Journal of Fiber Bioengineering and Informatics 9:3 (2016) 155–165
doi:10.3993/jfbim00242

Sub Bandage Pressure Measurement on a Compressible Limb for Treatment of Leg Ulcer

M.P. Sikka*, A. Mukhopadhyay

Dr. B R Ambedkar National Institute of Technology, Department of Textile Technology, Jalandhar Punjab-144011, INDIA

Abstract

Objective: The sub bandage pressure results from a complex interaction between the bandage types, applied tension, number of layers and surface hardness. In this paper, three parameters i.e. hardness of the limb, stretch (%) and number of bandage layers are changed at three levels and their individual and interactive effect on the sub bandage pressure for different types of high compression bandages is studied. Method: The study has been conducted on two types of high compression bandages (woven and knitted) using the Box-Behnken Design. The data obtained for sub bandage pressure of bandage samples on three plastic tubes with layer of foam of varying hardness is used to carry out response surface regression analysis and analysis of variance to find the contribution of each parameter on the sub bandage pressure for high compression bandages. Results: The effect of hardness is significant specifically in the case of woven bandages with some interactive effects with stretch (%) in knitted bandages. The sub bandage pressure increases with the increase in stretch% for all the samples but larger pressure differences were observed for increase in stretch % for limbs with higher hardness. The sub bandage pressure also increases with the number of bandage layers but a linear relationship was not observed between sub bandage pressure and the number of layers at low stretch %. The regression equations for various responses agree well with the experimental data as indicated by higher values of coefficient of determination. Conclusion: The number of layers and the stretch% contribute substantially towards the sub bandage pressure for both woven and knitted bandages. The contribution of hardness of the limb is found to be insignificant for knitted bandage sample which has the tightest structure and high initial modulus. The regression equations generated for various responses can be used to predict the sub bandage pressure of bandages during application of high stretch bandages.

Keywords: Sub Bandage Pressure; Hardness of Limb; Stretch%; Number of Layers; Regression Analysis

1 Introduction

Compression therapy is the principal treatment for leg ulcers associated with venous diseases. Usually the general form of Laplace equation which predicts the relationship between pressure, bandage tension and leg radius, has been used to confirm whether or not a prescribed bandage

*Corresponding author.
Email address: sikkam@nitj.ac.in (M.P. Sikka).

is providing the compression and graduation required by the patient. The equation predicts the pressures that can be observed on solid objects or objects with curved surfaces. However, the human leg is neither solid nor has a constant curved structure. The direct relationship that occurs in solid objects, therefore, may not apply to bodies with deformable surfaces like human leg [1, 2]. Although the Laplace equation has been modified by several authors over time [3, 4, 5] opredict the sub bandage pressure under compression bandages on the human leg but it becomes evident when attempting to apply such formulae that they do not accurately predict sub bandage pressure. Actually sub bandage pressure results from a complex interaction between the bandage types, tension applied, number of layers and surface hardness [6]. Most of the previous studies [7, 8, 9] deal with the effect of individual parameters on sub bandage pressure. This study aims at investigating both individual and the interactive effect of all these parameters on the sub bandage pressure generated in high compression bandages of different types.

2 Experimental

2.1 Materials

Six bandage samples (woven and knitted) were used for the study. The physical properties of the samples have been shown in Table 1.

Table 1: Physical property of the bandages

Sample	GSM	Thickness (mm)	EPI/wales per cm	PPI/courses per cm	Elastic yarn	
					Number of elastic yarns/inch	Count of elastic yarns (tex)
Woven (WS1)	177	0.083	32	45	80	8
Woven (WS2)	255	0.103	12	39	10	40
Woven (WS3)	288	0.187	14	24	10	75
Knit (KS4)	290	0.115	8	15	21	35
Knit (KS5)	410	0.112	6	18	16	150
Knit (KS6)	336	0.112	6	28	15	200

2.2 Experimental Design

The individual and interactive effect of hardness of the limb, stretch (%) and number of bandage layers on sub bandage pressure was studied at three levels using Box-Behnken Design. The actual values of different parameters corresponding to coded levels are mentioned in Table 2.

The concept of Box-Behnken design makes logical use of the 2^k factorial [10, 11]. To build a Box-Behnken design, factors are taken in pairs followed by building 2^2 factorials for all possible pairs while holding the other factors at the centre point. Box-Behnken design is considered to be very efficient when compared with the full factorial design. Through the use of this design, information on single linear effects, single quadratic effects along with the two factor linear interaction can be obtained. In a 3 factor Box-Behnken design at three levels, 12 treatment combinations are