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Human Kinetics
ORIGINAL RESEARCH REPORT

Comparison of the Graston Technique® With Instrument-Assisted Soft Tissue Mobilization for Increasing Dorsiflexion Range of Motion

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Context: Limited dorsiflexion (DF) range of motion (ROM) is commonly observed in both the athletic and general populations and is a predisposing factor for lower extremity injury. Graston Technique® (GT) is a form of instrument-assisted soft tissue mobilization (IASTM), used commonly to increase ROM. Evidence of the long-term effects of GT on ROM is lacking, particularly comparing the full GT protocol versus IASTM alone. ***Objective:*** To evaluate the effectiveness of 6 sessions of the GT or IASTM compared with a control (CON) group for increasing closed-chain DF ROM. ***Design:*** Cohort design with randomization. ***Setting:*** Athletic training clinic. ***Patients or Other Participants:*** A total of 23 physically active participants (37 limbs) with <34° of DF. Participants' limbs were randomly allocated to the GT, IASTM, or CON group. ***Intervention:*** Participants' closed-chain DF ROM (standing and kneeling) were assessed at baseline and 24–48 hours following their sixth treatment. Participants in the CON group were measured at baseline and 3 weeks later. The intervention groups received 6 treatments during a 3-week period, whereas the CON group received no treatment. The GT group received a warm-up, instrument application, stretching, and strengthening of the triceps surae. The IASTM group received a warm-up and instrument application. ***Main Outcome Measures:*** Closed-chain DF was assessed with a digital inclinometer in standing and kneeling. ***Results:*** A significant difference between groups was found in the standing position ($P = .03$) but not in kneeling ($P = .15$). Post hoc testing showed significant improvements in DF in standing following the GT compared with the control ($P = .02$). ***Conclusions:*** The GT significantly increases ankle DF following 6 treatments in participants with DF ROM deficits; however, no differences were found between GT and IASTM. The GT may be an effective intervention for clinicians to consider when treating patients with DF deficits.

Keywords: flexibility, manual therapy, myofascial release, rehabilitation

Limited dorsiflexion (DF) range of motion (ROM) is commonly observed in both the athletic and general populations and is believed to be a predisposing factor for lower-extremity injury.[1–4] A DF deficit can result from tightness of the muscles responsible for plantarflexion, specifically the gastrocnemius and soleus, a decrease in the posterior glide of the talus in the ankle mortise, and/or accessory motion loss at the tibiofibular, subtalar, and/or midtarsal joints.[5,6] A loss of terminal DF inhibits the ankle from attaining a stable closed-packed position during dynamic tasks,[7,8] and previous research has shown a deficit of <34° is predictive of injury.[9]

One treatment option that has been hypothesized to increase ROM is instrument-assisted soft tissue mobilization (IASTM).[10,11] This technique was developed from a method used in Chinese medicine called Gua Sha, which means to "scrape or rub the surface of the body to relieve blood stagnation."[12] The IASTM is designed to reduce clinician fatigue, increase the resonance felt through the instrument to detect adhesions, and allow for greater force and depth of treatment than what hands alone can produce.[11,13] The IASTM introduces microtrauma to an area with soft tissue restrictions and may evoke an inflammatory response to stimulate fibroblast recruitment and connective tissue remodeling and promote scar tissue breakdown and fascial adhesion release.[13–15] There are multiple IASTM techniques and instruments available, such as augmented soft tissue mobilization (Astym®), fascial abrasion technique (FAT), sound-assisted soft tissue mobilization, and the Graston Technique® as well as numerous others.[16]

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Graston Technique® (GT; Graston Technique, LLC, Indianapolis, IN) is a form of IASTM that utilizes specifically designed stainless steel instruments to detect and treat soft tissue dysfunction.[11,17] However, while IASTM involves only the application of the instruments as a myofascial treatment, GT has a prescribed protocol of soft tissue warm-up, IASTM application using specific strokes, stretching, strengthening, and the option of cryotherapy.[17] The GT is believed to improve musculoskeletal function and pain-free movement.[17] The GT protocol recommends the application of 4 to 12 treatments to an area before reevaluation for alternative therapy.[17] The GT assessment and treatment should follow a progression starting with scanning of the region, identifying any adhesions, and then treating those adhesions.[17]

Frequently, published studies reference using the GT, however, modify or exclude parts of the recommended protocol.[8,11,18–20] To our knowledge, no previous research has directly compared the full GT protocol, including soft tissue warm-up, instrument application, stretching, and strengthening, with only instrument application for increasing DF ROM. Therefore, the purpose of this study was to examine the effects of the GT protocol on improving DF ROM and to compare this with IASTM alone and a control (CON) group. We hypothesized that the GT would show greater increases in weight-bearing DF ROM when compared with IASTM as a stand-alone treatment or no intervention.

Methods

Design

A randomized, cohort study design was used to compare the GT protocol, IASTM, and CON group for improving DF ROM. The participants were required to visit the athletic training clinic for a total of 7 visits. A minimum of 48 hours of rest was provided between each treatment session. Participants were randomized into 1 of 3 groups using block randomization to keep the groups balanced with block sizes of 3 (1, 2, 3, 1, 2, 3, etc).

Participants

Based on the power analysis calculator G*Power 3 (Heinrich-Heine-Universitat, Dusseldorf, Germany)[21] for the analysis of variance statistic with a power = 0.80, alpha level = .05, moderate effect size ($f = 0.6$), and the means and SDs from a previous study on DF ROM,[22] the estimated sample size for the study was 30 limbs. To assess the effectiveness of GT on DF ROM, both limbs of 43 participants were initially recruited via in-class announcements throughout the School of Kinesiology and Recreation and screened for inclusion. A total of 24 healthy participants (10 males and 14 females) for a total of 37 limbs met the inclusion criteria and volunteered to participate (Figure 1). Demographic data for study participants are presented in Table 1. The Inclusion criteria required participants to meet the minimum ACSM guidelines[23] for physical activity and to have a standing DF measure of <34° in one or both ankles. Less than 34° of closed-chain DF has previously been associated with a 2.5 times increased risk of injury.[9] Exclusion criteria included any recent (within the past 6 mo) lower-extremity injury, any previous lower-extremity surgeries, any current treatment to the triceps surae, allergy to the emollient used during treatment, burn scars or varicose veins over the calf area, kidney dysfunction, pregnancy, taking medications such as anticoagulants, steroids, hormone replacements, nonsteroidal anti-inflammatory drugs, and/or fluoroquinolone antibiotics, healing wounds, or a contagious/infectious skin disease. The qualifying participants were asked, but none had any allergies to the emollient used (Graston Technique Soft Tissue Mobilization Emollient; Graston Technique LLC, Indianapolis, IN). All participants signed an informed consent form prior to participation, and the Illinois State University's Institutional Review Board approved the research.

Measurements

To determine the study eligibility, we measured closed-chain DF ROM using a digital inclinometer (SmartTool Pro 3600; Swiss Precision Instruments, Inc, Garden Grove, CA) with the participant's knee straight (standing DF ROM).[8] Ankles with <34° were included and randomly allocated to a group using block randomization. Previous research has shown this to be a reliable and valid method for assessing ankle ROM.[24–27] Three research assistants with a minimum of 2 years of goniometric experience measured ROM throughout the study. One clinician performed all instrument application, and exercise instruction was blinded to all measurements. The rater aligned the digital inclinometer along the anterior crest of the tibia so that the proximal end was immediately distal to the tibial tuberosity and the distal end aligned along the tibial crest (Figures 2 and 3). The angle of the tibia relative to the horizontal was measured, and readings were recorded in degrees. Before starting data collection, pilot testing was completed on both ankles of 10 individuals to calculate reliability. The interrater reliability for the standing measurement was high with an interclass correlation coefficient of .96 (95% confidence interval, .93 to .98; standard error of measurement = 1.4°). The interclass correlation coefficient for the kneeling measurement was .95 (95% confidence interval, .92 to .97; standard error of measurement = 1.3°).

To assess standing DF, each participant removed their shoes and positioned themselves with both hands on the wall in front of them. The participant placed the dominant foot on a tape line so that the second toe and center of the heel were directly over the tape. This was done to reduce subtalar joint pronation, which has been shown to affect ankle DF.[27] The participant leaned forward while maintaining full knee extension and heel contact with the ground (Figure 2). The nondominant limb remained in a position to maintain balance and not restrict any DF of the dominant limb. The participant was instructed to lean forward until they first felt a stretch in their calf and/or when they felt their heel begin to rise. Three trials were measured, returning to neutral between each measurement. The mean value of the 3 measurements was documented and used for data analysis. Measurements were then repeated on the nondominant limb.

For the kneeling measurement, the participant was instructed to kneel on the leg opposite from the one being tested with the test leg visually placed in 90° of hip and knee flexion. The participant placed their front foot on the tape line as previously stated. The participant was then instructed to lunge forward while keeping their heel in contact with the ground and their foot in line with the tape. The participant was instructed to lunge forward until they first felt a stretch in their distal calf and/or the heel began to rise. The average of 3 measurements were recorded.

Procedures

The participants met with the investigators to complete preparticipation questionnaires prior to beginning their first session. All procedures occurred over a 3-week time period for each qualifying participant. First, baseline ROM was performed as previously described to determine enrollment status. Qualifying limbs were randomly allocated to 1 of 3 groups, CON, IASTM, or GT, using block randomization. In instances when the participant's dominant and nondominant limbs qualified, they were both allocated to the same group. Limb dominance was self-reported by each participant as the preferred kicking limb.

Participants in the GT group reported to the athletic training clinic for each session. The author applying the GT was certified in the M1 Basic Training course, followed the guidelines when administering the intervention, and had approximately 1 year of experience.[17] Participants were instructed to ride a stationary bike (moderate resistance) for 5 minutes to warm up the triceps surae. The participant then lay prone on a treatment table with their feet hanging off the table and with the edge of the table resting above the talocrural joint in a comfortable position for the patient. The GT emollient was applied with the clinician's hands to the triceps surae. A sweeping stroke was used initially with the GT5 instrument to scan the calf for adhesions for 1 minute (Figure 4). Next, the GT4 instrument was used to focus on adhesions for the remaining 4 minutes, and specific adhesions were treated for not more than 60 seconds per treatment (Figure 5). The clinician also felt for any soft tissue deformities, such as trigger points or crepitus. For the first session, instruments were held at a 30° to 45° angle while moderate pressure was maintained and sweeping, fanning, and scooping strokes were used in all directions. As the sessions progressed on, the treatment angle increased to 60° while also increasing the pressure maintained to increase intensity of treatment throughout the 6 sessions. The total treatment time was 5 minutes regardless of whether all adhesions had been treated. The clinician closely monitored the patient's comfort throughout each treatment session. When the treatment was over, the emollient was

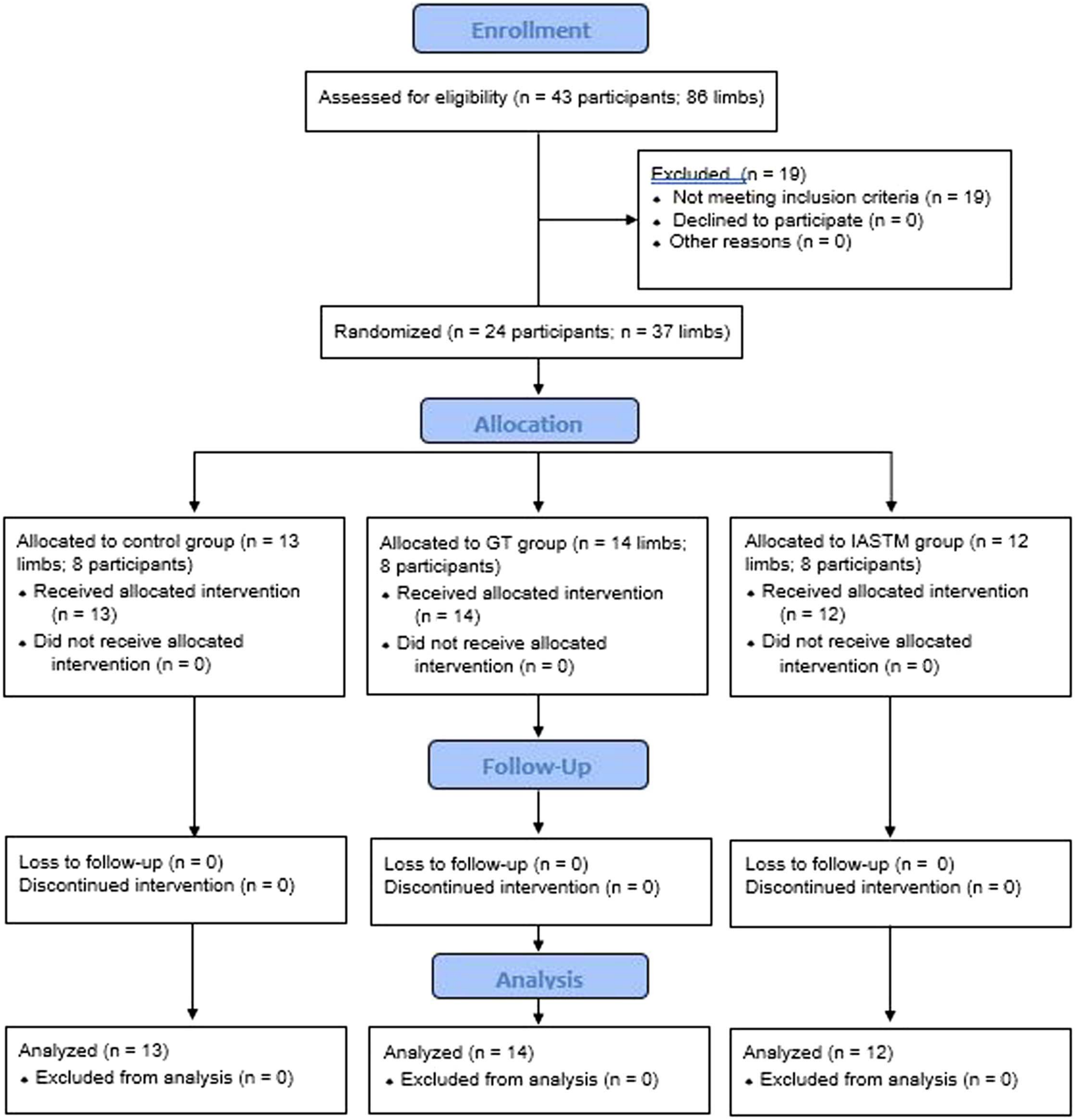

Figure 1 — CONSORT flow diagram. GT indicates Graston Technique; IASTM, instrument-assisted soft tissue mobilization.

wiped off with a clean towel. The participant was then instructed to perform calf stretches on the slant board, holding each stretch for 30 seconds. The stretch was performed 3 times with an extended knee (Figure 6) and 3 times with a flexed knee (Figure 7). Finally, the participant performed 1 set of 15 repetitions of calf raises (Figure 8), flexed knee calf raises (Figure 9), and single-leg eccentric calf raises on a step (Figure 10). For the eccentric calf raise, the participant was instructed to slowly lower from the top position to the bottom position of the movement. Each participant completed 6 treatment sessions.

Participants in the IASTM group reported to the athletic training clinic for each visit. This group performed the same procedures as the GT group, except the stretches and exercises following the instrument application were omitted. However, the exact same

Table 1 Demographic Data by Group

Group	N (limbs)	Age, y	Height, cm	Weight, kg
Control	13	19.8 (1.0)	166.7 (9.0)	64.4 (14.3)
IASTM	12	21.1 (3.0)	165.1 (10.6)	57.8 (10.2)
GT	14	20.5 (1.6)	169.9 (6.1)	64.2 (22.3)
All participants	37	20.5 (1.7)	167.2 (7.6)	62.2 (17.3)

Abbreviations: GT = Graston technique; IASTM = instrument-assisted soft tissue mobilization.

Figure 2 — Standing weight-bearing DF ROM measurement.

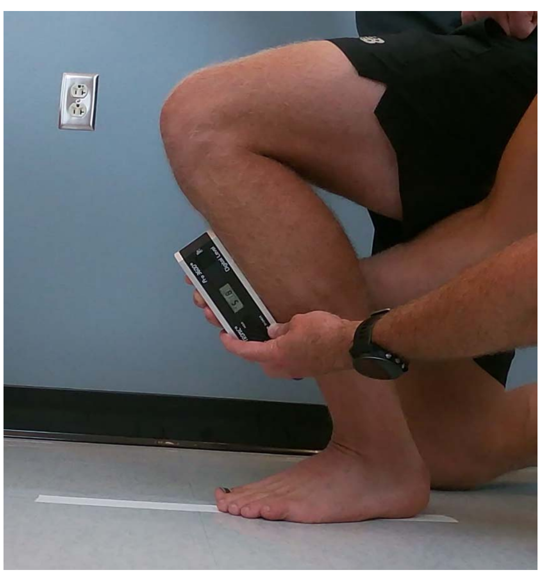

Figure 3 — Kneeling weight-bearing dorsiflexion range of motion measurement.

warm-up and instrument application was replicated for this group of participants. Each participant completed 6 treatment sessions.

Participants in the CON group had their baseline measurements for DF ROM assessed during their first visit. Upon allocation to the CON group, these participants received no treatment. All participants returned to the clinic after 3 weeks for postmeasurements. Posttreatment measurements for the GT and IASTM groups occurred 24 to 48 hours following the sixth treatment. All participants, regardless of treatment group, were instructed to maintain their current physical activity regimen and avoid any changes to their exercise or stretching routines.

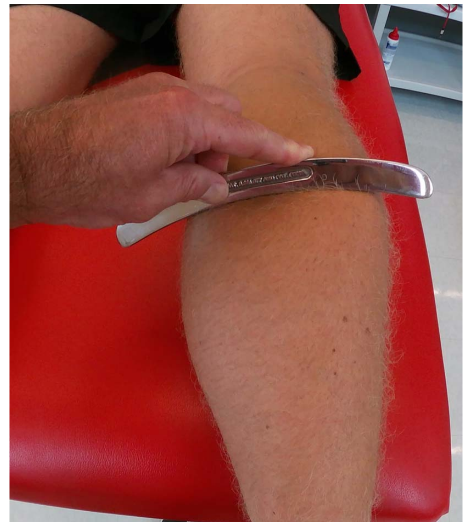

Figure 4 — Instrument-assisted soft tissue mobilization with Graston Technique® GT5 instrument.

Figure 5 — Instrument-assisted soft tissue mobilization with Graston Technique® GT4 instrument.

Statistical Analysis

All statistical analyses were performed using SPSS (version 22; IBM Corp, Armonk, NY). Preliminary analyses were conducted

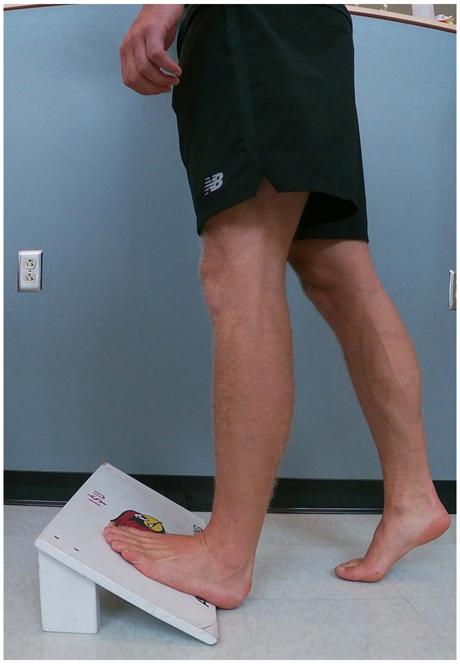

Figure 6 — Straight-leg calf stretch.

Figure 7 — Bent-leg calf stretch.

and showed no difference between groups for age ($P = .26$), height ($P = .39$), mass ($P = .19$), and standing ($P = .20$) or kneeling ($P = .20$) DF ROM. To compare the effects of the interventions on DF ROM, change scores were calculated by subtracting the baseline measurement from the posttreatment measurement in the standing and kneeling positions. Two 1-way analysis of variances were used to compare change scores across the 3 interventions for the standing and kneeling conditions. Differences identified by the analysis of variance were assessed using Tukey post hoc tests. Prior to running the analyses, preliminary assumption testing for

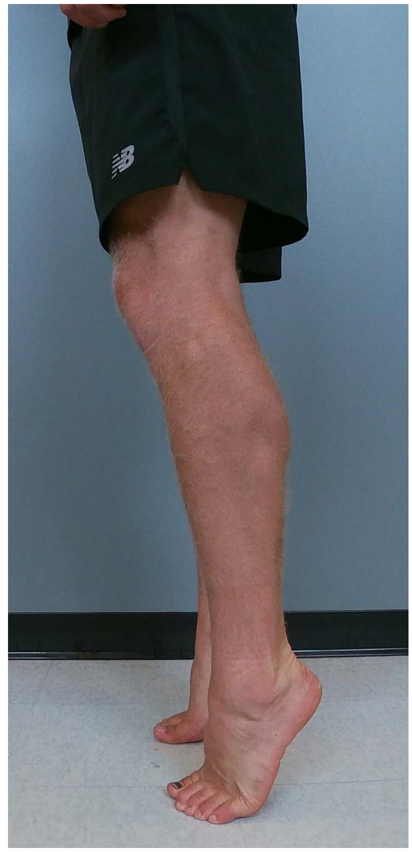

Figure 8 — Calf raise exercise.

normality and homogeneity of variance were completed with no violations. Effect sizes were calculated using the Cohen *d* and categorized as *trivial* (≤0.20), *small* (0.21–0.49), *moderate* (0.50–0.79), or *large* (≥0.80).[28] The alpha level was set a priori at $P < .05$.

Results

Means and SDs for all variables are reported in Tables 2 and 3. All limbs that were allocated to a group received the intended intervention and were analyzed posttreatment. A significant difference among groups was found in the standing ($F_{2,36} = 3.93$, $P = .03$) but not the kneeling ($F_{2,36} = 2.02$, $P = .15$) position. Post hoc analyses showed a significant difference between the GT and CON groups in standing DF ($P = .02$; effect size = 1.04; 95% confidence interval, 0.24 to 1.85) but no differences between CON and IASTM ($P = .39$) or the GT and IASTM ($P = .35$). No adverse reactions or unintended effects were reported by any participants.

Discussion

The purpose of this study was to evaluate the effectiveness of 6 treatments of the GT protocol or IASTM alone for increasing closed-chain DF ROM. Our findings partially supported our hypothesis by showing significantly greater increases in DF ROM in the standing position following the GT intervention. However, results did not show any differences between the GT and IASTM for either standing or kneeling DF ROM. To our knowledge, this is the first study to directly compare the GT protocol to IASTM as a stand-alone treatment but is most similar to Burke et al[29] who compared the GT to soft tissue mobilization with the clinician's hands. Patients in the study suffered from carpal tunnel syndrome, and findings showed improvements in subjective and objective measures, but there were no differences between the manual therapy techniques.[29]

Previous research has examined the effectiveness of improving DF ROM following the application of IASTM with mixed results.[8,18,30–32] Three[18,31,32] of these studies showed significant improvements in DF ROM following IASTM application, whereas 2[8,30] failed to show ROM gains. Our results add to this body of literature by showing significant increases in DF ROM in standing; however, these were only achieved using the full GT protocol of warm-up, instrument application, stretching, and strengthening exercise. These findings suggest the importance of including stretching and strengthening exercises for improving ROM to potentially remodel the tissue and enhance the effectiveness of the instrument application. Furthermore, although statistical significance was not reached, mean DF ROM gains of 3.85° were achieved in the kneeling position following the GT technique. Previous studies examining DF have indicated minimal detectable change (MDC) for closed-chain DF ROM to range from 1.5° to 6.4°[5,25,33] with one reporting a specific MDC value of 3.8°.[25] A recent systematic review stated that a limitation to many studies performed using IASTM is the reliance on *P* values. The authors cited the American Statistical Association and their concern with the dependence on *P* values and the neglected importance of treatment effect and clinical relevance in research today.[12,34] Based on our data and using the formula for calculating MDC, (MDC = standard error of measurement $\times 1.96 \times \sqrt{2}$), our MDC values ranged from 3.6° to 3.9°. Using these values, our results from the GT were demonstrating clinically relevant improvements in kneeling (3.85 [7.09]) and near clinically relevant improvements in standing (3.56 [5.14]) DF ROM. Results from the IASTM group showed only a 1° to 2° change in DF ROM for the 2 measurement positions. With further inspection of our data using the MDC of 3.8°, 1 (7.7%) ankle in the CON group exceeded MDC, whereas 3 (30%) and 7 (50%) achieved this in the IASTM and GT groups, respectively, for the standing position. Similar findings were also found in kneeling, with 0 (0%) ankles in the CON group exceeding the MDC, whereas 3 (30%) and 6 (42.9%) achieved this in the IASTM and GT groups, respectively.

Figure 9 — Bent-leg calf raise exercise.

We chose the DF deficit cutoff to be 34° based off the findings of Willems et al[1] and Pope et al,[9] who stated that having less than 30° or 34°, respectively, is predictive of injury. Rowlett et al[18] stated that a limitation of their study was using healthy individuals who did not have a DF ROM deficit and that participants' high

Figure 10 — Single-leg eccentric calf raise exercise start and end positions.

Table 2 Means and SDs for Standing Dorsiflexion ROM

	N (limbs)	Baseline	Postintervention	Change	95% CI
Control	13	22.42° (5.41°)	21.02° (5.77°)	−1.41° (4.32°)	−4.02 to 1.21°
IASTM	12	25.46° (4.11°)	26.49° (3.66°)	1.03° (4.50°)	−2.13 to 4.32°
GT	14	22.07° (5.56°)	25.64° (5.40°)	3.56° (5.14°)*	0.60 to 6.53°

Abbreviations: CI, confidence interval; GT, Graston Technique; IASTM, instrument-assisted soft tissue mobilization; ROM, range of motion.
*Significant difference from control group.

Table 3 Means and SDs for Kneeling Dorsiflexion ROM

	N (limbs)	Baseline	Postintervention	Change	95% CI
Control	13	29.88° (4.68°)	29.69° (4.22°)	−0.19° (2.32°)	−1.60 to 1.21°
IASTM	12	33.75° (5.71°)	35.67° (5.39°)	1.93° (5.20°)	−1.21 to 6.23°
GT	14	31.06° (5.60°)	34.91° (3.02°)	3.85° (7.09°)	−0.24 to 7.94°

Abbreviations: CI, confidence interval; GT, Graston Technique; IASTM, instrument-assisted soft tissue mobilization; ROM, range of motion.

initial values may have impacted the potential for change. We chose the higher end of the range for our cutoff and included participants with <34° of closed-chain DF ROM to decrease chances of the ceiling effect without negatively affecting the number of potential participants that would qualify. Despite these efforts, the IASTM group began the study with the greatest amount of DF ROM among the groups and, potentially, could have been affected by the ceiling effect.

Two recent systematic reviews on the effectiveness of IASTM have been published and both conclude that there are insignificant results for the efficacy of IASTM for improving ROM.[10,12] Furthermore, Nazari et al[12] concluded that the summarized studies included in the analysis were very low quality and lacked sound methodological quality. A major limitation for research on various IASTM techniques is the lack of standardization in the application of the treatment protocol and/or lack of formal training in the use of the technique. Previously published studies have significant variability in the study protocols, patient population, type of IASTM intervention, dosage time, and outcome measures. Cheatham et al[10] acknowledged these challenges by indicating that the insignificant results may be due to the methodological variability among studies. The authors went on to state "Perhaps, future studies should further define the intervention protocol by stating if the Graston® protocol was followed or just the tools were used."[10] Our study attempted to bridge this gap within the literature and our results suggest that there may be clinically important differences for improving DF ROM when using the GT compared with IASTM alone. Although manual therapy techniques such as GT and IASTM have been around for some time, the evidence for their effectiveness is still emerging. Clinicians are encouraged to continue to use sound, evidence-based decision making to address their patient needs.

Limitations

As with any research investigation, this study was not without limitations. First, we instructed participants to stop at the first point of tissue stretch and/or when they felt like their heel was going to lift off the ground during the ROM measures. This point of limitation is somewhat subjective; however, the same instructions were repeated to the participant during each measurement session. In addition, participants in the GT group were initially instructed how to perform the stretching and strengthening exercises. During the first visit, these were visually verified by the researchers to ensure proper execution. During the remaining 5 visits, the participants in the GT performed these exercises in the clinic; however, they were not directly supervised. These participants were instructed to notify the researchers if they had any questions about the exercises. Finally, we did not assess ROM increases immediately following the last visit for the IASTM or GT groups. Theoretically, we would have likely seen greater increases in ROM immediately after that treatment. Furthermore, having those data would have allowed us to compare with previous studies that examined the immediate effects of IASTM on DF ROM.

Conclusions

The GT significantly increased standing ankle DF ROM after 6 treatments in a DF deficit population. These results suggest that following the GT protocol has the potential to increase DF ROM. Based on the findings of this study, clinicians should consider adding the GT as a treatment for patients with DF deficits due to soft tissue restrictions. Additional research is needed on the long-term effects of the GT.

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