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Influence of elastic compression on venous return in athletes

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The venous circulation in athletes can be affected by a syndrome of "excessive flow" caused by exercise. This can cause ectasia of the veins depending on the type of sport practiced, may be due to prolonged high intra-thoracic or abdominal pressure. There are very few publications on the effects of elastic compression on sporting performance in athletes with no overt venous pathology. In small series of athletes running short or mid-length races and short marathons, or playing tennis, rheographic, plethysmographic and echo-Doppler investigations have shown faster venous emptying. Aim of this study is to assess the "acute" hemodynamic effects of elastic hose giving class I compression in athletes (Varisan Top – CIZETA Medicali). The study group comprised 38 people of both sexes (29 males, 9 females), hemodynamic changes were assessed on the basis of reflected-light rheographic findings (RLR). Filling time T0, T90, T$^1/_2$ and Delta R was the assessed parameters. Each leg is considered as one "functional unit", so the results were analysed on the basis of the total number of limbs (76). There was a significant reduction in refilling time after walking with the elastic hose. In conclusion it would appear that the use of class I elastic hosiery influences hemodynamics in athletes with no clinically or instrumentally detectable venous pathologies. Previous observations, though based on small numbers, suggest that the effects are favorable not only on hemodynamics but also on muscle metabolism, with possible repercussions on athletic performance.

KEY WORDS: Venous circulation - Veins, elastic compression.

The venous circulation in athletes can be affected by a syndrome of "excessive flow" caused by exercise. This can cause ectasia of the veins (exercise phlebectasia, or athlete's veins) and, depending on the type of sport practiced, may be due to prolonged high intra-thoracic or abdominal pressure (as in weight lifting), "explosive" increases in pressure in the deep venous circulation (as in tennis), or bending of the veins, obstructing the superficial and deep venous circulation (as in cycling).

During exercise the venous system makes a decisive contribution to maintaining cardiac filling pressure: splanchnic venous constriction plays a part, as does venous return ensured by valvular competence and the efficiency of the muscle pump. Arterial flow may rise by up to 20 times, with repercussions on the venous system, where the volume of blood may be 4-5 times normal; this is handled by venous "capacitance vessels", and is what causes ectasia. It is a physiological adaptation mechanism for responding to increased hemodynamic requirements. In an athlete, however, vascular dilatation, though comparable to that in a patient with vascular disease, is efficiently reduced by venous emptying during exercise, as confirmed by the narrowing of the vessels seen on echo-Doppler examination.[1, 2]

Il lavoro è stato supportato dalla Ditta Cizeta Medicali di Cuggiono (MI).

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TABLE I.—*Main details of subjects.*

No. (M/F)	38 (29/9)
Mean age (range)	37.4 (18-60)
Sport	
— Football (No. %)	10 (26.3%)
— Cycling	10 (26.3%)
— Walking	10 (26.3%)
— Tennis	6 (15.8%)
— Swimming	2 (5.3%)

There are very few publications on the effects of elastic compression on sporting performance in athletes with no overt venous pathology. In small series of athletes running short or mid-length races and short marathons, or playing tennis, rheographic, plethysmographic and echo-Doppler investigations have shown faster venous emptying, followed by accelerated filling after exercise in those wearing elastic stockings, with less reduction of the diameters of deep veins than in controls.[3, 4] These findings have sometimes been interpreted as a worsening of the instrumental picture, and this would in fact be true in patients with venous pathologies. However, in the situation described above, it seems more likely that the findings are attributable to a mechanical effect of the stocking which, by compressing the muscle mass, facilitates venous return, reducing stasis and probably also stimulating muscle metabolism.

Elastic hose therefore have an excellent effect on how the athlete's venous circulation adapts to exercise. Elastic compression helps prevent ectasia, facilitates heat dispersion, delays the subjective feeling of fatigue, and has a good effect on athleic performance.[4]

Aim of the study to assess the "acute" hemodynamic effects of elastic hose giving class I compression, in athletes taking part regularly in sports by a Rheographic reflected-light dynamic method.[5]

Materials and methods

The study group comprised 38 people of both sexes (29 males, 9 females), mean age 37.4 years (18-60), who regularly practiced a sport, either as amateurs or competitively (football, walking, tennis, swimming) and who had no clinical signs of venous pathology in the legs (Table I). They all gave informed consent.

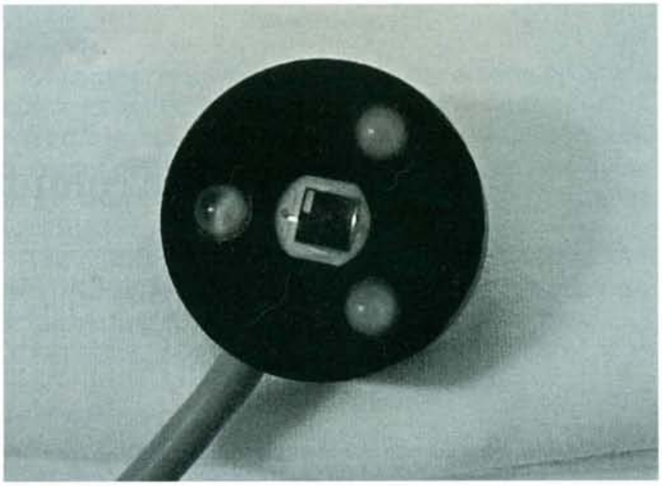

Fig. 1.—Microlab transducer.

Criteria for exclusion were: history of cardiovascular or osteoarticular disease, inability to walk on a moving belt, confirmed or suspected pregnancy, and breastfeeding.

Hemodynamic changes were assessed on the basis of reflected-light rheographic findings (RLR) using a Microlab Doppler System II photoplethysmograph consisting of a PVC transducer with three infrared light emitting devices (940 nm), positioned at the tips of an equilateral triangle, with a solid-state photodiode in the center (Figure 1). The following parameters were assessed by RLR:

— Filling time T0 (or refilling time, i.e. the time needed to refill the venous plexuses after completion of the exercise);

— T90 (i.e. the time needed to recuperate 90% of the emptying);

— T $^1/_2$ (i.e. the time needed to recuperate 50% of the emptying);

— Delta R (or maximum emptying, i.e. the peak emptying capacity of the venous plexuses, indicating the venous drainage capacity of the muscle pump.

For this assessment, instead of the classic dynamic flexion-extension test with the foot, we tested the athletes on a moving belt, so as to evaluate venous return in response to pressure on Lejar's venous sole and the subsequent contraction of the calf muscles. Walking normally on a moving belt permits a complete hemodynamic examination.

The photoplethysmograph transducer was placed about 10 cm above the medial malleolus, avoiding areas with varicosity or other skin alterations; it was fixed in place with a bi-adhesive tape disc and a silk plaster so it could not come off.

The walking test was conducted at standard speed and slope (4 km/h on a 10% slope) for 20 seconds or until the tracing became stable, but never for longer than one minute. Both legs were examined, starting with the right one, without elastic hosiery. The subjects were then allowed a 10-15 minute rest, supine, before the test was repeated with an elastic sock on the leg. During the walking test with the sock on, the transducer head was fixed at the same place as in the "control" test, just above the stocking (Table II).

For the compression test we used an elastic "knee-sock" (class I according to the German standard GGGRAL), model VARISAN Top (Cizeta Medicali, Cuggiono, Milan, Italy); the fabric is knitted with a multifilament fiber covering the elastomer (Lycra®) and therefore "breathes" well. This ensures a larger fiber-to-skin contact area, which facilitates evaporation. The elastic socks were tailored personally for each athlete, measuring the circumference of each leg at the ankle and calf, and the length from the heel to the back of the knee.

Wilcoxon's test was used for statistical analysis.

TABLE II.—*Phases of the study.*

I	LEG right	Recovery Calibration Walking (normal)
II	LEG left	Recovery Calibration Walking (normal)
II		Putting on elastic sock
I	LEG right	Recovery Calibration Walking with sock
V	LEG left	Recovery Calibration Walking with sock

TABELLA III.—*RLR results (mean±SD) in all athletes.*

	Refilling time	T 90	T 1/2	Delta R
Without sock	32.0±8.8	21.5±8.4	9.1±4.4	54.5±17.8
With sock	27.7±9.0	19.1±7.6	7.8±4.3	50.4±21.4
p	0.0032	NS	NS	NS

Results

Each leg is considered as one "functional unit", so the results were analysed on the basis of the total number of limbs (76).

There was a significant reduction in refilling time after walking with the elastic hose (p=0.0032). The other parameters - T 90, T$^1/_2$, Delta R – showed a tendency to a reduction, without reaching statistical significance (Table III).

Other findings

Nine legs showed a refilling time of less than 20 seconds in baseline conditions, i.e. when the athlete did the walking test without the elastic hose. We therefore analysed the results in two groups: 1) legs with refilling time >20 sec.; 2) legs with refilling time <20 sec (Table IV).

The 67 legs in group 1 showed a significant reduction in refilling time (p=0.0001), T 90 (p=0.04) and T$^1/_2$ (p=0.01). The Delta R/also tended to drop, but without reaching statistical significance. The nine legs in group 2 showed a tendency for the refilling time to rise towards normal (from 12.9 sec to 19.3 sec.); T 90 and T$^1/_2$ followed a similar pattern, and Delta R decreased (Figure 2).

TABLE IV.—*RLR results (mean±SD) in athletes with refilling time less than 20 seconds (group 1) or more than 20 seconds (group 2).*

	Refilling time		T 90		T 1/2		Delta R	
	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2
Without sock	34.6±5.4	12.9±5.1	23.3±7.1	8.14±3.1	9.8±4.1	3.8±2.7	56.4±16.6	40.9±20.8
With sock	28.8±8.0	19.3±12.2	19.8±7.1	14.3±10.0	8.0±4.0	6.9±6.3	52.7±20.2	34.0±23.7
p	0.0001	NS	0.04	NS	0.01	NS	NS	NS

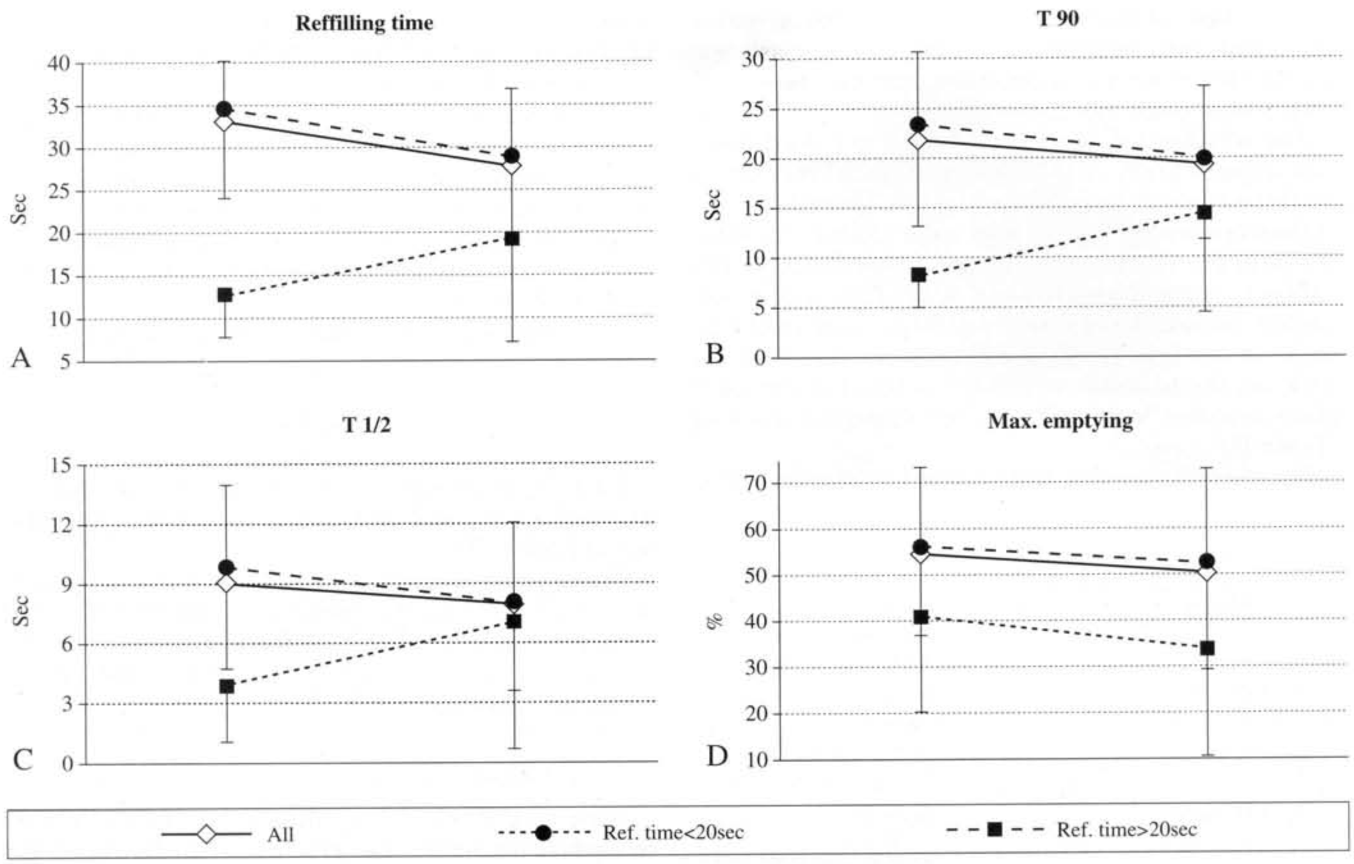

Fig. 2.—Results.

Discussion

Various studies have highlighted the utility of elastic compression for athletes during exercise.[3, 4] This can be explained from the hemodynamic viewpoint, since compression influences venous emptying and the refilling time, assessed by rheography in trained athletes after exercise wearing elastic hose;[3] however, there is also a "symptomatological effect", the athlete feeling less fatigue, less heaviness in the legs, and no muscle cramps.[3]. A French group [4] that assessed the utility of elastic compression in 19 marathon runners confirmed the improvement in recovery of venous function and the feeling of greater wellbeing after using the hose.

In the present study rheography showed the following differences when athletes wore the compression socks:

— Athletes with refilling time >20 seconds:

a) A significant reduction in refilling time;

b) Significant reductions in $T^1/_2$ and T90;

c) A reduction in Delta R.

— Athletes with refilling time <20 seconds:

a) A tendency for refilling time, $T^1/_2$ and T90 to rise;

b) A tendency for Delta R to fall.

In the first group, in accordance with previous reports, we interpreted the reduction in delta R and refilling time as indicative of a reduction in the subcutaneous venous plexus volume to be emptied or filled, as a result of the compression. In the second group, the refilling time was shorter than 20 seconds so these athletes can be considered to have an unidentified venous pathology of some sort. The venous reflux naturally tended to improve under the effect of the elastic compression. We interpreted the change in delta R the same way as in the first group.

In conclusion it would appear that the use of class I elastic hosiery influences hemodynamics in athletes with no clinically or instrumentally detectable venous pathologies. Previous observations, though based on small numbers, suggest that the effects are favorable not only on hemodynamics but also on muscle metabolism, with possible repercussions on athletic performance.

The use of reflected light rheography – an objectively reproducible, non-invasive measurement method – means that these observations can easily be verified not only in a vascular diagnostic laboratory but also on the sports field, with minimal organisational effort. Case-control studies are now needed to confirm the findings on larger caselists and to assess the metabolic and tissue repercussions and the real effect on performance.

Riassunto

Influenza della compressione elastica sul ritorno venoso negli atleti

La circolazione venosa negli atleti può essere affetta da una Sindrome da Iperafflusso che può causare ectasia venosa ed è determinata dall'aumento prolungato della pressione intraaddominale e toracica durante lo sforzo. Sono disponibili solo pochi studi sugli effetti di una compressione elastica sulla dinamica venosa in atleti senza evidenza di patologie flebologiche. In piccole serie di altleti praticanti corsa breve, mezza maratona e tennis, con metodiche reografiche, pletismografiche ed eco-doppler è stato evidenziato un più rapido «svuotamento» del sistema venoso superficiale dopo attività fisica. Scopo del nostro studio è stato quello di verificare gli effetti emodinamici «in acuto» di un gambaletto di I classe di compressione (Varisan Top – Cizeta Medicali), sull'emodinamica venosa in 38 atlleti. (29 maschi, 9 femmine), mediante Reografia a Luce Riflessa. Il refilling time, il $T^1/_2$, il T90 ed il Delta R sono stati i parametri utilizzati per il confronto. Ogni arto è stato considerato una «unità funzionale» separata e pertanto l'analisi dei dati è stata eseguita dui dati relativi a 76 arti. È stata dimostrata una significativa riduzione del Refilling Time quando le misurazioni siano state effettuate con la calza indossata. In conclusione sembrerebbe evidenziarsi un effetto emodinamico esercitato da una calza di I classe di compressione sul circolo venoso di atleti senza evidenza clinica o strumentale di flebopatia. Precedenti osservazioni, ancorché su piccoli numeri suggericono che gli effetti non siano favorevoli solo sull'emodinamica ma anche sul metabolismo muscolare con possibili ripercussioni sulla performance atletica.

Parole chiave: Circolazione venosa - Vene, compressione elastica.

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