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Compression stockings and sports: truths, myths and opinions

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Introduction

It is amazing how artifacts that optimize the performance of athletes arouse interest and have immediate adhesion. In addition to the known use of elastic stockings for venous and lymphatic insufficiency, their indication in other non-pathological conditions such as in combatting occupational edema has recently been demonstrated and scientifically proven [1-3]. However, the benefits of the use of compressive mechanisms in sport, as has been extensively publicized by the media thanks to the great interest of athletes and manufacturers, have not always been verified by methodologically correct studies that are able to substantiate their appropriate and effective medical prescription.

In General, the focus on elastic compression therapy is always to reestablish the balance between the tissues and the interstice space using sufficient external pressure to counter the high internal pressures that may arise in different pathological or non-pathological conditions [4]. The principles that underlie this technique seem to be ancient, but the true story of elastic compression is dated to the end of the 1940s when Jobst realized that the discomfort caused by chronic venous insufficiency (CVI) that he suffered in the lower limbs was greatly relieved when he entered a swimming pool. This led him to observe that the cause of the improvement was the backpressure of the water. Based on this observation, Jobst studied different ways to modify the coefficients of water pressure and then transposed them to elastic stockings for daily use [5]. One could even say that the graded compression stockings mimic the action of a 'swimming pool'.

In 2007, Flore et al. documented the value of elastic compression to prevent oxidative stress in healthy workers who work standing or seated for long periods of time, situations that, due to different mechanisms, may result in venous stasis and consequently in increases in lower limb volume during the workday. This often results in the development of interstitial edema, a condition known, in this case, as occupational edema [6].

Recently a number of studies in Occupational Medicine have been carried out due to concern about the increasing prevalence of this type of edema in healthy people who do not have impairment of the venous or lymphatic systems. The results of these studies favor the use of elastic stockings and raise certain reflections about work and the need to protect the health of workers on a long-term basis. It has also been demonstrated that occupational edema forms at different rates depending on the time of work shifts, with it usually being greater at the start of the morning. It was also proven that the use of elastic stockings throughout the day or just while working is very effective in preventing large volumetric variations by the end of the day [2,7,8].

In fact, this occupational edema is a result of hemodynamic variations that occur throughout the day. It is known that there is a separation of the valve cusps, which leads to increased venous reflux in the physiological circadian rhythm, which is influenced by posture or by biochemical changes in the blood. Such variations interfere in hemodynamics and generate venous hypertension that can be a consequence of changes in valvular competence [9,10]. The influence of gravitational pressure on filtration and reabsorption of fluid in tissues should be added to these hypotheses that attempt to explain occupational edema [11]. Hence, after studies with a precise methodology, there is no doubt that elastic compression represents the most effective prophylactic measure against occupational edema, irrespective of its etiology [1-3,12].

Recently, there has also been concern about protecting the legs of athletes. Research has documented that

scheduled physical exercises in the evening in the decubitus position can complement or even replace the use of elastic compression both in reducing and preventing edema of the lower limbs of patients with severe CVI ([13]. Immersion exercises, for example, help to reduce pregnancy-related edema [(14)]. Ankle flexion exercises, in which the calf muscles are activated, have been considered the most effective method to reduce edema of the leg and to relieve individual symptoms [(13)]. Walking and running are exercises that seem to prevent the formation of edema. It has been proven that in normal individuals or those with mild CVI, an associated of walking on a treadmill for 30 minutes with the use of 20-30 mmHg elastic compression stockings enables a significant reduction in the leg volume at the end of the workday. This leads us to believe that elastic compression has a synergistic effect with walking at the end of the day by stimulating the lymphatic and venous return and thus reducing edema of the lower limbs [(3)].

In fact, in healthy subjects, selected sports activities have an extremely positive effect on lymphatic and venous return. This, however, does not mean to say that amateur or professional sportspeople are an example of sanity and that their venous and lymphatic systems of the legs are without problems. On the contrary, these systems can be impaired due to the type, duration and intensity of the sport practiced, by the individual's physical fitness and training, and by the inadequacy of rest, which can lead to injuries and consequent loss in performance. It is recognized that 85% of athletes present dilated superficial veins as a result of increases in venous capacitance in which the role of the deep veins is paramount. Competitive sports, for example, are recognized as a risk factor for increased chronic venous hypertension of the superficial system of legs; muscle contraction (systole) in the presence of incompetent deep veins pump blood ("syphon") to the surface, resulting in dilation which is not always accompanied by reflux but which constitutes the so-called 'varicose veins of sportspeople' [(15)].

Insert figure 1 here

Figure 1: Dilated superficial veins without reflux in the lower limb of a professional bicycle racer. Award-winning work of the XII World Congress of International Union of Phlebology (IUP) in London in 1995. Photo kindly provided by the author Jeanneret C

In the late 1980s, studies started to be performed to investigate the effects of using elastic compression on the performance and recovery of athletes. The first works emphasized the lactic acid blood levels of runners and cyclists. The researchers did not find any significant benefit of elastic compression on the performance of the athletes. But subsequent studies involving runners, cyclers and athletes of jumping sports observed some important beneficial effect with the use of elastic stockings mainly in older individuals [(16)]. A few other studies also showed favorable effects of elastic compression stockings on venous hemodynamics in arterial perfusion, oxygenation of deeper tissues and muscle oscillation, always in relation to kinetic lactic acid and muscle discomfort (pain and cramp) [(17)].

The fact is that, despite all the controversy regarding the results of these initial studies, which, by the way, remains today, companies producing elastic compression garments bet highly in the market segment represented by professional and non-professional sportspeople and, in their marketing campaigns, continue advertising a series of benefits attributed to the use of these articles, notably the use of elastic compression stockings. Among these benefits, which are not yet considered to be consensus in the scientific community are: (a) performance optimization and recovery of the athlete (without specifying any sport in particular); (b) the improvement of arterial blood flow by consistent compression of the calf muscle which promotes relaxation of the arterial walls and a consequent increase (of up to 40%) in oxygen-enriched blood flow; (c) the improvement of the health of veins by the graduated compression of the ankle, which causes the de-oxygenated blood to be pushed back to the heart; (d) the improvement of blood flow, which allows the athlete to reach higher speeds with less expenditure of energy; (e) reduction in muscle wear and physical effort and (f) increased blood circulation (by up to 30%) with consequent reduction in the recovery time [(16,17)].

The positive side of this widespread publicizing of data has been the possibility of giving voice to sportspeople to talk about what elastic compression represent in their performance and their recovery. Their views however are mixed. What one clearly notices is the subjective reference of these athletes about the fact that the use of elastic stockings "decreases the sensation of tiredness and weight in the calves" and that they especially notice a quicker recovery from fatigue after practicing sports.

Robert Creasy, in a master thesis presented in Auckland, New Zealand, in 2008, performed an extensive review of all studies published worldwide on the effect of elastic compression on the performance of athletes from different sports modalities. This author, to present all the absurd controversy related to the subject, notes that the theme is not even close to a consensus because none of the works reviewed cared about (1) homogenization in terms of gender and age of the sample; (2) the indication of or the comparison of different degrees of compression or (3) the differentiation of effects according to the type of sport practiced. In this same work, the researcher studied the effects of different degrees of elastic compression on the performance of runners, on the physiological indicators of these individuals, and on the

perception of athletes. The only valid scientific conclusion that the author was able to make in almost 200 pages of rigorous study, was that the runners declared that they felt more comfortable when they used elastic stockings with lower pressure [18].

On the other hand, the study of Kemmler et al. in 2009 noted that semi-professional male runners showed significantly better performance with constant compression of the calf, represented by different metabolic thresholds. However, the basic mechanism of this better performance was partly explained by a relative improvement in the aerobic capacity [16].

Marcondes Figueiredo, in 2011, found that the use of elastic compression stockings was associated with lower plasma levels of two biomarkers of muscle injury (creatinine kinase and lactate dehydrogenase) after exercises during a pilot study conducted with a group of ten professional female volleyball players. Creatinine kinase is an enzyme that has been primarily linked with muscle injuries arising in the eccentric phase of an exercise, and can remain increased for up to seven days after the physical exertion. Lactate dehydrogenase, in turn, increases parallel to the production of lactic acid. This difference was not observed for myoglobin, i.e. there was no effect of elastic compression on the intracellular transport of oxygen in muscle tissue. In other words, the muscle damage was lower after high intensity volleyball practices carried out while using elastic compression. Note that the authors of this study recommend further studies involving other sports and a larger number of subjects before these findings are considered conclusive. The degree of pressure needed for these effects in different sports, in the different genders and in different age groups is also debatable [19].

The scientific literature suggests that there are indirect benefits of using elastic compression in some sports modalities, such as reduced levels of lactic acid and muscle trauma. Grevot C, referring to the success of the French National Team at the end of the 1998 World Cup, reported that the better performance of these players was due to an increase in venous return with faster drainage of toxins, reduced pain in the calf muscles and less fatigue and cramps [17].

Among the experts who are dedicated to the study of compression therapy, there are those who believe that the appropriate, thrifty and prophylactic use of elastic compression by sportspeople in fact reduces the risk of developing chronic venous hypertension and decreases the sensation of tiredness and weight in the calf muscles, which in itself would be a understandable reason for better performance. However although observing important benefits such as facilitating the recovery of professional athletes and decreasing the time needed by using graduated elastic stockings, (and this be arguably essential since without a speedy recovery the frequency of physical activity cannot be increased) it is noted that the opinions reported in contemporary scientific literature still diverge. Many experts are reserved to indicate this treatment for unproven therapeutic or prophylactic purposes. It is known however that the main reason is the fact of not knowing exactly which material, model or degree of compression would be ideal to indicate [20].

Thus, in order to routinely adopt the conduct of introducing the use of elastic stockings into sport, more accurate studies are required that measure the outcomes instrumentally and have convincing statistical analysis. Only in this way will the benefits already observed by athletes and demonstrated in some works be enjoyed by professional sportspeople (or not) as long as there is a prior assessment and correct prescription by a competent professional.

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