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Descriptive Analysis of Forces Applied by Trained Clinicians During 2-Handed Instrument-Assisted Soft Tissue Mobilization

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Instrument-assisted soft tissue mobilization (IASTM) is a common intervention among clinicians. Despite its popularity, little is known about the forces applied by the clinician using the instruments during treatment. The purpose of this investigation was to examine the forces applied by trained clinicians using IASTM instruments during a simulated treatment. Eleven IASTM–trained (Graston Technique, Técnica Gavilán, or Rock-Blades) clinicians (physical therapists = 2, chiropractors = 2, athletic trainers = 7) participated in the study. Each clinician performed 75 two-handed strokes distributed evenly across 5 IASTM instruments on a skin simulant attached to a force plate. Instrument-assisted soft tissue mobilization stroke application was analyzed for peak normal forces and mean normal forces by stroke. We observed an average peak normal force of 8.9 N and mean normal force of 6.0 N across all clinicians and instruments. Clinicians and researchers may use the descriptive values as reference for the application of IASTM in practice and research.

Key Words: massage, Graston technique

Key Points

- Instrument-assisted soft tissue mobilization 2-handed force simulation suggested variability among trained clinicians.
- Clinicians may be underestimating the applied instrument-assisted soft tissue mobilization force during treatment.

Clinicians use instrument-assisted soft tissue mobilization (IASTM) to treat musculoskeletal conditions by applying specifically designed instruments to enhance tissue healing (eg, promote healing, reduce scar tissue formation).[1,2] A common therapeutic hypothesis is that IASTM introduces tissue microtrauma to create an acute inflammatory process in order to enhance fibroblast activation and collagen alignment and maturation.[3] Instruments are also thought to provide clinicians with a mechanical advantage,[2,3] enhanced detection of altered soft tissue structures,[2,4] and improved patient outcomes.[1,2] Clinicians may use various instruments (eg, commercial instruments, stone) of different designs (eg, weight, shape, edge beveling) to apply IASTM with or without formal IASTM training.[2,5]

Clinicians should consider treatment variables (eg, instrument material, stroke type, stroke direction, stroke angle) when using IASTM.[6] Researchers[2,5] have used surveys to explore IASTM training, application, and practice patterns among clinicians. The survey responses indicated that formally trained clinicians had substantial variations across training and IASTM application (eg, treatment time, adjunct interventions used),[2,5] including a substantial portion (approximately 20% of respondents) who stated they rarely or never followed the application recommendations of their IASTM training.[5] Further, clinician force application estimations have varied from lighter forces (ie, $\leq$500*g*) to more moderate forces (ie, $\geq$500*g*) to not considering force application during treatment.[5] Thus, IASTM force applications are often not controlled, standardized, or considered.[5,6]

Evidence for the physiological effect of IASTM force application is based primarily on animal models.[7–9] Investigators[7] have demonstrated that short durations of increased force (ie, 0.5–1.5 N; approximately 51*g*–153*g*) enhanced fibroblast proliferation as the force increased. Thus, the fibroblastic response has been thought to depend on the mechanical force applied during treatment[7–9] and may be beneficial for tissue remodeling in humans.[1,3] Researchers[10] have also shown that a light-pressure (208g or 2.04-N) application improved the pain pressure threshold in those with delayed-onset muscle soreness (DOMS);

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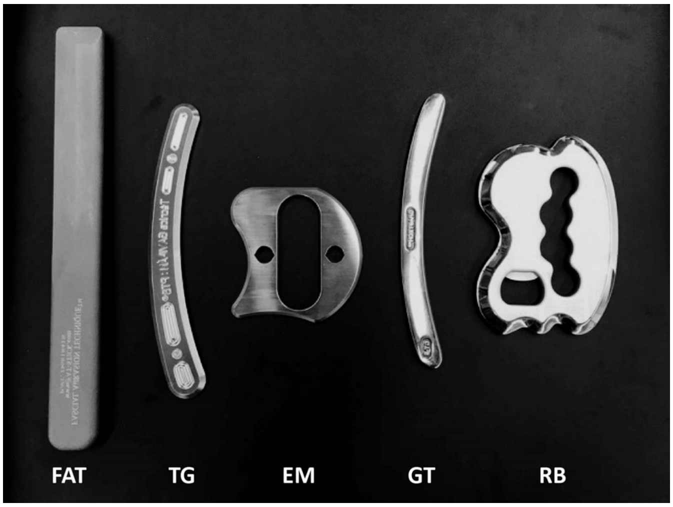

Figure 1. The 5 different instruments used in the study. Instruments in order from left to right: (1) Fascial Abrasion Technique (FAT) FAT Stick, mass = 293 g; (2) Técnica Gavilán (TG) Ala, mass = 196 g; (3) EDGE Mobility System (EM) Edge Tool, mass = 196 g; (4) Graston Technique (GT) GT #5, mass = 156 g; (5) RockBlades (RB) Mullet, mass = 178 g.

others[11] reported that larger treatment forces (range = 2.6–9.1 N) did not change inflammatory markers, range of motion (ROM), or maximum voluntary contraction peak torque in healthy participants.

High IASTM force application may also have unintended, undesired, or detrimental outcomes. Discomfort and bruising (eg, petechiae) are commonly mentioned adverse effects that may be related to higher IASTM forces, longer treatment sessions, repeated treatment sessions, or some combination of these factors.[6] Force parameters are informed by either limited research using tools instrumented with a force-feedback device,[7,11] estimated force application after practicing on a force plate in animal models,[8,9] or force estimates based on the weight of the instrument.[10] Wide force variations in the literature, a paucity of force recommendations in IASTM training courses, and a lack of evidence-based guidelines on the appropriate amounts of force to use cause clinicians to rely on intuition, patient feedback, personal preference and experience, or commercial IASTM training to guide treatment.[5,6]

Survey responses indicate that deviations from IASTM training recommendations occur and that clinicians may substantially underestimate their IASTM forces.[5] Thus, identifying the forces used by trained clinicians during IASTM may benefit clinical practice by providing more accurate information regarding treatment forces. Further, identifying IASTM forces may better inform study design by providing insight into potential force ranges used by clinicians. Therefore, the purpose of our study was to examine the forces used during a simulated 2-handed IASTM treatment to provide descriptive data regarding the range of quantified IASTM forces (ie, peak normal force [F_{peak}] and mean normal force [F_{mean}]) produced by IASTM–trained clinicians.

METHODS

The study was a randomized crossover study with IASTM–trained clinicians performing a simulated IASTM treatment with 5 instruments of different sizes, shapes, weights, and bevels. The 5 instruments used in this study were produced by different manufacturers (Figure 1): (1) Fascial Abrasion Technique (FAT), (2) Técnica Gavilán, (3) EDGE Mobility System, (4) Graston Technique, and (5) RockBlades. Participants performed 15 two-handed strokes using each instrument during a simulated treatment scenario for data acquisition. Data were collected during a single session lasting approximately 30 minutes in a university biomechanics laboratory. The study was approved by the university institutional review board, and all participants provided informed consent.

Table 1. Clinician Instrument-Assisted Soft Tissue Mobilization (IASTM) Demographics

Clinician	Manufacturer IASTM Training Completed	IASTM Experience, y	Frequency of IASTM Use in Clinical Practice
1	RB, TG	12	Rarely
2	TG	1	Frequently
3	TG	2	Frequently
4	GT, TG	6	Frequently
5	GT	5	Never
6	TG	9	Frequently
7	GT	4	Frequently
8	GT, RB, TG	10	Daily
9	TG	15	Rarely
10	TG	2	Rarely
11	TG	11	Frequently

Abbreviations: GT, Graston Technique; RB, RockBlades; TG, Técnica Gavilán.

Participants

A convenience sample of 11 trained clinicians (physical therapists = 2, chiropractors = 2, athletic trainers = 7) finished the study. Clinicians were included if they had previously completed at least 1 professional or commercial IASTM training course. Demographic (eg, clinician experience, IASTM training completed) and practice (eg, how often IASTM was used in practice) information was collected via an electronic survey (Qualtrics; Table 1). Participants reported taking Técnica Gavilán (n = 9), Graston Technique (n = 4), and RockBlades (n = 2) IASTM courses. Licensed clinical experience using IASTM ranged from 1 to 15 years (mean = 7 ± 4.6 years, median = 6 years), with variations in how often IASTM was currently used in clinical practice (*never* = 1 participant, *rarely* = 3 participants, *frequently* = 6 participants, *daily* = 1 participant).

Procedure

A skin simulant was affixed to a force plate (model HE6x6; Advanced Medical Technology, Inc) and stabilized on a treatment table (Figure 2). The skin simulant (Complex Tissue Model; Simulab Corp) had a 1-in (2.54-cm) thickness and replicated skin, subcutaneous fat, fascia, and preperitoneal fat. Participants were provided with the opportunity to use all 5 tools on the skin simulant and force plate before data collection. They applied their desired amount of emollient to the skin simulant and applied strokes with each tool to the skin simulant and force plate until they reported feeling comfortable applying the

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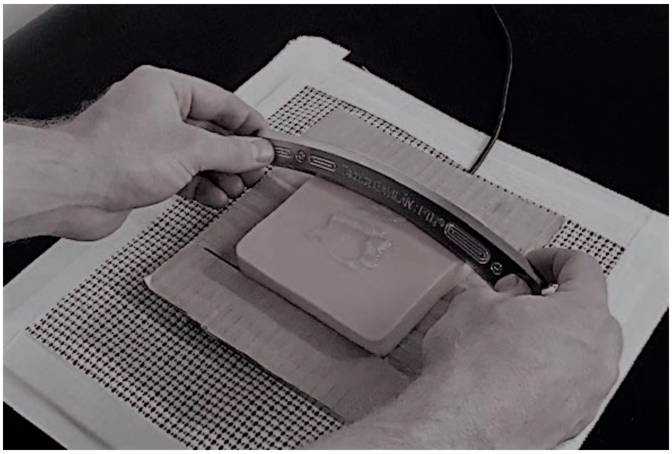

Figure 2. Image depicting the use of the Técnica Gavilán Ala (mass = 196 g) instrument during the simulated treatment scenario.

treatment stroke to the skin simulant and force plate with each instrument. The skin simulant was then cleaned and calibrated by the research team before data collection began.

After instrument familiarization, participants were read a standardized case description of an otherwise healthy patient experiencing gastrocnemius tightness and were informed that their evaluation had determined that IASTM application was an indicated treatment. They were then asked to perform the IASTM strokes on the skin simulant and force plate as if they were treating the described patient using 5 unidirectional sweeping strokes (lifting between strokes) for each of the 5 IASTM instruments on the simulated tissue. After the 5 strokes, the process was repeated through 2 additional trials (15 for each instrument) and repeated for each of the 5 instruments (a total of 75 strokes). Instrument order was randomized for each participant, and the average stroke duration was approximately 1 second. Data collected with the force plate were recorded at 500 Hz and acquired with NetForce software (version 3.5.3; Advanced Medical Technology, Inc); the force plate was calibrated between instruments and participants. The acquired data were exported into MATLAB (version 2019b; The MathWorks, Inc) to be filtered using a 10-Hz low-pass Butterworth filter so that we could determine the beginning and end of each stroke.

Data Analysis

Descriptive data for *average* F_{peak} (the sum of maximum vertical forces for each stroke divided by the number of trials) and *average* F_{mean} (the sum of mean vertical forces produced across the entire length of a single stroke divided by the number of trials) were collected for analysis. The F_{peak} and F_{mean} calculations were used to create descriptive plots and charts. Plots were created with R (version 3.6.2; The R Foundation for Statistical Computing Platform), and descriptive data were calculated in Excel (version 16.3; Microsoft Corp).

RESULTS

The IASTM–trained clinicians produced an average F_{peak} of 8.9 N and an average F_{mean} of 6.0 N across all instruments. For individual clinicians, the maximum F_{peak} spanned 4.2 to 21.3 N, and the minimum F_{peak} ranged from 1.1 to 11.2 N (Table 2; Figure 3; Supplemental Figures 1 and 2). Observed maxima for F_{mean} spanned 3.1 to 15.3 N, and minima for F_{mean} spanned 0.9 to 7.4 N. The difference between maxima and minima (range of forces) averaged 8.6 N for F_{peak} and 6.1 N for F_{mean} (Table 2).

DISCUSSION

Evidence-based recommendations on the amount of force to use during an IASTM intervention are lacking. Further, clinicians have indicated an inability to quantity the force used during an IASTM intervention and a willingness to deviate from the recommendations provided in their IASTM training.[5,6] We need to identify the forces used by trained clinicians during IASTM interventions to inform clinical practice and research design. Our purpose was to examine the forces used during a simulated 2-handed IASTM treatment to provide descriptive data regarding the IASTM forces (ie, F_{peak} and F_{mean}) produced by IASTM–trained clinicians. To our knowledge, this is the first study to document IASTM applied peak and average force by multiple trained clinicians during a 2-handed treatment using simulated tissue on a force plate. Our results indicated that wide ranges of F_{peak} and F_{mean} were used by clinicians who shared similar IASTM training (Tables 1 and 2; Figure 2; Supplemental Figures 1 and 2). Force variations may be related to differences in clinician experiences, intended treatment goals (eg, tissue adhesion breakdown), prior training, or challenges in estimating the applied force during treatment.

In a recent survey,[5] most clinicians (n = 606, approximately 80%) either did not know how to quantify the force being used (n = 344, 45%) or did not try to quantify the force used during IASTM treatment (n = 262, 34.3%). Of those who tried to quantify force (n = 153, approximately 20%), most (n = 101) estimated applied forces of 250 to 500*g* (2.45–4.90 N). Few respondents identified either *light force* (ie, $\leq$100*g* or 0.98 N, n = 25) or *substantial force* (ie, $\geq$500*g* or 4.90 N, n = 5) as being used during treatment.[5] Most of our participants (n = 9, 82%) produced average F_{peak} and F_{mean} forces greater than 5.9 N, and the group averages were 8.9 N and 6.0 N, respectively (Table 2). Our participants were relatively accurate in estimating applied force (Table 2); however, they generally estimated and produced forces that greatly exceeded prior clinician estimates.[5]

The estimated IASTM force applied may be influenced by the desired outcomes (eg, initiating an inflammatory response) and how prior studies were presented in IASTM training courses, at educational events, or during informal instruction.[2,5,6] For example, researchers[7] examining tendinitis in a rat model indicated that 1.5 N (approximately 153*g*) of force increased fibroblast proliferation compared with 1 N (approximately 102*g*). Further, a force of 250*g* to 300*g* (2.45–2.94 N) increased vascular perfusion and accelerated ligament healing of medial collateral ligament injuries in a rat model.[8,9] Thus, one may conclude that higher applied forces result in improved outcomes based on animal model research. In contrast, a light “feather stroke” (208*g* or 2.04 N) was applied to human rectus femoris after DOMS was induced. Improved 2-point discrimination and

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Table 2. Peak and Mean Forces (N) Applied by Clinicians for All Instruments Combined and Estimated Forces Reported After the Simulated Treatment

Clinician	Force Estimate	Measure	Maximum	Minimum	Range	Average
1	5–10	F_{peak}	11.2	4.8	6.4	7.7
		F_{mean}	8.2	3.3	4.9	5.5
2	0–5	F_{peak}	5.9	2.8	3.1	4.3
		F_{mean}	4.4	1.9	2.5	2.9
3	Varied	F_{peak}	15.5	4.1	11.4	9.5
		F_{mean}	8.8	2.6	6.2	5.8
4	Varied	F_{peak}	12.7	5.2	7.5	8.5
		F_{mean}	8.6	2.7	5.9	5.4
5	15–20	F_{peak}	16.7	5.4	11.3	11.4
		F_{mean}	12.5	2.7	9.8	7.8
6	5–10	F_{peak}	15.3	5.1	10.2	10.4
		F_{mean}	9.3	3.2	6.1	6.1
7	Unknown	F_{peak}	21.3	11.2	10.1	16.1
		F_{mean}	15.3	7.4	7.9	11.6
8	5–10	F_{peak}	13.6	4.6	9.0	9.5
		F_{mean}	11.0	3.6	7.4	7.3
9	0–5	F_{peak}	4.2	1.1	3.1	2.4
		F_{mean}	3.1	0.9	2.2	1.9
10	Varied	F_{peak}	18.3	5.6	12.7	10.7
		F_{mean}	12.6	3.9	8.7	7.2
11	0–5	F_{peak}	11.6	2.0	9.6	7.2
		F_{mean}	7.0	1.1	5.9	4.4
Overall	NA	F_{peak}	13.3	4.7	8.6	8.9
		F_{mean}	9.2	3.0	6.1	6.0

Abbreviations: F_{mean}, mean force; F_{peak}, peak force; NA, not available.

pain pressure threshold were found at 24 and 48 hours posttreatment; however, force quantification was not performed to ensure that the applied force was 208*g*.[9]

Instrument-assisted soft tissue mobilization is also commonly used in healthy patients or to address impairments (eg, decreased ROM).[3–6] The gastrocnemius, which served as the simulated treatment site in our study, was treated in recent investigations[11–13] in which the effects of IASTM on muscle properties and ROM in healthy participants were examined. Authors of only 1 study[11] quantified the force used, with force ranges for a single clinician of 4.68 to 9.07 N (495.58–924.88*g*) and 2.63 to 4.47 N (268.19–455.81*g*) for F_{peak} and F_{mean}, respectively. An IASTM intervention session (7–8 minutes, 3 sets of 7 strokes in the proximal and distal directions across 4 treatment sections) did not produce significant changes in inflammatory markers, passive musculotendinous stiffness, passive ROM, or maximum voluntary contraction peak torque.[11] Patient-perceived pain and function were initially impaired posttreatment,[11] which contradicted IASTM findings with light strokes,[9] as well as the results commonly reported in case studies and series.[1,6,14,15] The forces used by most of our participants were similar to those reported by Vardiman et al[11]; however, our results (Table 2) indicated that some clinicians (eg, participant 9) used lower force ranges, whereas others (eg, participant 7) used higher forces on simulated tissue.

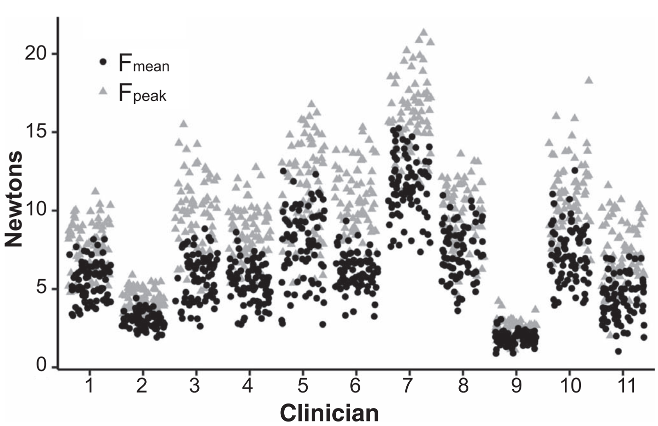

Figure 3. Mean and peak force (F_{mean} and F_{peak}) distribution by clinician across all instruments. The y-axis represents force in newtons.

Currently, the optimal IASTM force levels to maximize patient outcomes across different patient scenarios are unknown. Force variations across different instruments (eg, materials, edge beveling, brands), stroke application (eg, stroke type, 1-handed versus 2-handed strokes), intended treatment goals, treatment locations, and clinician training or experiences are also unknown. Our findings, along with prior research,[5,11] indicated that clinicians may grossly underestimate the forces used during 2-handed IASTM treatment and that these forces may greatly exceed those used in animal models[7–9] or for neuromodulation.[10] Preliminary research may also reflect that higher force levels during a single IASTM treatment may negatively influence patient-reported pain and function,[11] yet lighter forces may result in acute pain reduction.[9] Although our sample was limited (eg, IASTM training), we provide preliminary evidence that clinicians who complete certain training programs may tend to produce higher or lower forces during IASTM treatment (Table 1). Our results also showed substantial variations in F_{mean} and F_{peak} within and between clinicians, which may help explain varied outcomes in the IASTM literature.[5]

However, our study was limited by other factors that may influence IASTM application in practice. Our simulated

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case was standardized (eg, 1 treatment table height) with a scenario (eg, simulated tissue, strokes applied in a unilateral direction) that may have influenced the force application. Further, most participants had completed a single IASTM training course from 1 professional entity (ie, Técnica Gavilán; Table 1). We also asked participants to use only 5 instruments to apply only 1 type of IASTM stroke; it is possible that force production varies based on the treatment stroke (eg, type, speed, desired outcome), instrument (eg, FAT-Tool Stick versus FAT-Tool Pro Large, Técnica Gavilán Ala versus Garra, RockBlades Mallet versus Mohawk), treatment goal or scenario, or clinician IASTM training or experience. Research is needed to determine how different IASTM trainings, instruments, experiences, treatment goals, treatment areas, clinician-perceived tissue feedback, and patient feedback influence force application in practice and patient outcomes.

CONCLUSIONS

Our results provide insight into the amount of force applied by trained clinicians during a simulated 2-handed IASTM treatment scenario. Most participants used similar force ranges; however, the forces used exceeded those reported in soft tissue animal model studies, human DOMS trials, and clinician estimates. Optimal force production during IASTM treatment has not been established, but clinicians and researchers may consider our findings while designing studies or implementing IASTM in practice.

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SUPPLEMENTAL MATERIAL

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Supplemental Figure 2. Found at DOI: https://doi.org/10.4085/1062-6050-0282.21.S2

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