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Research article

Effects of Lower Leg Cupping on Ankle Dorsiflexion Range of Motion and Muscle-Fascial Stiffness

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Abstract

Objective evidence regarding the local effects of cupping on muscle and fascial stiffness remains limited. We investigated the acute effects of posterior lower leg cupping on ankle dorsiflexion range of motion (ROM), muscle and fascial stiffness assessed by shear-wave elastography (SWE), and lower-leg muscle activity during passive dorsiflexion. Sixteen healthy university students (10 men and 6 women; age: 20.7 ± 0.8 years; height: 173.4 ± 8.0 cm; body mass: 69.1 ± 9.8 kg) underwent cupping (CUP; moving cupping applied to the posterior lower leg for 1 min) and control (CON; 5 min supine rest) conditions in random order with a minimum 1-week washout period. The shear moduli of the deep fascia, superficial portion of the medial gastrocnemius (UMG) alongside its middle and deep portions, and deep intermuscular fascia were measured using SWE before and immediately after each condition. Ankle dorsiflexion ROM and lower-leg muscle activity during passive dorsiflexion were also assessed. Significant condition × time interactions were observed for ROM ($F = 31.10$, $p < 0.001$, $\eta^2p = 0.675$), deep fascia ($F = 10.38$, $p = 0.006$, $\eta^2p = 0.409$), and UMG ($F = 11.73$, $p = 0.004$, $\eta^2p = 0.439$). Under CUP, ROM increased significantly (+5.65 ± 4.08°, $p < 0.001$, dz = 1.39), whereas shear moduli of deep fascia (-1.49 ± 1.06 kPa, $p < 0.001$, dz = -1.41) and UMG decreased significantly (-0.75 ± 0.51 kPa, $p < 0.001$, dz = -1.46). No significant changes occurred under CON for any of these variables. No significant changes were observed in the middle or deep portions of the medial gastrocnemius, deep intermuscular fascia, or muscle activity. A single bout of posterior lower leg cupping significantly reduced deep fascial and superficial medial gastrocnemius stiffness and increased ankle dorsiflexion ROM without altering muscle activity. These findings suggest that the mechanical effects of suction-based stimulation extend continuously from the skin through the deep fascia to the superficial muscle layer, and that the improvement in ROM is associated with changes in tissue mechanical properties rather than changes in neuromuscular activation.

Key words: Cross-over studies, elasticity imaging techniques, myofascial release therapy, shear wave elastography, subcutaneous tissue.

Introduction

Myofascial release has become a widely adopted conditioning strategy in sports settings. Tools such as percussion massage devices and flossing bands reportedly reduce muscle and fascial stiffness and increase joint range of motion (ROM) (Liu et al., 2024; Maemichi et al., 2025). A common feature of these tools is that they apply compressive force directed inward from the body surface. Compressive stimulation is thought to induce transient ischemia and reactive hyperemia in subcutaneous tissues (Gefen, 2008), while the resulting shear stress within the tissue may alter the viscoelastic properties of the fascia, thereby contributing to improved extensibility and ROM (Schleip and Muller, 2013). However, because the predominant direction of force is compressive, deformations that separate adjacent fascial layers are unlikely to occur. Moreover, the influence of such tools on fascial gliding may be limited (Chaudhry et al., 2008).

In contrast, cupping, which has gained popularity in sports settings in recent years, has fundamentally different mechanical characteristics from other myofascial release tools. By creating negative pressure within cups, cupping lifts the skin and subcutaneous tissue, applying a tensile force directed away from the underlying structures. This mode of tissue deformation is thought to stretch the fascia and create space between the fascial layers and underlying muscles, potentially improving fascial gliding and joint ROM (Murray and Clarkson, 2019). Whereas compressive stimulation is thought to induce viscoelastic changes and vascular responses by pressing tissue inward, suction stimulation may influence the spatial arrangement and gliding properties of fascial layers by lifting tissue outward (Al-Bedah et al., 2019). These two approaches are therefore mechanically distinct.

The origin of cupping dates back to ancient Egypt. Moreover, it has a long history of use as a traditional medical practice across China, the Arab world, and other regions (Musumeci, 2016). Interest in cupping within competitive sports grew rapidly following the 2016 Rio de Janeiro Olympics, when distinctive circular marks were observed on elite swimmers' bodies. The development of silicone cups has expanded the versatility and ease of application. Dynamic techniques, such as moving cupping, in which a cup slides across the skin while maintaining suction, as well as functional approaches combining cupping with movement and stretching, have become widely used in sports practice.

Although several studies have reported increases in joint ROM following cupping interventions (Bridgett et al., 2018; Murray and Clarkson, 2019), cupping has also been reported to alleviate pain and reduce local muscle tension, which may further contribute to improvements in joint mobility (Al-Bedah et al., 2019). However, most have focused on ROM as the sole outcome measure. Objective investigations of the local effects of suction stimulation on tissue-level properties, such as muscle and fascial stiffness, remain limited. Clarifying the nature of the tissue changes induced by suction stimulation is important for understanding the mechanisms of cupping and scientifically evaluating its differences from other myofascial release techniques.

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Therefore, we aimed to investigate the acute effects of 1-min moving cupping applied to the posterior lower leg on muscle and fascial shear modulus as assessed by shear-wave elastography (SWE), ankle dorsiflexion ROM, and lower-leg muscle activity during passive dorsiflexion. A moving cupping technique was employed, through which a silicone cup was applied under suction and slid in a proximal-to-distal direction. We hypothesized that cupping would reduce stiffness in superficial tissue layers while leaving deeper structures unaffected. Furthermore, we hypothesized that the ankle dorsiflexion ROM would increase and muscle activity during passive dorsiflexion would remain low and unchanged following the intervention.

Methods

Participants

Sixteen healthy university students (10 men: age 20.7 ± 0.9 years, height 177.5 ± 5.9 cm, body mass 75.0 ± 7.2 kg; 6 women: age 20.7 ± 0.5 years, height 166.6 ± 6.4 cm, body mass 59.4 ± 3.9 kg; overall: age 20.7 ± 0.8 years, height 173.4 ± 8.0 cm, body mass 69.1 ± 9.8 kg) without a history of orthopedic injury in the lower limb or neurological abnormality were enrolled. All participants were recreationally active and had no previous experience with cupping therapy. All measurements and interventions were performed on the right leg. All participants provided written informed consent before participation. This study was approved by the Waseda University Human Research Ethics Committee (approval number: 2026 - 086) and registered in the UMIN Clinical Trials Registry (UMIN000061727).

Study design

A randomized crossover design was used, in which each participant completed two conditions: cupping (CUP) and control (CON). The order of both conditions was randomly determined; moreover, a minimum one-week washout period was imposed between the conditions to prevent carryover effects. Under each condition, SWE and ankle dorsiflexion ROM measurements were performed before (PRE) and immediately after (POST) the intervention. Under the CUP condition, a 1-min moving cupping intervention was applied to the posterior lower leg. Under the CON condition, the participants rested in the supine position for 5 min to control for the effect of time. The 5-min rest period was chosen to be longer than the cupping intervention duration to conservatively account for any time-dependent tissue changes during the measurement period.

Cupping intervention

The cupping intervention was performed with the participant in the prone position. A silicone cup (Functional Cupping Method, M size; BeWings Co. Ltd., Tokyo, Japan) was applied to the posterior lower leg to target the medial gastrocnemius and soleus muscles. Lotions were applied to the skin surface before intervention. The cup was manually compressed and placed on the skin until the upper rim contacted the skin surface, creating negative pressure through elastic recoil. Although this procedure was performed identically for all participants, suction pressure was not objectively quantified. The cup was repeatedly slid in the proximal-to-distal direction along the muscle fiber orientation of the medial gastrocnemius at an approximate rate of one slide per 2 seconds for 1 min (Figure 1). The 1-min intervention duration was selected based on practical considerations in sports conditioning and is consistent with durations reported in previous studies on cupping (Murray and Clarkson, 2019). Participant discomfort was monitored verbally using a visual analog scale (VAS; 0 = no pain, 10 = intolerable pain); VAS scores during the intervention ranged from 7 to 8. A stopping criterion was set at a VAS score indicating intolerable pain (VAS = 10). All participants completed the intervention without interruption. The intervention was performed by the same practitioner, who held a cupping qualification and national medical license.

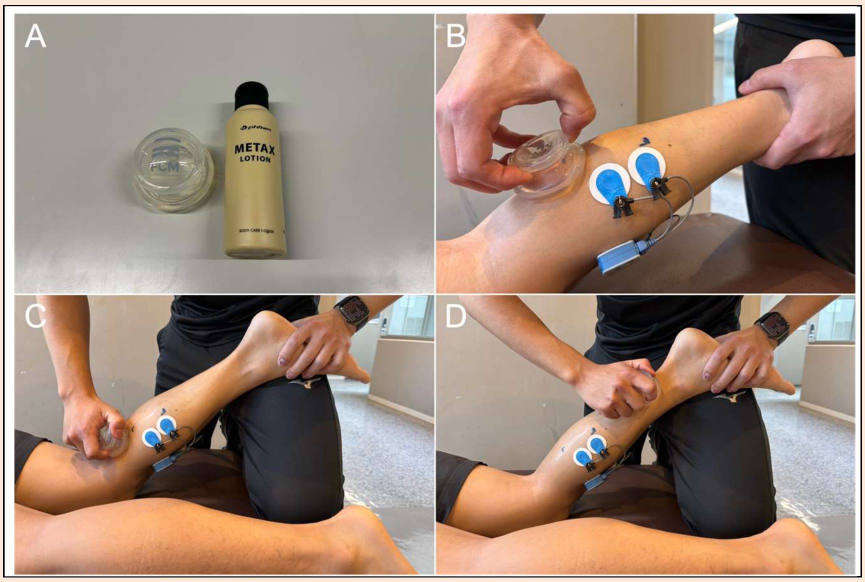

Figure 1. A cupping intervention was applied to the posterior lower leg. A silicone cup (Functional Cupping Method, M size; BeWings Co., Ltd.) was manually compressed and applied to the skin surface overlying the medial gastrocnemius. The cup was repeatedly slid in a proximal-to-distal direction along the muscle fiber orientation at an approximate rate of one slide per 2 seconds for 1 min.

SWE

Muscle and fascial stiffness were assessed using SWE (Aplio α; Canon Medical Systems, Otawara, Japan) with a 5 - 14 MHz high-frequency linear probe. SWE measures the propagation velocity of shear waves within tissue; shear modulus (μ, in kPa) was calculated from the shear-wave velocity assuming a tissue density of 1000 kg/m^3 ($\mu = \rho v^2$, where ρ is tissue density and v is shear-wave velocity), with higher values indicating greater tissue stiffness (Lacourpaille et al., 2012; Nordez and Hug, 2010). Measurements were taken with the participant in the supine position on the dynamometer, with the right lower limb in full extension and the ankle at 0° (neutral position). The measurement site was the medial gastrocnemius at 30% of the lower-leg length measured. The probe was aligned longitudinally with the muscle fiber orientation. Skin surface markings were made prior to PRE measurements to ensure that the same site was measured for POST. Three images were acquired for each measurement under identical conditions. Five ROIs were defined from superficial to deep: the deep fascia (DF), the superficial portion of the medial gastrocnemius (UMG), the middle portion (MMG), the deep portion (LMG), and the deep intermuscular fascia (DIF) (Figure 2). The mean of the three measurements was used as the representative value for each ROI.

Ankle dorsiflexion ROM and muscle activity

Ankle dorsiflexion ROM was measured using an isokinetic dynamometer (BIODEX System 3; Biodex Medical Systems, Shirley, NY). The participants were positioned supine, with the right knee in full extension and the ankle in the neutral position. The heel was secured to the foot attachment using a belt throughout the measurement. The dynamometer was set to rotate at 2°/s; the ankle was passively dorsiflexed from the neutral position. Discomfort was monitored using a VAS; the angle at which the participant reported intolerable pain was recorded as the maximum dorsiflexion ROM (i.e., a pain-limited ROM endpoint). Three trials were performed per condition; the mean value was used as the representative value.

Surface electromyography (EMG) was simultaneously performed during passive dorsiflexion using wireless surface electrodes (ULTIUM; Noraxon, Scottsdale, AZ, USA). The tibialis anterior (TA), medial gastrocnemius (MG), and soleus (SOL) were measured. Electrodes were placed at the proximal one-third of the muscle belly of the TA, at the point of maximum bulk at the proximal one-third of the MG, and at the distal one-third of the muscle belly of the SOL. The skin was prepared by alcohol wiping and light abrasion before electrode placement to reduce impedance. Raw EMG signals were band-pass filtered at 50 - 1000 Hz, full-wave rectified, and smoothed using a moving average with a 50-ms window to calculate the EMG amplitude. Based on the ROM measurements, the maximum dorsiflexion angle was defined as 100%, and EMG amplitudes were recorded at 0%, 30%, and 60% of the maximum dorsiflexion angle.

To normalize muscle activity, the maximum voluntary isometric contraction (MVIC) of the ankle plantar flexion and dorsiflexion was measured after the ROM measurements. Regarding plantar flexion MVIC, the participants were instructed to gradually produce maximal force over 3 s and sustain it for 3 s. Considering dorsiflexion MVIC, the participants performed maximal dorsiflexion for 3 s, while the examiner manually fixed the forefoot. Three trials were conducted in each direction. The EMG amplitude of the trial that produced the highest peak torque was used as the reference value. The TA was normalized to the dorsiflexion MVIC amplitude, whereas the MG and SOL were normalized to the plantarflexion MVIC amplitude. The muscle activity at each angle was expressed as a percentage of the corresponding MVIC (%MVIC).

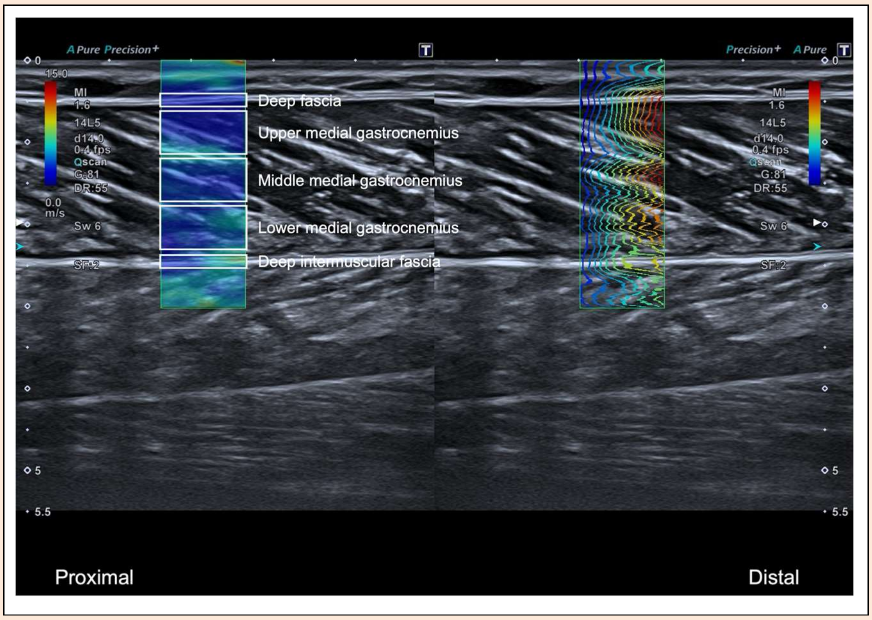

Figure 2. Representative shear-wave elastography (SWE) image of the medial gastrocnemius showing five regions of interest (ROIs) defined from superficial to deep: deep fascia (DF), superficial portion of the medial gastrocnemius (UMG), middle portion (MMG), deep portion (LMG), and deep intermuscular fascia (DIF). The color map indicates shear modulus, with warmer colors representing higher values (greater stiffness).

Statistical analysis

An a priori power analysis was conducted using G*Power (version 3.1; repeated-measures ANOVA, within-between interaction; effect size f = 0.40; α = 0.05; power = 0.80), based on the effect size reported in a study using a similar crossover design to investigate shear modulus following a manual therapy intervention (Ikeda et al., 2019). This analysis indicated that a minimum of 16 participants was required and all 16 completed the study.

All data are expressed as the mean ± standard deviation. Two-way repeated-measures analysis of variance (ANOVA; condition × time) was performed for all dependent variables, including shear modulus at each ROI, ankle dorsiflexion ROM, and %MVIC of the TA, MG, and SOL at each angle (0%, 30%, and 60%). Partial eta-squared (η^2p) was calculated as a measure of effect size and interpreted as small (≥ 0.01), medium (≥ 0.06), or large (≥ 0.14). When a significant interaction was detected, Bonferroni-corrected post-hoc paired t-tests were performed for within-condition PRE-to-POST and between-condition POST comparisons. The effect sizes for post hoc comparisons were calculated using Cohen's dz and interpreted as small (|0.20|-|0.49|), medium (|0.50|-|0.79|), or large (≥ |0.80|). Where no significant interaction was found for %MVIC variables, post-hoc testing was not performed, and the results are presented descriptively. The MVIC values for the TA, MG, and SOL were also analyzed using the same two-way repeated-measures ANOVA. The level of statistical significance was set at $p < 0.05$. All analyses were performed using the Pingouin library (version 0.5) in Python (version 3.11).

Results

A significant condition × time interaction was found for ankle dorsiflexion ROM (F(1, 15) = 31.10, $p < 0.001$, η^2p = 0.675). Post-hoc testing revealed that ROM increased significantly from PRE to POST under the CUP condition (t(15) = 5.55, $p < 0.001$, dz = 1.39, large), whereas no significant change was observed under the CON condition (t(15) = 1.05, p = 0.925, dz = 0.26). No significant difference was found between the conditions PRE (p = 1.000); however, the ROM was significantly greater under the CUP condition than that under the CON condition POST (t = 3.78, p = 0.005, dz = 0.95, large) (Figure 3).

A significant condition × time interaction was also observed for deep fascia shear modulus (F(1, 15) = 10.38, p = 0.006, η^2p = 0.409). Post-hoc testing revealed a significant decrease in shear modulus under the CUP condition from PRE to POST (t(15) = 5.62, $p < 0.001$, dz = -1.41, large), whereas no significant change was observed under the CON condition (t(15) = 0.00, p = 1.000). No significant difference was observed between conditions at PRE (p = 0.137) or POST (t = -2.31, p = 0.106, dz = -0.58, medium).

A significant condition × time interaction was observed for the UMG shear modulus (F(1, 15) = 11.73, p = 0.004, η^2p = 0.439). Post hoc testing revealed a significant decrease in the shear modulus under the CUP condition (t(15) = 5.84, $p < 0.001$, dz = -1.46, large), whereas no significant change was found under the CON condition (t(15) = 0.97, p = 1.000, dz = 0.24). No significant difference was found between the conditions at PRE (p = 0.790); however, the shear modulus was significantly lower under the CUP condition at POST (t = -2.93, p = 0.031, dz = -0.73, medium).

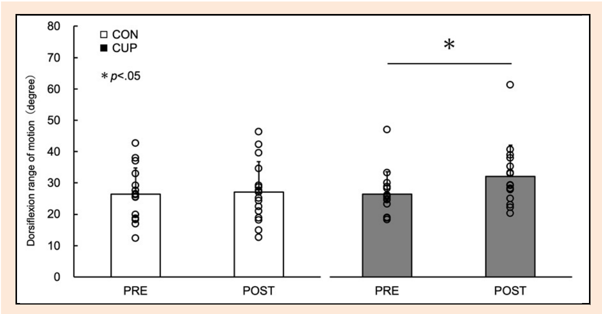

Figure 3. Ankle dorsiflexion range of motion (ROM) before (PRE) and after (POST) the cupping (CUP) and control (CON) conditions. Individual data points and group means ± SD are shown. * $p < 0.05$ vs. PRE within CUP condition (Bonferroni-corrected post-hoc paired t-test; dz = 1.39, large). † $p < 0.05$ for POST CUP vs. POST CON (post-hoc paired t-test; dz = 0.95, large).

With regard to MMG and LMG, no significant interaction, main effect of time, or main effect of condition was observed (MMG: F(1, 15) = 3.66, p = 0.075, η^2p = 0.196; LMG: F(1, 15) = 0.23, p = 0.637, η^2p = 0.015). No significant PRE-to-POST changes were observed in either condition.

No significant interaction (F(1, 15) = 0.31, p = 0.585, η^2p = 0.020), main effect of time (F = 0.16, p = 0.697), or main effect of condition (F = 0.06, p = 0.813) was observed for DIF (Table 1).

The MVIC values for the TA, MG, and SOL showed no statistically significant condition × time interaction or main effect of time for any muscle, indicating no significant PRE-to-POST changes under either condition. The muscle activity at 0%, 30%, and 60% of the maximum dorsiflexion angle was calculated as %MVIC using these reference values.

The muscle activities of the TA, MG, and SOL during passive dorsiflexion were low under both conditions across all angles (1 - 5 %MVIC). No significant PRE-to-POST changes in %MVIC were found in either condition. Moreover, no significant condition × time interactions were found for any muscle or angle. These results indicate that the cupping intervention did not affect lower leg muscle activity during passive dorsiflexion (Table 2).

Discussion

The present findings indicate that a single bout of moving cupping applied to the posterior lower leg was associated with a significant increase in ankle dorsiflexion ROM and a significant decrease in shear moduli of deep fascia and UMG. In contrast, no statistically significant changes were observed in the middle MMG or deep LMG portions of the medial gastrocnemius or DIF.

Table 1. Shear modulus of muscle and fascia before and after intervention (kPa).

		CON	CUP	P	η2p
Deep fascia	PRE	5.6 ± 1.5	6.3 ± 1.4	0.006	0.409
	POST	5.6 ± 1.6	4.9 ± 1.3 *		
Upper medial gastrocnemius	PRE	4.2 ± 0.8	4.5 ± 0.9	0.004	0.439
	POST	4.5 ± 1.2	3.8 ± 0.6 *†		
Middle medial gastrocnemius	PRE	2.9 ± 0.4	3.0 ± 0.4	0.075	0.196
	POST	3.0 ± 0.5	2.9 ± 0.3		
Lower medial gastrocnemius	PRE	3.5 ± 0.5	3.6 ± 0.8	0.637	0.015
	POST	3.5 ± 0.4	3.5 ± 0.6		
Deep intermuscular fascia	PRE	7.6 ± 2.0	7.7 ± 1.7	0.585	0.020
	POST	7.6 ± 1.9	7.4 ± 2.1		

Values are expressed as mean ± SD (n = 16). P = p-value for the condition × time interaction (two-way repeated-measures ANOVA). η^2p = partial eta-squared (small ≥ 0.01, medium ≥ 0.06, large ≥ 0.14).

Table 2. Muscle activity during passive ankle dorsiflexion (%MVIC) and MVIC reference values.

			PRE Mean±SD	POST Mean±SD
Tibialis Anterior Muscle(MVIC)		CON	292.2±118.8	284.9±111.2
		CUP	283.5±93.2	256.3±67.3
Medial Gastrocnemius Muscle(MVIC)		CON	133.2±88.2	129.2±58.2
		CUP	104.3±65.2	113.4±56.2
Soleus Muscle(MVIC)		CON	72.1±22.1	70.3±30.2
		CUP	81.3±42.2	80.9±43.4
Tibialis Anterior Muscle(%MVIC)	0%	CON	1.2±1.0	0.8±0.8
		CUP	0.7±0.8	0.8±1.1
	30%	CON	1.3±1.9	1.6±2.8
		CUP	1.4±2.3	1.9±3.0
	60%	CON	4.0±6.8	5.1±4.2
		CUP	3.3±3.8	3.0±3.4
Medial Gastrocnemius Muscle(%MVIC)	0%	CON	2.3±1.2	2.5±3.1
		CUP	2.0±1.6	2.5±2.8
	30%	CON	2.4±1.9	2.5±2.4
		CUP	2.1±1.5	2.3±2.6
	60%	CON	2.5±1.9	2.4±2.0
		CUP	2.2±1.5	2.4±2.6
Soleus Muscle(%MVIC)	0%	CON	3.1±1.4	2.7±1.8
		CUP	2.3±1.5	2.3±1.3
	30%	CON	2.5±1.1	2.6±1.6
		CUP	2.9±2.3	3.5±3.1
	60%	CON	3.2±1.7	3.0±1.4
		CUP	3.1±2.2	2.8±1.8

Values are expressed as mean ± SD (n = 16). No significant condition × time interaction was observed for any muscle or angle (all p > 0.05). Results are presented descriptively.

The significant increase in ankle dorsiflexion ROM following cupping (mean change: +5.65 ± 4.08°, dz = 1.39) is consistent with that in previous reports, suggesting that cupping contributes to improvements in joint ROM (Murray and Clarkson, 2019). Two primary mechanisms have been proposed to explain changes in joint ROM: (1) alterations in the viscoelastic properties of muscle, tendon, and connective tissue, and (2) neural factors such as changes in stretch tolerance or protective reflex activity (Behm et al., 2016). In the present study, the muscle activity of the TA, MG, and SOL during passive dorsiflexion remained low (1 - 5 %MVIC) and did not change significantly under either condition, suggesting that the increase in ROM was not attributable to alterations in protective muscular contraction during passive stretch. This is consistent with previous research reporting improvements in ROM following instrument-assisted soft tissue mobilization (IASTM) without accompanying changes in muscle activity (Ikeda et al., 2019). Furthermore, MVIC values did not statistically significantly change following the intervention, indicating that cupping did not affect the maximal neuromuscular output capacity. This further supports the interpretation that the observed improvement in ROM was not driven by changes in neuromuscular activation during passive stretch, although changes in stretch tolerance, a sensory-neural process, cannot be excluded given the pain-limited ROM endpoint. The observed reductions in deep fascia and UMG stiffness might have contributed to improvements in ROM through enhanced fascial extensibility and viscoelastic changes in the superficial muscle bellies. A trend toward ROM increase was also found under the CON condition; however, it did not reach statistical significance, which might reflect a temporary increase in stretch tolerance resulting from repeated ROM measurements (Magnusson et al., 1996). The significant between-condition difference in POST supports the specific effect of cupping intervention on ROM.

With 16 participants, the deep fascia and UMG showed significant condition × time interactions, with large effect sizes. The significant decrease in deep fascia shear modulus under the CUP condition (dz = -1.41, large) and the significant decrease in UMG shear modulus (dz = -1.46, large) suggest that suction-based stimulation exerts mechanical influence across contiguous superficial tissue layers, from the skin through the deep fascia to the superficial muscle belly. Because cupping lifts the tissue directly beneath the skin in a traction-directed manner, the superficial fascia, which is anatomically closest to the skin, is well-positioned to receive the resulting mechanical deformation directly (Fede et al., 2025). Lifting the superficial fascia may relieve mechanical loading at the fascia-muscle interface, potentially inducing viscoelastic changes in that region (Langevin et al., 2011). The absence of significant changes in the deep fascia or UMG under the CON condition confirmed that the passage of time alone did not alter the stiffness of the superficial tissues, further supporting the specificity of the cupping effect.

No statistically significant changes were found in the MMG shear modulus. In contrast to the changes observed in deep fascia and UMG, the effect size in MMG was small, suggesting that the mechanical influence of cupping did not extend to this depth. The mean subcutaneous adipose tissue thickness in the posterior lower leg has been reported to be approximately 6 mm (Gibney et al., 2010). It is plausible that the depth of tissue deformation induced by the cup size used in this study was limited to this range, with the magnitude of deformation attenuating as the tissue depth increased. A similar pattern of no statistically significant changes was found in the LMG. This pattern is consistent with muscle-specific differences in stiffness changes previously reported following passive stretching of the triceps surae (Hirata et al., 2016).

The consistent absence of significant changes in the MMG, LMG, and DIF is also consistent with the finding that IASTM, which applies a compressive force to the posterior lower leg, does not alter the shear modulus of the gastrocnemius or soleus (Ikeda et al., 2019), suggesting that the direct effects of surface-applied mechanical stimulation on deep muscle and fascial stiffness may be limited, at least with the modalities and parameters studied to date.

The finding that changes were found in the deep fascia and UMG, but not in the MMG, LMG, or DIF, supports the interpretation that the mechanical effects of suction stimulation are depth-dependent. Foam rolling applied to the calf has been reported to acutely increase ankle dorsiflexion ROM through compressive mechanisms (Behm et al., 2016). Although both foam rolling and cupping may improve joint mobility, their underlying mechanisms may differ: foam rolling applies compressive force that primarily targets the muscle belly, whereas cupping applies tensile force that preferentially affects superficial fascial layers. The significant reductions in deep fascia and superficial muscle stiffness observed in the present study are consistent with a traction-directed mechanism that may be mechanistically distinct from compression-based approaches. Whether these mechanistic differences translate into distinct clinical advantages warrants future comparative investigation. In clinical and sports practice, cups with varying diameters, heights, and material hardness are selected for different purposes. Larger cups generate a wider zone of negative pressure and greater tissue displacement, potentially enabling access to deeper fascial and muscle layers. Our results are consistent with this premise, although direct comparative studies using different cup sizes are needed to test it. Future comparative studies using different cup sizes might contribute to establishing evidence-based guidelines for cup selection based on target tissue depth.

Limitations

This study had some limitations. First, the suction pressure of the cup was not objectively quantified, limiting the standardization and reproducibility of the intervention. Second, individual differences in subcutaneous adipose tissue thickness were not accounted for; thicker subcutaneous adipose tissue may attenuate the transmission of suction-based stimulation to deeper fascial layers (Gibney et al., 2010). Third, the possible influence of sex-related differences in tissue properties on the results was not examined; future studies should investigate sex-stratified responses to cupping. Fourth, fascial gliding between tissue layers was not directly assessed; the relationship between the observed stiffness changes and improvements in fascial gliding remains to be clarified in future studies (Langevin et al., 2011). Fifth, only immediate post-intervention effects were assessed. Measurements at 5- and 10-min post-intervention would provide valuable information regarding the time course of these changes. Sixth, it is uncertain to what extent post-testing ROM would have been affected by pre-testing ROM at 1 min (intervention duration) versus 5 min (control duration).

Conclusion

A single bout of moving cupping applied to the posterior lower leg significantly reduced the shear moduli of the deep fascia and UMG and increased ankle dorsiflexion ROM without altering muscle activity or maximal neuromuscular output capacity. These findings suggest that the mechanical effects of suction-based stimulation extend continuously from the skin through the deep fascia to the superficial muscle layer, and that the improvement in ROM is associated with reduced superficial tissue stiffness rather than changes in neuromuscular activation during passive stretch. Whether cup size selection can be used to target specific tissue depths warrants investigation in future studies.

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Key points

- A single bout of moving cupping on the posterior lower leg significantly reduced the shear modulus of the deep fascia and superficial medial gastrocnemius, and increased ankle dorsiflexion range of motion.
- No significant changes in muscle activity during passive dorsiflexion or maximal voluntary isometric contraction were observed, suggesting that ROM improvements were not driven by altered neuromuscular activation.
- The mechanical effects of suction-based stimulation appeared depth-dependent, with no significant changes in deeper tissue layers (middle or deep medial gastrocnemius, deep intermuscular fascia).
- Significant reductions in deep fascial and superficial muscle stiffness indicate that the mechanical influence of suction-based stimulation extends continuously from the skin through the superficial fascial and muscle layers.
- These findings provide objective, tissue-level evidence that may help distinguish the mechanisms of suction-based myofascial release from compressive techniques.

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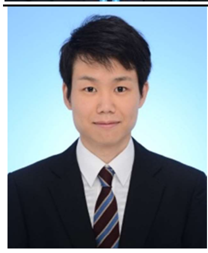

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