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Progressive compression, plantar load and calf venous pump

Mosti and Partsch1 exhaustively demonstrated that a progressive compression improves calf ejection fraction (cEF) more than a classic regressive compression. These findings were convincingly ascribed to the higher pressure obtained at the calf “…where it is needed…”.

We are currently evaluating changes in ankle range-of-motion (aROM) and plantar load related to different compression devices. Our preliminary results suggest an additional possible explanation. In fact, we observed that the higher the compression on the foot and ankle, the greater the reduction of the aROM and variations of both static and dynamic baropodometric findings (Fig. 1A,B). In turn, in an experimental model of progressive compression (CircAid Juxta-Fit applied without the underlying elastic anklet, with a pressure of about 50 mmHg at the calf with no compression of the foot and ankle), the aROM and baropodometry did not modify. Distribution of plantar load even improved in some cases (Fig. 1C).

The mean age of the patients in whom Mosti and Partsch calculated cEF after a standardized walking test was 53.7 ± 12.1 years, and 75% of legs were assigned to C-classes C3—C5. It is well known that ageing and severity of venous insufficiency per se reduce aROM, and that limited ankle flexibility and plantar abnormalities reduce the efficacy of the calf pump.

Accordingly, it could be speculated that, besides the positive effects of higher compression of the calf, the greater cEF obtained with progressive stockings also could be because of the lower “compression profile” of the foot and ankle, resulting in a more physiologic flexibility of the plantar and tibio-tarsal joints.

In turn, the higher compression exerted by regressive stockings on the foot and ankle could possibly further reduce their flexibility, so influencing gait dynamics and activation of pumping muscular chains. This would be especially true for older subjects and those with more severe venous insufficiency.

Figure 1. A 63-year-old male. Baropodometric findings from the right foot in basic conditions (A), with multi-layer bandaging (B) and CircAid Juxta-Fit applied without the compression anklet (C).

REFERENCES
1 Mosti G, Partsch H. Improvement of venous pumping function by double progressive compression stockings: higher pressure over the calf is more important than a graduated pressure profile. Eur J Vasc Endovasc Surg 2014 Feb 10. http://dx.doi.org/10.1016/j.ejvs.2014.01.006.
Response to ‘Re. Improvement of Venous Pumping Function by Double Progressive Compression Stockings: Higher Pressure Over the Calf is More Important Than a Graduated Pressure Profile’

The point raised in this letter is very interesting and deals with the functional association between ankle movement and the calf muscle pump.

We agree that venous pumping function will decrease when ankle mobility is reduced. Experiments investigating the influence of artificially restricted mobility of the ankle joint clearly demonstrated a reduction of the blood volume expelled during standardized exercise by foot volumetry.2

Nevertheless, a high performing compression bandage or a fitting compression stocking of good quality ideally should not impede the mobility of the ankle joint. This is particularly true in acute experiments as reported in all our papers. In the long term, reduced ankle mobility using compression bandages has been always claimed but never proved.

In an acute experiment, we are convinced that the improvement of the muscle pump largely overcomes the theoretical concept of reduced impairment of ankle movement because of lower distal compression pressure.

In a previous paper we compared an elastic stocking with a strong inelastic bandage.2 Theoretically, the stiff compression device could impede the ankle movement more than the stocking, but the increase of ejection fraction was significantly better with inelastic bandages confirming the superior role of increased pressure over the calf compared with ankle mobility.

In another paper comparing graduated and inversely graduated inelastic bandages exerting the same pressure at ankle level and the same degree of “ankle fixation”, we again observed a significantly higher increase of the EF just by increasing the pressure over the calf.3

Finally in our last paper,4 we compared one and two superimposed “progressive” stockings and added a third stocking only over the calf. Certainly two or three stockings superimposed over each other would “impede” ankle movement more than one stocking, but, once again, the increase of muscle pump is significantly higher with superimposed stockings despite a possible reduction of ankle movement.

In conclusion, we thank the authors of the letter for their interest in our work and for discussing the theory of restricted ankle movement because of high distal compression pressure in conventional compression hosiery, a concept which should be proven by further investigations.

Based on our experiments we are still convinced that the increase of pressure over the calf muscle is the main determinant of the venous pump increase, at least in acute experiments, and that its importance largely overcomes the potential role of better ankle movement being less impeded if the distal compression pressure is lower.

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