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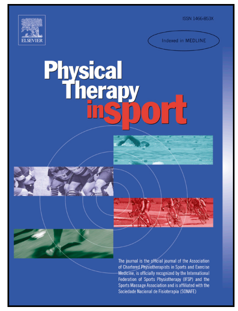

Tissue flossing on ankle range of motion, jump and sprint performance: A follow-up study

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Tissue flossing on ankle range of motion, jump and sprint performance: A follow-up study

Original Investigation

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Running Head: *Floss bands and performance*

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ABSTRACT

Objectives: Previous results from our laboratory suggest that band flossing results in increased ankle range of motion (ROM) and jump performance 5-minutes following application. However, the time-course of such benefits is yet to be examined.

Design: Parallel group design.

Setting: University laboratory.

Participants: 69 recreational athletes (32 male/37 female).

Main Outcome Measures: Participants performed a weight-bearing lunge test (WBLT), a counter-movement jump (CMJ) and a 15m sprint test (SPRINT) pre and up to 45-mins post application of a floss band to both ankles (FLOSS) or without flossing of the ankle joints (CON).

Results: There was a significant intervention x time interaction in favour of FLOSS when compared to CON for the WBLT ($p < 0.05$). These results were associated with *trivial* to *small* effect sizes at all time points. *Small*, but non-significant ($p > 0.05$) benefits were seen for FLOSS when compared to CON for CMJ force (mean ±90%CI: 89 ±101 N) and 15m SPRINT times (-0.06 ±0.04 s) at 45-mins post.

Conclusion: There is a trend towards a benefit for the use of floss bands applied to the ankle joint to improve ROM, jump and sprint performance in recreational athletes for up to 45-minutes following their application.

Keywords: *flossbands, mobility bands, vascular occlusion, ischemic pre-conditioning, ROM*

INTRODUCTION

Tissue flossing involves the wrapping of a thick rubber band around a joint or muscle, which may partially occlude blood-flow. In a practical setting, it is often applied while concomitantly performing range of motion (ROM) tasks for 1-3 minutes (Driller & Overmayer, 2017, Plocker et al. 2015). The mechanisms involved with tissue flossing using a floss band may be similar to that of ischemic preconditioning or blood-flow restriction training, whereby reperfusion of blood to the occluded area may be associated with subsequent increases in growth hormone and catecholamine responses, enhanced muscle force and contractility and increased efficiency of excitation-contraction coupling in the muscles (Reeves et al., 2006; Takarada et al., 2000 Lawson & Downey, 1993 Pang et al., 1995). Previous results from our laboratory would support the use of tissue flossing on ankle ROM and single-leg jumping performance in recreational athletes (Driller & Overmayer, 2017), however, the time-course associated with such benefits is yet to be investigated.

Our previous study investigated the use of floss bands applied to one ankle joint (with the other ankle acting as the control) on dorsiflexion and plantarflexion ROM and subsequent single-leg vertical jump performance in 52 recreational athletes (Driller & Overmayer, 2017). Results showed significant improvements in all ROM measures (dorsiflexion, plantarflexion and a weight-bearing lunge test) as well as single-leg jump performance following the application of a floss band to an average pressure of 182 ± 38 mmHg for ~2 minutes. Tissue flossing was associated with *small* but statistically significant ($p < 0.05$) improvements for the dorsiflexion (~6%), weight-bearing lunge test (~14%) and jump velocity tests (~6%) when compared to the control leg, 5-minutes after removing the floss band. While this was a somewhat novel finding, the practical application of such a technique is still limited by the fact that the tests were only performed a short time after removal of the bands, posing the questions of how long the benefits may last for. Furthermore, performance results in this study were limited to a jump test, which may not be applicable to all sports. To the authors knowledge, other than our previous work, the only other study to have investigated the use of tissue flossing in an acute setting was by Plocker et al. (2015). This study investigated the effect of applying floss bands to both shoulders in 17 male athletes. The study reported trends towards improvements (non-significant) in shoulder ROM, but not for upper-body power (bench-press) when compared to the control trial. Given the results of this study are limited to a published conference proceeding, it is difficult to ascertain the exact protocols, including the pressure applied by the floss-band and the duration after which the measures were performed.

It is relatively uncertain as to how long the possible benefits of tissue flossing may last, with limited information available to practitioners. For example, it is unknown if this technique would be useful to incorporate into a warm-up before exercise, if the benefits only last for ~5-minutes. Therefore, given the relatively novel technique of tissue flossing is currently lacking in the research literature despite some positive findings in preliminary studies, the modality clearly requires further research. The aim of the current study was to expand that of our previous work and investigate the use of tissue flossing on ankle (talocrural joint) ROM, jumping and sprinting performance at different time points following the application of the floss bands in recreational athletes.

METHODS

Participants

69 recreational athletes (32 male / 37 female, mean ± SD; age: 19 ± 2 years) volunteered to participate in the current study. Participants were recruited through a University sport science under-graduate program. All participants were participating in regular physical exercise sessions (~3 times per week) and were free from lower-limb injuries (hip, knee or ankle) that may have affected their ability to perform the jump or sprint tests. Written informed consent was obtained from each participant, and ethical approval was obtained from the Human Research Ethics Committee of the institution.

Experimental Design

Participants were randomly split into two groups; an experimental group (FLOSS, n = 38) or a control group (CON, n = 31). Participants attended a sport science laboratory for a single testing session. Prior to any testing, participants performed a standardized warm-up consisting of a 5-minute jog and dynamic stretches (e.g. one-leg standing knee flexion, bodyweight calf-raises, bodyweight squats, bodyweight countermovement jumps). Following the pre tests, researchers applied a floss band (Life Flossbands, Sydney, Australia), to both ankles of participants in the FLOSS group. Post tests (5, 15, 30 and 45 minutes) were then performed in the same order as the pre tests. The order of tests for all participants were as follows: the weight bearing lunge test (WBLT), the counter-movement jump test (CMJ) and the 15m sprint test (SPRINT). Performance tests were selected as they are applicable to most team-sports and cause minimal fatigue when re-measured multiple times with adequate recovery. All participants were familiar with the testing protocols, but none had experienced tissue flossing before taking part in the study.

Methodology

Weight-bearing lunge test (WBLT)

The WBLT was performed as a measure of dorsiflexion range of motion on both right and left legs (Driller & Overmayer, 2017). Measurement was made using the tape measure from the tip of their big toe to the wall, in centimeters. The weight-bearing lunge test (WBLT) is a functional and reliable method to indirectly assess dorsiflexion by measuring the maximal advancement of the tibia over the rear foot in a weight-bearing position (Bennell et al., 1998). Previous investigators have reported robust inter-tester and intra-tester reliability associated with the assessment of WBLT performance in healthy adults, with high levels of test-retest reliability demonstrated (standard error of measurement = 1.1°, 95% CI = 2.2) (Bennell et al., 1998).

Counter-movement jump test (CMJ)

Data regarding the peak force (N) during a countermovement jump were measured using a forceplate. Countermovement jumps were performed and the best of three attempts at each time point, determined by peak force (N), was recorded and used for subsequent analysis. Participants performed three maximal CMJ's with ~3 seconds between each jump. Two force plates (PASCO PS 2142, Roseville, CA, USA) were used to measure peak force (PF) at a sample rate of 500Hz. Each trial started with the subjects standing on top of the force plates with their knees fully extended and their hands on their hips to eliminate the influence of arm swing (Cormack, Newton, McGuigan, & Doyle, 2008). Participants were then instructed to descend to a self-selected countermovement depth and to jump as high and quickly as possible (Secomb et al., 2015).

Sprint test (SPRINT)

The straight-line sprint test was performed indoors on a wooden-surface basketball court. During each trial, participants were asked to sprint as quickly as possible over 15m. Dual-beam electronic timing gates (Speedlight TT, Swift Performance, Lismore, Australia) were positioned each 5m in order to obtain 5m, 10m and 15m split times. Participants began each sprint from a standing position with their front foot 0.50 m behind the first timing gate (Buchheit, Simpson, Peltola, & Mendez-Villanueva, 2012). Time was measured to the nearest 0.01 second, with the fastest time obtained from two trials at each time point (pre, 5, 15, 30, 45 mins post) used for later analysis.

Application of floss band

A standard ankle-bandaging technique was used by researchers by applying the floss band (Life Flossbands, Sydney, Australia) accordingly: Across the transverse of the foot, aligned with the distal head of the metatarsals of the foot. The wrap circulated around the foot twice, followed by 3 wraps completed in a figure 8 (to lateral malleolus, around the achilles, to medial malleolus, towards the distal head of the 5^{th} metatarsal, around the bottom of the foot and back to the beginning) (Figure 1). This bandaging technique is the same as used previously (Driller & Overmayer, 2017). Once the floss bands were applied to both ankles, in a seated position, participants performed an active ROM task -

continuous repetitions of plantarflexion and dorsiflexion for two minutes (taken to the extreme ranges of motion). Both the FLOSS and CON groups performed the active ROM task, with the only difference between groups being the floss band application. After two minutes, the floss band was then removed and the participants were instructed to stand up and walk around for one minute to allow for blood flow to return to the foot.

Figure 1 – The floss band ankle bandaging technique used by researchers. Figure obtained from Driller & Overmayer (2017).

Kikuhime pressure measurement

In a selection of participants (n = 12), interface pressure between the skin and the floss band was measured to assess the level of compression (mmHg) achieved by the wrapping technique. The Kikuhime pressure monitor (MediGroup, Melbourne, Australia) sensor was placed on the anterior aspect of the tibia on the midline between the lateral and medial malleolus (Figure 2). The Kikuhime pressure monitor has been shown to be a valid (ICC = 0.99, CV = 1.1%) and reliable (CV = 4.9%) tool for use in the sport setting (Brophy-Williams, Driller, Halson, Fell, & Shing, 2014). Mean pressure (± SD) applied by the floss band in the cohort of the study population (n=12), as identified using the Kikuhime pressure monitor, was 178 ± 18 mmHg.

Statistical Analysis

Statistical analyses were performed using the Statistical Package for Social Science (V. 22.0, SPSS Inc., Chicago, IL). A two-way analysis of variance for repeated measures (ANOVA) was performed to determine the effect of different treatments (FLOSS or CON) over time (pre, 5min, 15min, 30min and 45min post) on all measured variables. There were no outliers in the data, as assessed by inspection of a boxplot and examination of studentized residuals (greater than ±3 SD) and all data was normally distributed, as determined by Shapiro-Wilk's test ($p > 0.05$). Sphericity was assessed via the Mauchly's test for sphericity, and where violated ($p < 0.05$), a Greenhouse-Geisser correction equation was used. Where significant treatment and time interactions occurred, simple main effects were run. An independent t-test was used to compare groups for pre-test values. Descriptive statistics are shown as means ± standard deviations unless stated otherwise. Standardized changes in the mean of each measure were used to assess magnitudes of effects and were calculated using Cohen's *d* and interpreted using thresholds of 0.2, 0.5, 0.8 for *small, moderate and large*, respectively (Cohen, 1988). An effect size of ±0.2 was considered the smallest worthwhile effect with an effect size of <0.2 considered to be *trivial*. The effect was deemed *unclear* if its 90% confidence interval overlapped the thresholds for *small* positive and negative effects (Batterham & Hopkins, 2006). Statistical significance was set at $p < 0.05$ for all analyses.

RESULTS

There were no significant differences between FLOSS and CON groups for any of the measured variables pre test ($p > 0.05$, Table 1).

There were no significant differences ($p > 0.05$) between right and left legs for the WBLT, therefore the mean value from both sides combined was used for analysis. There was a statistically significant interaction between intervention and time for the WBLT ($p = 0.03$, Table 1, Figure 1). However, this was not associated with any significant differences between groups at all time points, but was associated with a significant effect over time between baseline and all time points in the FLOSS group. These results were associated with *trivial* effect sizes at all time points (d = 0.15-0.18), except for 5-mins post, where there was a *small* effect in favour of FLOSS (d = 0.20, Table 2).

There were no significant intervention and time interactions for CMJ force between FLOSS and CON groups across time points ($p = 0.21$). However, there were *small* benefits associated with FLOSS when compared to CON at the 30-min (d = 0.32) and 45-min (d = 0.21) post time points (Table 2, Figure 1).

There were no statistically significant interactions between interventions and time points for 5m, 10m or 15m split times ($p > 0.05$) during the SPRINT (Table 1). The differences in 15m time between groups were associated with *small* effect sizes in favour of FLOSS at all time points (d = -0.21 to -0.27, Table 2).

Table 1 – Comparison of all pre and post measures (5, 15, 30 and 45-minutes) for experimental (FLOSS) and control (CON) groups. Data presented means ± SD. # Represents significant difference to pre within-group value ($p < 0.05$).

	Pre		5-min Post		15-min Post		30-min Post		45-min Post	
	FLOSS	CON	FLOSS	CON	FLOSS	CON	FLOSS	CON	FLOSS	CON
WBLT (cm)	8.9 ± 3.6	8.3 ± 3.3	9.7 ± 3.7#	8.3 ± 3.7	9.7 ± 3.7#	8.5 ± 3.7	9.7 ± 3.6#	8.4 ± 3.5	9.6 ± 3.6#	8.2 ± 3.7
CMJ (N)	1708 ± 381	1649 ± 454	1747 ± 392	1624 ± 477	1783 ± 398	1668 ± 465	1803 ± 373	1609 ± 552	1789 ± 422	1648 ± 466
5-m SPRINT (secs)	1.14 ± 0.08	1.14 ± 0.07	1.15 ± 0.07	1.15 ± 0.08	1.14 ± 0.06	1.16 ± 0.09	1.15 ± 0.07	1.16 ± 0.09	1.14 ± 0.06	1.16 ± 0.08
10-m SPRINT (secs)	1.96 ± 0.13	1.99 ± 0.14	1.96 ± 0.12	2.00 ± 0.15	1.95 ± 0.13	2.01 ± 0.15	1.96 ± 0.13	2.02 ± 0.16	1.95 ± 0.15	2.02 ± 0.15
15-m SPRINT (secs)	2.71 ± 0.22	2.76 ± 0.24	2.67 ± 0.19	2.78 ± 0.23	2.68 ± 0.21	2.78 ± 0.23	2.69 ± 0.21	2.80 ± 0.26	2.69 ± 0.21	2.81 ± 0.23

Table 2 – Comparison of all post measures (5, 15, 30 and 45-minutes) to pre test values. Data presented as raw difference in values (mean ± SD) with effect sizes for comparison between experimental (FLOSS) and control (CON) groups.

	5-min Post ΔFLOSS - ΔCON Effect size	15-min Post ΔFLOSS - ΔCON Effect size	30-min Post ΔFLOSS - ΔCON Effect size	45-min Post ΔFLOSS - ΔCON Effect size
WBLT (cm)	0.7 ± 0.3 0.20, *Small*	0.6 ± 0.4 0.15, *Trivial*	0.7 ± 0.5 0.18, *Trivial*	0.7 ± 0.5 0.18, *Trivial*
CMJ (N)	69 ± 67 0.16, *Trivial*	56 ± 70 0.13, *Trivial*	135 ± 148 0.32, *Small*	89 ± 101 0.21, *Small*
5-m SPRINT (secs)	-0.02 ± 0.02 -0.23, *Small*	-0.02 ± 0.02 -0.30, *Small*	-0.03 ± 0.02 -0.35, *Small*	-0.03 ± 0.02 -0.40, *Small*
10-m SPRINT (secs)	-0.01 ± 0.02 -0.09, *Trivial*	-0.02 ± 0.02 -0.16, *Trivial*	-0.03 ± 0.02 -0.19, *Trivial*	-0.03 ± 0.03 -0.23, *Small*
15-m SPRINT (secs)	-0.05 ± 0.03 -0.21, *Small*	-0.05 ± 0.03 -0.23, *Small*	-0.06 ± 0.03 -0.27, *Small*	-0.06 ± 0.04 -0.27, *Small*

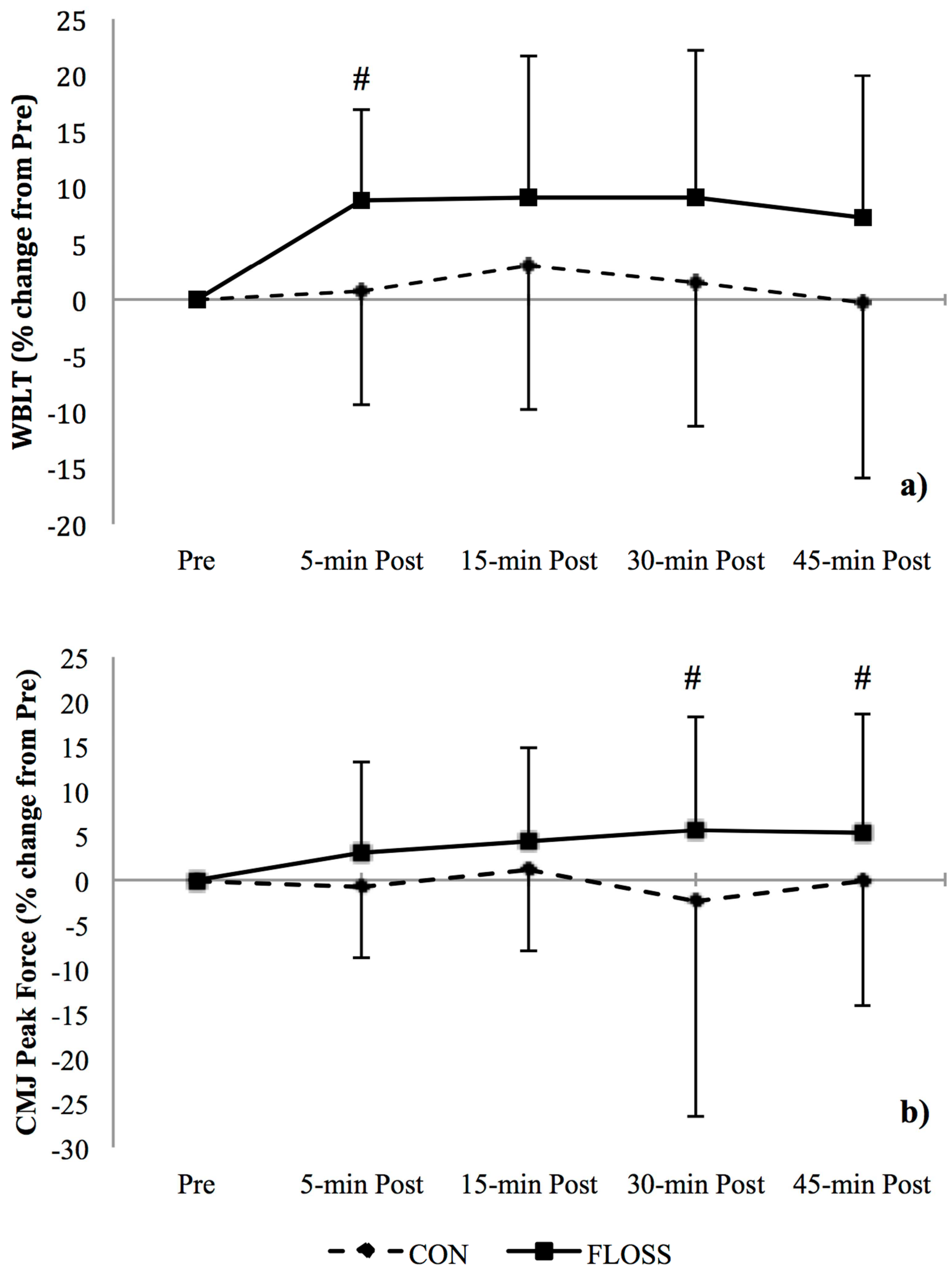

Figure 1 – Percentage change from pre-test (baseline) values for the experimental (FLOSS) and control (CON) groups for a) the weight bearing lunge test, measured in cm (WBLT), and b) countermovement jump peak force measured in N (CMJ). Dashed line represents CON, solid black line represents FLOSS. # represents *small* effect size between groups.

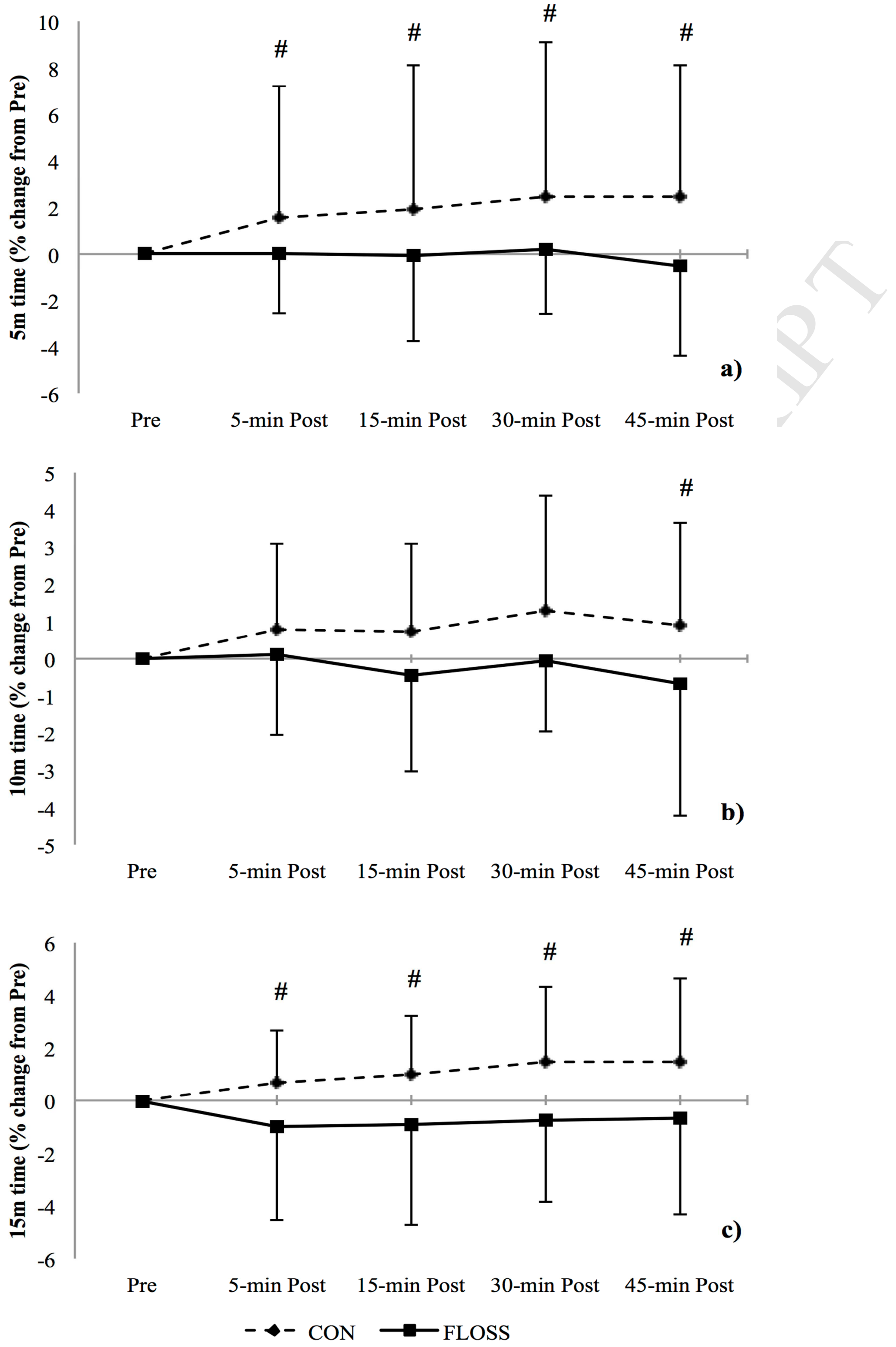

Figure 2 – Percentage change from pre-test (baseline) values for the experimental (FLOSS) and control (CON) groups for the SPRINT test across the different splits: a) 5m time, b) 10m time, and c) 15m time. Dashed line represents CON, solid black line represents FLOSS. # represents *small* effect size between groups.

DISCUSSION

Findings from the current study would suggest that there is a trend towards a benefit when using floss bands applied to the ankle joint to improve ankle ROM, countermovement jump and 15m sprint performance in 69 recreational athletes for up to 45-minutes following their application. The floss band trial resulted in significant treatment and time interaction when compared to the control trial for a weight-bearing lunge test. At the final time point tested in the current study (45-mins post), the floss band trial was associated with a *small* effect in comparison to the control group for 15m sprint time. *Small*, but non-significant benefits were also seen for the floss group when compared to the control for countermovement jump peak force 45-minutes after application of the floss bands. These results may have significant applications for practitioners considering the use of tissue flossing via floss bands for injury prevention and performance.

The results in the current study are in agreement with previous research from our laboratory (Driller & Overmayer, 2017), showing benefits to both ROM and jump performance following the application of floss bands to the ankle joint. The current study extends these findings by showing possible benefits to sprint performance and also by highlighting benefits that last longer than the 5-minutes following application reported in our previous study. While the mechanisms related to the improvements have not been measured in either of our studies, previous research investigating other methods of occlusion (e.g. tourniquets, blood pressure cuffs) have reported the physiological responses. More specifically, Takarada et al. (2000) reported growth hormone and norepinephrine levels were significantly increased after a tourniquet on the upper-leg (~214mmHg) was released. It has been suggested that elevated norepinephrine is associated with improved vertical jump ability (Morales et al., 2014). Therefore, while we can only speculate, it is possible that hormonal responses following the release of the floss bands (178 ± 18mmHg) in the current study could have contributed to enhanced jump and sprint performance. The mechanisms relating to increased ankle ROM in the FLOSS group are also relatively unknown, however, it is reasonable to assume that the fascial alterations during ROM exercises with the bands applied and increased joint lubrication from blood reperfusion following band application could have increased dorsiflexion at the talocrural joint, and improved the weight-bearing lunge test scores.

These results may have significant implications for practitioners considering using this technique during a warm-up prior to exercise. Indeed, ankle dorsiflexion is an important component in the absorption of lower limb load when landing from a jump, as common in most sports (Malliaras, Cook, & Kent, 2006). Reduced ankle ROM is also a risk factor for the development of patellar tendinopathy and other lower-limb injuries in athletes (Fong, Blackburn, Norcross, McGrath, & Padua, 2011; Malliaras et al., 2006). Not only has increased ankle ROM been shown to decrease the likelihood of lower-limb injuries (Fong et al., 2011; Griffin et al., 2006; Hewett et al., 2005), but the potential performance benefits to both team and individual athletes must be considered. Future research should consider testing this technique in highly-trained athletes implementing cross-over designs, utilizing sport specific tests and a range of sporting populations (e.g. team and individual sports) and across different joints (e.g. knee, hip, shoulder, elbow). Further research may also include the use of tissue flossing in a chronic setting (over a number of weeks) prior to or during exercise sessions. Indeed, preliminary pilot work would suggest that this may be effective for improving both ROM and performance. Bohlen et al., (2014) examined the effects of 14 days of band flossing combined with joint mobilization and resistive exercise on plantar/dorsiflexion strength in five participants. Participants performed lower limb exercises with floss bands applied to one knee while the contralateral leg acted as the control. Their results showed that dorsiflexion peak torque increased 22% in the treatment leg ($p=0.06$), while there was no change in the control leg after the 14-day period. Given jump and sprint performance were improved in the current study up to 45-minutes following floss band application, it could be speculated that improving performance during training sessions in a chronic setting, may lead to greater physiological adaptations, and therefore, performance.

A limitation in the current study was the lack of a placebo/sham condition. The psychological advantage that may be associated with the use of band flossing can not be discounted. However, the experimental intervention in this case is difficult to provide a placebo condition for, therefore future studies could investigate different levels of pressure applied by the bands, in a cross-over design (e.g. <50mmHg, 100mmHg, 150mmHg, >200mmHg). This would allow for the optimal pressure of band flossing to be determined, and also give greater insight into the possible mechanisms, for example, whether or not the benefits are likely to be associated with a blood-flow occlusion effect. Another limitation of the current study was the time points used (up to 45-minutes post application of the floss bands). While the results would suggest that sprint performance had returned close to baseline values at 45-minutes post in the FLOSS group, it could be argued that both jump performance and the weight-bearing lunge test were still above baseline levels. Therefore, it may have been useful to extend the time frame and repeat these measures until they returned to baseline values.

Conclusion

The current study adds further information to the relatively novel technique of tissue flossing to improve ROM and athletic performance. It extends our previous work by demonstrating that the potential acute benefits of applying floss bands to the ankle (talocrural) joint for 2 minutes, may improve ROM, jump and sprint performance for up to 45-minutes after removing the bands. Future research to determine whether these same benefits are evident in highly-trained athletes is warranted.

References

Batterham, A. M., & Hopkins, W. G. (2006). Making meaningful inferences about magnitudes. *International Journal of Sports Physiology and Performance, 1*(1), 50-57.

Bennell, K., Talbot, R., Wajswelner, H., Techovanich, W., Kelly, D., & Hall, A. (1998). Intra-rater and inter-rater reliability of a weight-bearing lunge measure of ankle dorsiflexion. *Australian Journal of Physiotherapy, 44*(3), 175-180.

Brophy-Williams, N., Driller, M., Halson, S., Fell, J., & Shing, C. (2014). Evaluating the Kikuhime pressure monitor for use with sports compression clothing. *Sports Engineering, 17*(1), 55-60.

Bohlen, J., Arsenault, M., Deane, B., Miller, P., Guadagno, M., & Dobrosielski, D. (2014). *Effects of Applying Floss Bands on Regional Blood Flow*. Paper presented at the International Journal of Exercise Science: Conference Proceedings.

Buchheit, M., Simpson, B. M., Peltola, E., & Mendez-Villanueva, A. (2012). Assessing maximal sprinting speed in highly trained young soccer players. *International Journal of Sports Physiology and Performance*, *7*(1), 76-78.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences. Vol. 2. *Lawrence Earlbaum Associates, Hillsdale, NJ*.

Cormack, S. J., Newton, R. U., McGuigan, M. R., & Doyle, T. L. (2008). Reliability of measures obtained during single and repeated countermovement jumps. *International Journal of Sports Physiology and Performance, 3*(2), 131-144.

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.

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.

Griffin, L. Y., Albohm, M. J., Arendt, E. A., Bahr, R., Beynnon, B. D., DeMaio, M., . . . Hannafin, J. A. (2006). Understanding and preventing noncontact anterior cruciate ligament injuries a review of the Hunt Valley II meeting, January 2005. *The American Journal of Sports Medicine, 34*(9), 1512-1532.

Hewett, T. E., Myer, G. D., Ford, K. R., Heidt, R. S., Colosimo, A. J., McLean, S. G., . . . Succop, P. (2005). Biomechanical measures of neuromuscular control and valgus loading of the knee predict anterior cruciate ligament injury risk in female athletes a prospective study. *The American Journal of Sports Medicine*, *33*(4), 492-501.

Lawson, C. S. & Downey, J. M. (1993). Preconditioning: state of the art myocardial protection. *Cardiovascular Research, 27*(4), 542-550.

Malliaras, P., Cook, J. L., & Kent, P. (2006). Reduced ankle dorsiflexion range may increase the risk of patellar tendon injury among volleyball players. *Journal of Science and Medicine in Sport, 9*(4), 304-309.

Morales, A. P., Sampaio-Jorge, F., da Cruz Rangel, L. F., de Oliveira Coe, G. M., Leite, T. C., & Ribeiro, B. G. (2014). Heart rate variability responses in vertical jump performance of basketball players. *International Journal of Sports Science, 4*(2), 72-78.

Pang, C. Y., Yang, R. Z., Zhong, A., Xu, N. Boyd, B., & Forrest, C. R. (1995). Acute ischaemic preconditioing protects against skeletal muscle infarction in the pig. *Cardiovascular Research, 29*(6), 782-788.

Plocker, D., Wahlquist, B., & Dittrich, B. (2015). *Effects of tissue flossing on upper extremity range of motion and power.* Paper presented at the International Journal of Exercise Science: Conference Proceedings.

Reeves, G.V., Kraemer, R. R., Hollander, D. B., Clavier, J., Thomas, C., Francois, M., & Castracane, V. D. (2006). Comparison of hormone responses following light resistance exercise with partial vascular occlusion and moderately difficult resistance exercise without occlusion. *Journal of Applied Phyisology, 101*(6), 1616-1622.

Secomb, J. L., Lundgren, L. E., Farley, O. R., Tran, T. T., Nimphius, S., & Sheppard, J. M. (2015). Relationships between lower-body muscle structure and lower-body strength, power, and muscle-tendon complex stiffness. *The Journal of Strength & Conditioning Research*, *29*(8), 2221-2228.

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.

- Floss bands applied to the ankle for 2mins resulted in *small* improvements in ROM
- Floss bands resulted in *small* improvements in jump and sprint performance
- Beneficial effects of floss bands lasted up to 45 minutes following application
- Floss band use during a warm-up may reduce risk of injury and improve performance
- This study extends our previous findings by including a time-course investigation

Conflict of Interest
None.

Ethical Statement
All ethical guidelines outlined by the journal have been followed. Ethical approval was also granted for this study by the Institution. The work has been carried out in accordance with the Declaration of Helsinki

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