A FIELD STUDY ON USE OF PRESSURE GARMENTS IN LOCAL HOSPITAL

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Abstract: *Pressure garments are used to cure medical problems like, scar management, venous & lymphatic disorder and bone & muscle injury. Theoretically the amount of exerted pressure should be different in different medical conditions. But the actual scenario in hospitals is not known. The present paper discusses the utilization of pressure garments at a government hospital in New Delhi. The span of the study was one month. A complete flowchart of the use of pressure garment is presented. A private organization was supplying the pressure garments to the patients. Doctors, occupational therapist and patients were interviewed. Later, after three weeks, the patients were again contacted and the condition of the medical problem was assessed. The problems associated with pressure garments were identified according the feedback of the patients. To analyze the fabric and garment related problems, two different pressure garments for full leg were customized according to the present author's leg measurement. These garments were analyzed in terms of pressure generation. The fabrics of these garments were also characterized in terms of physical, mechanical and comfort properties. In conclusion, this work presents the shortage of appropriate knowledge in this present area among the medical practitioners and a recommendation has been made to improve the performance of the present pressure garment.*

Keywords: *Pressure garment, elastic knitted fabrics, pressure measurement, medical clothing*

1. Introduction

Pressure therapy is widely used technique to control the hypertrophic scar, venous and lymphatic disorder and bone and muscle problem [1]. The requirement of therapeutic pressure for each medical problem is different. 25 mmHg is the pressure recommended in scar management [2], 10-49 mmHg for venous and lymphatic disorders [3-4] and 15-20 mmHg for muscle injuries [5]. However, limited standard methods are available to define the pressure level. These standards are based on anthropometric and demographic requirement of the population which can vary from country to country. BS 6612 proposed by British Standard Institution has three classes of pressure ranging from 14 mmHg to 35 mmHg. European standard (CEN) for medical compression hosiery prescribes (CEN-ENV 12718) four classes (I to IV) of pressure from 10 to 46 mmHg. The standard proposed by the German Institute for Quality Assurance and Labeling also prescribes three classes of pressure (RAL-GZ 387/1) ranging from 18 to 46 mmHg. For Indian population the information on such standard is scarce. Commercial manufactures mostly use their own specification based on the patient's experience and tolerance limit of pressure on the body which is very non scientific approach. Information regarding the actual practice of use of pressure garments in Indian population is little. The present author did a survey at a familiar hospital in New Delhi to know the actual practice of use of pressure garments.

The present paper discusses about the utilization of pressure garments at hospital. The garments given to the patients were also analyzed in terms of fabric properties and pressure generation on bodies. The gaps of knowledge were identified and some recommendations were made to improve the scenario.

2. Part 1: Current practice at hospital

Mostly 3 types of medical requirements need pressure garments-

1) In scar management: - skin grafting, post operative scar management, cosmetic surgery.
2) Venous and lymphatic problems: - blood vessel swelling (varicose vein), Deep vein thrombosis, and lymphodema, swelling in leg due to prolonged sitting or standing.
3) Orthopedic problem: - In accidental cases supportive belts and collars were prescribed.

The use of pressure garment is shown here in Figure 1. Patients purchased pressure garments after doctors prescribe them. An agent from a private company of pressure garment used to be available at the hospital premises. He contacted with the patient and delivered the required pressure garment. Patients could purchase readymade pressure garments from the market also.

The agent measured the limb size with measuring tape. It was impossible to follow any standard posture during taking the limb measurement, due to injury of the patient. The design of the pressure garment, the position of the zip, Velcro was decided by the agent. The cost of the PG depended on the design. The company follow their own procedure to take measurement. They provided some pressure garment design chart and pictorial guideline on measuring procedure. The agent just recorded the measured values on the chart.

There was no pressure measuring sensors available at the hospital. Even, they were not aware about such kind of pressure sensors. Occupational therapists check the performance of the garment by assessment of the injury after one month. Depending on the feedback from occupational therapist and patients, the pressure garment again modified. As there was no pressure sensor, the defect in the garment in terms of pressure generation could be detected after 1 month. Thus healing process was delayed and patients suffer silently. The scientific procedure of selecting a garment should be checking the interface pressure by pressure sensor at the time of wearing. The awareness regarding the amount of pressure and pressure sensor should be developed among the doctors, occupational therapists, agents and patients.

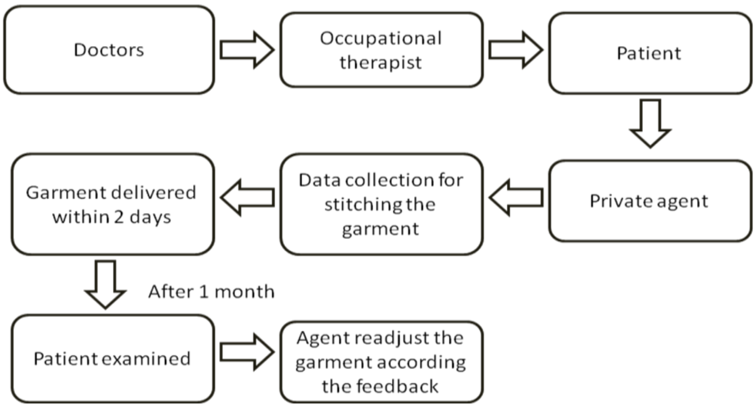

Figure 1: Flow chart of use of pressure garment

2.1 Interaction with patients

Six patients were interviewed. All of them had an accident. Skin was grafted from one limb after operation. Pressure garments were suggested to control the hypertrophic scar at the skin grafted body limb. All of the patients were suggested pressure garment. Pressure garments were customized and delivered by the private company. When this interview was conducted, patients had been using pressure garments since past 2-3 months. Patients' history was recorded. Pressure developed by the pressure garments was measured and recorded.

It was found that, the garment was stitched with 15-20% reduction factor depending on the pressure requirement. All of the garments had graduation in pressure- highest pressure at furthest body part and lowest at closest body part. The amount of pressure varied within 20-34 mmHg for all the patients.

The performance of the garment was assessed by the occupational therapist by examining the condition of the affected body part. It was found that the healing process was very slow. Standard time recommended is 3 months to 3 years. Here in this hospital, pressure garments was suggested for at least 1 year.

Pressure therapy is a very slow and long process. Patients used to lose their patience and stopped using the pressure garment which deteriorated the condition. In addition, the problems faced by patients were:

a) Donning-doffing as fabric was not stretchable.
b)
c) Very uncomfortable for hot and humid condition as the fabric was very dense and less permeable.
d) Itching
e) Perspiration
f) Pilling

Some of these problems were fabric related which can be improved by engineering the fabric.

3. Part 2: Evaluation of fabrics currently used for pressure garment

Little information is available on the fabric characteristics used for pressure garments. Two types of fabrics were used at the hospital. One type was for scar management and other for varicose problems.

3.1 Materials and methods

Two full leg pressure garments were customized according to the author's leg measurement. The type of fabric was different in two garments. The first garment was used for controlling scar (coded as S) and other for controlling varicose problem (coded as V).

Pressure development was measured by Kikuhime pressure sensor (TT Medi Trade, Denmark). The present author was the subject. Pressure was measured at the front side of the right leg at three positions- ankle, calf and middle thigh.

Thickness of fabric was measured using ESSDIEL (Manchester, UK) thickness tester according to ASTM D1777.

Tensile tests were carried out in the course wise direction of the fabric as this was the main load development direction. 150×50 mm^2 samples were tested on Instron tensile tester at gauge length of 75 mm and upper jaw speed of 300 mm/min. Five tests per sample were performed.

Thermal resistance, conductivity and absorbency of samples were measured using the Alambeta testing instrument (Sensora, Czech Republic) according to ISO 11092 testing standards. At least 5 samples were tested and average value was reported. The relative water vapour permeability was measured on Permetest (Sensora Instruments, Czech Republic) according to ISO 11092. Air permeability was tested according to BS5-636 standard using Textest AG FX 3300 (Switzerland). Air pressure difference of 98 Pa was set between the two surfaces of the fabric. The KES-FB-4S Surface Tester was used in accordance with the instruction manual to measure the coefficient of friction (MIU), mean deviation of friction (MMD) and fabric surface roughness (SMD in μm) at the back side of the fabric as this side is going to be the next to skin layer.

3.2 Results and discussion

Pressure developed

The amount of measured pressure is shown in Figure 2. The S garment is showing pressure 20 mmHg at thigh and 35 mmHg at ankle. Similarly V garment is exerting 25 mmHg pressure at thigh and 50 mmHg at ankle. Both of the garments are showing maximum pressure at ankle and minimum pressure at thigh. Proper pressure graduation was observed. This implies appropriate blood circulation and improved healing process.

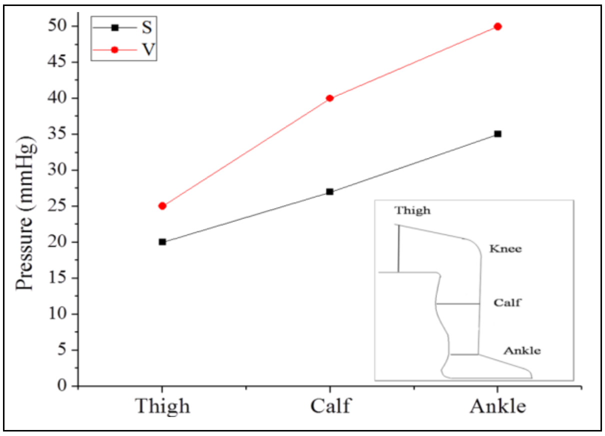

Figure 2: Pressure measured on front side of right leg by pressure garment

Tensile behaviour of the fabric

Load extension behaviour of fabric is shown in Figure 3. Figure 3a depicts the load extension up to break and 3b up to 100% extension level. It can be seen from Figure 3a that S fabric fails at 5.7 kN/m load and 380% extension whereas the same for V fabric are 3.5 kN/m and 270%. S fabric is stronger and more extensible than that of V fabric. But during use pressure garments never go beyond 100% extension. So when Figure 3b is observed it can be seen that S fabric has lower load at any given extension than V fabric. It implies that, during pressure generation garment made of S fabric would show less pressure than that of V fabric.

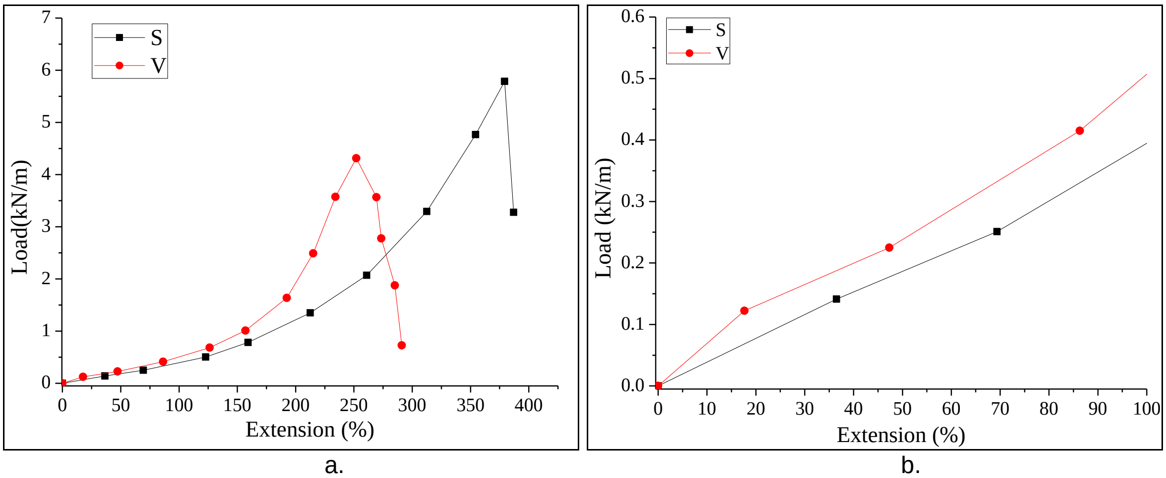

Figure 3: Load extension behaviour of fabric; a. up to break, and b. up to 100% extension level

Thermophysiological and frictional behaviour

Thermal resistance, relative water vapour permeability and surface frictional coefficient is given in Table 1. Thermal resistance is directly related to the air entrapped in the structure. Increase in fabric thickness increases the thermal resistance. In this case the thicknesses of fabrics were 0.94 mm and 1.32 mm in fabrics S and V respectively. Thus the thermal resistance of V fabric is higher (16.9 $\times 10^{-3}$ m^2K/W) than that of S fabric (12.7$\times 10^{-3}$ m^2K/W).

The relative water vapour permeability measures the amount of vapour that can pass through the fabric pores. The present fabrics show similar values. This implies that, similar amount of vapour can pass through the structure.

Airpermeability of the fabrics were very low as given in Table 1. Both of the fabrics show very poor airpermeability.

Surface frictional coefficient of S and V fabrics were 0.203 and 0.192.The fabrics are going to remain in skin contact for 23 hr a day. Pressure garments are also applied on newly developed skin. So to prevent skin break, fabric should be smooth, having less frictional coefficient. In this case the MIU values are quite similar that is reported in literature (0.2-0.3) [6].

Table 1: Thermophysiological and frictional characteristics of the fabrics

Fabric Code	Thermal resistance ($\times 10^{-3} m^2K/W$)	Relative water vapour permeability (%)	Airpermeability ($cc/cm^2/s$)	Surface Frictional Coefficient (MIU)
S	12.7	37	9.07	0.203
V	16.9	38	7.23	0.192

4. Conclusions

The following conclusions are drawn from the current investigation.

- Awareness on pressure sensor should be increased. Pressure should be routinely checked and adjustment in the garment should be made.
- Manufacturers and hospital staff have little information on the fabric properties used.
- The major problem is donning doffing of the garment as the patient has limited mobility due to injury. The fabrics are less stretchable. It would be more appropriate if the fabric construction and type of elastic thread are changed to improve the extensibility.
- The fabric test results showed the current fabrics used in pressure garments were non-breathable and less extensible which improved discomfort of the garment. More open fabric structure can be selected to improve the comfort property.

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