Terminology: resistance or stiffness for medical compression stockings?

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Abstract

Based on previous experimental work with medical compression stockings it is proposed to restrict the term stiffness to measurements on the human leg and rather to speak about resistance when it comes to characterize the elastic property of compression hosiery in the textile laboratory.

Introduction

Pressure and stiffness are the two items which characterize a medical compression stocking (MCS). The meaning of pressure is easy to understand for a health care professional. The correct meaning of stiffness is less easy to explain, especially since this word can relate to two different concepts.

Laboratory pressure and interface pressure: definition

Pressure is defined as a force per unit of surface area, for example Newton/m² or cN/cm². For many reasons medical compression manufacturers and doctors prefer using mmHg.8,9

Two different pressures should be differentiated: laboratory and in vivo pressures

The laboratory (lab) pressure is determined by manufacturers using a dynamometer, a special device made only for these measurements (Figures 1 and 2). Several brands of dynamometers exist and all give measurements in cN/cm² (force/cm²) easily transformed in mmHg.6,8

The stocking to be measured is placed on a model leg so as to locate and mark the different points along the leg (B, C, D, etc.). The B point (ankle region of the stocking) is marked first and then the B-segment is placed in the dynamometer jaws. Force is measured during stretch and also in the relaxed phase. Results are printed on a rolling chart.

Hysteresis curves obtained: on the x-axis the circumference of the MCS is plotted in centimeter (which simulates the leg’s perimeter) and on the y-axis the corresponding pressure in mmHg (Figure 3).

Therefore it is easy to identify the MCS pressure depending on its size. This permits to declare the lab pressure in mmHg (or the compression class) on the box of the garment.

The pressure on the human leg is measured in clinical studies (or due to personal interest) by using special pressure probes as Kikuhime (TT MediTrade, Sore, Denmark) or Picopress® [(Microlab Elettronica Sas, Roncaglia di Ponte San Niccolò (PD), Italy]. The sensor is placed on the B1 point where the medial gastrocnemius muscle turns into its tendinous part and the MCS is applied.10 The pressure measured on the leg in mmHg is called the interface pressure.1-5

This method allows the pressure measurement at several levels along a leg.

Resistance and stiffness: definition

In the European Prestandard for medical compression hosiery stiffness is defined as the increase in compression per centimeter increase in the circumference of the leg.5

Two different types of Stiffness exist: the stiffness on the human leg following the above definition and the corresponding parameter derived from the hysteresis curve.

In fact the same word is used in two situations: for the lab measurement of stiffness used by the manufacturers and the stiffness measurements on human legs made by investigators in the course of their assessment of the quality of MCS. Such a distinction should be made by presenters and authors when discussing this topic.

Therefore in an oral presentation or publication there may be some confusion: Do the author mean lab or in vivo stiffness?

Proposition

Pressure is measured in two different situations: in lab and in vivo. The same two situations exist for the measurement of stiffness. The word used by industry to characterize the hardness or rigidity of numerous materials, for example in physics or aeronautics, is the word resistance. The authors and some International Compression Club (ICC) members propose that this word should be used in our Medical Compression vocabulary which means inelasticity.11 Perhaps words similar to resistance or resistance coefficient could be used such as hardness, rigidity, firmness, inelasticity and others.

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Figure 1. The IFTH dynamometer (Paris, France).
Definition and measurement

The resistance (laboratory measurement)

The authors suggest the definition of resistance in medical compression as the stiffness measurement performed by a dynamometer. The value should be declared on the packaging for individual compression garments. At present this value is not shown, perhaps to avoid confusion or questions from interested users. The resistance coefficient (RC) number will reflect the hysteresis curve at the MCS size point. In the curve shown in Figure 3 the RC is +/-1 mmHg/cm. This means that this MCS is more rigid, firm or resistant than a 0.5 mmHg/cm and less resistant than a 2 mmHg/cm.

Figure 2. The HOSY dynamometer (Germany).

The stiffness (measurement on the leg)

At the B1 point two measurements of the interface pressure are done during two successive different positions of the leg, at rest and during a significant muscle contraction (e.g. dorsiflexion, standing). This will create two different but similar circumstances, one maximum the other minimum. The difference between the two values characterizes the stiffness of the MCS. The properties of any MCS can therefore be more completely described using the following measurements: the pressure and the RC measured in the lab, and interface pressure and stiffness measured on the leg.

Arguments to differentiate resistance of a medical compression stocking and its stiffness

In summary arguments to differentiate resistance of a MCS and its stiffness are: i) the two measured points are different: B point for resistance and B1 point for stiffness; ii) the two values cannot be compared (for the moment): - the resistance results are obtained in mmHg/cm corresponding to the steepness of hysteresis curves using a dynamometer; - for stiffness only pressure increase is measured as a routine but not the change of leg circumference.

To consider these parameters could yield much useful information: i) MCS characteristics should be completed and recorded on the box; ii) this would allow a useful comparison between different brands of MCS.

Conclusions

To avoid confusions it could be extremely useful if ICC members, companies and doctors agree with this proposed terminology: resistance instead of stiffness measured in lab and stiffness measured on the leg.

References

1. Partsch H, Clark M, Bassez S, et al. Measurement of lower leg compression in vivo. Recommendations for the performance of measurements of interface pressure and stiffness. A consensus statement. J Dermatol Surg 2006;32:224-33.
2. Rabe E, Partsch H, Jünger M, et al. Guidelines for clinical studies with compression devices in patients with venous disorders. Eur J Vasc Endovasc Surg 2008;35:494-500.
3. Partsch H, Flour M, Coleridge Smith P, et al. Indications for compression therapy in venous and lymphatic disease - a consensus. Int Angiol 2008;27:193-219.
4. Khaburi JA, Nelson EA, Hutchinson J, Dehghani-Sanjii AA. Impact of variation in limb shape on sub-bandage interface pressure. Phlebology 2011;26:20-8.
5. Hirai M, Niimi K, Iwata H, et al. Comparison of stiffness and interface pressure during rest and exercice among various arms sleeves. Phlebology 2010;25:196-200.
6. European Committee for Standardization (CEN). Non active medical devices. Working Group 2 ENV 12718: European Pre-standard ‘Medical Compression Hosiery.’ CEN TC 205. Brussels: CEN; 2001.
7. Cornu-Thenard A. Measuring units for elastic stockings: priority to mmHg rather than classes. Phlébologie 1992;45:457-8.
8. Partsch H. Evidence based compression-therapy. An initiative of the International Union of Phlebology (IUP). VASA 2004;34:3-37.
9. Stolk R. Quick pressure determining device for Medical Stockings. Swiss Med 1988;10:91-6.
10. Stout N, Partsch H, Szolnoky G, et al. Chronic edema of the lower extremities: international consensus recommendations for compression therapy clinical research trials. Int Angiol 2012;31:316-29.
11. Cornu-Thenard A. Reduction of a venous edema by elastic stockings, unique or superimposed. Resistance coefficient notion. Phlébologie 1985;38:159-68. [Abstract in English].

Figure 3. Hysteresis curve of a 25 mmHg medical compression stocking (MCS) with a 23-24 cm size. The resistance coefficient equals the tangent at the MCS size point. On this hysteresis curve the pressure increases in 1 mmHg between 23 and 24 cm. So the resistance coefficient equals 1 mmHg on 1 cm, equals 1.