Acute Effects of The Voodoo Flossing Band on Ankle Range of Motion

Journal of Medical Biomedical And Applied Sciences
Doi : 10.15520/jmbas.v7i6.190
Received : 24 April 2019
Accepted : 29 May 2019

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Abstract

Objective: Whilst voodoo floss bands are thought to increase range of motion through tissue compression, partial occlusion and fascial deformation, this has not been demonstrated. Consequently, this study aimed to investigate the short-term effects of using floss bands on range of motion in the ankle.

Design: This crossover design had participants go through range of motion tests prior to the application of the floss band. After the floss band was applied, participants were required to perform various non-weight bearing and body weight exercises, followed by post-intervention range of motion testing. In this study, one ankle served as the intervention (FLOSS) leg whilst the contralateral ankle served as the control (CON).

Setting: The Bangor University School of Sport, Health and Exercise Sciences (SSHES) Laboratory.

Participants: 5 recreational male athletes.

Main outcome measures: Pre and post measures included handheld goniometry for dorsiflexion (DF) and plantarflexion (PF), weight bearing lunge test (WBLT) performed with straight leg (SL) and bent leg (BL) and a subjective tightness rating (TIGHT).

Results: FLOSS resulted in one significant ($p < .05$) enhancement across the outcome measures as compared to CON in dorsiflexion ($p < .032$). However, there is a trend toward significant improvement and clinical meaningfulness ($p < .15$) in favor of FLOSS over CON in bent leg weight bearing lunge test ($p < .145$).

Conclusion: Applying floss bands to extremities to achieve an increase in range of motion is a plausible and potentially helpful treatment alternative. This study was limited by a small sample size and low power, however, even with few participants improvements were seen in FLOSS over CON.

Keywords: voodoo floss bands, mobility bands, ROM, self-myofascial release

1. Introduction

Athletes and coaches alike are constantly looking for the next “magic bullet” that might allow them to train at a high level and compete optimally, while minimizing risk and optimizing the treatment of athletic related injuries. To achieve this, much attention has been devoted to the fascial system and myofascial release, as a means of improving range of motion and overall athletic movement. The fascial system is thought to play a pivotal role in the mechanics of movement and muscle pain associated with delayed onset muscle soreness (DOMS) and overuse/ repetitive pain (Gibson et al. 2009). These theories have led to the creation of many myofascial release therapies that are used daily by athletes all over the world, including but not limited to: clinician administered myofascial release/massage (transverse friction, positional release, active release, deep tissue, etc.), cupping therapy, instrument assisted soft-tissue mobilization (IASTM), foam rolling and flossing/mobility bands, the latter being the subject of this study. Voodoo floss bands (mobility or floss bands for short) are thick rubber bands that are wrapped around an extremity or joint to help loosen the tissues, increase range of motion and reduce pain.

To understand the theories behind the floss band, first a good understanding of the fascial system in the body is necessary. The fascia is a continuous sheet of tissue that encompasses all parts and systems of the body (Klinger et al. 2014). It is designed to allow for optimal contractions by providing tension throughout the limbs and torso during movement, it is also thought to be a prime source of mechanical information (proprioception) in the body (Stecco et al. 2013). The fascia is also important for limb and movement coordination, muscle interaction, and finally it allows for full range of motion from the joints and tissues by allowing stretching and sliding effects of each fascial layer (Stecco et al. 2013; Dowling 1998; Chaitow 2014). There are many types of fascia; from the periosteum that surrounds the bones to the epimysium and the perimysium that wrap the muscles (Myers 2014). The focus here will be on the larger and more superficial fascial layers that wrap the individual muscle groups and allow for movement between the skin and the muscle underneath. These layers are the epimysium, the deep fascial layer, the layer of potential space between deep and superficial layers, and the superficial fascial layer. Each layer slides or glides on each other with the help of muscular contractions and hyaluronic acid (HA) which acts as a lubricating agent in the ground substance found in the layers of potential space between the fascia (Stecco et al 2013). Ground substance can be defined as a gel like substance found between the fascial layers which is comprised of glycoaminoglycans, proteoglycans and various other extracellular components. When fatigue occurs, it changes the pH in the muscle and ground substance, causing an increase in viscosity and a decrease in the lubricating effect, causing tissues to feel “stiff” (Stecco et al 2013). When viscosity increases and HA becomes more adhesive than lubricating, changes to the lines of stress in the muscle can result in micro tearing of the epimysium, causing delayed onset muscle soreness (DOMS). A side effect of DOMS is inflammation, and chronic inflammation can lead to scar tissue formation (fibrosis) in between the fascial layers that limits the sliding/gliding potential of the tissue (Klinger et al. 2014). As fascial function decreases (whether from increased HA viscosity or formation of a point of adhesion), the total range of motion in the affected tissues and joints can become limited, which in turn exacerbates injury risk (Warren & Jones, 1987). Practitioners in the field of sports medicine and rehabilitation recognize that restricted motion is a predisposing factor to many injuries; this is especially so in the ankle, with knee pain, anterior cruciate ligament (ACL) tears, fatigue and overuse syndrome in the foot and lower leg as potential consequences (Fong, et al, 2011; Warren & Jones, 1987). Hence, treatments that are able to loosen the myofascia, improve and maintain range of motion, whilst being cost effective, space efficient and user friendly are much sought after.

Use of Voodoo floss bands for injury prevention/treatment was made popular by the book “Becoming a Supple Leopard” by Starrett and Cordoza (2013). With the book reaching the New York Times best sellers list, use of the band skyrocketed. Since then mobility bands have made their way into athletics and sports medicine as a regular form of self-administered myofascial release. These bands are thought to have a threefold effect on the body and the underlying tissues. First, the strong compressive force coupled with movement during compression is proposed to stimulate mechanoreceptors in the underlying fascial layers to provide pain relief or “pain-gating” according to the gate control theory of pain management (Vaughn & McLaughlin, 2014; Stecco et al. 2013). Secondly, the strong compression of the band provides localized ischemic compression of the intended tissues and when the band is removed there is reactive hyperemia/reperfusion of the tissues. This is thought to enhance blood flow via nitric oxide release, thereby aiding muscle nutrition and removal of intramuscular by-products to improve efficiency of muscular contraction (Reeves et al. 2006; Takarada et al. 2000). Finally, there is a fascial shear created by the compressive force of the band and the muscular movements during compression. This is thought to cause a deformation in the fascial adhesion points, and the heat generated by the frictional force may return HA viscosity to normal, restoring the fascia’s sliding/gliding potential (Chaitow, 2014; Stecco et al., 2013; McPartland & Simons, 2006). Although there is considerable anecdotal evidence to support the use of mobility bands, there is little quantitative evidence to support its use.

Currently, the information on Voodoo floss bands is limited to 3 studies done in athletic settings; two were published as conference proceedings and one in the *Journal of Physical Therapy in Sport*. For the literature review, multiple search engines were used to identify studies including; the Bangor University library search engine, Google Scholar, and Pubmed. The search terms: “flossing bands”, “voodoo floss”, “muscle floss band”, “myofascial release”, “self-myofascial release”, and “fascial treatments” were used. These search terms produced three studies on the use of voodoo floss bands (Bohlen et al., 2014; Plocker et al., 2015; Driller and Overmayer, 2017) which stand as the current base of knowledge on the use of floss bands.

Bohlen et al., (2014) looked at the effects of once daily use of the floss band over a 14-day period coupled with joint mobilization and resistive exercises on blood flow and calf strength in plantar flexion (PF) and dorsiflexion (DF), using the contralateral leg as a control. This study was conducted on 5 participants, 1 male and 4 females, with a mean age of 20 ± 1 years. Each floss session included 10 repetitions of active ankle DF and PF, 10 unweighted squats and 10 heel raises. The results showed an increase in DF peak torque of 22% in the treatment leg relative to the control leg but no change in blood flow was observed.

In the Plocker et al., (2015) study, voodoo floss bands were applied to both shoulders of 17 male participants and acute effects on range of motion (ROM) with goniometry and upper extremity power via 3D accelerometers during a bench press were investigated. The control condition involved the same participants doing identical activities, minus the floss band. In this study, there were no significant changes in ROM or power when using the floss band compared to the control. Although, the authors suggest that the floss bands may have a more impactful benefit in less complex joints, such as the ankle.

Finally, Driller and Overmayer, (2017), looked at the acute effects of floss band use on ankle ROM and jump velocity in fifty-two college age participants. These participants included 26 males and 26 females between the ages of 18-24 who were recreationally active. The procedure utilized included: non-weight bearing active ankle ROM, body weight squats and walking with the band on. Participants used the band on one leg, determined randomly by computer, with their contralateral leg as the control. ROM and jump test were completed on each leg before and after band use. The leg that used the floss band showed improvements in ankle ROM in the weight bearing lunge test, and non-weight bearing handheld goniometry, along with increased jump velocity.

With two out of the three studies showing significant effects in favor of floss bands, it is necessary to find the mechanism for these results. The theory of the floss band reducing or eliminating the adhesion points in between fascial layers may have merit, and therefore could be a valuable self-treatment for athletes.

The question for this study is as follows: Will treatment of the ankle with a voodoo floss band result in an increase in ankle range of motion in college age participants? The hypothesized result to this question is as follows: there will be an acute increase in ankle range of motion in the participants in both handheld goniometry and weight bearing lunge test.

2. Methods

2.1 Sampling

A convenience recruitment from students participating on Bangor University Athletics teams, older than the age of 18, with no bias toward gender was used. The advertisement for the study was done via email, Facebook and paper fliers placed around the School of Sport, Health and Exercise Sciences (SSHES) and the University grounds (particularly Treborth athletic grounds). Participants were accepted into the study if they participated at least 3 days in vigorous activity including: running, jumping, or weightlifting. A sample size calculation for this study based on Driller and Overmayer required a sample size of 64 participants to meet a .90 power rating and a 95% confidence level, although it may not be possible to recruit that many participants from the surrounding community. Also, because this study took a convenience sample there might be a selection bias and decreased external validity. However, because this product is geared toward athletes and those who are physically active on a regular basis, the sampling method should provide a better idea of the effects on the target population. Additionally, because it is impossible to blind in a treatment experiment like this, there may have been some experimenter bias introduced. Nevertheless, because this is a study of acute physiologic responses to external stimuli, this study is less likely to suffer from: diffusion, history, attrition, maturation, or the learning effect.

2.2 Inclusion and exclusion criteria

Eligible participants were those who met the exercise criteria and who suffered from tightness, stiffness, heel pain, Achilles tendon pain or calf pain. Exclusion criteria was as follows; did not meet the required activity limit; had a current or recent injury to the lower extremity of either side; had recent lower extremity surgery; was currently under the care of a clinician for myofascial pain syndrome or any other condition; had deep tissue massage or clinician administered myofascial release in the previous month; used a foam roller within 24 hours of the study; had cancer in the involved tissue; had a history of compartment syndrome and/or peripheral vascular disease; or was pregnant.

2.3 Participant information

All eligible participants who chose to volunteer in the study received a patient information sheet (Appendix 1) detailing what was to occur 48 hours before the visit. This information sheet lists the goals of the study, the risks or disadvantages of participating, the purpose of the study and how to give feedback. Next, each participant filled out a brief health history questionnaire (Appendix 3) which gathered pertinent medical information. This questionnaire gave a brief insight into the recent health and wellness of the participant and ensured that no conditions were made worse by the intervention. After each participant read the information sheet and filled out their health questionnaire, they had an opportunity to ask any questions about the project; if they were happy to proceed, they signed an informed consent form (Appendix 4).

2.4 Procedures

The primary outcome measure, range of motion, was measured in two ways. First was handheld goniometric measurements of dorsiflexion (DF) and plantarflexion (PF). Goniometry is a validated form of range of motion testing for clinical use. The only disadvantage to goniometric measurements is that the identification of prominent structures for use as landmarks is subject to tester proficiency (Rome, 1996). Using one researcher for all goniometric measurements helps to provide accurate data. Ankle range of motion was assessed with the patient long seated on a treatment table. The proximal fibular head was palpated and marked along with the center of the lateral malleolus and the styloid process of the fifth metatarsal. These points were used as landmarks to accurately and reliably place the goniometer. Then the participant was asked to actively dorsiflex, at the point of maximal active range of motion, the patient was asked to relax and over pressure was applied by the researcher to achieve the maximal joint range of motion, this was repeated for plantarflexion (Starkey et al., 2010; Rome, 1996). The second range of motion measure is the weight bearing lunge test (WBLT) with knee straight and bent. The difference between knee positioning during this test shows flexibility in the gastrocnemius and soleus respectively (Cosby and Chinn, 2011). For the weight bearing lunge test, the participants had a bubble inclinometer placed approximately four inches above the calcaneal insertion of the Achilles tendon and placed both feet approximately 4 inches from the wall. With instruction, the participant slid back the foot with the inclinometer and attempted to "get the knee as close to the wall as possible" while maintaining a straight knee. Next, with the same leg they were asked to flex both the knee and hip, trying to get the knee as close to the wall as possible. The same procedure was reproduced on the opposite side immediately after. This test has been shown to have great inter and intra- rater reliability compared to traditional non-weight bearing range of motion measures, as well as being an accurate test for functional capacity of the ankle joint (Powden et al., 2015; Chisholm et al., 2012; Cosby and Chinn, 2011). There was be a secondary outcome measure of a patient reported stiffness or tightness on a numerical rating scale. This attempted to capture the subjective point of view to accompany the objective data.

Consenting participants first graded their perceived tightness for both ankle joints on the numerical rating scale (Appendix 2) between 1 and 10, before the intervention was carried out. Although this form of questionnaire has not been validated for use in tightness or stiffness ratings, the difference between the subjective and objective data will give a more robust data set and a better insight on the efficacy of the intervention or the possible existence of a placebo effect. Then, each participant had their ankle range of motion assessed (PF and DF) bilaterally via handheld goniometry (Starkey et al., 2010; Rome, 1996). Next, the patients were asked to perform WBLT on both legs with the knee straight and bent (Cosby & Chinn, 2011). Then, each participant had one leg randomly allocated (via computer allocation) that was used for the floss band intervention, whilst the contralateral leg acts as a control.

After the baseline measures, the floss band was applied to the approximate tightness of 180mmHg to the allocated ankle. The band was applied distally to proximal starting at midfoot and wrapping up to cover the ankle joint, calcaneus, Achilles tendon, and inferior soleus. To apply the band with a consistent amount of compression, a modified sphygmomanometer was used on the anterior tibia, above the ankle mortis. Use of a sphygmomanometer in this way has not been previously validated, however, this was a way to create a repeatable study and works along the same principles as the Kikuhime sensor used in Driller and Overmayer in 2017. Participants then performed approximately 2 minutes of activity, with the band on one leg, including; 20 repetitions of active range of motion (AROM) (including plantar flexion, dorsiflexion, circumduction) while non-weight bearing on a treatment table. Next the participants were asked to do 10 body weight squats, followed by 15 eccentric heel raises on a raised platform or step (Bohlen et. Al, 2014). During the exercises, both legs were worked at the same time.

Since there is no a set protocol for use of the floss band on the ankle, the goal of the listed exercises was to create the most movement and friction between the compressed tissues and the most fascial shear possible to cause a deformation in the fascial layers (Ercole et al., 2010). A similar protocol was utilized during the Bohlen et al. study in 2014. After, the band was removedand the participant could move and walk around to promote blood flow to the extremity.

When the participant was content with the return of circulation, post-intervention tests were performed. In the same order as the pre-tests, the participants were asked to give their perceived tightness/stiffness of each ankle on the numerical rating scale. Then, participants were measured for ankle DF and PF, and WBLT on both legs with the knees both straight and bent (Rome, 1996; Starkey et al., 2010; Cosby and Chinn, 2011).

2.5 Stopping criteria

Although in previous studies there were no negative side effects or conditions associated with the use of the floss band, testing will be stopped if participant decides to stop early for any reason, the participant loses feeling or has an increase in pain in the distal extremity, participant develops an allergic reaction to the floss band, feels faint or dizzy during the intervention, or has some other unforeseen complication that might be life or limb threatening.

2.6 Equipment and Cost

For this study, the materials used were: a treatment table, a body marker, a pulse oximeter (to measure patient vitals), a handheld goniometer, an elevated platform/step, a voodoo floss band, a tape measure, alcohol prep pads, and an inclinometer/tiltmeter (digital inclinometer). Although the materials list is rather extensive, all the necessary equipment is either owned by the researchers or Bangor University's School of Sport, Health and Exercise Science and available for rental.

2.7 Statistical Testing

A one-way repeated measure analysis of variance (ANOVA) test was utilized to determine differences in pretest and posttest scores across 2 conditions (FLOSS and CON) for the different variables. The analysis was performed in SPSS version 22.0.

3. Results

A total of 5 participants were recruited from Bangor University sports teams and the School of Sport, Health and Exercise Sciences (SSHES) undergraduate programs. This amount yielded a total of 10 data sets (as each person counts as both experiment and control). The participants were all male, with a mean age of 23.6, all recreationally active, and all healthy with no injuries at the time of the study.

There were no significant differences between the intervention group and the control group prior to testing for dorsiflexion, plantarflexion, straight leg weight bearing lunge test, bent leg weight bearing lunge test or perceived tightness. DF saw a significant increase ($p < .032$) in favor of FLOSS with a *p*-value of .05. There was an overall increase in range of motion of 105.0% for dorsiflexion with goniometry compared to the control at 30.7%. The analysis also pointed toward a meaningful trend in BL ($p < .145$) with a *p*-value of .15, with an overall increase of 24.9% in range of motion compared to the control at 9.8%. There were no other significant differences between FLOSS and CON across the other variables. However, there were marginal increases in plantarflexion and straight leg weight bearing lunge test and marginal decreases in perceived tightness. Plantarflexion saw an increase of 6.3% in the floss group compared to a 14.1% increase in the control. Straight leg weight bearing lunge test saw a 20.0% increase compared to a 14.9% in control. Finally, perceived tightness saw a 72.0% decrease in the floss group compared to a 41.0% decrease in the control.

Table 1- Effect of using floss bands on ankle range of motion

	FLOSS (Mean ± SD)		CON (Mean ± SD)		*p*-Value	Partial ETA squared
	Pre	**Post**	**Pre**	**Post**		
DF (degrees)	4.0 ± 4.3	8.2 ± 4.0	5.2 ± 4.6	6.8 ± 4.1	.032*	.458
PF (degrees)	54.0 ± 7.3	57.4 ± 6.8	52.6 ± 10.6	60.0 ± 5.8	.252	.160
SL (degrees)	22.8 ± 2.1	27.4 ± 2.6	21.4 ± 4.7	24.6 ± 2.9	.254	.159
BL (degrees)	24.8 ± 4.3	30.8 ± 1.1	24.6 ± 4.9	27.0 ± 2.5	.145[b]	.246
TIGHT	2.2 ± 1.7	0.6 ± 0.9	2.4 ± 2.1	1.4 ± 1.1	.536	.5

*denotes statistical significance at $p < .05$

[b] denotes statistical trend toward clinical meaningfulness at $p < .15$

Table shows the mean, standard deviation, interaction *p*-value, and partial ETA squared between the intervention group (FLOSS) and the control group (CON) across the various dependent variables: dorsiflexion (DF), plantarflexion (PF), straight leg weight bearing lunge test (SL), bent leg weight bearing lunge test (BL), and subjective perceived tightness (TIGHT).

4. Discussion

The aim of this study was to determine whether using voodoo floss bands has an impact on ankle range of motion in both load bearing and non-load bearing range of motion testing. The objective measures used to determine the effects of floss bands on the ankle were: dorsiflexion (DF) and plantarflexion (PF) with non-load bearing goniometry, and bent leg (BL) and straight leg (SL) weight bearing lunge test (WBLT). Also, a subjective tightness score was taken before and after the intervention for both the control and intervention. The results of the study show significance in dorsiflexion goniometry ($p < .032$, Table 1) and a trend toward significance for bent leg weight bearing lunge test ($p < .145$, Table 1) in favor of the intervention group over the control. Based on a power calculation, the number of participants needed to provide a robust set of data was 64 participants. Unfortunately, due to time and sampling constraints only 5 participants were gathered. Although the sample and effects sizes were small, they may provide practical implications for athletes and sports medicine practitioners for improving ankle range of motion. This potential to improve ROM may be applicable in other joints of the body. Although there was only a clinical significance in the dorsiflexion and trend toward clinical significance in the bent leg weight bearing lunge test, with a larger patient population it is plausible that the other outcome measures may follow suit.

While this study has small power, due to low sample size, it shows a significant finding for improvement of range of motion. Although results are positive, the mechanism behind how the floss bands work is still unknown. The main theories for how floss bands work include: true fascial deformation (Ercole et al. 2010), restoring pH balance and the lubricating factor of hyaluronic acid (Stecco et al. 2013; Klinger et al. 2014), ischemic compression with hyperemic “flush” and associated hormone production (Reeves et al. 2006; Takarada et al. 2000), and “pain gating” (Vaughn & McLaughlin, 2014). While all the theories are still yet to be proved, it is not too far of a jump to say that all might be working together. Even though the likelihood of true fascial deformation occurring during use of the floss band is low (with upwards of 100kg of pressure needed to cause microfailure) (Threlkeld 1992) it is possible that the targeted tissue can respond in other ways. Hyaluronic acid is likely behind much of the range of motion increase. While the band was on, friction between the layers of tissue was increased whilst the participants were active, which created an increase in heat. It is plausible that the heat generated by the friction was enough to reach an internal temperature of 40°C (Stecco et al. 2013) which is needed to restore the lubricating factor of said hyaluronic acid (Stecco et al. 2013; Klinger et al. 2014). It is also possible that hyaluronic acid was distributed more evenly by the circumferential pressure provided by the floss band, due to hyaluronic acid acting as a Bingham viscoplastic fluid (Chaudhry 2013). It remains unclear whether the intramuscular effects of floss band use mirror that of Blood Flow Restriction (BFR) training, however, it is not too far of a stretch to theorize that there would be similar effects on hormone production (namely HGH and IGF-1). In addition to the stimulation of hormone production, floss bands may have marked vasodilative effects and possibly stimulate production of nitric oxide (NO).

More research is needed on floss band use to expand on the findings of Plocker et al. (2015), Driller and Overmayer (2016), and Bohlen et al. (2014) and to determine the effects on range of motion on various parts of the body, the hemodynamic and intramuscular effects, effects on pain pressure threshold (PPT) and the long-term implications of band use.

For those interested in the clinical significance, floss bands can be used as another tool for sports medicine professionals to help improve the overall performance of their athletes. While range of motion improvements have been seen, floss bands are not a “silver bullet” or magic cure and should be used properly and safely in conjunction with normal conservative treatments like stretching, therapeutic exercises and joint mobilizations. More studies need to be done to determine the actual mechanism for the said increase and the long-term effects of band use.

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