Journal of Sport Rehabilitation, 2022, 31, 120-124
https://doi.org/10.1123/jsr.2020-0247

Human Kinetics
TECHNICAL REPORT

Instrument-Assisted Soft Tissue Mobilization Forces Applied by Trained Clinicians During a Simulated Treatment

Nickolai J.P. Martonick, Ashley J. Reeves, James A. Whitlock, Taylor C. Stevenson, Scott W. Cheatham, Craig P. McGowan, and Russell T. Baker

Context: Instrument-assisted Soft Tissue Mobilization (IASTM) is a therapeutic intervention used by clinicians to identify and treat myofascial dysfunction or pathology. However, little is known about the amount of force used by clinicians during an IASTM treatment and how it compares to reports of force in the current literature. ***Objective:*** To quantify the range of force applied by trained clinicians during a simulated IASTM treatment scenario. ***Design:*** Experimental. ***Setting:*** University research laboratory. ***Participants:*** Eleven licensed clinicians (physical therapist = 2, chiropractor = 2, and athletic trainer = 7) with professional IASTM training participated in the study. The participants reported a range of credentialed experience from 1 to 15 years (mean = 7 [4.7] y; median = 6 y). ***Intervention:*** Participants performed 15 one-handed unidirectional sweeping strokes with each of the 5 instruments for a total of 75 data points each. Force data were collected from a force plate with an attached skin simulant during a hypothetical treatment scenario. ***Main Outcome Measures:*** Peak force and average forces for individual strokes across all instruments were identified. Averages for these forces were calculated for all participants combined, as well as for individual participants. ***Results:*** The average of peak forces produced by our sample of trained clinicians was 6.7 N and the average mean forces was 4.5 N. Across individual clinicians, average peak forces ranged from 2.6 to 14.0 N, and average mean forces ranged from 1.6 to 10.0 N. ***Conclusions:*** The clinicians in our study produced a broad range of IASTM forces. The observed forces in our study were similar to those reported in prior research examining an IASTM treatment to the gastrocnemius of healthy individuals and greater than what has been reported as effective in treating delayed onset muscle soreness. Our data can be used by researchers examining clinically relevant IASTM treatment force on patient outcomes.

Keywords: manual therapy, measurement properties, therapeutic modalities, clinical interventions

Instrument-assisted Soft Tissue Mobilization (IASTM) is a clinical intervention applied with handheld tools to address myofascial dysfunction or pathology.[1–3] Clinicians have reported that instruments improve the detection of soft tissue restriction or abnormality, treatment efficiency, and patient outcomes, and may be more effective than using one's hands for addressing chronic pain or overuse conditions.[4–6] Laboratory and clinical investigations have indicated IASTM may improve range of motion, reduce pain scores, and normalize clinical measures of dysfunction (ie, apparent hamstring tightness).[4–6] A proposed mechanism for observed improvements in musculoskeletal conditions after IASTM intervention is the remodeling of scar tissue, which has been attributed to an increased fibroblast proliferation and improved collagen synthesis, maturation, and alignment.[7–9] However, a recent systematic review indicated the body of evidence supporting IASTM is still emerging, and a gap between research and clinical practice exists in part, due to a lack of homogeneity in IASTM application.[1]

Inconsistencies in the research are reflected in what clinicians are reporting about their applications of IASTM in practice. In recent surveys, clinicians who have taken formal IASTM training reported substantial variations across the suggested treatment protocols (eg, stroke type, stroke direction, angle of application, etc).[3,10] Approximately 20% of these respondents indicated that they rarely or never followed the recommendations of their IASTM training.[3,10] Additionally, clinicians have reported consideration for the quantity of force applied with some attempting to use lighter forces (ie, 500 g [5 N] or less), or more substantial force (ie, 500 g or more), while others have suggested specific force quantification is not being considered during IASTM application.[3,10]

There have also been variations in the reporting of forces in the current IASTM literature, and the results of investigations that report treatment force are mixed.[6–9,11] For example, Cheatham et al[6] reported treatment force parameters associated with a "feather stroke" (ie, force application was limited to the weight [205 g] of the instrument), but did not measure the forces during application to help ensure consistent force production. In this case, the tested IASTM application produced significant decreases in 2-point discrimination and pain pressure threshold in participants with delayed onset muscle soreness (DOMS).[6] In contrast, researchers investigating the effect of IASTM on the gastrocnemius muscle group of healthy individuals used electronic instrumentation to track treatment forces (range = 2.6–9.1 N) and reported no significant changes in inflammatory markers, passive range of motion, or maximum voluntary contraction peak torque after IASTM application.[11]

Due to the paucity of information for the quantification of force during IASTM in humans, clinicians and researchers may reference animal trials that have provided further physiological evidence of force quantification.[7–9] For instance, researchers have demonstrated that incised medial collateral ligaments in a rat model had greater tensile strength and qualitatively improved collagen alignment under light microscopy after IASTM application.[7,8] The ligamentous healing improvements were produced with only 250

Martonick, Reeves, Cheatham, McGowan, and Baker are with the University of Idaho, Moscow, ID, USA. Whitlock and Stevenson are with the WWAMI Medical Education Program, Moscow, ID, USA. Martonick (nmartonick@uidaho.edu) is corresponding author.

to 300 g (2.5–3.0 N) of downward IASTM force being applied during the treatment.[7,8] Additionally, it was found that an increase in magnitude in IASTM force (ie, 0.5–2 N) resulted in enhanced fibroblast proliferation in the Achilles tendons of rats.[9] While the morphology of humans is vastly different, this evidence may be used to support the idea that applying increased IASTM force in humans promotes the healing process by creating microtrauma at the affected tissue.

Although the aforementioned animal investigations quantified IASTM forces, it is not common for force application to be reported in human trials, and intervention details are often missing or inconsistent. Thus, clinicians and researchers may follow their own preferences or nonevidence-based sources in providing care depending on their training, experiences, or limitations in the available literature.[1,3] Before the efficacy of the treatment can be established, the range of force used by trained clinicians during IASTM should be identified. Identifying the range of force used by trained clinicians when using instruments of varied sizes, shapes, weights, and materials would inform clinical practice research protocols when examining the potential effects of force on IASTM treatment outcomes. Therefore, the purpose of this study was to provide descriptive data for the range of quantified IASTM force applied by trained clinicians using 5 different instruments.

Methods

Study Design

The University Institutional Review Board approved the study (# 19-157). The study was conducted in a university biomechanics laboratory and utilized 5 different IASTM instruments (Figure 1): (1) Fascial Abrasion Technique™, *FAT Stick* (Niagra Falls, ON, Canada), mass: 293 g; (2) Técnica Gavilán (Tracy, CA) *Ala*, mass: 196 g; (3) EDGE Mobility System™ (Lake View, NY) *Edge Tool,* mass: 196 g; (4) Graston Technique (GT; Indianapolis, IN) *GT #5*, mass: 156 g; and (5) RockBlades (Durham, NC) *Mullet*, mass: 178 g. All data were collected during a single session lasting approximately 30 minutes. The average normal forces (ie, the average force perpendicular to the treatment plane from the beginning to end of a single stroke) and the averages of peak normal force (ie, the peak force plate reading during a single stroke) across 15 strokes for each of the 5 instruments were recorded.

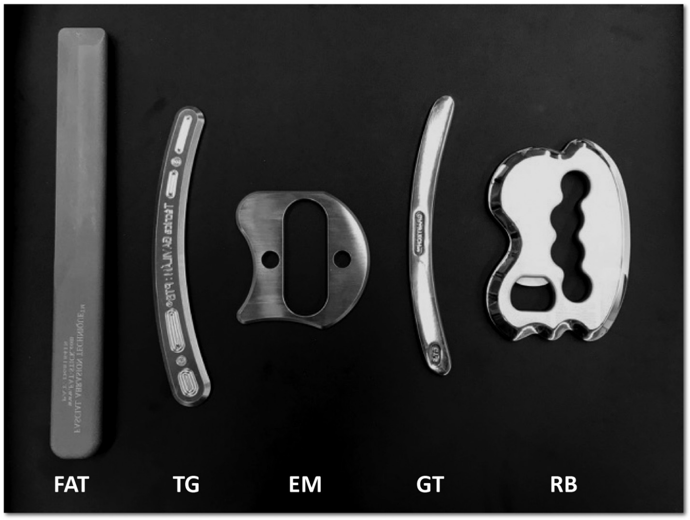

Figure 1 — Instrument-assisted Soft Tissue Mobilization instruments. EM indicates EDGE mobility system; FAT, fascial abrasion technique; GT, Graston Technique; RB, RockBlades; TG, Técnica Gavilán.

Participants

We collected IASTM force data from a sample of 11 licensed clinicians (physical therapist = 2, chiropractor = 2, and athletic trainer = 7) who completed at least one professional IASTM training course. Prior to the data collection, the clinicians completed a survey related to their prior training (Table 1), and how frequently they used IASTM in practice. The participants reported a range of credentialed experience from 1 to 15 years (mean = 7 [4.7] y; median = 6 y). Of the 11 clinicians, one never used IASTM in practice, 3 rarely used IASTM, 6 reported frequent use, and one clinician used IASTM daily. Clinicians were asked to use their dominate hand for all strokes. This was operationally defined as the same hand that they use to write with (9 right and 2 left). Following the data collection, participants reported how much force they thought they were applying. Clinicians replied "unknown" if they were unsure how much force they used, and clinicians reported "varied" if they felt their forces were not consistent (Table 1). Participants provided informed consent prior to participating in the study.

Instrumentation

A skin simulant (Complex Tissue Model; Simulab Corporation©, Seattle, WA) designed for suturing practice was selected as the best method for modeling soft tissue. The simulant contained skin, subcutaneous fat, fascia, and preperitoneal fat. We attached the 1″ thick skin simulant to a 6 × 6″ force plate (HE6X6; AMTI©, Watertown, MA) to quantify forces applied during IASTM application. Raw data were acquired with the force plate set to record at 500 Hz and processed with NetForce software (version 3.5.3; AMTI). The raw data were exported into MATLAB (version 2019b; MathWorks, Natick, MS), and filtered with a 10-Hz low-pass Butterworth filter for analysis.

Procedures

The clinicians were provided with a practice session of 5 one-handed strokes for each instrument. A standardized treatment scenario asking them to perform an IASTM treatment for a patient who reported calf tightness was read to each clinician. Clinicians were asked to perform the IASTM treatment as they would in practice. Instrument order was randomized for each clinician; each clinician performed 5 one-handed, unidirectional sweeping strokes on the skin simulant (lifting between strokes) and then switched instruments until each instrument had been used. This process was repeated 3 times in the same order for a total of 15 strokes with each instrument and 75 total strokes. The average stroke duration was approximately 1 second. Participants were positioned standing next to the treatment table during IASTM application.

Data Analysis

Descriptive data for peak forces were calculated as the sum of maximum vertical forces for each stroke, divided by the number of trials. The mean force was defined as the average of the vertical forces produced across the entire length of a single stroke, divided by the number of trials. These calculations were used to create descriptive plots and a chart (Figures 2–4, Table 1) to represent the

Table 1 Forces (N) by Clinician for All Instruments and Strokes

Clinician	Training	Perceived force	Measure	Maximum	Minimum	Range	Average
1	TG and RB	5–10	Peak	6.3	1.6	4.7	4.0
			Mean	4.3	1.1	3.2	2.9
2	TG	0–5	Peak	3.6	1.9	1.7	2.6
			Mean	2.1	1.2	1.0	1.6
3	TG	Varied	Peak	10.6	4.3	6.3	7.1
			Mean	7.3	2.7	4.7	4.2
4	TG and GT	Varied	Peak	11.2	2.9	8.2	6.6
			Mean	5.8	1.8	4.0	3.8
5	GT	15–20	Peak	13.6	5.2	8.3	7.9
			Mean	8.0	3.3	4.8	5.5
6	TG	5–10	Peak	9.9	2.0	7.9	4.6
			Mean	6.8	1.1	5.7	2.8
7	GT	Unknown	Peak	19.0	10.0	9.0	14.0
			Mean	13.5	6.2	7.2	10.0
8	TG, GT, and RB	5–10	Peak	11.6	4.0	7.6	6.6
			Mean	8.0	3.1	5.0	5.1
9	TG	0–5	Peak	11.8	4.3	7.5	6.8
			Mean	8.4	3.1	5.3	5.2
10	TG	5–10	Peak	11.5	3.3	8.3	7.2
			Mean	7.4	2.1	5.3	4.8
11	TG	0–5	Peak	11.0	2.6	8.4	5.7
			Mean	7.2	1.6	5.6	3.6
Total	NA	NA	Peak	10.9	3.8	7.1	6.7
			Mean	7.2	2.5	4.7	4.5

Abbreviations: EM, EDGE mobility system; FAT, fascial abrasion technique; GT, Graston Technique; RB, RockBlades; TG, Técnica Gavilán.

data from our sample. Plots were created with R software (version 3.6.2; The R Foundation for Statistical Computing Platform, 2019) and the descriptive data in Table 1 were calculated in Excel (version 16.3; Microsoft®, 2019).

Results

The average of peak forces produced by our sample of trained clinicians was 6.7 N and the average mean forces was 4.5 N. Across individual clinicians, average peak forces ranged from 2.6 to 14.0 N, and average mean forces ranged from 1.6 to 10.0 N (Table 1). The minimum observed peak force for a single stroke was 1.6 N and the maximum peak force was 19.0 N.

Discussion

Our investigation quantified the peak and mean forces applied by trained clinicians during a simulated IASTM treatment scenario. To the best of our knowledge, this was the first study to quantify the forces used by a group of trained clinicians during IASTM. The clinicians in our study produced what may be considered a broad range of peak and mean forces. For example, we observed a difference of 11.4 N between the average peak forces of the clinician who applied the most force and the clinician who applied the least. The observed range of force in our study (Figure 2) could be due to the limited evidence for what may be an appropriate amount of IASTM force when treating muscle tissue.

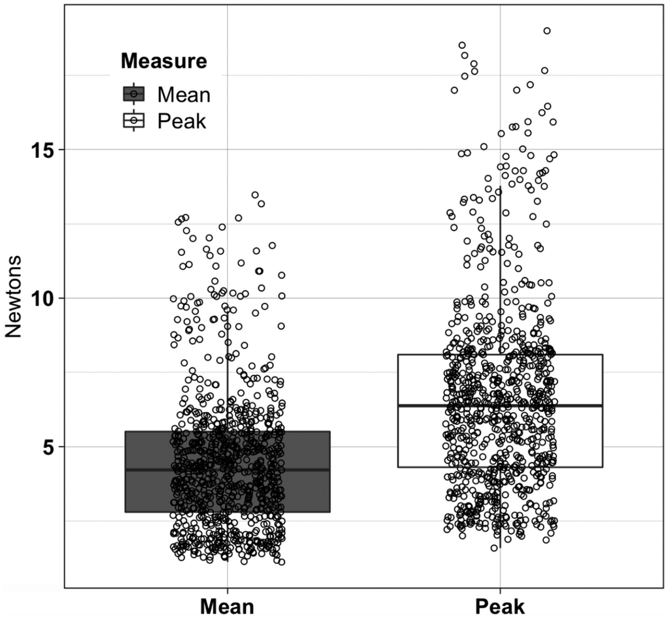

Figure 2 — Peak and mean forces from all clinicians, instruments, and strokes. Box and whisker plots with distribution of individual strokes layered over the top.

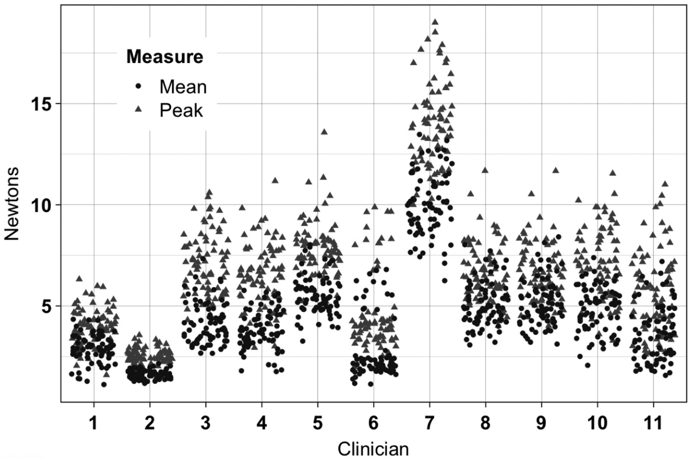

Figure 3 — Distribution of peak and mean forces from individual clinicians.

The gastrocnemius muscle group is often utilized when studying the possible effects of IASTM.[11–13] Interestingly, 8 of our 11 clinicians (Figure 3) produced forces similar to those reported by researchers using force instrumentation to standardize treatment forces at the gastrocnemius.[11] Overall distribution of peak force (Figure 4) produced by our samples also appears to be similar to the forces reported by Vardiman et al.[11] This suggests that the forces used in their study are relevant to what clinicians are using in practice.

In contrast to using instrumentation to standardize the force application, participant comfort and pain tolerance has also been used as the determining factor for how much force to apply during IASTM of the gastrocnemius.[12,13] Clinicians may interpret these methods to say that greater magnitudes of force are more beneficial, so long as they do not cause the patient to have pain. However, it is currently unknown how much force is necessary to produce benefits from IASTM. Levels of discomfort from IASTM likely vary between individuals and using this to measure force application may lead to reported side effects such as bruising and soreness.[4,14]

The concept of producing a greater treatment benefit from higher magnitudes of force may stem from literature reviews[4,14] that referenced animal research which demonstrated increased fibroblast proliferation and healing when more force was applied.[8] However, these findings may not translate to patients, and the forces reported in animal trials are minimal compared to the average peak and mean forces applied by the clinicians in our study. The difference may have occurred because the previous animal model research utilized a different structure (ie, ligament vs muscle/tendon) and a smaller instrument intended for a more precise application. Our sample of clinicians also tended to use more force than what has been shown to decrease pain pressure threshold in humans experiencing DOMS.[6] This could be the result of participants being trained to apply more force when treating a tight muscle (ie, treatment scenario) versus in patients with DOMS. While our sample is not large enough to fully assess the effect of training differences, it is notable that our 2 clinicians with the highest average peak and mean force values were primarily trained in the Graston Technique (Table 1).

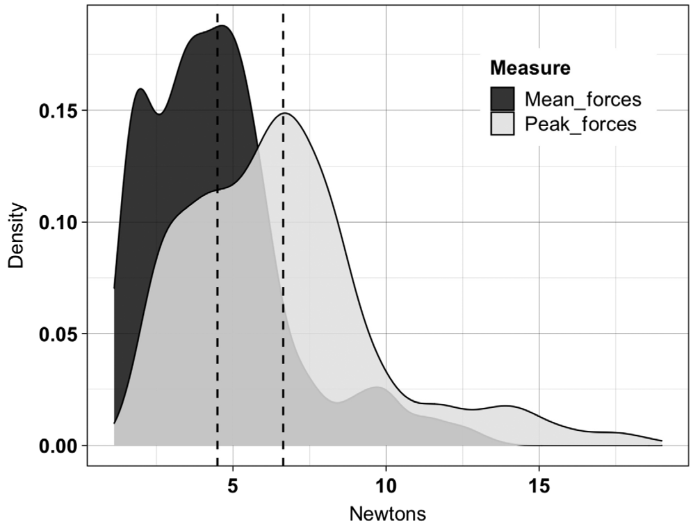

Figure 4 — Density plot for forces from all clinicians, instruments, and strokes. The dashed lines represent the average peak and mean forces.

Although assessment of IASTM force application is valuable, the quantification of force application during an IASTM treatment is challenging. Prior investigations using a rat model reported an estimate of the amount of force applied, based on kinesthetically similar pressures produced on a force plate.[5,6] Researchers have also estimated IASTM force production by using only the weight of the instrument[6] or with electronically instrumented tools to measure force during an IASTM intervention.[10] We directly measured normal forces applied by the clinician through a force plate, which may be a more accurate measurement of IASTM forces. However, our methods may not accurately represent clinical practice. This could be part of the reason that only 4 of our 8 clinicians, who reported a numerical estimate of their force production after the trial, did so accurately (Table 1). Two of the clinicians who did not quantify their forces reported that they thought forces varied between instruments, the other was unsure. Until instrumentation for quantifying forces from IASTM becomes more readily available, it will be difficult for clinicians to accurately judge how much force they are applying in practice.

Because we used a simulated treatment scenario, there are factors that could have influenced the amount of force applied by our clinicians. For example, our simulated tissue was void of myofascial adhesions and strokes were only applied in a unilateral direction. We also did not adjust the height of the treatment table relative to the height of the clinician. In practice, clinicians may be seated or adjust patient positioning for improved stability. A majority of the clinicians in our sample also had a similar training background (ie, Técnica Gavilán), which may have had an influence on the forces they applied. Future research should begin to examine the IASTM forces used by clinicians on healthy human tissue and when myofascial adhesions are identified.

By examining the forces produced across 5 instruments of varied sizes, shapes, weights, and bevels, we provided the best available evidence for the IASTM forces that may be applied by clinicians in practice. Our sample of clinicians produced forces greater than those used in soft tissue rat models[7–9] or human DOMS trials,[6] but our data were similar to previously conducted research examining IASTM application to the gastrocnemius.[11] The data we reported in this study provide a range of forces for researchers to examine when assessing different IASTM force applications on patient outcomes. While standardized IASTM forces have yet to be developed or refuted, clinicians should consider force as a variable in their IASTM treatment protocols.

References

1. Cheatham S, Lee M, Cain M, Baker R. The efficacy of instrument assisted soft tissue mobilization: a systematic review. *J Can Chiropr Assoc*. 2016;60(3);200–211.
2. Seffrin C, Cattano N, Reed M, Gardiner-Shires A. Instrument-assisted soft tissue mobilization: a systematic review and effect-size analysis. *J Athl Train*. 2019;54(7):808–821.
3. Baker R, Start A, Larkins L, Burton D, May J. Exploring the preparation, perceptions, and clinical profile of athletic trainers who use instrument-assisted soft tissue mobilization. *Athl Train Sports Health Care*. 2018;10(4):169–180.
4. Hammer W. The effect of mechanical load on degenerated soft tissue. *J Bodyw Mov Ther*. 2008;12:246–256.
5. Baker R, Nasypany A, Seegmiller J. Instrument-assisted soft tissue mobilization treatment for tissue extensibility dysfunction. *Int J Athl Ther Train*. 2013;18(5):16–21.
6. Cheatham S, Kreiswirth E, Baker R. Does a light pressure instrument assisted soft tissue mobilization technique modulate tactile discrimination and perceived pain in healthy individuals with DOMS? *J Can Chiropr Assoc*. 2019;63(19):18–25.
7. Loghmani T, Warden S. Instrument-assisted cross-fiber massage accelerates knee ligament healing. *J Orthop Sports Phys Ther*. 2009;39(7):506–514.
8. Loghmani T, Warden S. 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):1–9.
9. Gehlsen G, Ganion L, Helfst R. Fibroblast responses to variation in soft tissue mobilization pressure. *Med Sci Sports Exerc*. 1999;31(4):531–535.
10. Cheatham S, Baker R, Larkins L, Baker J, Casanova M. Instrument assisted soft-tissue mobilization: a survey of practice patterns among allied health professionals. *J Athl Train*. In Press. doi:10.4085/1062-6050-0047.20
11. Vardiman J, Siedlik J, Herda T, et al. Instrument-assisted soft tissue mobilization: effects on the properties of human plantar flexors. *Int J Sports Med*. 2015;36(3):197–203.
12. Stanek J, Sullivan T, Davis S. Comparison of compressive myofascial release and the Graston Technique for improving ankle dorsiflexion range of motion. *J Athl Train*. 2018;53(2):160–167.
13. Ikeda N, Otsuka S, Kawanishi Y, Kawakami Y. Effects of instrument-assisted soft tissue mobilization on musculoskeletal properties. *Med Sci Sports Exerc*. 2019;51(10):2166–2172.
14. Kim J, Sung D, Lee J. Therapeutic effectiveness of instrument-assisted soft tissue mobilization for soft tissue injury: mechanisms and practical application. *J Exerc Rehabil*. 2017;13(1):12–22.