

PROPERTIES AND CHARACTERISTICS OF COMPRESSION BANDAGES AVAILABLE IN SRI LANKA FOR TREATMENT OF COMPRESSION THERAPY

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INTRODUCTION

Compression therapy is one of the popular methods to treat venous ulcers without having side effects from the medicines. Compression has been shown to reduce venous reflux and increase blood flow towards the heart, which may be a significant factor in achieving ulcer healing. Compression therapy is the application of pressure to produce a desired clinical effect and is usually achieved by the use of an appropriate bandage or elasticated hosiery (Thomas, 1982).

Compression bandages are used to treat chronic venous incompetency, which affects 27% of the adult population. Currently the effective treatment for venous diseases is to apply constant pressure by tightly wrapping elastic bandages around the affected area of the leg. Unfortunately, there are several limitations with compression bandages, specifically the effectiveness of compression therapy dependent on medical staff and resulting compression variability. The purpose of this project is to find out the parameters and characteristics those have to be considered by therapist before applying them for treatments.

As mentioned above, it is estimated that about 1/3 of out adult person will require compression therapy at some point in their life. This disorder is known to have a negative impact on the quality of the person's life. Venous incompetency is also accompanied by extreme swelling (edema) in the lower extremities, therefore hindering activities in day to day life, such as walking or being active. Varicose veins are present in 25-33% of adult females and 10-20% in adult males (DeBaie, 2009).

Although the compression therapy treatments are popular in Sri Lankan hospitals and preferred by doctors as well as by patients, a preliminary investigation shows that there are no standard procedures to select the suitable bandages and the method of application. Currently, compression bandages available in local market are used without considering their performance and durability characteristics, but based on the different price categories, unavailability of specifications of bandages and unawareness of consequences. Different performance characteristics will impact on the effectiveness of the treatment and the healing process. Repeated application of these bandages may effect on the durability characteristics, which lead to change the performance characteristics, impacting on the healing of venous ulcers.

The history of the compression therapy goes back to more than 2000 years. Different methods of compression therapy have been described over the last 2000 years. Bandages were already mentioned in the treatment of leg ulcers from letters of Hippocrates. Descriptions of limb compression therapy are found in the Corpus Hippocraticum during 450-350BC (Feltz, 2005). The power to drive the blood back up the leg is provided by the calf muscle, which on walking contracts and relaxes in a regular movement. The contraction of the calf muscle forces the blood upward out of a segment of vein; backflow is prevented by the bicuspid valve (Browse 1982). Relaxation of the calf muscle allows the refilling of deep vein with blood from the superficial veins and thus the cycle is repeated.

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The pressure generated by a bandage is principally determined by the tension, the width of the bandage, the number of layers applied and the degree of curvature of the limb. Sub-bandage pressure may be calculated using a simple formula derived from the Laplace equation as follows (Thomas, 1997);

$$P = \frac{T \times N \times 4630}{C \times W}$$

Where, T= Bandage Tension (in Kgf),

P = Pressure (in mmHg),

C = Circumference of the limb (in cm),

W = Bandage width (in cm),

N = Number of bandage layers applied.

According to this formula, that a bandage applied with constant tension to a limb of normal proportions will automatically produce graduated compression with the highest pressure at the ankle, where circumference is lower than the upper leg area. In other words, this pressure will gradually reduce up the leg as the circumference increases. However, compression therapy can cause significant damage, if it is incorrectly applied and practitioners should be aware of that as a constrain to therapy.

Objective of this study is to identify the different bandage types used in Sri Lankan hospitals for compression therapy treatment and study the physical parameters such as structures, physical properties and the stress strain behaviors. So that medical staff can have a better understanding about the pressure development during the usage compression bandage materials.

METHODOLOGY

Different types of bandages were collected from pharmacies after getting instruction from medical personnel, who are involved in compression therapy. Structures, weight, width, fibre types and composition of the yarns of the collected bandages were not similar. Eleven bandage samples were taken for investigation and the physical properties were tested before investigating the compression behavior of them. Thereafter they were tested experimentally for physical properties and characteristics, which control bandage performances.

The tested physical properties are fabric structure, fibre type, warp and weft density, yarn count, area density and thickness. Stress strain behavior of bandages has been tested using "Tinius Olsen Tensile Tester". It has done several cycles of stress and strain test with maximum extension of 100mm and 10 seconds retention time for each bandage. Stress-strain behavior analyzed to find stress requirement to achieve 60mmHg pressure as the maximum pressure, which could be applied in practice (DeBaie, 2009).

RESULTS AND DISCUSSION




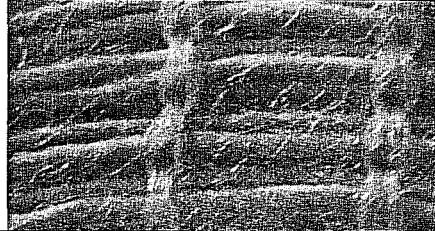
Sample category	Description	Enlarge Photograph showing structure
1 Woven fabric	Both weft and warp yarns are cotton. More crimped twisted warp yarns with leno weave	
2 Warp inlay	Warp knitted fabric. Weft yarn is multifilament rayon and warp knitted yarn is textured polyester with inlay rubber yarn along warp direction.	
4 Woven	Woven structure, weft yarn is textured rayon and warp yarn is cotton. Weave structure is leno.	
5 warp knitted structure	Warp knitted (pillar stitches) structure with weft inlay yarn set. The warp knitted is surrounded a rubber yarn. Weft yarn is cotton and warp knitting yarn is textured nylon.	

Table 1: Selected samples for comparison of stress strain behavior

According to the Table 1, most of the selected samples belong to woven fabric category and few of them are warp knitted structures with warp inlay yarn. Some of the woven fabrics have warp elastane yarn with very high weft density.

Stress strain curves were taken for all samples and results are shown in Figure 1. Sample number is as per the Table 1. As it shows, some of the bandages have very low elasticity, but with high elongation at the initial stage. The middle part of the extension curves of fabric samples 2 and 5 show that the extension is proportional to the force applied. It means that the pressure developed in that extension segment is also linear. The curves shown in graph for sample 1 and 4 have no liner segments and it means the pressure developed after applying the bandages are not easily predictable. Smaller changes in extension gave the greater changes in pressure applied to the legs.

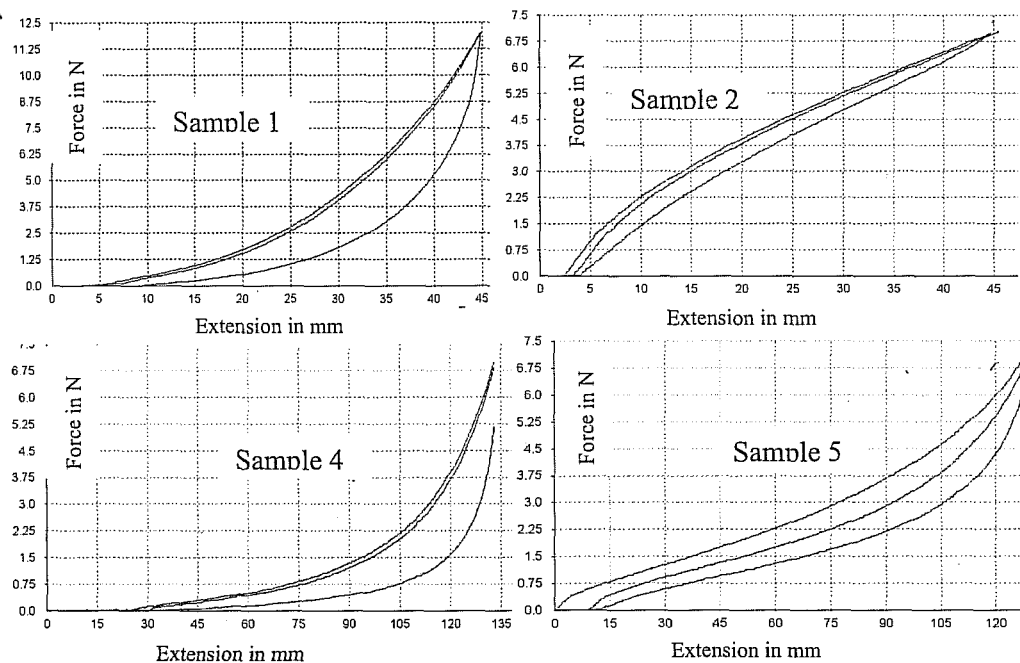


Figure 1: Stress-strain curves for fabric samples

Fabric samples with elastane yarn in length direction have more linear force extension behavior as the sample 2 and 5 in Figure 1. It seems that the woven bandages with low weft densities have only extension at initial stage. The bandages with elastane yarn and higher weft densities or inlay weft yarn have higher elastic range of linear force extension behavior.

CONCLUSION

The test results show that the introduction of elastane-filament spun cotton yarn or rubber yarn in warp direction increase the linearity of stress – strain curve. Increasing the weft inlay density in warp knitted structure also increase the linearity of stress – strains of a bandage. These results can be used to select well performed compression bandage system for effective treatment for chronic venous incompetency.

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