

## COMPRESSION PROFILE OF SPORT COMPRESSION STOCKINGS IN RUNNERS

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The purpose of this study was to determine the interface pressure applied using two compressive stockings: medium compression (MC) and strong compression (SC); in three conditions: before, during and after running test. Ten male runners (n=10) exerted two laboratory test condition in different days: a) without compression stockings and b) with one kind of compression in each leg. Interface pressure was registered using PicoPress<sup>®</sup> device. In both compression conditions, the interface pressure was higher in proximal than distal sensors (MC p<0,05; SC p<0,001). Similar results were taken in dynamic condition, and lower level compression was observed after running test. In conclusion, compressive forces were higher in proximal compared to distal leg area. This is contradictory to the gradual decreasing compression principle.

**KEY WORDS:** compressive stockings, runners, interface pressure

**INTRODUCTION:** There's clinical scientific evidence to support the use of compression garments in therapy to prevent and treat diseases of vascular and lymphatic (Sim Lim, Ch & Davies, AH, 2014; Partsch H, 2014). Although in a clinical setting the most effective compression design is graduated (Lim et al., 2014), there are yet needed investigations involving healthy participants and sport compression garments, cause there is not normative framework in sport compression stockings. Most sports field research of compression garments have not measured the interface pressure levels applied by the garments (Reich-Shupke et al., 2016) and the pressure applied is significantly affected by garment type, size and posture (Brophy-Williams et al., 2015). However, there are few studies data about pressure measured in vivo during running. In clinical therapy there are 4 common grade of compression used: Class I (18-21mmHg), II (23-32mmHg), III (33-40mmHg) and IV(>40mmHg); but in sports field remains unclear which is the range of compression effective for each situation or sport and its effects (Born DP, Sperlich B & Holmberg, HC, 2013). The objective of this study was to determine the pressure applied using two compression stockings: medium compression (MC) and strong compression (SC) in different moments: before, during and after running test. These applied pressures should correspond with pressures established by manufacturer's specifications.

**METHODS:** Ten male runners (n=10; 35±5 years; 40±10km/week) performed a laboratory running test with one kind of compression stocking in each leg (randomized). Garments were fitted according to manufacturer's guidelines, and the runner was instrumented with PicoPress<sup>®</sup> sensors to measure interface pressure before, during and after the running test. PicoPress<sup>®</sup> transducer measures the pressure exerted by elastocompression and each sensor is located in anatomical regions of interest between compression garment and skin. Interface pressure was measured by PicoPress<sup>®</sup> in four regions in static, standing and supine position (two on the maximum perimeter of the calf, one in the external supramalleolar and another one on anterior tibial area). While running, measurements were taken every five minutes in both legs and in three regions (anterior tibial area was removed). The running test consisted in 35 minutes (5 minutes warm up at 8km/h and 30 minutes at the 75% of their maximal aerobic speed, measured previously in an incremental running test) and was performed in a treadmill in laboratory conditions. SPSS was used to statistical analysis.

**RESULTS:** In both conditions interface pressure was higher in proximal (MC  $17.52 \pm 2.99$  mmHg; SC  $17.69 \pm 3.09$  mmHg) than distal (MC  $15.00 \pm 6.41$  mmHg; SC  $15.60 \pm 5.54$  mmHg) sensors in dynamic (MC  $p < 0.05$ ; SC  $p < 0.001$ ). Average interface pressure in all sensors were higher in MC ( $20.95 \pm 6.17$  mmHg) compared to SC ( $18.98 \pm 6.06$  mmHg) ( $p < 0.05$ ).

In static measurements, all pressure data were lower after the running test ( $21.47 \pm 6.26$  vs  $18.40 \pm 5.75$ ) ( $p < 0.001$ ).

**DISCUSSION:** Previous our experimental phase, we thought MC and SC were going to exert similar pressure data as manufacturer's specifications, however, we obtained that MC had stronger compression than SC, so it's suggested that manufacturer's should take into account these indications. We suggest it's needed a standard framework in sport compression garments fabrication.

It is reported that the optimal method of applying compression to increase blood flow is in a decreasing graduated way (i.e. highest pressure exerted at the distal end of the limb decreasing to a lower pressure exerted at the proximal end of the limb (Bochmann et al, 2005). With the stockings studied we obtained higher compressive forces in proximal than distal area (MC and SC), in opposition of the principle of gradual decreasing compression exposed by socks' manufacturer. This situation has been observed in both dynamic and static conditions, so it's important to reconsider the theoretical principles that are used to predict the final compression in these garments. Though other authors like Partsch (2012) also found positive results with negative pressure gradient so it remains unclear how sport compression stockings can improve performance and/or recovery.

Exercise has not meant a decrease in compression applied of compression stockings evaluated on the tibia (medial) and external supramalleolar area, however this material fatigue has been observed in the maximal perimeter of the calf muscle. These data has to be taken into account by manufacturers.

**CONCLUSION:** Although compressive stockings exerted different pressures, the optimal pressure to achieve the greatest increase in venous blood flow is yet to be determined, and it would be also interesting to know companies procedures to determine compression specifications of its garments.

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## DO SPORT COMPRESSION STOCKINGS IMPROVE COMFORT AND ACCELEROMETRY PARAMETERS IN RUNNERS?

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In this study, we analysed accelerometry data from runners foot strikes with and without sport compression stockings. Also, we measured comfort perceived with these garments due its importance to a succesful performance. Ten male runners (n=10) exerted two laboratory test condition in different days: a) without compression stockings and b) with one kind of compression in each leg. Accelerometry data were registered using sensors in tibia and head. Also participants filled out a comfort test in stockings' condition. Medium compression (MC) impacts attenuation was lower than no compression (NC) condition ( $p<0,05$ ). General comfort perceived was 66%. In conclusion, compression stockings demonstrated a protective effect against impacts and were perceived as comfortable.

**KEY WORDS:** compressive stockings, impacts, comfort, running

**INTRODUCTION:** Comfort perception is an important parameter in sport performance (Kolcaba & Steiner, 2000). Thereby, an improve in comfort of compressive stockings could lead to a better performance. Thus, when there's an introduction of a sport garment is necessary to evaluate its effectiveness and has been demonstrated that a positive perceived comfort is necessary to success in the use of these garments in runners' performance (Lucas-Cuevas et al., 2014). Other authors like Mündermann et al. (2003) also found comfort as an important and relevant feature of garments like foot orthoses cause its effects in kinematic, kinetic and EMG variables in recreational runners. Every time the foot strikes to the ground, has placed a fast deceleration which is transmitted from foot to head (Whittle, 1999). These impacts may lead to overuse injuries (Whittle, 1999). Thus, minimize this body deceleration is interesting due to its relation with injuries, performance (Mercer et al., 2002) and comfort (Kolcaba & Steiner, 2000). So if comfort is important for a successful introduction of any sports garment, we should to take it in account for our study to understand better if can be related with accelerometry variables in runners. Hence, the aim of our study was to measure perception of comfort and strike deceleration using different running compression stockings (different compression grade) in runners.

**METHODS:** Ten male runners (n=10; 35±5 years; 40±10km/week) performed two laboratory running tests: one without stockings and another one with one kind of compression stocking (medium and strong) in each leg (randomized). The running test consisted in 35 minutes (5 minutes warm up at 8km/h and 30 minutes at the 75% of their maximal aerobic speed, measured previously in an incremental running test) and was performed in a treadmill in laboratory conditions. Garments were fitted according to manufacturer's guidelines (to choose correct sizes), and runners were instrumented with accelerometry sensors in tibia and head through which we record accelerometry data samples during 15 seconds every 5 minutes along the test looking for effects due to fatigue. Also, runners filled out a visual scale of perceived comfort before and after the test with compression stockings. In this scale there were different items related with comfort like perceived temperature in stockings' area or garments' fitting. SPSS was used to statistical analysis, using normality tests, ANOVA and post-hoc Bonferroni to check differences between conditions.

**RESULTS:** Both compressive garments obtained better values of perceived comfort, reaching a general comfort of 66%. Perceived temperature in sport compressive area and use of stockings in summer were the items less valued for runners. Regarding impacts attenuation, there were significant differences ( $p=0.003$ ) between medium compression and no compression conditions ( $28.876\pm 7,110\%$  vs  $47.504\pm 8,052\%$ ). Not statistically significant differences were found between stockings conditions. We also didn't find significant relation between strikes' attenuation and fatigue.

**DISCUSSION:** Previous studies also found beneficial results in perceived comfort by the use of compression garments (Lucas-Cuevas et al, 2014). This is necessary for a successful introduction of sport garments due its relation with performance (Kolcaba & Steiner, 2000).

In relation to accelerometry data, we didn't found much significant differences, probably because we need more samples, but we could notice a tendency by which there's a "protective effect" induced by compression stockings (Lucas-Cuevas et al, 2014), cause less attenuation in stockings condition was achieved, what means less impact is transmitted from tibia to the head. Also is possible could be needed to choose runners with similar strike pattern (rearfoot, midfoot or forefoot strike) to reduce deviations in accelerometry data, because in our study we choose runners with similar performance but we notice differences in accelerometry data due to kinematics, though we didn't measure kinematic data we observed quite much differences in running technique. We suggest future studies regarding how different kind of compression stockings may lead, or not, to differences in impacts attenuation and also longer and more realistic conditions of fatigue like running endurance events like 10k or half-marathon.

**CONCLUSION:** The use of sport compression stockings improve comfort perception but a worse sensation by raised temperature in stockings' area. Irrespective compression grade, stockings demonstrated a protective effect during running due to better attenuation of impacts.

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