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Opinion
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Quantifiable Soft Tissue Manipulation (QSTM): A Requisite to Advance the Field of Manual Therapy

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Abstract

Quantifiable soft tissue manipulation (QSTM) that can characterize the motion and forces delivered during soft tissue examination and treatment of common musculoskeletal (MS) conditions in a real-time and clinically applicable manner is needed to achieve optimal outcomes. Soft tissue manipulation (STM), e.g. massage, is a type of mechanotherapy that has been used with benefit frequently by clinicians worldwide since ancient times. Instrument-assisted STM (IASTM) is a type of STM that uses rigid devices to assess and treat soft tissue abnormalities in a targeted and precise manner. Remarkably, however, the forces delivered during STM approaches have not been adequately quantified. Unlike other mechano-therapeutic approaches, e.g. ultrasound, traction, exercise, electrical stimulation, current manual therapy practice relies mostly on subjective description of STM evaluation findings and treatment parameters. This makes documentation, analysis, comparison, progression and optimization of this non-invasive intervention difficult to establish and validate. It is the authors' strong opinion that there is need for QSTM to objectively measure, characterize and record the 3-dimensional (3D) forces and motion trajectories of STM evaluation and intervention. Innovative technology aimed to help address this void in research, educational and clinical practice has been developed by our research team and introduced in this article. The QSTM system has two components: an electronic, handheld device (applicator) for 3D characterization of force and a computer with software for data acquisition and analysis. Preliminary testing has demonstrated that the QSTM prototype can provide accurate sensed values and good intra-, inter-rater reliability. Device revisions are in progress and further testing is planned in animals and humans. QSTM is an essential technology needed for the standardization, comparison and optimization of STM therapies and a requisite to advance the field of manual therapy.

Keywords: Soft tissue manipulation; Soft tissue mobilization; Manual therapy; Massage; Physical therapy; Rehabilitation

Introduction

Musculoskeletal (MS) conditions are frequently treated by clinicians, with low back pain (LBP) being the leading cause of disability in the United States [1,2]. Soft tissue manipulation (STM), e.g. massage, is a type of manual therapy often used to address MS conditions and a variety of other disorders [3,4]. Instrument-assisted STM (IASTM) is a type of STM that uses rigid devices with demonstrated benefits [5-14]. Although STM is an ancient intervention used worldwide with known positive effects, much remains to be understood about its mechanisms and optimal outcomes [3,15-17]. In essence, STM is a form of mechanotherapy that imparts a mechanical stimulus to the tissue [18]. Since cells are mechanosensitive, STM possesses the potential to directly influence cell and tissue structure and function [19,20]. Although STM dose-frequency studies are available, the literature is void of replicable clinically-applicable dose-pressure studies; in large part due to the lack of adequate quantification methods for STM motion and force in patients [21-24]. Attempts to quantify STM forces have been made in animals and in humans, but none of these methods are applicable for realistic, real-time clinical use [24-32]. This poses a significant gap in the current understanding of the underlying biological mechanisms of STM and markedly limits the ability (1) to document, replicate and reproduce STM applications, (2) to monitor, adjust, and advance the STM treatment methodology; and (3) to establish optimal STM dosing protocols specific to different clinical conditions. Other therapeutic modalities, e.g. ultrasound, electrical stimulation, traction, etc. have parameters that can be monitored objectively, but characterization of STM evaluation and treatment is mostly relegated to the use of subjective qualifiers. Thus, it is the opinion of the authors that quantifiable soft tissue manipulation (QSTM) needs to become a new standard of patient care in soft tissue manipulation and is requisite to advance the field of manual therapy.

QSTM is advancement in current IASTM practice and has important implications in research, clinical practice and education/training. It cannot replace the use of manual contact, nor serve as a substitute for the complexity of clinician's judgment in sensing soft tissue quality, monitoring patient response and adjusting treatment parameters. However, QSTM rehabilitation technology would significantly elevate the objectivity in soft tissue evaluation and treatment. QSTM is needed to complete dose-pressure response studies in a clinically relevant manner, to establish optimal dose parameters (e.g. pressure, rate, angle of force, stroke duration reflecting STM intensity and depth) and force patterns leading to optimal outcomes for various musculoskeletal disorders at different stages of healing and repair. For example, depending on the condition, or stage of tissue healing, it needs to be determined whether light force or more aggressive STM force is most indicated. Patterns of recovery can also be established in

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that some conditions may require diminishing or escalating STM force across treatment sessions. The implications of QSTM in research seem apparent; however, the availability of QSTM for clinical use is essential for applying research findings in evidence-based practice. QSTM is needed to foster consistency and replication within and between therapists and across sessions; comparison of protocols and resultant outcomes; provide objective measures demonstrating progression or regression in soft tissue quality; document and modify treatment parameters; and provide objective feedback to the patient, all of which will catalyze a paradigm shift in soft tissue treatment. Importantly, QSTM will facilitate education and training in manual therapy by providing objective feedback to the learner. In response to the need for more objective characterization of STM evaluation and intervention, our research team has designed, fabricated and initially evaluated a STM mechano-therapeutic motion and force sensing device system prototype that provides real-time quantification of motion and force.

Materials and Methods

An electronic, handheld quantifiable soft tissue manipulation (QSTM™) device system was developed based on established criteria (US Patent Filed: PCT/US2016/052164) [33,34]. It needed to be user-friendly, durable, water-proof, and provide information on treatment parameters (e.g. stroke force, angle, frequency, duration) in real-time, in a clinically relevant and applicable manner. The system includes an ergonomically designed IASTM device (applicator) (Figure 1) that uses modern sensor technologies, as well as state of the art computing and communication technologies to revolutionize the practice of STM. The QSTM™ system also consists of a data acquisition system and Windows/Android/OSX compatible computer technology. The sensed motion and force data are streamed to the computer that performs sensor fusion and displays the force, orientation angles, and manipulation motion pattern at skin-tool interface in real time (Figure 2). The QSTM system can also detect the reaction force disturbance caused by the tissue restrictions and irregularities assisting examination of soft tissue quality.

Results

Preliminary testing was conducted to test the accuracy of the device compared to an external reference scale for maximal compression with the device at 90° with respect to the scale plate, and then again at 45° with respect to the scale plate, and to initially evaluate the inter-rater and intra-rater reliability of the QSTM™ device force measurements between two novice clinicians with compressions of the device held at 90° against the force plate. With the QSTM device held at a 90° angle device to the plate, the average force was 21.88 (4.9 lbs) ± 4.18N (0.94 lbs), range 15.38 (3.46 lbs) -30.11N (6.77 lbs) (n=60 trials), and the accuracy of the device was excellent for determining compressive force, within 1N, as compared to the external device (at 90°, ρ=0.92; at 45°, ρ=0.97). Intra-rater reliability was better for examiner B than A (n=15 trials) (Examiner A, ICC=0.220, p=0.324, 95% CI=1.323-0.738; Examiner B (ICC=0.619, p=0.041, 95% CI=-0.136-0.872), and inter-rater reliability was good (Cronbach's alpha=0.653, ICC=0.653, p=0.003, 95% CI=0.271-0.835). Based on initial findings, device revisions are in progress. Future studies will further validate the system in animals and humans.

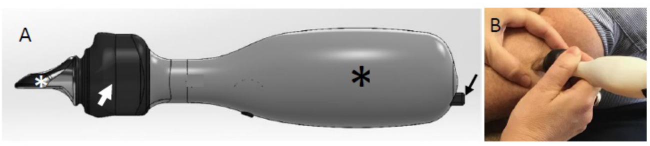

Figure 1: Sensor based QSTM device. A schematic drawing of a QSTMTM device prototype is illustrated in A) depicting the treatment tip (white asterisk), location of the force transducer (white arrow), device handle (black asterisk), and wire connection (black arrow). B) The QSTM device prototype being used for cross fiber massage to the forearm.

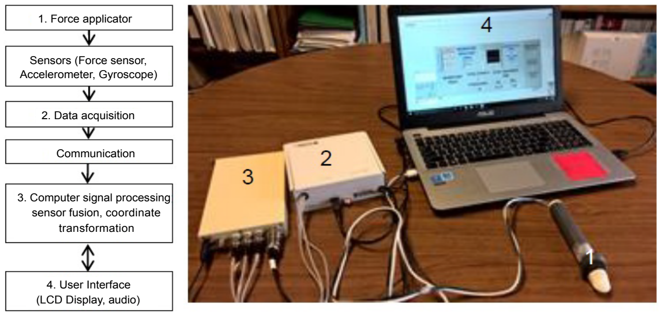

Figure 2: Block diagram and figure of a QSTM device system prototype. The QSTM™ device applicator (1) connects to a host PC (4) through a signal processor (3) and an USB data acquisition card (2).

Conclusion

QSTM is essential to advance the field of manual therapy to the level of a mechanotherapy prescription. Novel QSTM technology will permit STM protocols to be better established, validated, standardized and compared for a wide variety of diagnoses across the life span.

References

1. Picavet HS, Hazes JM (2003) Prevalence of self-reported musculoskeletal disease is high. Ann Rheum Dis 62: 644-650.
2. Hoy DG, Smith E, Cross M, Sanchez-Riera L, Blyth FM, et al. (2015) Reflecting on the global burden of musculoskeletal conditions: lessons learnt from the Global Burden of Disease 2010 Study and the next steps forward. Ann Rheum Dis 74: 4-7.
3. Field T (2016) Massage therapy research review. Complement Ther Clin Pract 24: 19-31.
4. Karels C, Polling W, Bierma-Zeinstra S (2006) Treatment of arm, neck and/or shoulder complaints in physical therapy practice. Spine 31: E584-E589.
5. Brosseau L, Wells GA, Poitras S, Tugwell P, Casimiro L, et al. (2012) Ottawa Panel evidence-based clinical practice guidelines on therapeutic massage for low back pain. J Body Mov Ther 16: 424-455.
6. Loghmani MT, Bane S (2016) Instrument-assisted Soft Tissue Manipulation: Evidence for its Emerging Efficacy. J Nov Physiother S3: 012.
7. Loghmani MT, Warden SJ (2009) Instrument-Assisted Soft Tissue Mobilization Accelerates Knee Ligament Healing. JOSPT 39: 506-514.
8. Loghmani MT, Warden SJ (2013) Instrument-assisted cross fiber massage increases tissue perfusion and alters microvascular morphology in the vicinity of healing knee ligaments. BMC Complement Altern Med 13: 1-9.
9. Davidson CJ, Ganion LR, Gehlsen GM, Verhoestra B, Roepke JE, et al. (1997) Rat tendon morphologic and functional changes resulting from soft tissue mobilization. Med Sci Sports Exerc 29: 313-319.
10. Looney B, Srokose T (2011) Graston Instrument Soft Tissue Mobilization and Home Stretching for the Management of Plantar Heel Pain: A Case Series. J Manipulative Physiol Ther 34: 138-142.
11. Bayliss AJ, Klene F, Gundeck E, Loghmani MT (2011) Treatment of a patient with post-natal chronic calf pain utilizing instrument-assisted soft tissue mobilization. JMMT 19: 1-8.
12. McCrea EC, George SZ (2010) Outcomes following augmented soft tissue mobilization for patients with knee pain: A case series. Orthopaedic Physical Therapy Practice 22: 69-74.
13. Burke J, Buchberger DJ, Carey-Loghmani MT, Dougherty PE, Greco DS, et

al. (2007) A pilot study comparing two manual therapy interventions for carpal tunnel syndrome. JMMT 30: 50-61.

14. Vardiman JP, Siedlik J, Herda T, Hawkins W, Cooper M, et al. (2014) Instrument-assisted soft tissue mobilization: effects on the properties of human plantar flexors. Int J Sports Med 36: 197-203.
15. Kong LJ, Zhan HS, Cheng YW (2013) Massage therapy for neck and shoulder pain: a systematic review and meta-analysis. Evid Based Complement Alternat Med 61327.
16. Kumar S, Beaton K, Hughes T (2013) The effectiveness of massage therapy for the treatment of nonspecific low back pain: a systematic review of systematic reviews. International J General Med 6: 733-774.
17. Weerapong P, Hume PA, Kolt GS (2005) The mechanisms of massage and effects on performance, muscle recovery and injury prevention. Sports Med 35: 235-256.
18. Huang C, Holfeld J, Schaden W, Orgill D, Ogawa R (2013) Mechanotherapy: revisiting physical therapy and recruiting mechanobiology for a new era in medicine. Cell 19: 555-564.
19. Thompson WR, Scott A, Loghmani MT, Ward SR, Warden SJ (2016) Understanding mechanobiology: physical therapists as a force in mechanotherapy and musculoskeletal regenerative rehabilitation. Phys Ther 96: 560-569.
20. Best TM, Gharibeh B, Huard J (2013) Stem cells, angiogenesis and muscle healing: a potential role in massage therapies? BMJ 47: 556-560.
21. Sherman KJ, Cook AJ, Kahn JR, Hawkes RJ, Wellman RD, et al. (2012) Dosing study of massage for chronic neck pain: protocol for the dose response evaluation and analysis of massage [DREAM] trial. BMC Complement Altern Med 12: 158.
22. Sherman KJ, Cook AJ, Well RD, Hawkes RJ, Kahn FR, et al. (2014) Five-week outcomes from a dosing trial of therapeutic massage for chronic neck pain. Ann Fam Med 12: 112-120.
23. Cook AJ, Wellman RD, Cherkin DC, Kahn JR, Sherman KJ (2015) Randomized clinical trial assessing whether additional massage treatments for chronic neck pain improve 12- and 26-week outcomes. Spine J 15: 2206-2215.
24. Best TM, Crawford SK, Haas C, Charles L, Zhao Y (2014) Transverse forces in skeletal muscle with massage-like loading in a rabbit model. BMC Complement Altern Med 14: 393.
25. Wang Q, Zeng H, Best TM, Haas C, Heffner NT, et al. (2014) A mechatronic system for quantitative application and assessment of massage-like actions in small animals. Annals of biomedical engineering 42: 36-49.
26. Gehlsen GM, Ganion LR, Helfst R (1999) Fibroblast responses to variation in soft tissue mobilization pressure. Med Sci Sports Exerc 31: 531-535.
27. Haas C, Butterfield TA, Zhao Y, Zhang X, Jarjoura D, et al. (2013) Dose-dependency of massage-like compressive loading on recovery of active muscle properties following eccentric exercise: rabbit study with clinical relevance. Br J Sports Med 47: 83-88.
28. Hass C, Butterfield TA, Abshire S, Zhang X, Jarjoura D, et al. (2013) Massage timing affects post-exercise muscle recovery and inflammation in a rabbit model. Med Sci Sport Excer 2013: 1105-1112.
29. Haas C, Best TM, Wang Q, Buterfield TA, Zhao Y (2012) In vivo passive mechanical properties of skeletal muscle improve with massage-like loading following eccentric exercise. J Biomechanics 45: 2630-2636.
30. Butterfield TA, Zhao Y, Agarwal S, Haq F, Best TM (2008) Cyclic compressive loading facilitates recovery after eccentric exercise. Med Sci Sports Excer 1289-1296.
31. Zeng H, Butterfield TA, Agarwal S, Haq F, Best TM, et al. (2008) An engineering approach for quantitative analysis of the lengthwise strokes in massage therapies. J Medical Devices 2: 1-8.
32. Lee H, Wu S, You J (2009) Quantitative application of transverse friction massage and its neurological effects on flexor carpi radialis. Manual Therapy 14: 501-507.
33. Loghmani MT, Anwar S, Alotaibi A, March K, Chien S (2016) “Quantification of Force during Soft tissue Massage for Research and Clinical Use”, US Patent Application No. PCT/US2016/052164.
34. Alotaibi A, Anwar S, Chien S, Loghmani MT (2016) Development of a Force Sensing Instrument Assisted Soft Tissue Mobilization Device. Proceeding ASME International Mechanical Engineering Congress and Exposition, Phoenix, AZ, USA.

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