

EFFECTS OF TISSUE FLOSSING IN INCREASING ANKLE DORSIFLEXION RANGE OF
MOTION IN DIVISION 1 FOOTBALL ATHLETES

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ABSTRACT

Objective: Tissue compression combined with partial vascular occlusion using tissue flossing is thought to cause a deformation in fascial tissue, thus increasing range of motion within a joint. The aim of the current study is to investigate the effects of tissue flossing as an intervention to increase ankle dorsiflexion range of motion in Division I football athletes. **Design:** This study 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 to perform non-weight bearing and weight bearing exercises, which were succeeded by post-intervention range of motion testing. In the current study, one ankle served as the intervention (FLOSS) while the contralateral ankle served as the control (CON). **Setting:** College/University, Division I Athletic Training Room. **Participants:** 9 male collegiate football athletes. **Main Outcome Measures:** Pre and post measures included handheld goniometry for dorsiflexion (DF) and weight bearing lunge test (WBLT). **Results:** FLOSS resulted in significant ($p < 0.05$) improvements in both standard dorsiflexion goniometric measurements ($p < 0.01$) and the weight bearing lunge test ($p < 0.016$) over time (pre vs. post). However, there were no significant differences between FLOSS and CON for each outcome measure at each time point. **Conclusion:** The utilization of tissue flossing to increase ankle dorsiflexion range of motion is a plausible and potentially beneficial therapeutic intervention. Although this study was limited by a small sample size, results indicated improvements were made in FLOSS over time.

Keywords: voodoo floss bands, tissue flossing, ankle dorsiflexion, ROM

Introduction

The voodoo floss technique, also known as tissue flossing, is a relatively new therapeutic intervention, gradually gaining popularity in the past few years among physical therapists and athletic trainers alike. Tissue flossing involves the wrapping of a thick latex rubber band around a joint, muscle, or group of muscles, and introducing movement to the area (Starrett, 2013). Tissue flossing has a three-fold effect on tissues: 1) provide pain relief through the coupling of compression and movement, 2) enhance blood flow to improve efficiency of muscular contraction through a reperfusion of blood into the tissues, and 3) restore the fascial tissue's natural sliding/gliding potential through the deformation of fascial adhesions (Stevenson, 2019). In clinical applications, tissue flossing has gained popularity for its anecdotal success in improving flexibility and range of motion.

Ankle sprains are the most common musculoskeletal injury in athlete populations (Delahunt, 2018). Evidence shows that after an ankle injury, dorsiflexion range of motion is severely affected (Denegar, 2002). Reduced ankle dorsiflexion range of motion is reported to be a predisposing factor for other lower limb musculoskeletal injuries such as patellar tendinopathy, Achilles tendinopathy, ACL ruptures, stress fractures, and recurrent ankle sprains (Fong, 2011; Young, 2013). As such, addressing range of motion deficits, specifically dorsiflexion in the ankle joint, in rehabilitation and preventative programs is important in preventing injury or re-injury.

Given the relatively new status of tissue flossing in the clinical setting, there is limited research validating its efficacy. The aim of the current research study is to evaluate the use of tissue flossing as an intervention to increase ankle dorsiflexion range of motion in Division I football athletes.

Review of Literature

Tissue flossing is a relatively new therapeutic intervention that is reported to increase joint range of motion (Starrett, 2013). The intervention works by wrapping a band around a joint or muscle and introducing movement, thus creating a fascial shearing effect (Starrett, 2013). Tissue flossing has three major effects on tissues. The first is to provide pain relief through compressive forces. The second is to enhance blood flow to the area through ischemic compression which is believed to cause a release of nitric oxide and thus improve efficiency of muscular contractions. Both pain relief and enhanced blood flow are a result of the compression of the voodoo floss band. The third is to create a fascial shear in the tissue to restore the sliding and gliding potential of the fascial layers (Stevenson, 2019).

Fascia is an important structure in the body as its function affects movement coordination. It also allows for full range of motion in joints due to sliding and gliding of each layer against one another. Hyaluronic acid acts as a lubricant as each fascial layer glides against each other. Under fatigue or stress, there is a decrease in the lubricating effect of the hyaluronic acid and an increase in viscosity, which causes tissues to become stiff (Stecco, et. al, 2013). Tissue flossing causes a deformation in fascial adhesions, which causes hyaluronic acid viscosity in the tissues to return to normal. This causes an increase in tissue flexibility and range of motion (Stecco, et. al, 2013).

Ankle sprains are the most common musculoskeletal injury in athlete populations (Delahunt, 2018; Wikstrom, 2019) and account for 29% of all documented injuries in professional American football players. Furthermore, individuals with a history of ankle sprains are at a two-fold increased risk for reinjury (Delahunt, 2018; Knapik, 2018). One major risk factor for this high risk of reinjury is a loss of or deficit in ankle dorsiflexion range of motion

(Denegar, 2002). Such a deficit can be attributed to a lack in flexibility of the calf musculature or restricted posterior talar glide (Denegar, 2002). Because of this, addressing range of motion, particularly dorsiflexion, during the rehabilitation of an ankle sprain or other ankle injury is especially important.

Restricted posterior talar glide may be a contributing factor of dorsiflexion range of motion deficits. In regards to increasing range of motion, tissue flossing is reported to have similar benefits of other therapeutic interventions. For example, joint mobilizations are a common manual therapy technique used by practitioners to decrease pain and increase range of motion that may be caused by arthrokinematic restrictions. Terada et. al (2013) conducted a systematic review of therapeutic interventions for increasing ankle dorsiflexion and found that oscillatory ankle joint mobilizations are beneficial in restoring the posterior glide of the talus. Currently, there is a lack of evidence to support the efficacy of tissue flossing in increasing range of motion.

Previous research regarding the use of tissue flossing as a therapeutic intervention has only be traced to a handful of studies. Driller and Overmayer (2017) researched the effects of tissue flossing on ankle range of motion and single leg jump performance. Participants (n=52) performed 20 repetitions of dorsiflexion and plantarflexion to the end ranges on both ankles, one with the floss band application and the other serving as the control. Measurements were taken pre-intervention and 5 minutes post-intervention and included plantarflexion and dorsiflexion with standard goniometry, dorsiflexion using the weight-bearing lunge test, and maximal jump height and peak jump velocity using a linear position transducer. The researchers found small, but significant improvements in all range of motion measures and single-leg jump performance in the ankle that received the intervention as compared to the control. One limitation of this study

was that the post-intervention measures were performed a short time after the floss bands were removed, which posed questions of how long the effects of tissue flossing would last.

To address these questions, Driller and Overmayer (2017) performed a follow-up study that examined the effects of tissue flossing on ankle range of motion, jump performance, and sprint performance. The study included recreational athletes (n=69) who performed repetitions of ankle dorsiflexion and plantarflexion for two minutes. One ankle was subject to floss band application while the other served as the control, similar to the previous study. The researchers measured dorsiflexion using the weight-bearing lunge test, peak jump force through a countermovement jump using a force plate, and sprint time using a 15-meter sprint test. Post-test measurements were taken at the 5, 15, 30, and 45 minute marks after the removal of the floss band. Results indicated tissue flossing was in fact beneficial in improving ankle range of motion, countermovement jump performance, and 15-meter sprint speed. The floss band group showed greater significant treatment and time interaction over the 45-minute interval with the weight bearing lunge test as compared to the control group. The results of this study provide evidence that tissue flossing may have lasting effects longer than 5 minutes post-intervention (Driller and Overmayer, 2017).

A similar study conducted by Mills (2018) found no significant benefits for tissue flossing on range of motion and performance measures. This study included 14 rugby union athletes who were split into pairs. Each pair completed testing on two separate occasions, measuring the effects of one intervention (the floss band) in one trial and the other intervention in the second trial (no floss band). For each trial, the participant was to complete a pre- and post-test taken at both 5 and 30 minutes after removal of the floss band or completion of exercises. Following the pre-test, participants were to perform 2 minutes of dorsiflexion and plantarflexion

to the end ranges of motion. The researchers measured dorsiflexion using the weight-bearing lunge test, peak jump force through a countermovement jump using a force plate, and sprint time using a 20-meter sprint test.

In a more recent study, Stevenson, et al. (2019) looked at the acute effects of tissue flossing on ankle range of motion in recreational collegiate athletes (n=5). Ankle range of motion was measured through standard goniometry and the weight bearing lunge test, both straight leg and bent leg, and participants were asked to rank their perceived level of tightness in the ankle joints. For each participant, one ankle was allocated to the floss band group while the other acted as the control. Following the pre-tests, participants were instructed to perform 20 repetitions of active dorsiflexion and plantarflexion, 10 body weight squats, and 15 heel raises. The results of this study demonstrated significant improvements in dorsiflexion as measured by standard goniometry and a trend towards significant improvements in the bent-leg weight bearing lunge test. Though this study was limited by its small sample size, it demonstrated the practical and clinical applications of using tissue flossing as a therapeutic intervention.

In summary, the current evidence moderately supports using the voodoo floss technique, or tissue flossing, as a therapeutic intervention for improving ankle range of motion. However, the biggest limitation of this intervention is its limited evidence in the research. As such, the results of this study would influence and add to the existing pool of research and would help determine the efficacy of tissue flossing as an effective therapeutic intervention.

Methods

Participants

Participants were recruited via the athletic trainers and the primary researcher via word of mouth. Participants first completed a written informed consent prior to the beginning of this study, describing the objectives of this study and the potential risks and benefits. Approval for all procedures was obtained from the Departmental Review Board (approval #1920-119). A total of 9 male Division I collegiate football players ages 18-25 (mean age = 21) were recruited for this study.

Participants with a history of ankle injury were not excluded from this study. Exclusion criteria included a lower limb injury that required altered weight-bearing status during the time of data collection. Participation was terminated if a participant sustained such injury during their time in the study. Furthermore, participants were pre-screened for a latex allergy. Any participant that identified a latex allergy was excluded from participation in the study.

Design

This study utilized an intervention pre-test and post-test design. Participants' ankles were randomly assigned to either the experimental group or the control group. The primary independent variable of this study was the use of the voodoo floss band. Data was collected on both ankles, as both ankles were taken through the same exercises and outcome measures. The primary dependent variable, dorsiflexion range of motion, was measured in two ways: standard goniometry and the weight bearing lunge test (WBLT).

Procedures

Participants were required to sign an informed consent paper before beginning participation in this study. The primary outcome measure, dorsiflexion range of motion, was measured in two ways: standard goniometry and the weight bearing lunge test (WBLT).

Goniometry is a validated form of measuring ankle joint dorsiflexion. However, one of the key disadvantages of this technique is user variability in reading and interpreting the data and in finding the necessary landmarks (Rome, 1996). For the goniometric measures, the participant was seated on a treatment table with only their feet hanging off the edge of the table. Landmarks used included the lateral malleolus as the fulcrum point, fibular head for the stationary arm, and the base of the fifth metatarsal for the moving arm. The participant was then asked to actively dorsiflex to the endpoint of maximal active range of motion. Measurement was taken between the starting and ending values.

The WBLT has been shown to be an effective measure of a functional range of motion of the ankle joint and has great inter-rater and intra-rater reliability. It is also commonly used because of its inexpensive and minimal set-up. However, one disadvantage of this test is that it cannot be used in patients in which a weight bearing status is contraindicated (Bennell, 1998). For the WBLT, a strip of tape was placed on the floor, starting against a wall with hash marks at 1-20cm marks. The participant started with their big toe at the 2cm hash mark and was asked to tap their knee against the wall, without raising their heel off the ground. If successful, the participant progressively moved 1cm back and completed the same task until the participant could not touch their knee against the wall without their heel lifting off the ground. Measurement was recorded at the last successful hash mark. Both measurements would be taken during the pre- and post-test measurement sessions.

Between the pre- and post-test measurement session, the participants were asked to come in twice a week for four weeks, for a total of eight total treatment sessions. During each treatment session, the participants received the voodoo band treatment on the treated ankle. The band was be wrapped around the angle joint using a standard ankle bandaging technique and left

on for 2 minutes. The band was wrapped twice around the transverse arch of the foot, aligned with the distal heads of the metatarsals of the foot, followed by three wraps completed in a Figure 8 pattern (to the lateral malleolus, around the Achilles, to the medial malleolus, to the base of the fifth metatarsal, around the bottom of the foot, and back to the start). The remaining part of the band was wrapped around the distal lower leg with the last few inches tucked into the band. The band was pulled with 50% of full tension throughout the wraps to the bottom of the foot, increased to 75% through the ankle joint, and reduced back to 50% through the wraps to the distal lower leg. A similar wrapping technique was used in the Driller and Overmayer study in 2017. The patient then completed 20 repetitions of active dorsiflexion/plantarflexion range of motion (ankle pumps), 20 repetitions of ankle circumduction (clockwise and counterclockwise), 10 body weight squats, and 15 eccentric heel raises for both the wrapped ankle and unwrapped ankle. The band was then be taken off and the participant was allowed to walk around for one minute while the researcher monitored the return of blood flow to the foot. A similar protocol was used during the Stevenson study in 2019.

Statistical Analyses

Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS). A dependent t-test was performed to compare the differences pre- and post-intervention between the control and experimental groups for each measure. Statistical significance was set at $p < 0.05$ for all analyses.

Results

There were no significant differences between the intervention group and control group prior to testing for dorsiflexion goniometry and the weight bearing lunge test. There was a

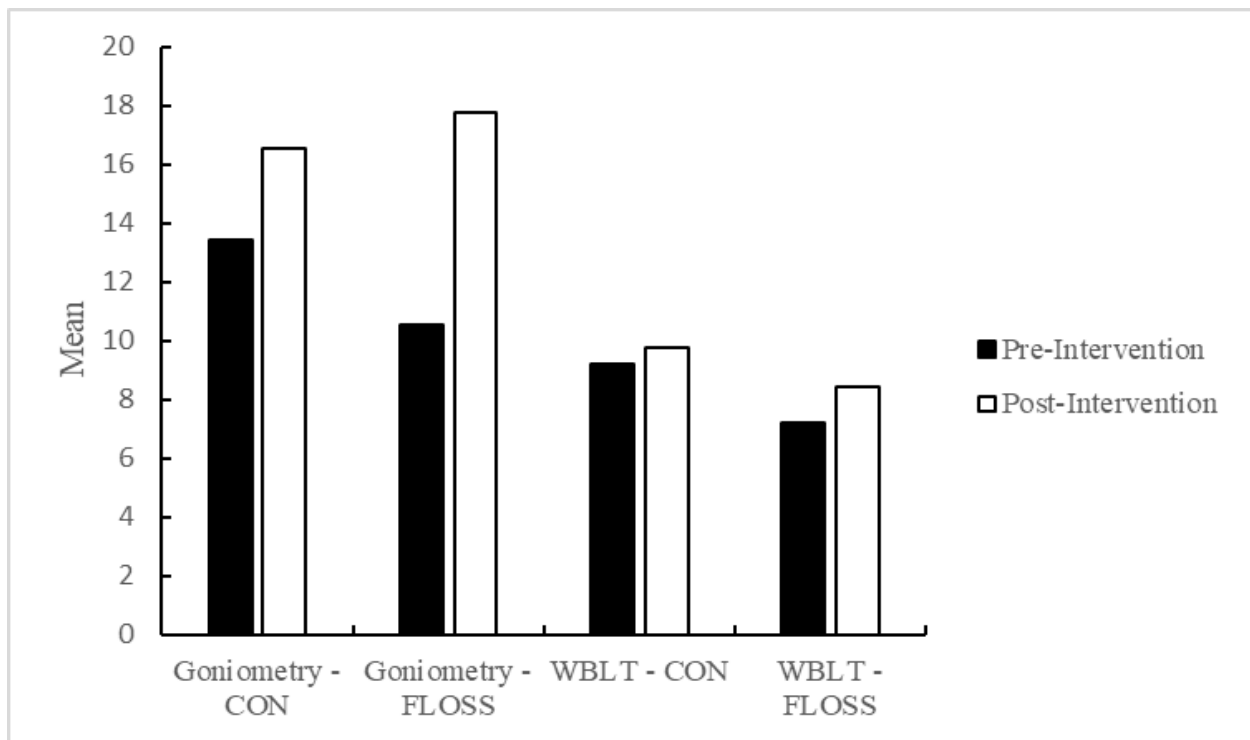
statistically significant improvement over time in dorsiflexion goniometry (DF) measurements in both the CON and FLOSS groups ($p < 0.05$). FLOSS resulted in significant improvements over time in the WBLT ($p < 0.05$), while there was no significant differences over time in CON ($p > 0.05$; Table 1, Figure 1). However, there were no significant differences between the intervention group and control group in the post-test measurements for dorsiflexion goniometry and the weight bearing lunge test.

Table 1. Pre and post measures (mean \pm SD) for floss band (FLOSS) and control (CON) trials.

	FLOSS (mean \pm SD)		CON (mean \pm SD)	
	Pre	Post	Pre	Post
WBLT (cm)	7.22 \pm 3.77	8.44 \pm 4.39*	9.22 \pm 3.53	9.78 \pm 3.96
DF (deg.)	10.56 \pm 3.71	17.78 \pm 5.21*	13.44 \pm 4.28	16.56 \pm 4.36*

*Represents significant difference between pre and post ($p < 0.05$).

Figure 1. Pre and post measures (mean) for floss band (FLOSS) and control (CON) trials.



Discussion

The aim of this study was to determine whether using tissue flossing as a therapeutic intervention would result in an increase in ankle dorsiflexion range of motion. The objective measures used to determine the effects of the voodoo floss bands on the ankle joint were a standard dorsiflexion goniometric measurement (DF) and the weight-bearing lunge test (WBLT). There was a significant difference in dorsiflexion goniometry ($p < 0.001$, Table 1) and in the WBLT ($p < 0.016$, Table 1) in favor of the intervention group (FLOSS) over the control group (CON).

Based on a power calculation, the number of participants needed to provide a robust set of data was 32 participants. Because each participant served as both the control and the intervention (one ankle received the floss band application and one ankle did not), this meant only 16 subjects were needed for this study. Unfortunately, due to COVID-19 restrictions and closures, only data for nine participants was collected. Although the sample size was small, this particular study indicated a significant finding for improving ankle dorsiflexion range of motion. Future studies should employ similar protocols with larger sample sizes to further explore these trends.

The findings of the current study could have practical implementations in the clinical setting. Reduced or restricted ankle dorsiflexion range of motion has been cited as a major risk factor in lower extremity injury (Denegar, 2002) and is commonly seen as a result of ankle injury. As such, it is important to address this restriction in the rehabilitation process. Incorporation of tissue flossing as a therapeutic intervention in the rehabilitation of ankle injuries can help to increase ankle dorsiflexion range of motion, thus lowering the risk of reinjury and the potential for future lower extremity injury. Previous research has also implied that tissue flossing

may result in improvements in athletic performance such as jump and sprint performance (Driller and Overmayer, 2017; Mills, 2018). Future studies however should focus on specific protocols to provide clinicians with a strong basis for evidence-based incorporation of this technique in the rehabilitation process.

One unique aspect of this particular study was its study design. Previous research included single testing sessions, unlike the current study which utilized a multi-session protocol. Such research has examined the acute effects of tissue flossing, concluding that use of this intervention does result in short-term increases in range of motion (Stevenson, 2019; Driller & Overmayer, 2017; Mills, 2018). While not explicitly measured in this study, it can be speculated that tissue flossing does have some long-term effects, including a long-term improvement in range of motion. However, more evidence is needed through future research to examine the long-term effects of tissue flossing as a therapeutic intervention.

Although the results of this study did show an improvement in ankle dorsiflexion range of motion, the mechanisms behind how tissue flossing works are still relatively unknown. Since such mechanisms were not measured in the current study, any theories are somewhat speculative. Application of the voodoo floss band includes wrapping of a joint in a compressive pattern, thus causing partial vascular occlusion which may cause a number of physiological responses. Tissue flossing is proposed to have a three-fold effect on tissues, the first of which being a sensation of pain relief as a result of the coupling of compressive forces and movement which stimulate mechanoreceptors in the fascia (Stevenson, 2019). Second, the compression of the voodoo floss band provides ischemic compression during application. Upon removal of the band, there is a reperfusion of the affected tissues, thus enhancing blood flow to the area (Takarda, 2000). The third potential response centers around the fascial shearing effect, which is brought upon by the

coupling of movement and compression. This can be argued as the most important response as this causes a deformation in fascial adhesions, and returns hyaluronic acid viscosity to normal levels, thus restoring the sliding/gliding potential of the fascial tissue (Stecco, 2013). The greater the function of fascial tissue, the greater the total range of motion is within a joint. (Stevenson, 2019).

As previously mentioned, there are many avenues of future research in regards to tissue flossing. More evidence is needed to determine specific mechanisms of action in order to properly determine exactly how tissue flossing produces its proposed effects. Future studies should also aim to utilize larger sample sizes, as the sample size of the current study was small. Furthermore, more evidence is needed regarding the long-term effects of tissue flossing in regards to increasing range of motion, thus supporting or refuting the findings of the current study.

Limitations

One of the major limitations of the current study were COVID-19 restrictions and closures. During the data collection period, quarantine began and human subjects research was put on pause. This mostly affected those participants who were in the middle of their protocol, as they had to completely restart when allowed. When human subjects research was resumed, fewer subjects agreed to participate in the current study which was reflected in the low sample size.

Another limitation of the current study was subject compliance. Over the course of the study, very few participants adhered to their session schedule, which, in some cases, exceeded the four-week benchmark for completion of participation in the study. The exceeded length of this study might have impacted these results in some way, but the exact implications are

unknown. Future studies could utilize a stricter session schedule to increase subject compliance. Furthermore, a small number of subjects began participation in the study but chose to drop out during the course of their sessions, which resulted in a low sample size.

Conclusion

The current study suggests that utilization of tissue flossing results in an increase in ankle dorsiflexion range of motion. The potential benefits regarding the results of this study may have significant implications in the sport and rehabilitation setting, providing a novel strategy for injury prevention and treatment through increasing ankle dorsiflexion range of motion. However, further research is needed on the usage of tissue flossing as a therapeutic intervention in long-term treatments.

References

- Bennell, K., Talbot, R., Wajswelner, H., Techovanich, W., Kelly, D., & Hall, A. J. (1998). Intra-rater and inter-rater reliability of a weight-bearing lunge measure of ankle dorsiflexion. *Australian Journal of physiotherapy*, 44(3), 175-180.
- Delahunt, E., Gribble, P. (2019). Clinical assessment of acute lateral ankle sprain injuries (ROAST): 2019 consensus statement and recommendations of the international ankle consortium. *British Journal of Sports Medicine*, 1-7.
- Denegar, C. R., Hertel, J., & Fonseca, J. (2002). The effect of lateral ankle sprain on dorsiflexion range of motion, posterior talar glide, and joint laxity. *Journal of Orthopaedic & Sports Physical Therapy*, 32(4), 166-173.
- Driller, M. W., & Overmayer, R. G. (2017). The effects of tissue flossing on ankle range of motion and jump performance. *Physical Therapy in Sport*, 25, 20-24.
- Driller, M., Mackay, K., Mills, B., & Tavares, F. (2017). Tissue flossing on ankle range of motion, jump and sprint performance: a follow-up study. *Physical Therapy in Sport*, 28, 29-33.
- Fong, C. M., Blackburn, J. T., Norcross, M. F., McGrath, M., & Padua, D. A. (2011). Ankle-dorsiflexion range of motion and landing biomechanics. *Journal of Athletic Training*, 46(1), 5-10.
- Knapik, D. M., Trem, A., Sheehan, J., Salata, M. J., & Voos, J. E. (2018). Conservative management for stable high ankle injuries in professional football players. *Sports health*, 10(1), 80-84.
- Mills, B., Mayo, B., Tavares, F., & Driller, M. (2020). The effect of tissue flossing on ankle range of motion, jump, and sprint performance in elite rugby union athletes. *Journal of Sport Rehabilitation*, 29(3), 282-286.
- Rome, K. (1996). Ankle joint dorsiflexion measurement studies. A review of the literature. *Journal of the American Podiatric Medical Association*, 86(5), 205-211.
- Starrett, K., Cordoza, G. (2013). *Becoming a supple leopard*. Las Vegas, NV: Victory Belt Publishing Inc.

- Stecco, A., Gesi, M., Stecco, C., & Stern, R. (2013). Fascial components of the myofascial pain syndrome. *Current pain and headache reports*, 17(8), 352.
- Stevenson, P. J., Stevenson, R. K., & Duarte, K. W. (2019). Acute effects of the voodoo flossing band on ankle range of motion. *Journal of Medical Biomedical and Applied Sciences*, 7(6), 244-253.
- Takarada, Y., Nakamura, Y., Aruga, S., Onda, T., Miyazaki, S., & Ishii, N. (2000). Rapid increase in plasma growth hormone after low-intensity resistance exercise with vascular occlusion. *Journal of applied physiology*, 88(1), 61-65.
- Terada, M., Pietrosimone, B. G., & Gribble, P. A. (2013). Therapeutic interventions for increasing ankle dorsiflexion after ankle sprain: a systematic review. *Journal of athletic training*, 48(5), 696-709.
- Wikstrom, E. A., Bagherian, S., Cordero, N. B., & Song, K. (2019). Six Sessions of Anterior-to-Posterior Ankle Joint Mobilizations Improve Patient-Reported Outcomes in Patients With Chronic Ankle Instability: A Critically Appraised Topic. *Journal of sport rehabilitation*, 28(4), 381-384.
- Young, R., Nix, S., Wholohan, A., Bradhurst, R., & Reed, L. (2013). Interventions for increasing ankle joint dorsiflexion: a systematic review and meta-analysis. *Journal of foot and ankle research*, 6(1), 1-10.