Myofascial Compression Interventions: Comparison of Roller Massage, Instrument Assisted Soft-Tissue Mobilization, and Floss Band on Passive Knee Motion Among Inexperienced Individuals

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ABSTRACT

Myofascial compression interventions have become popular in rehabilitation and fitness. To date, no studies have directly compared foam rolling, instrument assisted soft-tissue mobilization, and floss band among unexperienced individuals. The primary purpose of this investigation was to compare the immediate post intervention effects of foam rolling, instrument assisted soft-tissue mobilization, and floss band on passive knee joint range of motion (ROM) among inexperienced individuals using a standard treatment time. The secondary purpose was to determine the interchangeability of the interventions and to provide preliminary research for long-term comparison studies. This pretest-posttest randomized controlled trial was conducted in a university laboratory. Thirty participants (M=15, W=15) were randomly assigned to three groups: (1) foam rolling, (2) instrument assisted soft-tissue mobilization, and (3) floss band. The intervention time for each group was 2-minutes. The outcome was passive knee joint ROM. Between group analysis revealed a statistically significant post-intervention difference between the three interventions for passive knee flexion ROM ($p < .001$). Within group comparison for ROM revealed a 2 degree ($p < .001$) post-intervention increase for foam rolling, a 3.5-degree ($p < .001$) increase for the instrument assisted soft-tissue mobilization, and a 4-degree ($p < .001$) increase for the floss band. The three interventions produced similar immediate post intervention effects on passive knee joint ROM among inexperienced individuals. Clinically, these interventions may be interchangeable by producing similar effects on knee ROM. Clinicians may want to consider these finding prior to administering these interventions with their patients.

Key Phrases
Massage, muscle soreness, pain, release

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INTRODUCTION

Myofascial compression is a popular intervention used by allied health professionals.[1] There are several types of myofascial compression interventions such as foam rolling (FR), instrument assisted soft-tissue massage (IASTM), and floss band (FB). These interventions can be found in various clinical and fitness settings. The research on these types of interventions has increased over the past decade.

The research on FR has documented positive outcomes with reduced post exercise decrements in muscle performance,[2-6] increased post treatment pressure pain thresholds (PPT),[4,7-9] and decreased post exercise muscle soreness in healthy individuals.[2,3,10-12] Several recent studies have also documented positive post intervention effects of FR for different sports,[11,13-15] occupations,[16] and chronic pain conditions.[17] The IASTM research suggests that the intervention is an effective treatment for tendoinopathies,[18,19] arthrofibrosis,[20,21] cerebral palsy,[22,23] musculoskeletal pathologies,[18,24-26] post mastectomy,[27] post total joint arthroplasty,[28,29] and athletic performance measures.[18,24-26] The FB research is still emerging and the available studies have documented post intervention improvements in jump and sprint performance,[30,31] reduced effects of edema in post-surgical patients,[32] and improved pain and function in individuals suffering from Achilles tendinopathy.[33]

One of the most common outcome measures professionals use for all three interventions is joint range of motion (ROM).[34] Researchers have found that FR may improve joint ROM at the shoulder,[35,36] lumbopelvis,[37,38] hip joint,[39-45] knee joint, [9,45-47] and ankle.[48,49] IASTM has also been shown to improve joint ROM at the shoulder,[27,28,50,51,52] hip and knee joint,[51,53,54,55] ankle,[56] and spine.[57] The FB research has documented improved post intervention ankle joint ROM in healthy individuals.[30,31] To date, no studies have directly compared the effects of all three interventions on joint ROM among individuals with no prior experience. Only one study has compared the effects of FR and IASTM on passive hip and knee joint ROM in collegiate soccer players.[51] The study author did not document if the athletes had prior experience with myofascial compression interventions. The primary purpose of this investigation was to directly compare the immediate post intervention effects of foam rolling, instrument assisted soft-tissue mobilization, and floss band on passive knee joint ROM among inexperienced individuals using a standard treatment time. The secondary purpose was to determine the interchangeability of the interventions and to provide preliminary research for long-term comparison studies. The researchers hypothesize that all three interventions will produce similar post treatment effects on passive knee joint ROM after a standard treatment time.

METHODS

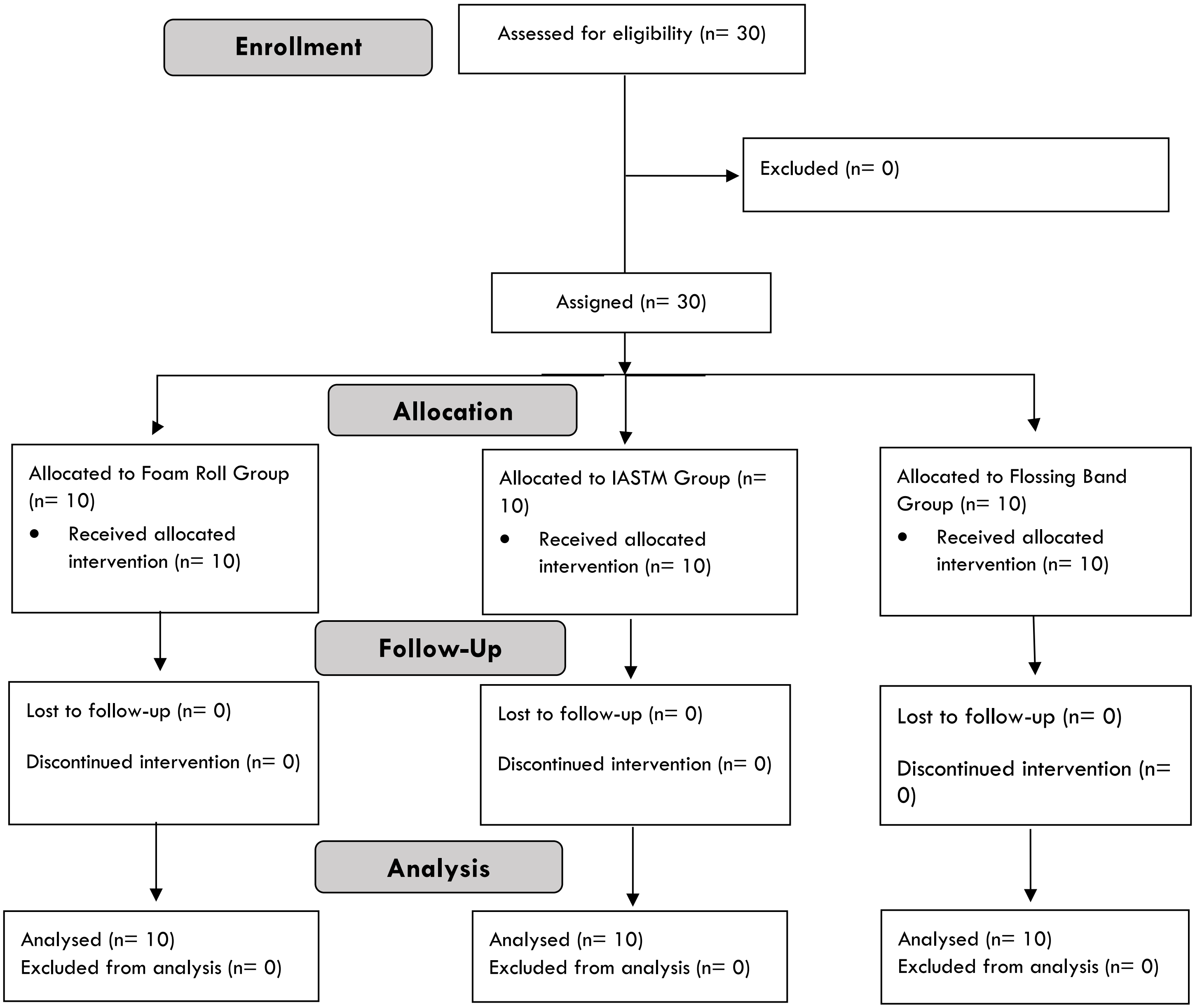
Participants

Thirty healthy, active adults (M=15, W=15) were recruited via convenience sampling and enrolled in the study. Participants were randomly assigned into one of three groups: foam roller (FR) (N=10), instrument assisted soft-tissue mobilization (IASTM) (N=10), and flossing bands (FB) (N=10) (**Figure 1**). A random number generator was used to allocate participants to each group. Participants reported no prior experience using any of the myofascial interventions in this study. Participant exclusion criteria included the following: musculoskeletal, systemic, neurosensory, or metabolic conditions that would affect joint ROM of the lower extremity or the inability to avoid medications that may affect testing.[18,58,59] Participant demographic information is described in **Table 2**. This pre-test, post-test clinical study was approved by the Institutional Review Board at Florida International University.

Outcome Measure and Instrument

The outcome measure used for this investigation was passive knee joint ROM. The Clinometer Smartphone Application™ (Plaincode, Stephanskirchen Deutschland) was used to measure each participant. The Clinometer app has been shown to be valid and reliable for measuring lower extremity ROM.[60-64] For testing, the participant was placed in the prone lying position on a table. The investigator grasped the left ankle and passively moved the left knee. The knee was flexed to the point where the joint could no longer be passively moved without providing overpressure or to the point of initial discomfort. This position was held and a measurement was taken. The investigator monitored for any compensatory movement throughout the lumbopelvis and lower extremities. The investigator took the average of 3 measurements for each participant. Left passive knee joint ROM measurements have been used in prior myofascial compression studies.[65-67]

Figure 1: Data Collection Diagram



Interventions

The FR group used a commercial foam roll and related instructional video were used in this investigation (TriggerPoint, a division of Implus, LLC, 2001 TW Alexander Drive Durham, NC 27709, USA). The video demonstrated the use of the foam roll on the left quadriceps muscle group. The GRID® surface foam roll used in this investigation was commercially manufactured with a hard-hollow core (14 cm diameter) with a moderately firm outer ethylene-vinyl acetate (EVA) foam (**Figure 2**). Participants were issued the foam roll and followed the video with no feedback from the observing investigator. The instructor in the video provided a brief introduction and then discussed the foam rolling technique. The instructor divided the left quadriceps into zone one: top of patella to middle of the quadriceps and zone two: middle quadriceps to anterior inferior iliac spine. The model in the video was instructed to get in the plank position, position the roller above the left patella and roll back and forth in zone one 4x at a cadence of 1inch per second. The model was then instructed to stop at the top of zone one followed by 4 active knee bends to 90 degrees. This sequence was repeated for zone two. The intervention portion lasted a total of 2 minutes. This video has been used in prior foam roll research.[68]

For the IASTM group, the investigator administered an instrument intervention using the Smart Tools® crossbar tool (423 grams) (Smart Tools, 20636 Castlemaine Circle, OH 4419, USA) (**Figure 2**) to the left quadriceps muscle. The investigator was a trained researcher certified in several IASTM paradigms. Participants lied supine on a table with hip and knee straight. A water-based gel was used to decrease friction between the skin and instrument. The investigator delivered a superior and inferior longitudinal stroke with the crossbar perpendicular to the soft tissues while maintaining a 45° instrument edge angle. The investigator first began by placing the edge of the instrument just above the patella. The investigator then delivered a superior stroke up towards the anterior inferior iliac spine (AIIS). Just before reaching the AIIS, the investigator reversed the cross bar and delivered an inferior stroke back to the starting position while maintaining the edge angle. The investigator used a 2 second cadence to complete the sequence using only the weight of the tool. The total intervention lasted 2 minutes.

For the FB group, a 5.08 cm (2-inch) Rockfloss® floss band (RockTape®, a division of Implus, LLC, 2001 TW Alexander Drive Durham, NC 27709, USA) was used along with a related instructional video. The video demonstrated the use of the floss band to the left quadriceps muscle. Participants were issued the floss band and followed the video with no feedback from the observing investigator. The video narrator provided a brief introduction and then demonstrated the technique using a model. The model wrapped the floss band around the left quadriceps muscle (distal to proximal) using a 50% overlapping pattern with an elongation stretch of 50% band length (**Figure 2**).[69] The wrap covered the quadriceps muscles above the patella to below AIIS. The model then demonstrated an active movement sequence consisting of standing hip flexion (30 seconds), seated knee extension and flexion (30 seconds), and bodyweight squats (1minute). The intervention portion lasted a total of 2 minutes. Participants followed the video and wrapped their own leg.

Figure 2: Different myofascial compression devices: Grid foam roller, IASTM tool, and floss band

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Pilot Study

Pilot training was conducted over two-sessions to practice the testing procedures and establish intrarater and interrater reliability among three investigators for passive knee joint ROM. Fifteen participants were independently recruited and enrolled for this portion of the investigation. The Intraclass Correlation Coefficient was used to calculate intrarater (ICC model 3, k) and interrater reliability (ICC model 2, k).[63,70] The results revealed good intrarater (ICC= 0.99; 95% CI 0.88-1.0) and interrater (ICC= 0.94; 95% CI 0.67-0.99) reliability among all investigators. These coefficients are in accordance with the minimum threshold of ≥ .90 for ICC values postulated to be acceptable for clinical decision making.[71]

Procedures

Prior to testing, eligible participants reviewed and completed study related materials including the written IRB consent form and demographic questionnaire. All participants underwent one session of testing that included pre intervention measures, followed by the intervention, and then immediate post intervention measures. All participants were tested between the hours of 10 A.M. and 2 P.M. and were instructed to not participate in any strenuous activity 5 hours prior to testing. Participants were also instructed to refrain from taking any medications (e.g. opioids, muscle relaxants) that would interfere with testing. All participants were blinded to the testing results and other individuals in the study.

For each group, one investigator was assigned to take three pre intervention and three immediate post intervention measures and was blinded from the intervention. A second investigator was present to explain the intervention procedures (FR and FB) to each participant and answer any questions. For the IASTM group, the second investigator administered the intervention. These testing methods have been used in prior myofascial research.[72]

Statistical Analysis

The statistical analysis was performed by the program SPSS version 25.0 (IBM SPSS, Armonk, NY, USA). The descriptive statistics for participants were calculated for age, height, body mass, and body mass index (BMI). The ANOVA statistic was used for continuous descriptive data and the Kruskal Wallis statistic for ordinal descriptive data. The ANCOVA statistic was used to measure between group differences. The independent variable was the group, dependent variable was post test scores, and pretest scores was the covariate.[73] Post hoc within group differences were measured with the paired *t*-test. The average of three joint ROM measurements was used for all pre-test and post-test calculations. The effect size was also measured ($d = M_1 - M_2 / \sigma_{pooled}$). The effect size values were interpreted as: >0.70 was considered strong, 0.41 to 0.70 was moderate, and < 0.40 was weak.[74] All statistical assumptions were met for the ANOVA, ANCOVA and paired *t*-test statistics. Statistical significance was considered $p < .05$ using a two-tailed test.

RESULTS

Thirty participants were enrolled and completed the study (mean age= 25.43 ± 2.46 years; height= 170.00 ± 9.17 cm; body mass= 73.82 ± 9.65 kg; body mass index (BMI)= 26.65 ± 3.83 kg/m^2) (**Table 1**). Descriptive analysis revealed no statistically significant difference between groups for age (p=0.10), height (p=0.70), body mass (p=0.55), or BMI (p=0.14). All enrolled participants completed the study with no adverse events or attrition.

The between group analysis for passive knee joint ROM revealed a statistically significant post intervention difference between the three groups [$F_{(1,39)} = 612.32$, $p = < 0.001$, partial $\eta 2 = 0.944$]. The post hoc within group analysis

Table 1. Participant demographics (N=30)

Characteristics	Age (years)	Height (cm)	Mass (kg)	BMI (kg/m²)
Foam Roll Group (N=10)	26.13 ± 2.56 (range 23-30)	169.50 ± 8.72 (range 155-183)	72.73 ± 9.35 (range 59-89)	24.67 ± 2.84 (range 21-28)
IASTM Group (N=10)	24.80 ± 2.04 (range 23-28)	168.15 ± 9.49 (range 150-180)	77.59 ± 9.49 (range 57-99)	27.34 ± 4.45 (range 21-36)
Floss Band Group (N=10)	24.40 ± 2.13 (range 22-31)	172.39 ± 10.37 (range 158-188)	72.26 ± 10.57 (range 57-108)	27.90 ± 4.83 (range 21-38)

Data reported as mean± SD; range (min-max); m=meters; BMI= body mass index; kg/m²= kilograms-meter squared

Table 2. Pre and post-intervention results (N=30)

	Pretest	Posttest	Change	P-Value	Effect Size
Foam Roll Group					
Knee Flexion ROM (degrees)	115.60 ± 8.66	117.93 ± 9.06	2.33 ± 0.40	<.001	.26
IASTM Group					
Knee Flexion ROM (degrees)	121.97 ± 13.81	125.48 ± 13.00	3.51 ± 0.81	.004	.26
Floss Band Group					
Knee Flexion ROM (degrees)	110.73 ± 8.48	114.73 ± 8.43	4.00 ± 0.03	<.001	.47

Data reported as mean ± SD, kPa= kilopascals; statistical significance considered p<.05; Effect size: $d = M_1 - M_2 / \sigma_{pooled}$

revealed an approximate post intervention knee flexion increase of 2 degrees (p <.001, ES=.26) for FR, 3.5 degrees (p=.004, ES= .26) for IASTM, and 4 degree (p<.001, ES=.47) for FB (**Table 2**).

DISCUSSION

The primary purpose of this investigation was to directly compare the immediate post intervention effects of FR, IASTM, and FB on passive knee joint ROM among inexperienced individuals. To date, no studies have compared these interventions among this population. The results suggest that these interventions produced a statistical significant post intervention effect. However, there was less than a 2° post treatment difference between interventions which may not be clinically meaningful in some settings. It is important to note that the passive joint ROM in this study was taken with a digital device which may be more accurate than standard goniometry.[60] These findings are similar to prior research documenting increased post intervention knee ROM values that ranged from 2-7° for the these interventions.[45-47,51,55]

The secondary purpose was to determine the interchangeability of the three interventions using a standard treatment time of 2-minutes which has been a common intervention time used in prior myofascial research.[68,69] There was a ROM difference of 1-2° between all three interventions which suggests they may produce similar post treatment responses when using the same treatment time and body region (quadriceps muscle). These findings support their interchangeability. For example, a professional may administers a skilled 2-minute IASTM technique to the quadriceps then prescribe a 2-minute self FR or FB intervention as a home exercise to maintain the effects of the IASTM treatment. The results of this study are consistent with findings from the Markovic study which compared the efficacy of a 2-minute FR and IASTM intervention on soccer players.[51] The authors documented improved post intervention passive knee and hip joint ROM from both interventions ($p < 0.05$). Thus, these myofascial compression interventions produced similar post treatment effects.

There are two main scientific theories being postulated by researchers regarding the post treatment effects of these myofascial compression interventions. These interventions may provide a greater deformation of the local myofascial tissues which creates a mechanical and neurophysiological effect. For the mechanical effect, the pressure of the device or wrap may change the viscoelastic properties of the myofascia by mechanisms such as thixotropy (reduced viscosity), reducing myofascial restriction, fluid changes, and cellular responses.[48,75] Clinically, these changes may be observed as a greater lengthening or "stretch tolerance" of the muscle and surrounding tissues as measured by changes in joint ROM. For the neurophysiological effect, the mechanical pressure from the device or wrap may have produced a local and global neurophysiological effect that influences tissue relaxation in the target and surrounding tissues through central nervous system afferent input from the Golgi tendon reflex and mechanoreceptors (e.g. Golgi tendon organ).[7,48,75-78] Perhaps, the active joint movements in the FR and FB interventions enhance the effects of the devices as well as the assisted IASTM intervention. Prior research suggests that active myofascial interventions may enhance the neurophysiological effect producing greater benefits.[68,79] Future studies are needed to validate these theories.

Limitations

There are four limitations with this study. First, this study tested healthy non-experienced participants with no pathology. This limits the generalizability to this population. Second, the three different myofascial compression interventions studied were from specific manufacturers. Other similar interventions from different manufacturers may have produced different results. Third, the immediate post intervention effects were investigated. The long-term effects of the intervention cannot be determined. Fourth, the interventions in this study used a specific technique (e.g. left quadriceps) for a predetermined 2 minute intervention time which has been used in prior myofascial research.[68,69] Other treatment techniques and intervention times may have produced different results.

CONCLUSION

This was the first study to directly measure the immediate post treatment effects of three different myofascial compression interventions on passive knee joint ROM among individuals with no prior experience using a standard treatment time. The results suggest that all three interventions may produce similar immediate post treatment effects which supports their interchangeability. Future studies are needed to further validate these results over a long post intervention time period. The goal of this study was to be exploratory and establish the methodology for long-term investigations. Clinicians may want to consider these results when choosing and administering myofascial compression interventions with their patients.

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