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Study of Properties of Medical Compression Fabrics

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Abstract

Compression garments apply pressure to the body to provide health benefits, such as increasing the blood circulation, shaping the body and supporting healing after medical procedures. Fabrics used for compression garments are elastic, and the amount of fabric stretching and the ability of maintaining the stretching force are directly related to the compression effectiveness. However, there is currently little information about the fabric and its mechanical properties, and there is a demand from compression garment manufacturers to better understand the fabric properties and their serviceability. This paper studied the physical and mechanical properties of 4 Nylon/Spandex knitted fabrics as commercial medical compression garments. In particular, fabric elasticity and bursting strength were examined to demonstrate the applicability of the fabrics for providing satisfactory compression. It was observed that the compression garment fabrics had an open knitted structure with stable dimensions, and Spandex was only present in the wale direction. Tensile assessment revealed that the compression fabrics were strong and their breaking extension was well beyond 200%. The fabric stretching force had a near linear relationship with its elongation when the fabric was stretched upto 100% extension. After fatigue stretching, the average immediate recovery of compression fabrics examined was more than 95% and the average elastic recovery after an extended period of relaxation was at least 98%. High fabric bursting strength and compression extension were also found. The results of fabric physical and mechanical properties from this study are very important for understanding whether a fabric is suitable for engineering compression garments, and also for estimating the required compression force for designing an individualised compression garments with the medical compression fabrics.

Keywords: Compression Garment; Bursting Strength; Stress Relaxation; Elasticity; Fabric

1 Introduction

Compression garments are special garments that apply a certain pressure to the body mainly for medical [1-5], sports [6,7] and body shaping [8] purposes. Compression garments have been used in the medical field to treat burns (scar management), low blood pressure, muscle strains and sprains. They have also been used to accelerate the healing process and prevent deep vein thrombosis during long haul flights.

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After a burn injury has healed, the skin often scars as a result of collagen production, and becomes hard and dark coloured. It is believed that applying pressure using a compression garment helps to flatten the scar, though there might be insufficient evidence to support the widespread use of pressure garment therapy for the prevention of abnormal scarring after burn injury [9].

Compression garments have also been used to provide compression on the body's muscles to increase the blood flow, which improves performance, reduces the risk of injury, and accelerates muscle recovery during and after exercise. Hence the use of a compression garment, in particular a gradual compression garment, in sports activities is becoming a popular trend, and many professional players and athletes already wear compression clothing on a regular basis. Increasingly, compression garments are also used as shapewear to enhance body image, such as creating attractive contours, lifting breasts, and reducing abdominal size. They are worn under normal loose-fitting clothing.

Most medical compression garments are individually designed and manufactured for a particular part of the body, such as stockings, gloves, sleeves, face masks and body suits. They are worn for an appointed time, depending on the medical treatment need.

The circumference of a compression garment is smaller than the body size. When in use, the garment is stretched, providing optimum compression. Depending on needs, special garments are also used to provide targeted compression on specific groups of muscles. The pressure usually exceeds the capillary pressure, 24 mmHg, though a low level of compression (5–15 mmHg) can also achieve good clinical results [10].

The level of compression is governed by the garment size as well as the amount of fabric stretching. Fabrics for compression garments are usually engineered with stretchable structure and containing elastomeric material to achieve highly stretchable and appropriate compression.

Elastic recovery is the most important performance indicator for compression garments. When a fabric is stretched to a level below its breaking strength and is then allowed to recover, the fabric normally does not immediately return to its original shape. Its elastic recovery depends on the compression force provided, the length of time that the force is applied for, and the length of time that the fabric is allowed for recovery.

Each compression garment is required to last for at least several months. As an example, compression garments for preventing hypertrophic scarring after severe burns may be worn for up to 2 years. Fabric fatigue occurs when a fabric is repeatedly stressed at a force level less than that needed to cause failure in a single application. For compression fabrics, the residual extension should be as small as possible after fatiguing. It is therefore essential that compression garments maintain good durability and do not stretch out of shape after repeated wear and laundering. This paper aims to assess and better understand the mechanical properties of some knitted compression fabrics used for making long lasting compression garments.

2 Experimental

2.1 Fabrics

The Therapist Support Laboratory Pty. Ltd., a specialist manufacturer of custom made compression garments in Australia, provided 4 types of fabrics coded FT, BB, PN1 and PN2 for this