EFFECTS OF TWO DIFFERENT COMPRESSION STOCKINGS IN VENOUS RETURN BEFORE AND AFTER RUNNING

Inmaculada Aparicio [1, 2], Francisco J. Oficial[1] , Iván Julián[3], María Blanes[2]and Pedro Pérez-Soriano [1]

[1]GIBD, Department of Sport and Physical Education, University of Valencia, Valencia, Spain[1]
[2]AITEX, Textile Research Institute, Alcoy, Spain[2]
[3] Nursing Department, University of Valencia, Valencia, Spain[3]

In this study it analyse venous return with different compression stockings (CS). 10 experienced runners ran in two experimental test during 35 minutes in a treadmill at 75% of their maximal aerobic speed. Venous blood flow was measured before/after test with magnetic resonance (RMN). Results indicated that fatigue increased venous blood flow in all conditions ($p<0.05$), but larger differences were found without stocking condition (WS) (right=1,63 ml/s; left=1,66 ml/s). No significant differences ($p>0.05$) were found with medium compression stocking (MS). Results suggest that CS didn´t increase venous return and decrease comparing to WS. Nevertheless, if compression stockings lead faster recovery, we couldn't measure because RMN isn't faster like other methods.

KEY WORDS: compression garments, venous flow, magnetic resonance, exercise.

INTRODUCTION: Compression garments (CG) have been used historically to treat circulatory and lymphatic pathologies (Hamdan 2012). This concept has been extrapolated to the sport field, and nowadays the use of compression garments is widespread in athletes. However its physiological benefits in sport are still unknown (Priego, Lucas-Cuevas, Aparicio, Giménez, Cortell-Tormo & Pérez-Soriano, 2015)

Compressive stockings are garments that fit perfectly to the shape of the leg, applying pressure in the covered region. They apply constant pressure to the leg, in order to maintain a reduced caliber of the veins and thus prevent the accumulation of blood in the extremities (Morris & Woodcock, 2010). These garments are capable of adapting to a wide range of sizes and shapes, and the application of pressure depends on the pumping. Correct leg measurement is important prior to the selection of the compression stocking size, otherwise incorrect pressure gradients can increase the risk of venous diseases (Morris & Woodcock, 2010)

The wearing of hyper-compressive body-molded CG has been suggested to provide circulatory benefits for athletes during training and competition (Dascombe, Hoare, Sear, Reaburn, & Scanlan 2011) While CG manufacturers claim that wearing CG improves muscular power, endurance, proprioception, thermoregulation, and recovery, there is limited supportive data (Priego et al. 2015) Interestingly, the recommended level of compression has been taken from clinical investigations, with no published data suggesting that it is sufficient to benefit athletic performance (Priego et al. 2015).

There are studies that demonstrated that an external pressure applied by compresssion stockings induced venous return/or blood flow increases in healthy subjects and patients with chronic venous insufficiency (Ibegbuna, Delis, & Nicolaides, 1997). However, in sport, not enough scientifical evidence has been found to affirm these effects (Priego, et al 2015).

The aim of this study was to examine the venous flow at the level of the popliteal vein, before and after running, without compression stocking (WCS), and with the use of two types of compression stockings: Strong Compression Stocking (SCS) and Medium Compression Stocking (MCS)

METHODS: 10 male runners (age [35 ± 5 years], and weekly mileage [40 ± 10 km/week]) participated in the study. Runners carried out 2 laboratory tests: 1) without any stocking (WCS); and 2) With compression stockings randomized according to its size: a) Medium compression stocking (MCS) in one leg and b) Strong compression stocking (SCS) in the other leg. At each test participants ran for 35 minutes in a treadmill (5 minutes at 8km/h followed by 30 minutes of the 75% of their maximal aerobic speed, which was previously measured in an incremental running test). Two Measurements were taken in supine position in the Magnetic Resonance equipment before and just after test.

The equipment was RM: Siemens 1.5T, MAGNETON SONATA, Software versión numeris/4 MR A30. In the test with compression stockings, legs were analysed separately, because in the same test SCS and MCS were used in a randomized way in both legs.

Venous return flow sequences were obtained by cardiovascular magnetic resonance phase contrast imaging by initially determining "cardiac gating" in supine position and after breathing rhythmically. Subsequently, protocols created "ad-hoc" were established for the determination of the sequences to analyse the average flow of return in the popliteal vein. It allowed to evaluate the volume of blood per second during the acquisition time of the images and the region of Interest (ROI) selected (popliteal vein).

Statistical analysis was made by IBM® SPSS® Statistics (SPSS®-IBM® Corporation, New York, USA). It was checked the normality of the variables (Shapiro-Wilk), and with the adjusted data to the normality, it was performed a T-test to compare the average between the two created groups to each factor analysed. The significativity was established in $\alpha=0.05$.

RESULTS: There were found differences in venous blood flow comparing before (in rest) and after the test (exhaustion) in all conditions (WCS, MCS and SCS). In WCS condition, both legs showed significative differences in rest (Right(R)=0,73 ml/s, left(L)=0,74 ml/s) compared to fatigue (R=1,63 ml/s; L=1,66 ml/s) ($p<0.05$). With the use of MCS, any leg presented significative differences comparing rest vs fatigue $p>0.05$. And with SCS were found differences between legs, in right leg $p<0.05$ and in left leg $p>0.05$.

Exercise increased venous return flow in all conditions, But the highest values were obtained in WCS condition (R=1,63 ml/s; L=1,66 ml/s), followed by MCS condition (R= 0,96 ml/s; L= 1,13 ml/s) and STC(R= 0,72 ml/s; L= 0,97 ml/s) respectively.

Table 1
This table shows both legs in both moments (before and after the test) comparing WCS vs MCS and WCS and SCS. p(<0.05)

Condition		WCS		MCS		Difference	IC		p	WCS		SCS		Difference	IC		p
		Average	SD	Average	SD					Average	SD	Average	SD				
Right	Rest	0,897	0,232	0,634	0,133	0,263	-0,157	0,683	0,157	0,593	0,191	0,517	0,208	0,075	-0,141	0,292	0,412
Right	Fatigue	1,912	0,814	0,957	0,374	0,955	-0,462	2,372	0,135	1,402	0,400	0,723	0,191	0,680	0,239	1,120	0,011
Left	Rest	0,647	0,256	0,563	0,181	0,084	-0,044	0,211	0,153	0,804	0,223	0,574	0,091	0,230	-0,230	0,690	0,210
Left	Fatigue	1,524	0,449	1,188	0,861	0,336	-0,849	1,522	0,475	1,745	0,384	0,968	0,198	0,777	0,285	1,269	0,015

Considering the type of stocking, only significant differences were found p<0,05 in WCS vs SCS in fatigue in both legs, showing higher flow WCS in right leg(fatigue WCS=1,40 ml/s; fatigue SCS=0,72 ml/s) and in left leg(fatigue WCS=1,74 ml/s; fatigue SCS=0,97 ml/s)

DISCUSSION: Compressive garments are widely used in sport with the aim of improving venous flow but it should be more analysed (Priego et al.2015, Lucas-Cuevas, Priego-Quesada, Aparicio, Giménez, Llana-Belloch & Pérez-Soriano 2015). In this sense, the aim of this study was to evaluate the speed of venous return flow at the popliteal vein before and after exercise, under three conditions: WCS, and with the use of two types of Compression Stockings: SCS and MCS.

The results show higher venous return after the exercise without using compression stockings comparing to the use of compression stockings, independently if they are SCS or MCS. These results differ from Dascombe et al. (2011), where they found a slight increae with the use of compression stockings. Their participants run at 90% of the Vo2max until volitional exhaustions, and our test was at 75% of their VO2max. This could explain some of the differences. Moreover, Bringard et al. (2006), studied compression stockings in different positions, but without any exercise and showed a significantly lower venous pooling and a higher calf oxygen saturation level with compression stockings in comparison to elastic tights and shorts (no compression) in supine and standing position in rest. The differences between studies may be due to the different compressions used in CG, the purpose of the use of compression stockings, as well as to the different tests performed.

In the condition WCS exist a difference in the venous flow (rest vs fatigue), being higher the venous flow after the exercise, that is, the venous return behaves in a normal way as usually happens during any practice of physical activity and / or sport, when they are active movements (Sochart & Hardinge, 1999). However, this increase in venous return in not produce with the use of compression garments during running, and this is in contradiction with most of sports compression garments manufacturers, which indicate the increase of venous flow as a benefit. In this sense, in the therapeutic compression stockings, this increase in the venous return has been demonstrated (Ibegbuna, et al. 2003), however in the sports compression stocking in running, more research is needed Priego et al. 2015; Lucas-

Cuevas et al., 2015). Moreover, we haven´t found any explanation to understand differences found between right and left leg with SCS, probably it is needed more sample.

In this study, measures of venous flow has been taken by magnetic resonance, because of that it is considered that this not increase of venous flow could be due to the time that has passed since the end of the running test and the measurement. The measurement was taken approximately 5 minutes after the test and it could be probably that the return to the resting state of venous flow is faster with the use of compression stockings than without their use.

CONCLUSIONS: The results suggest that running facilitate venous return, but the use of CG with different compressions don´t increase the velocity of venous return after running, unless the CG decreases the venous return comparing to the condition without compression stocking. In the same way, the degree of compression between the evaluated stockings (Strong / Medium) did not make any difference in the venous return flow. Moreover it is needed more research about the level of garment compression or monitored peripheral circulation.

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