graston Technique.

The activities of mechanosensitive neurons were quantified using two-point discrimination and pain threshold and were measured before and after the application of IASTM at anterior thigh region. Two-point discrimination was measured 3 times using an electronic digital caliper (Model 3C351 Carbon Fiber Digital Caliper, Central Tools Inc., Cranston, RI, USA) in the center of treatment area. The subjects were instructed to report if they felt one or two points while the investigator adjusting the distance between the 2 tips of the caliper. Pain threshold was measured 3 times using a hand-held digital dynamometer (Lafayette Manual Muscle Tester Model 01163, Lafayette Instrument Company, Lafayette, IN, USA) in the same area. The subjects were instructed to report to the investigator that they started to feel pain or discomfort while the investigator gradually increase the force pushing on thigh through the dynamometer. A familiarization trial was conducted for pain threshold for each subject. In addition, circumference at mid-thigh, the center of treatment area, was also recorded before and after the application of IASTM to determine if significant soft tissue deformation occurred after the application of IASTM. The subject remained in a supine position during the measurement.

The mean two-point discrimination distance, pain threshold, and mid-thigh circumference for all subjects were calculated using descriptive analysis and reported with the mean and standard deviation. Paired student t-test was used to determine the significance of the difference with an alpha value level set at 0.05. Microsoft Excel for Mac version 15.25 was used for the data analysis.

RESULTS

Twenty-three subjects, 9 females and 14 males, mean age 25.7 (SD 6.4) years old were recruited. The mean 2-point discrimination was 40.2 (SD 9.4) mm before IASTM and increased to 44.9 (SD 12.0) mm after IASTM. The increase was statistically significant ($p < 0.01$) pre and post IASTM. The mean pain threshold was 18.2 (SD 6.6) lb and increased slightly to 18.7 (SD 6.8) lb after IASTM; however, no statistical significance was found ($p = 0.44$) pre and post IASTM. The mean mid-thigh circumference was 53.4 (SD 7.1) cm before IASTM and decreased slightly to 53.2 (SD 7.0) cm; again, no statistical significance was found ($p = 0.15$).

DISCUSSION

The data indicates that IASTM changes the neural activities in 2-point discrimination but not in pain threshold. As mechanoreceptors with larger axons are responsible for 2-point discrimination and mechano-nociceptors with smaller axons are responsible for pain perception. The results support that IASTM changes the neural activities of mechanoreceptors with larger axons but not the activities of mechano-nociceptors with smaller axons. No significant soft tissue deformation occurred after the application of IASTM, therefore the change in neural activities was not related to skin deformation. To our knowledge, this is the first study on the effects of IASTM on activities of mechanosensitive neurons. The data provides insight for elucidating the therapeutic mechanisms of IASTM from a neurophysiological perspective.

Limitations of the research project include sampling process and a small sample size due to our limited available resources. Convenience sampling significantly impacts the generalizability of the results. The subjects were all young, healthy volunteers, and the sample lacks diversity. Future research with a larger sample size from a more diversified population is necessary. In addition, the research design was a quasi-experimental study therefore randomization, control group, and double-masking was not possible, which might lead to threats to the internal validity.

In this study, no significant change was found in pain threshold in the healthy sample immediately following one session of 10 minutes of IASTM intervention. Due to the limited generalizability, it is possible that IASTM may increase the pain threshold for patients with certain pathologies who may be more responsive to the treatment. It is also possible that the pain threshold may increase after multiple sessions of treatment.

The GT1 instrument from Graston Technique was used in this study. It should be noted that Graston Technique has a set of 6 instruments and GT1 is one of them. It should also be noted that, in addition to Graston Technique, there are other commercial companies providing various instruments with different shapes and materials, including, Técnica Gavilán, Hawk Grips, Functional and Kinetic Treatment and Rehab (FAKTR), Adhesion Breakers, Fascial Abrasion Techniqu, SEED Technology, etc.^{1, 16}. One similar technique related to IASTM is Guasha, a popular Asian medical treatment often considered a form of IASTM but with different treatment rationale, goals, and application. Interestingly, a systematical review of Guasha based on 5 RCTs and 2 controlled clinical trials (CCTs), concluded that the current evidence was insufficient to show that Guasha was effective in pain management²⁶.

In recent years, the old term mechanotherapy has been expanded and updated for physical therapists^{27, 28}. Recent research in mechanobiology demonstrated the effects of physical forces on cells and tissues have led to the realization that the old therapy model should be updated. In regenerative rehabilitation, these mechanotherapies trigger certain biological responses to enhance the integration, healing, and restorative capacity of musculoskeletal tissues. Physical therapists should become leaders in the field of regenerative rehabilitation and understand the principles of mechanobiology and how mechanotherapies augment tissue responses. IASTM can provide controlled mechanical forces to the target tissues and can potentially play an important role in mechanotherapies. We urge that the role of mechanosensitive neurons in mechanotherapies should not be overlooked. In animal models, it has been demonstrated that instrument assisted cross fiber massage (IACFM) can change regional perfusion, vascularity, and knee ligament biomechanical properties of knee medial collateral ligament injuries^{29, 30}. Also in animal models, it has been demonstrated that integrin alpha2beta1 plays a significant role in modulating mechanoreceptive response of slowly and rapidly adapting cutaneous mechanoreceptors to compressive indentation in mechano-transduction³¹. We anticipate advancements of current research will facilitate future practice of mechanotherapies by physical therapists and other health professionals through IASTM.

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REFERENCES

- 1) Cheatham SW, Lee M, Cain M, et al.: The efficacy of instrument assisted soft tissue mobilization: a systematic review. *J Can Chiropr Assoc*, 2016, 60: 200–211. [[Medline](#)]
- 2) Stow R: Instrument-assisted soft tissue mobilization. *Int J Athl Ther Train*, 2011, 16: 5–8. [[CrossRef](#)]
- 3) Loghmani MT, Bayliss AJ, Clayton G, et al.: Successful treatment of a guitarist with a finger joint injury using instrument-assisted soft tissue mobilization: a case report. *J Manual Manip Ther*, 2015, 23: 246–253. [[Medline](#)] [[CrossRef](#)]
- 4) Bayliss AJ, Klene FJ, Gundek EL, et al.: Treatment of a patient with post-natal chronic calf pain utilizing instrument-assisted soft tissue mobilization: a case study. *J Manual Manip Ther*, 2011, 19: 127–134. [[Medline](#)] [[CrossRef](#)]
- 5) Baker RT, Hansberger BL, Warren L, et al.: A novel approach for the reversal of chronic apparent hamstring tightness: a case report. *Int J Sports Phys Ther*, 2015, 10: 723–733. [[Medline](#)]
- 6) Lee JJ, Lee JJ, Kim DH, et al.: Inhibitory effects of instrument-assisted neuromobilization on hyperactive gastrocnemius in a hemiparetic stroke patient. *Biomed Mater Eng*, 2014, 24: 2389–2394. [[Medline](#)]
- 7) White KE: High hamstring tendinopathy in 3 female long distance runners. *J Chiropr Med*, 2011, 10: 93–99. [[Medline](#)] [[CrossRef](#)]
- 8) 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: 23–31. [[Medline](#)]
- 9) Hammer WI: The effect of mechanical load on degenerated soft tissue. *J Bodyw Mov Ther*, 2008, 12: 246–256. [[Medline](#)] [[CrossRef](#)]
- 10) Aspegren D, Hyde T, Miller M: Conservative treatment of a female collegiate volleyball player with costochondritis. *J Manipulative Physiol Ther*, 2007, 30: 321–325. [[Medline](#)] [[CrossRef](#)]
- 11) Hammer WI, Pfefer MT: Treatment of a case of subacute lumbar compartment syndrome using the Graston technique. *J Manipulative Physiol Ther*, 2005, 28: 199–204. [[Medline](#)] [[CrossRef](#)]
- 12) 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: 313–326. [[Medline](#)] [[CrossRef](#)]
- 13) Burke J, Buchberger DJ, Carey-Loghmani MT, et al.: A pilot study comparing two manual therapy interventions for carpal tunnel syndrome. *J Manipulative Physiol Ther*, 2007, 30: 50–61. [[Medline](#)] [[CrossRef](#)]
- 14) Laudner K, Compton BD, McLoda TA, et al.: 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: 1–7. [[Medline](#)]
- 15) 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: 690–696. [[Medline](#)] [[CrossRef](#)]
- 16) Lee JH, Lee DK, Oh JS: The effect of Graston technique on the pain and range of motion in patients with chronic low back pain. *J Phys Ther Sci*, 2016, 28: 1852–1855. [[Medline](#)] [[CrossRef](#)]
- 17) Ge W, Khalsa PS: Encoding of compressive stress during indentation by slowly adapting type I mechanoreceptors in rat hairy skin. *J Neurophysiol*, 2002, 87: 1686–1693. [[Medline](#)] [[CrossRef](#)]
- 18) Ge W, Khalsa PS: Encoding of compressive stress during indentation by group III and IV muscle mechano-nociceptors in rat gracilis muscle. *J Neurophysiol*, 2003, 89: 785–792. [[Medline](#)] [[CrossRef](#)]
- 19) Khalsa PS, Ge W: Encoding of tensile stress and strain during stretch by muscle mechano-nociceptors. *Muscle Nerve*, 2004, 30: 216–224. [[Medline](#)] [[CrossRef](#)]
- 20) Fung YC: *Biomechanics: mechanical properties of living tissues*. Springer-Verlag, 1993.
- 21) Ge W, Pickar J: Change of paraspinal muscle spindle resting discharge evoked by mechanical vibration. *Conf. Proc. Annu. Int. Conf. IEEE Eng. Med. Biol. Soc. IEEE Eng. Med. Biol. Soc. Conf.*, 2005, 5: 5002–5005.
- 22) Ge W, Cao DY, Long CR, et al.: Plane of vertebral movement eliciting muscle lengthening history in the low back influences the decrease in muscle spindle responsiveness of the cat. *J Appl Physiol* 1985, 2011, 111: 1735–1743. [[Medline](#)] [[CrossRef](#)]
- 23) Ge W, Long CR, Pickar JG: Vertebral position alters paraspinal muscle spindle responsiveness in the feline spine: effect of positioning duration. *J Physiol*, 2005, 569: 655–665. [[Medline](#)] [[CrossRef](#)]
- 24) Ge W, Pickar JG: Time course for the development of muscle history in lumbar paraspinal muscle spindles arising from changes in vertebral position. *Spine J*, 2008, 8: 320–328. [[Medline](#)] [[CrossRef](#)]
- 25) Ge W, Pickar JG: The decreased responsiveness of lumbar muscle spindles to a prior history of spinal muscle lengthening is graded with the magnitude of change in vertebral position. *J Electromyogr Kinesiol*, 2012, 22: 814–820. [[Medline](#)] [[CrossRef](#)]
- 26) Lee MS, Choi TY, Kim JI, et al.: Using Guasha to treat musculoskeletal pain: a systematic review of controlled clinical trials. *Chin Med*, 2010, 5: 5. [[Medline](#)] [[CrossRef](#)]
- 27) Huang C, Holfeld J, Schaden W, et al.: Mechanotherapy: revisiting physical therapy and recruiting mechanobiology for a new era in medicine. *Trends Mol Med*, 2013, 19: 555–564. [[Medline](#)] [[CrossRef](#)]
- 28) Thompson WR, Scott A, Loghmani MT, et al.: Understanding mechanobiology: physical therapists as a force in mechanotherapy and musculoskeletal regenerative rehabilitation. *Phys Ther*, 2016, 96: 560–569. [[Medline](#)] [[CrossRef](#)]
- 29) Loghmani MT, Warden SJ: Instrument-assisted cross-fiber massage accelerates knee ligament healing. *J Orthop Sports Phys Ther*, 2009, 39: 506–514. [[Medline](#)] [[CrossRef](#)]
- 30) Loghmani MT, Warden SJ: Instrument-assisted cross fiber massage increases tissue perfusion and alters microvascular morphology in the vicinity of healing knee ligaments. *BMC Complement Altern Med*, 2013, 13: 240. [[Medline](#)] [[CrossRef](#)]
- 31) Khalsa PS, Ge W, Uddin MZ, et al.: Integrin alpha2beta1 affects mechano-transduction in slowly and rapidly adapting cutaneous mechanoreceptors in rat hairy skin. *Neuroscience*, 2004, 129: 447–459. [[Medline](#)] [[CrossRef](#)]