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ABSTRACT

Body Tempering (BT) is a newer myofascial release (MFR) technique that is used by athletes and healthcare professionals. The effects of BT are stated to be similar to foam rolling (FR) and other MFR techniques, but there is minimal research assessing the effects of BT on power and range of motion (ROM). The purpose of this study was to determine the effect of BT on ankle dorsiflexion ROM and power, as well as to compare the effects of BT to traditional FR. Twenty college-aged participants (10 males-10 females) were tested before and after intervention on three measurements of the broad jump (single-leg and double-leg) and weight bearing lunge test. Week one, each participant was randomly assigned to a 30-second treatment (BT or FR) performed on both calves, simultaneously, at a pace of 1 pass every 2 seconds. Week two, the treatment that was not received in session one, was administered. Paired sample t-tests between post-intervention and baseline measurements, as well as BT and FR showed statistically significant differences in FR and BT between pre and post single-leg jump averages for the left leg (FR-Pre: 93.22 cm, Post: 96.77 cm; p = .046) (BT-Pre: 94.53 cm, Post: 100.27 cm; p = .03) and the right leg (FR-Pre: 92.28 cm, Post: 99.38 cm; p= .007) (BT-Pre: 94.22 cm, Post: 99.83 cm; p= .036). Average ROM was only found to be statistically significantly different for BT on the right leg (Pre: 8.32 cm, Post: 8.80 cm; p = .035). There were no statistically significant differences in power (p= .293 -left leg; p= .894 -right leg; p= .362 -bilaterally) or ROM (p= .791 -left leg; p=.825 -right leg) when comparing the BT to FR interventions. When throwing, jumping, and running, single leg power is important, and these techniques could increase muscle performance needed during activity.

Key Phrases
Clinician-rated outcomes, manual techniques, College and University Patient population, body tempering, foam rolling

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INTRODUCTION

Functional movement and power are vital to an athlete's performance, but these qualities can be hampered by myofascial adhesions or decreased ROM of muscle and fascia.[1] To help the body perform at maximum capacity these myofascial adhesions need to be treated or released.[1] MFR is a process by which pressure is applied to tissue, supplying increased blood flow to the area and reducing myofascial adhesions once the pressure is released.[2] Fascia exhibits the phenomenon of thixotropy, in which it becomes more fluid or soft when it is moved or disturbed and more solid when it sits undisturbed.[3] Therefore, MFR allows tissue to relax and become more elastic.[1,4]

There are several MFR techniques, all of which can be divided into two categories: invasive and non-invasive. Invasive techniques include injection therapy and dry needling, and noninvasive techniques include massage, stretching, myofascial release, ischemic bands, Graston, deep tissue massage, neuromuscular therapy, therapeutic ultrasound, and laser.[5] The exertion of mechanical pressure that many of these techniques provide is theorized to decrease myofascial adhesions between tissue layers, improve muscular compliance and decrease muscle stiffness of the muscle fibers.[2] This in turn will be beneficial to performance and mobility. In previous studies, common techniques, such as dry needling,[6] ischemic bands,[7] Graston,[8] deep tissue massage,[9] and FR[1] have been shown to improve performance and mobility.

Body Tempering (BT) is a new, noninvasive tool used to accelerate sport activity performance and recovery by combating soft tissue restrictions similar to the effects of FR.[10] Although the effects of BT have been compared to FR, there is minimal research on the modality because it is so new. The manual provided at The Body Tempering™ certification course states, "While Body Tempering does not have a body of literature to directly support it as a specific method, its biomechanical effects are very similar to spinal/joint mobilizations, FR, Instrument Assisted Soft Tissue Mobilization, and soft tissue mobilization."[10] BT is performed using a heavy metal cylinder placed on the respective muscle(s), which is then passively rolled along the length of that muscle.[10] BT's main technique, Dynamic Tempering, refers to having a clinician roll out the muscle in a manner similar to FR but the device is laid on top of the body, allowing the body to relax instead of having activated musculature like when a patient completes FR their self.[10] With the use of the weighted cylinder and passive movement, it is stated in the manual that trigger points and myofascial adhesions cannot hold up to the BT cylinder like they could with less aggressive methods such as FR.[10]

Despite BT's increasing popularity with athletes in the NFL, NCAA, and Crossfit, there is minimal research available to support its use to improve performance and ROM compared to other MFR techniques.[10] Therefore, the purpose of this study was to examine the BT MFR technique's effectiveness in improving mobility and power. The secondary purpose was to examine the effects of the BT MFR technique compared to FR and a control session (warm-up only).

PARTICIPANTS

Twenty participants completed the study (10 males: 23.20 ± 3.68 years, 179.07 ± 9.06 cm, 86.86 ± 10.66 kg; 10 females: 22.80 ± 1.48 years, 161.8 ± 5.75 cm, 64.37 ± 6.12 kg). Inclusion criteria included male and female recreational athletes, defined as someone who exercises at the CDC recommended levels of 2-3 hrs/week on average, between ages 18-35 years old.[11] Participants were excluded if they had the following: a current lower extremity orthopedic injury, a lower extremity orthopedic injury in the previous six months, osteoporosis with or without unexplained non-traumatic fracture, lymphatic/fluid retention disorders, impaired sensation, COPD/lung pathology, blood pressure/cardiac issues, or rashes/skin deformities including but not limited to open wounds.[10]

Participants were recruited through email, posters, and word of mouth. This study was approved by The Institutional Review Board (IRB) of the XXX and all participants provided consent prior to participating in the study.

OUTCOME MEASURES

Instruments and Measurements

Pre-Participation Demographic Questionnaire

Before participating, each participant completed a questionnaire providing their age, gender, self-reported height and weight, and previous injury history.

Weight Bearing Lunge Test

Participants were in a lunge position (knee on ground) facing a wall without shoes with the test foot and knee perpendicular to a wall.[12] While maintaining this position, participants performed a lunge in which the knee was flexed with the goal of making contact between the anterior knee and the wall while keeping the heel firmly planted on the floor. Valgus and varus collapse were not specifically controlled for, but the PI observed the knees throughout the test to ensure proper motion. The participants continued to move their foot back slowly until their heel could no longer stay in contact with the ground at the same time their knee was touching the wall. [13] According to Bennell et al. (1998), the weight bearing lunge test has intra-rater intraclass correlation coefficients (ICC) ranged from 0.97 to 0.98 and the inter-rater ICC value was 0.99.[12] For assessing ankle dorsiflexion these results have excellent reliability.

<u>Broad Jump</u>

A tape measure was laid out on the floor and participants started with their toe on the starting mark. The contralateral leg was positioned with the hip and knee angles at approximating 90 degrees of flexion and their hands were placed on their hips. A single maximal hop was executed without swinging the contralateral leg or removing the hands from the hips. The participants were encouraged to achieve maximal horizontal distance and to land on the same foot without simultaneously placing the opposite foot down for support. Once their landing foot touched down, however, they were free to extend the opposite leg to avoid falling.[14] For double-leg jumps, participants were allowed to use a counter movement jump technique and participants were asked to jump out as far as possible each time. They were to hold the position until the investigator told them to move. Measurements were taken from the back of the heel closest to the starting point and were measured to the closest half centimeter. If the participant did not stabilize after their jump, they were asked to repeat the attempt.

The broad jump is used to measure power output, specifically horizontal power output. The ALPHA Health-Related Fitness Test Battery protocol was followed when administering the test.[15] Markovic et al. (2004) concluded that double CMJ (horizontal) is the most reliable and valid field test for the estimation of explosive power of the lower limbs in physically active men.[16] The single leg horizontal distance test has a high test-retest reliability, with ICC values between 0.88 to 0.96.[17]

<u>Statistical Analysis</u>

Data analysis for this study included descriptive statistics that were calculated for the demographic information and dependent variables. Comparisons were made between the baseline measurements performed before each session and the measurements performed after each intervention, as well as between the measurements assessed after each intervention. These comparisons were performed using a paired-samples T-test with an alpha set to < 0.05. IBM SPSS statistics package 26 was utilized for the analysis.

INTERVENTION

<u>Body Tempering Roller</u>

The BT roller (Forge; Watkinsville, GA) is a large metal cylinder (22.68 kg) used to apply pressure to the identified muscle tissue (**Figure 1**).[18]

Figure 1. BT device used in the study. In this study, a 10 lb. plate was added to each side of the device to make the total weight 50 lbs. (the device itself weighs 30 lbs.).

<u>Foam Roller</u>

The participants used a 15.24 cm x 91.44 cm polyethylene foam roller (Power Systems, high-density foam rollers, Knoxville, TN). The foam roller was a high-density, pre-molded piece of foam in the shape of a cylinder.[19]

Procedures

This study consisted of two separate interventions/sessions, with at least one-week in-between each. The same procedures were followed at each session, and the only thing that changed was the intervention device that was used (i.e., BT-session one and FR-session two, or vice versa)

Participants arrived on the first day and completed the consent form and demographic questionnaire. Once they agreed to participate, participants were randomly assigned to initially participate in either the BT group or the FR group. Each participant began with a general warm up on a bike, pedaling at 60 rpm at a self-selected resistance for 3-4 minutes.[20] Participants then engaged in a 5 min standardized warmup consisting of dynamic mobility (e.g., walking knee lift and lunge walk) and calisthenics (e.g., skipping and jumping jacks) exercises (**Table 1**).[21] After completing the warmup, participants rested for 2 minutes before participating in three baseline measurements of active dorsiflexion (ADF) ROM on each ankle. This was assessed using the weight-bearing lunge test with the participant self-selecting which ankle was assessed first. Unilateral and bilateral broad jump were assessed next, to examine power. Single-leg (unilateral) jumps were performed before the double-leg (bilateral), with each participant self-selecting to start on the right or left.

Table 1. Standardized warm-up

Exercises	Sets	Yards
Jog	1	30
Backpedal	1	30
Skip	1	30
Quad Stretch Walk/Knee Hug Walk	1	15/15
Fwd Lunge/Bkwd Lunge	1	15/15
Shuffle Right/Left	1	15/15
RDL Walk/Straight Leg March	1	15/15
High Knees/ Butt Kickers	1	15/15
Carioca Right/Left	1	15/15
Sprint	1	30

Depending on the group each participant was assigned to either a 30 second BT treatment or a 30 second FR treatment was, then, applied to the triceps surae muscle group.[2,21-23] The treatment was performed at a pace of one pass every 2 seconds (4 seconds for a complete cycle).[10,24] Participants reported for a second session at least one week after the first in order to complete the other intervention. All treatments were held at approximately the same time of day and participants were instructed to maintain their normal exercise routine. The PI attended each treatment session and performed all BT interventions. During the BT intervention, participants laid prone on a soft surface (**Figure 2**).[25] The PI rolled a cylinder proximally and distally on both triceps surae muscle group, simultaneously, for approximately 30 seconds.[1,2,10,26,27] Those participating in the FR intervention rolled both triceps surae muscle group at the same time for 30 seconds at the same tempo as the BT group.[24] After the treatment period, each participant rested for 1 min and then the PI reassessed the double- and single-leg broad jump and ankle dorsiflexion.

Figure 2. Application of BT Device

The participants tested both the broad jump (double and single legs) and ankle dorsiflexion three times,[28] and the best score and the averages were recorded.

RESULTS

Paired sample t-tests were used to compare post-intervention and baseline measurements, as well as BT to FR. Detailed results can be found in **Tables 2-5**. Statistically significant differences ($p \leq .05$) were found between pre- and post-FR single leg jump averages for the left leg (Pre: 93.22 ± 23.32 cm, Post: 96.77 ± 20.54 cm; $p = .046$) and the right leg (Pre: 92.28 ± 22.81 cm, Post: 99.38 ± 22.52 cm; $p = .007$). Statistically significant differences were also found between pre- and post-BT single leg jump averages for the left leg (Pre: 94.53 ± 21.65 cm, Post: 100.27 ± 19.79 cm; $p = .03$) and the right leg (Pre: 94.22 ± 20.74 cm, Post: 99.83 ± 19.48 cm; $p = .036$). Average ROM was only found to be statistically significantly different for BT on the right leg (Pre: 8.32 ± 3.08 cm, Post: 8.80 ± 3.20 cm; $p = .035$), which 19 of the 20 participants indicated was their dominant leg. There were no statistically significant differences in power or ROM when comparing the BT to FR interventions.

DISCUSSION

The purpose of this study was to determine the effect of BT on ankle dorsiflexion and power. The secondary purpose was to compare the effects of BT to traditional FR. The results of our study showed statistically significant improvement in the unilateral jump on the left and right leg after both BT and FR. These results are important for those who participate in many sports that require a participant to have single leg explosiveness to accomplish a task successfully, including running, throwing, and jumping. That explosiveness is known as the word power. With power being defined as work over time,[29] the quicker the athlete can move a certain distance, the more powerful they are. The ability for the athlete to produce more power could lead to greater success in their competitive arena, thus making these results intriguing for the athlete.

Although our study resulted in statistically significant differences in single-leg jumps, no statistically significant differences were found between the results of the baseline measurements and either intervention for the double-leg jump. Aligning with the double-leg results from our study, in a systematic review assessing effects of self-MFR, Beardsley et al. (2015) found all but two of the reviewed documents to show no changes in double leg performance measures after a session of self-MFR.[22] It has been shown in research that the mechanical output per leg is less in two-leg jumps than in one-leg jumps, and thus has been given the name bilateral deficit.[30] This same effect can be seen in our study as the patients saw statistically significant increase in their single leg jump, but there was no statistically significant changes when looking at the double-leg jump.

In terms of ADF ROM, only the pre-intervention to post-intervention of BT on the right limb showed statistically significant difference. In the MacDonald et al. (2013) study, they found an increase in ROM in both limbs two and ten minutes after completing the treatment session after rolling both limbs individually.[1] Our results may have been different due to rolling both limbs at the same time. In the Skarabot et al. (2015) study, they assessed FR by itself, and compared it to FR plus a static stretching intervention. FR by itself resulted in no increase in ROM, while the combination showed a statistically significant increase.[23]

Nineteen of the twenty participants in our study stated that the right leg was their dominant leg. The lack of ROM on the dominant leg due to increased usage may have allowed for greater improvement compared to the less used non-

Table 2: Pre- and Post-Measurements for Average Jumping Distance (mean ± SD)

Intervention			Pre-Measurement (cm)	Post-Measurement (cm)	p-value
Foam Rolling	Left	Avg	93.22± 23.32	96.77 ± 20.54	0.046*
		Longest	101.35 ± 24.90	102.35 ± 20.42	0.628
	Right	Avg	92.28± 22.81	99.38 ± 22.53	0.007*
		Longest	99.45 ± 22.962	103.60 ± 22.86	0.137
	Both	Avg	184.77 ± 33.92	180.98 ± 35.17	0.464
		Longest	189.50 ± 34.32	186.73 ± 36.27	0.586
Body Tempering	Left	Avg	94.53 ± 21.65	100.27 ± 19.79	0.030*
		Longest	101.13 ± 21.42	105.98 ± 21.25	0.069
	Right	Avg	94.22 ± 20.74	99.83 ± 19.48	0.036*
		Longest	101.53 ± 20.49	105.78 ± 17.72	0.130
	Both	Avg	187.38 ± 34.28	186.41 ± 36.24	0.497
		Longest	192.78 ± 34.31	191.63 ± 35.55	0.489

*=significant finding ($P < 0.05$)

Table 3: Post Intervention measurement comparison (FR and BT) (mean ± SD)

Intervention		FR (cm)	BT (cm)	p-value
Avg Jump Distance	Left	96.767 ± 20.540	100.267 ± 19.790	0.293
	Right	99.375 ± 22.525	99.833 ± 19.481	0.894
	Both	180.975 ± 35.165	186.408 ± 36.242	0.362
Longest Jump Distance	Left	102.350 ± 20.415	105.975 ± 21.249	0.334
	Right	103.600 ± 22.857	105.775 ± 17.720	0.533
	Both	186.725 ± 36.274	191.625 ± 35.554	0.414

Table 4: Pre- and Post-Measurements for ROM (mean ± SD)

Intervention		Pre-Measurement (cm)	Post-Measurement (cm)	p-value
Foam Rolling	Left	8.567 ± 3.122	8.833 ± 2.974	0.069
	Right	8.325 ± 3.011	8.725 ± 2.909	0.073
Body Tempering	Left	8.517 ± 2.918	8.930 ± 3.113	0.079
	Right	8.321 ± 3.078	8.800 ± 3.201	0.035*

*=significant finding ($P < 0.05$)

Table 5: Post Intervention ROM comparison (FR and BT) (mean ± SD)

Intervention		FR (cm)	BT (cm)	p-value
ROM	Left	8.833 ± 2.974	8.930 ± 3.113	0.791
	Right	8.725 ± 2.909	8.800 ± 3.201	0.825

dominant leg. In a previous study on frequency of injury in soccer athletes, it was shown there was no difference in ROM between either leg, but the dominant (shooting leg) was more likely to get injured.[31] Because this leg is more dynamic in use, it is injured more often. During the injury process, tissue goes through a remodeling phase which can be extremely prolonged, and even when finished, it might not heal correctly or align the best possible way.[32] The participants could have had previous injuries, past the six month criteria, that affected the tissue in their dominant leg. This tissue healing could have caused an underlying deficit that the BT device aided upon intervention. Because the non-dominant side was uninjured and there was no underlying deficit there was no improvement that could be seen whether that was with the BT or the FR.

FR the calves consists of a lot of upper body and core strength, as the participant needs to hold themselves in a proper position throughout the duration of the treatment. This ability, or lack thereof, can change the amount of force the participant has on the intended tissue. Because this study was completed on the general population and not athletes, many of the participants struggled to complete a treatment session for 30 seconds due to lack of strength. This lack of ability to hold oneself up to provide force into the calf could have caused a lack of change in the tissue when FR. This would explain why ADF ROM was statistically significantly different in the dominant leg while BT, but not while FR.

A potential limitation of this study is that the weight used for the BT device was not able to be adjusted because we were testing with just fifty pounds. It is stated in the BT manual that a high pain level should be achieved to see benefits.[10] To ensure consistency in the study, we used one weight the entire time. Changing the weights out based on individual pain scale might have elicited different results. A second potential limitation of this study is the participants ability FR ability, and therefore force applied, was linked to their strength and being able to hold themselves up. Many of these participants did not have the strength to hold themselves up and complete a 30 second treatment session, causing a lack of force into the foam roller, and therefore affecting the results. A third potential limitation is the sample size. While the power of the study was met, this is still considered a small number of participants. Including more participants would increase the strength of this study. A fourth, and final, limitation is that only the triceps surae group had the intervention completed on it. Jumping was tested during this study and jumping requires more than just the triceps surae group (i.e., quadriceps, hamstrings, hip flexors, and extensors). If all the lower extremity musculature was worked on, then the jumping data could have been different. Future studies should focus on the number of treatments per session. Only one treatment was completed per session, and the participants expressed that they did not feel much different before or after the intervention. Increasing the number of treatments per session could elicit a greater benefit or even a benefit that was not seen during the singular treatment. In the study, participants, also, often mentioned, "oh, it's already done." This indicated that the length of the treatment might change outcomes for the athlete and is something that can be focused on. Throughout the literature on FR there is varying lengths of treatment that are executed, usually thirty seconds to two minutes.[22] While there are a few studies that show changes under thirty seconds, there is a general consensus that one should spend thirty seconds of treatment time when FR.[2,22,23] After two minutes there seemed to be detrimental effects in one study.[21] While this study looked at thirty second treatment lengths there is time to play with while still staying under that two min period. Using that lengthened time period is something that can be examined to see if greater effects are seen when BT. Throughout the study, pain was assessed during treatment for safety purposes, but led to another idea. One participant said BT was significantly more painful than it was for the other participants; they then stated they felt a lot better and "looser" in their calves (which the others did not state). The individual data for this participant made significant improvements from pre intervention to post intervention for BT; comparing it to FR makes it even more apparent. Assessing the difference in pain level between the amount of weight on the BT device might elicit an interesting connection between pain and benefit for the athlete.

CONCLUSION/CLINICAL APPLICATION

Athletes, coaches, and clinicians should understand the effects these treatments will have and determine if they will benefit the subsequent performance individually. In this study, BT and FR both showed an improvement in power development in individual legs, but not when the double leg jump was completed. Single-leg power is used when competing in many athletic events (throwing, jumping, running) and applying BT or FR pre-contest could increase muscle performance needed during activity. Both techniques were comparative in the effects on power and dorsiflexion ROM, thus showing while both techniques worked, one may not be better than the other. Using this information, athletes preparing for power-type movements could benefit from BT or FR. Although an increase in power was noted in both techniques, only an increase in ADF ROM was recorded in the R leg while BT. While there was some benefit to ROM, it is inconclusive whether it would have a real benefit to the athlete pre-activity. With the aforementioned stated, BT is a passive technique and could be more appealing to the athlete than FR (active technique), thus motivating them to complete these myofascial activation activities. Giving the athlete another option to incorporate into their routine could lead to their success and good health, which in the end is what all clinicians and coaches want to see for the individual. On top of that, there were no detrimental effects noted in this study, leaving the athlete the freedom to use these techniques before activity, without fear of harm to their subsequent performance.

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