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).[1-6] 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.[7,8]

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).[8] Several brands of dynamometers exist and all give measurements in cN/cm² (force/cm²) easily transformed in mmHg.[8,9]

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 Kikuhïme (TT MediTrade, Sore, Denmark) or Picopress® [(Microlab Elettronica Sas, Roncaglia di Ponte San Nicolò (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*.[6]

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.

Figure 1. The IFTH dynamometer (Paris, France).

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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.

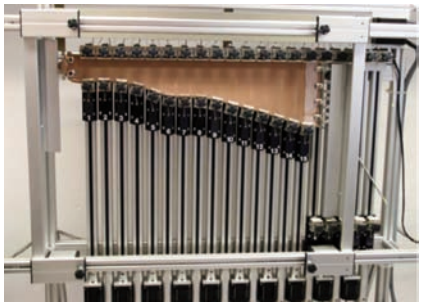

Figure 2. The HOSY dynamometer (Germany).

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 circumferences, one maximum the other minimum. The difference between the two values characterizes the stiffness of the MCS.[1,11] 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.

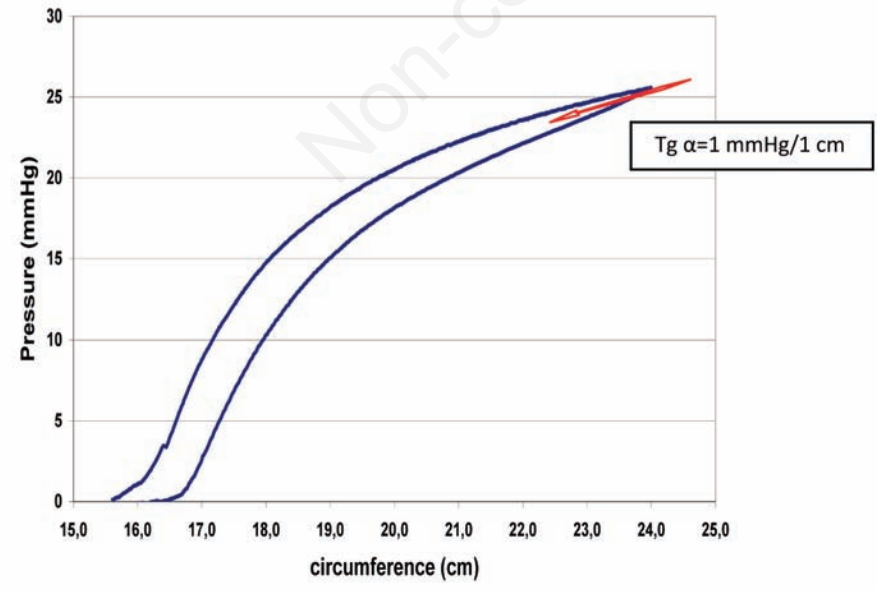

Figure 3. Hysteresis curve of a 25 mmHg medical compression stocking (MCS) with a 23-24 cm size. The resistance coefficient equals the tangent at the MCS size point. On this hysteresis curve the pressure increases in 1 mmHg between 23 and 24 cm. So the resistance coefficient equals 1 mmHg on 1 cm, equals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

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*.

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