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NO EVIDENCE OF SHORT-TERM CHANGES IN POSTURAL BALANCE AND MUSCLE STRENGTH WITH APPLICATION OF THE FLOSS BAND

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Abstract: Introduction: The Floss Band is a tool that has been growing in the sports world in order to improve various parameters to improve performance. **Objective:** to investigate the effects of the Floss Band technique applied around the ankle associated with resisted heel raising exercises on postural balance and maximum isometric strength of the plantar flexors. **Methods:** 22 volunteers, men and women, randomly divided into two groups: Floss Band group (GF) and Sham group (GS). Everyone performed pre- and post-intervention tests, namely static postural balance through the displacement of the center of pressure (CoP) measured by a Wii Balance Platform, and maximum voluntary isometric contraction (MVIC) using a load cell. In the GF, the Floss Band was applied around the tibiotarsal joint with a pressure of 160 mmHg and in the GS group, the Floss Band was placed in the same region, but with 0 mmHg pressure. Participants in both groups performed a plantar flexion exercise in CCF, with 3 sets of 12 repetitions. At the end of the interventions, the tests were repeated.

Results: In the CoP displacement variable, only GS improved, while in the MVIC variable there was no improvement in both groups. **Conclusion**: it was concluded that as an acute effect, the Floss Band does not generate an improvement in static postural balance and MVIC, while the GS demonstrated an improvement in balance, attributed to Post-Activation Potentiation (PPA).

Keywords: Floss Band; Peripheral Vascular Occlusion; Postural balance; Muscle strength.

INTRODUCTION

In the sports world, high-level athletes and/or those who practice recreational physical activities are always looking for new techniques, methods and devices to improve performance. The findings regarding the combination of movement with the Floss Band may be a promising modality to improve performance (KIELUR; POWDEN, 2021). The Floss Band is a relatively new tool and has had a high growth rate in the sports market (KIEFER et al., 2017). Developed by Kelly Starrett, it is being used by some coaches and sports therapists in treatments and rehabilitation. The technique consists of involving a body segment or joint during the performance of active and passive movements, which last up to two minutes, with some authors differing in the application time, reaching up to 3 minutes, with the aim of improving mobility and strength (CHEATHAM; BAKER, 2020) and range of motion (ROM), restoring joint mechanics and releasing adhered tissue (HODEAUX, 2017). According to a published meta-analysis, the benefit of the technique for improving ROM was not proven (KIELUR; POWDEN, 2021), but it was shown to be promising for the outcome of muscular strength and with inconclusive results for muscular power. This occurs because the technique has a potential for vascular occlusion, which varies from 160 to 220 mmHg (KIELUR; POWDEN, 2021), a mechanism that has been extensively studied and used to increase muscle strength with low-load exercises (BOENO et al, 2018).

Peripheral vascular restriction is characterized as a reduction in blood flow in the muscle (LOENNEKE et al., 2011). Decades ago, a training method called KAATSU emerged in Japan, combining vascular restriction with low-load resistance exercises to gain strength and muscular hypertrophy (BOENO et al., 2018; BRYK et al., 2016; NAKAJIMA et al., 2006; OHTA et al., 2003; SHINOHARA et al., 1997). Several authors have carried out research on the subject and realized that these gains are similar to traditional high-intensity resistance exercise (80% of 1RM) (BOENO et al., 2018; BRYK et al., 2016; COSTA et al., 2012; TAKARADA

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et al., 2000), but using smaller loads (20-50% of 1RM) (BOENO et al., 2018; BRYK et al., 2016) which reduces overload/mechanical stress on a joint, causing less discomfort to the practitioner.

Despite the effects of vascular occlusion on strength and hypertrophy, the cellular mechanisms responsible for these gains are still not well understood (FUJITA et al., 2007). It is believed that vascular occlusion promotes a stimulation of local metabolism, with an increase in growth factors, an increase in protein synthesis (LOENNEKE; WILSON; WILSON, 2010; YASUDA et al., 2010) and higher levels of muscle activation of anaerobic fibers. (type 2) (CENTNER; LAUBER, 2020). Researchers consider the hypothesis that these mechanisms are interrelated (LOENNEKE et al., 2012). It has already been shown that low-intensity resistance training in combination with vascular occlusion produces changes in neuromuscular function indices, such as increased post-activation potentiation (PPA) (MOORE et al., 2004). PPA is a state of neuromuscular enhancement (with increased strength of muscle contraction) due to a preceding applied stimulus, often a conditioning voluntary contraction (LIMA et al., 2014; XENOFONDOS et al., 2017). This mechanism was recently investigated to improve postural balance with favorable and promising results (FERNANDES et al., 2021). Following this logical rationale, it is possible to assume that the Floss Band, as a blood flow restricting technique, increases neuromuscular activation, triggering PPA and thus improves postural balance.

The Floss Band technique is in the development phase and there are still not many studies on the subject, most of which investigate the outcomes: ROM and joint mobility. Studies have pointed to its potential as a blood flow restricting technique. Based on the knowledge available to date, it is possible to assume that the Floss Band technique associated with resistance exercise would be effective in improving muscle strength and postural balance. In this sense, the objective of the present study is to investigate the effects of the Floss Band technique applied around the ankle associated with resisted heel raising exercises on postural balance and maximum isometric strength of the plantar flexors.

MATERIALS AND METHODS

This study is observational, cross-sectional, randomized with a convenience sample. The study was approved by the ethics committee via Plataforma Brasil CAAE 51689321.6.0000.8108, opinion number 5,097,723. 23 adult volunteers of both sexes were selected, aged between 18 and 45 years, and physically active in accordance with WHO guidelines (adults must perform at least 150 minutes per week of moderate-intensity aerobic physical activity or at least 75 minutes per week of vigorous intensity) (WHO, 2020). Volunteers whose systolic blood pressure at rest exceeded 140 mmHg or diastolic blood pressure exceeded 90 mmHg, BMI ≥ 30, which is considered obesity (ANJOS, 1992), people with circulatory problems, people who use an orthosis or prosthesis in lower limbs (LL), injuries in the LL that make it impossible to perform a test or present pain in the ankle joint on the day of the assessment.

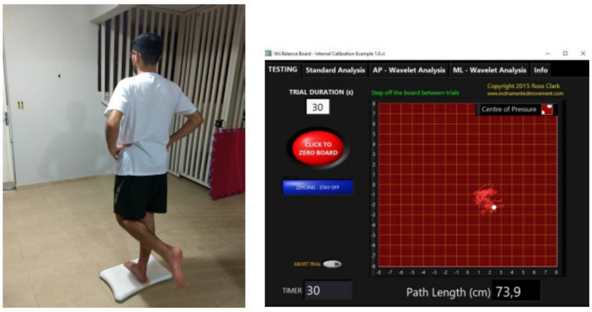
EVALUATIONS

The assessment process began with measuring blood pressure using a sphygmomanometer and a stethoscope. Resting systolic and diastolic blood pressure were obtained in the sitting position after 5 minutes of rest, using the auscultatory method with a properly calibrated aneroid sphygmomanometer (Premium®) and stethoscope (Rappaport®). Resting heart rate (HR Rep) was obtained in the sitting position after 5 minutes of rest. O2 saturation was measured using a finger oximeter (G-Tech® and Oled Graph model). Body weight was then checked with a digital scale (123 Useful QF-2003D) and height with a portable stadiometer, for later calculation of BMI.

The level of physical activity was assessed using the "International Physical Activity Questionnaire" (IPAQ), short Brazilian version. The short IPAQ consists of 7 open questions that allow weekly estimation of the time spent in moderate and vigorous physical activities, in different situations, such as: work, transport, domestic tasks and leisure, and also the time spent in passive activities, carried out in the position sitting. The validity, reliability and reproducibility of the short version of the IPAQ were tested and confirmed (MATSUDO et al., 2001).

To analyze static balance, the WII Balance Platform (Nintendo®, Kyoto, Japan) was used, which was connected to a computer via Wi-Fi communication and customized software (Labview 8.5 National Instruments, Austin, TX, USA) was used to reading the data. The WII Balance platform was validated by comparing it to a laboratory force platform (AMTI Model OR6-5, Watertown, MA, U.S.A.) and ICC = 0.77–0.89) (CLARK et al., 2010).

The balance test was carried out on the Wii platform in a semi-static position with single-leg support for 30 seconds, with the gaze fixed in front, where an "X" was placed at a distance of 2 meters from it, and the participants were asked to arms remained at the waist throughout the test (as illustrated in Figure 1). Two more collections were carried out with a 1-minute rest between each one and the mean and standard deviation were obtained.



Wii Balance Board - Internal Calibration Example 1.0.vi

TRIAL DURATION (s) 30

TIMER 30

Path Length (cm) 73,9

Step off the board between trials

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Figure 1- Balance test.

To evaluate the isometric muscle strength of the plantar flexor muscles of the lower limb, a load cell (Figure 2A) adapted from a portable suspension scale (model MNCS-M; Bode Technical Services, Denver, CO; maximum tension-compression) was used. = 200 kgf, precision of 0.1 kgf, 5-digit display), to quantify the maximum voluntary isometric contraction force (MVIC) in kg, as in Figure 2. This equipment has already proven to be valid and reliable for measuring muscle strength (FERREIRA et al., 2021; OLIVEIRA et al., 2020). To carry out the test, the participant remained seated on the ground with the knee extended, the device was fixed to an immovable structure and the strap was placed on the participant's forefoot (ROMERO-FRANCO; JIMÉNEZ-REYES; MONTAÑO-MUNUERA, 2017). The test was performed (Figure 2B), after a verbal command to perform plantar flexion with the greatest possible force and hold for 3 seconds. After the movement, the participant rested for 2 minutes, then performed it twice more, totaling 3 repetitions and the average between the measurements was calculated.

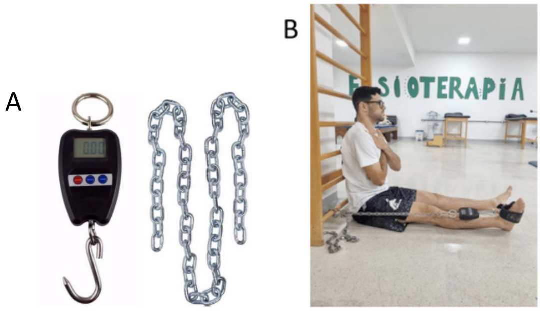

Figure 2A: Load cell adapted from a portable suspension scale. Figure 2B - Positioning of the participant to measure plantar flexor strength.

To quantify the compression generated by the Floss Band on the talocrural region, a manometer was used fixed to the region with masking tape (Figure 3) and slightly inflated with 3 squeezes, meaning that when the area was wrapped with the Floss Band the device would show in mmHg the pressure imposed on the area.

Figure 3: Manometer

The participant's preferred lower limb was chosen to carry out the balance and muscular strength tests, and all tests were performed with the same limb. Switching between the right and left limbs was not permitted after the initial choice. All tests were explained verbally and demonstratively. Participants completed a pre-test to ensure understanding of the entire procedure.

INTERVENTION

In the initial sample, a randomization process was carried out with the blind participant, using papers written GF (Floss Band Group) and GS (Sham Group) in equal quantities, folded and stored in brown envelopes, so that the researchers and participants were unable to see the contents inside. The envelopes were placed on a table where the participant approached and picked up an envelope, opened it and showed us which acronym was written, so that it could be placed in its respective drawn group.

After distributing the participants into the GF and GS groups, the warm-up began, consisting of 2 minutes of walking at natural speed, for each participant, in a straight line going back and forth in a location approximately 10 meters away.

In the GF, after heating, the Floss Band was applied to the tibiotarsal joint from distal to proximal with an average pressure of 160mmHg (BRYK et al., 2016), which was measured using a sphygmomanometer (Figure 4A), which was located between the Floss Band and the aforementioned joint. Soon after, the participant was asked to perform a bipedal ankle plantar flexion resistance exercise in a Closed Kinetic Chain (CCF) (Figure 4B). The exercise was performed with 3 sets of 12 repetitions (DRILLER et al., 2017; DRILLER; OVERMAYER, 2005; KIELUR; POWDEN, 2021; STEVENSON et al., 2019) and a 30-second rest that was timed by a clock between series and another, and when it ended, the Floss Band was immediately removed.

In the GS, after heating, the Floss Band was applied without any pressure (Figure 4C) on the tibiotarsal joint from distal to proximal. Soon after, the participant was asked to perform the same protocol with the resistance exercise of bipedal ankle plantar flexion in CCF, with immediate removal of the Floss

Band after completing the exercise.

Immediately after the intervention, balance and strength tests were repeated in this sequence. However, it is impossible to collect multiple tests due to the risk of losing the effect of the intervention.

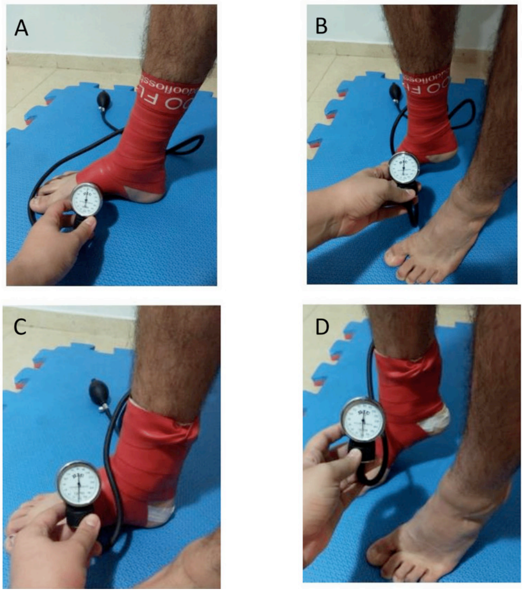

Figure 4A – Floss Band Application of the Floss Band to the GF with a pressure of 160 mmHg. Figure 4B - Intervention in GF with resistance exercise of the plantar flexor muscles under compression of 160 mmHg. Figure 4C - Application of the Floss Band to the GS with a pressure of 0 mmHg. Figure 4D - Intervention in GS with resistance exercise of the plantar flexor muscles under 0 mmHg compression.

DATA ANALYSIS METHODOLOGY

After collecting the data, they were tabulated using the Microsoft Office® package. The descriptive analysis was presented as mean, standard deviation and percentile. The Crombach α test was carried out to verify the reliability of the results provided by the Wii Balance Board platform. Data normality was tested using the Shapiro–Wilk test. Inferential analyzes of continuous data were performed by mixed analysis of variance (ANOVA) with repeated measures to classify differences within (time effect) and between groups (protocol effect). All data were reworked using Holm's post hoc test to avoid multiple comparisons. Significance was set at $p < 0.05$. The effect size was calculated using partial Eta-squared. All statistical procedures were performed using JAMOVI software (version 1.6.3 for Windows).

RESULTS

A total of 23 people was recruited to participate in the study, one was excluded due to exceeding the BMI determined in the selection criteria. The 22 participants were divided into two groups: Floss Band (GF) and Sham (GS), where they were allocated by randomization process. In Table 1, we can see the characteristics of the participants in each group, such as gender, age, body mass index (BMI), level of physical activity (very active, active, irregularly active A and irregularly active B) and dominant lower limb. The table shows homogeneity in all characteristics.

Crombach's α test was used to test the reliability between repeated measurements of pressure center displacement (cm) and plantar flexor strength (Kgf), the results were 0.951 and 0.955, respectively.

In Table 2, the results of the analysis of variance are presented for the variables of total displacement of the center of pressure and isometric strength of the plantar flexors. A significant difference was found with a reduction in the center of pressure displacement values only in the GS. And although the effect size is large, there was no difference between the groups after the protocols. No differences were found for plantar flexor strength.

DISCUSSION

Both groups were very similar in their characteristics: age, sex, body weight and level of physical activity, which brings reliability to the study. The present study verified, through the Crombach α test, reliability between the values measured by the platform. The center of pressure displacement results did not show any intra-group difference in the FG. On the other hand, a significant difference was found in the intra-group comparison in GS with a large effect size (η2p=0.365). No difference was found in the inter-group comparison for the CoP displacement variable. For the maximum isometric voluntary contraction variable, there was no intergroup difference, nor was there an intragroup difference.

Analyzing the results regarding displacement, there was no evidence of difference in GF, it is possible that the occlusion caused by the technique generates an anaerobic environment (KIELUR; POWDEN, 2021) causing oxidative stress and consequently greater muscle fatigue, having as an acute effect a decrease in the ability to move. neuromuscular response (LOENNEKE; WILSON; WILSON, 2010; YASUDA et al., 2010), reducing the speed of neural input and consequently the contractile capacity of the muscle.

On the other hand, the SG who performed the same exercise protocol, but without occlusion, there was a significant difference, with a reduction in the displacement of the center of pressure and a large effect size. This improvement in GS balance after the protocol can be explained by post-activation potentiation (PPA), which is responsible for changes in neuromuscular function (MOORE et al., 2004) with improved response in muscle contraction strength due to an action antecedent (LIMA et al., 2014; XENOFONDOS et al., 2017) which in the present study was resistance exercise with low load for plantar flexor muscles. It appears that vascular occlusion in GF inhibited PPA, possibly due to oxidative stress.

Although we hypothesize the improvement in muscle strength due to the vascular occlusion mechanism, as already evidenced by BOENO et al. (2018), BRYK et al. (2016), COSTA et al. (2012) and TAKARADA et al. (2000), the present study did not show any change in this variable in the GF and GS groups. It was expected to find an improvement in muscle strength due to greater recruitment of type 2 fibers (CENTNER; LAUBER, 2020) or a worsening of this variable due to muscle fatigue caused by oxidative stress (SOUZA JR.; OLIVEIRA; PEREIRA, 2005), however this was not a significant difference was found in the MVIC variable. It is worth mentioning that the studies that obtained positive results were longitudinal studies (BOENO et al., 2018; BRYK et al., 2016; COSTA et al., 2012; TAKARADA et al., 2000), that is, these results are due to a chronic effect of occlusion.

In the present study, the Floss Band application site was around the talocrural joint with the aim of increasing joint stability, neuromuscular control and thus improving the displacement of the center of pressure. This region was chosen due to its relevance in the reactive strategy for recovering postural balance, with neuromuscular responses going from distal to proximal (HORAK, 2016). This region is made up of several ligaments which are important means of proprioceptive information (KISNER; COLBY, 2016, p.264), but it is a place with few muscle fibers (muscle bellies), which may explain the fact that it was not found changes in the CIVM. When small disturbances in postural balance occur, the first muscles to contract are the plantar flexors with constant activation of the m. soleus and intermittent activation of m. medial gastrocnemius, showing the importance of m. medial gastrocnemius muscle in producing additional torque to maintain a balanced standing position (HEROUX, DAKIN, LUU, INGLIS AND BLOUIN, 2014). In this sense, it is possible that the technique has a greater effect on the muscle belly region of the triceps surae muscle.

A limitation in the study is the difficulty of always applying the same pressure with the Floss Band, with a variance of around 20 mmHg, which leads us to think about the traditional use of the cuff, which is coupled to a manometer, allowing greater security in measurements and practicality. The present study verified the acute effect; therefore, it is left as a suggestion for future studies: the investigation of the chronic effects of the application of the Floss Band on the variable's displacement and maximum isometric strength.

CONCLUSION

Based on the present study, it is concluded that the acute effect of the Floss Band technique applied to the talocrural region did not promote improvement in single-leg balance nor did it result in an increase in maximum isometric strength. A suggestion for future studies is: the application of the Floss Band on the muscle belly of the m. triceps surae and the investigation of the chronic effects of applying the Floss Band on the variable's displacement and maximum isometric strength.

The result obtained in the Sham Group in the variable displacement of the center of pressure corroborates previous studies, which showed that low-intensity resistance training promoted post-activation potentiation, with an acute improvement in the speed of neuromuscular response, with consequent improvement in balance.

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Results	**Groups**		**Value of p**
	Floss Band	**Sham**	
N	11	11	
Men	9 (81,8%)	8 (72,7%)	
Age (years)	29,4 ± 6,9	25,2 ± 4,75	0,115
BMI (Kg/m^2)	23,8 ± 2,81	23,9 ± 3,18	0,917
Physical Activity Level - n (%)	11 (100%)	11 (100%)	
Very active	5 (45,5%)	7 (63,7%)	
Active	4 (36,5%)	3 (27,3%)	
Irregularly active A	1 (9%)	1 (9%)	
Irregularly active B	1 (9%)	0 (0%)	
Dominant right lower limb	9 (81,81%)	8 (72,72%)	

Table 1: Anthropometric characteristics of participants and level of physical activity.

Variables	Group: Floss Band		Group: Sham		Effect: time	Protocol effect	P Holm
	AV*1 (1)	AV2 (2)	AV1 (3)	AV2 (4)			
	Average ± DP*	Average ± DP	Average ± DP	Average ± DP			
Total Displacement (cm*)	128 ± 24,6	118 ± 19,1	124 ± 42,4	108 ± 32,5	F*=11,48; p*=0,003; η2p=0,365	F=0,310; p=0,584; η2p=0,015	4<3: pHolm = 0,040
Plantar flexion strength (Kgf*)	53,1 ± 27,3	59,8 ± 33,1	46,8 ± 21,8	45,2 ± 18,8	F=1,37; p=0,256; η2p=0,064	F=0,933; p=0,346; η2p=0,045	NS*

Table 2. Analysis of variance for intra and inter group comparisons.

*DP: Standard deviation; cm: centimeters; Kgf: kilogram force; F: analysis of variance; p: p-value; NS: Not significant;