Assessment of Burst Strength and Dilation in Vascular Grafts

Y. ULCAY and B. POURDEYHIMI

Department of Textile Engineering, University of Uludağ, Bursa, Türkiye

Department of Textile & Consumer Economics, University of Maryland, USA

The purpose of this study has been to investigate the burst strength and dilative properties of several types of vascular graft. Burst strength and dilation can be counted among the most important mechanical characteristics of vascular grafts. In this study, the objective has been accomplished; by carrying out the burst strength measurements both in tubular form using devices developed in textile laboratories of University of Maryland and in flat form employing AAMI (Association for the Advancement of Medical Instruments) test method VP20-1986, by examining the creep behavior of tubular specimens under static loads.

1. INTRODUCTION

Vascular grafts (arterial grafts) made of synthetic fibers have been used since 50's to repair diseased or injured arteries [J. Moreland, B. Pourdeyhimi]. Vascular grafts are made of some basic textile structures and can be classified as woven, knitted and nonwoven. Materials, such as polyamide, polytetrafluorethylene, polyacrylics, polymethylmethacrylate, polyester, stainless steel and glass fibers have been evaluated as potential raw materials for arterial grafts since 1952[Creeck 1957, Edwards 1958, Pourdeyhimi 1986, Sauvage 1978, Szilagyi 1977]. Polyester among those did not show any significant biodegradation, loss in strength or adverse reactions in biological environment[Cooke 1974, Feldstein 1990, Julian 1958, King 1970, Ottinger 1976, Yashar 1978].

Plain and twill in woven structures and single jersey in knitted structures are mainly used in the manufacturing of arterial textile grafts.The successful use of textile arterial grafts are believed to be depended on the porosity, flexibility and durability of the structure[Pourdeyhimi 1986]. Due to lack of related standards and guidelines in the field of textile arterial, many different types of vascular grafts have been introduced into the market with widely different properties since the commercial use of vascular grafts have started in the US in 1957. Although they have been widely used for the last three to four decades, complications in vascular grafts used in human arteries are not uncommon. It is an accepted fact that the synthetic textile arterial grafts are not 100% compatible with the natural blood vessels, which are capable of renewing themselves by time. Therefore, the failure of vascular grafts is not unusual. Most of such failures have been related to the mechanical mismatch between the textile arterial and the body arterial[Clarks 1976]. Dilation and bursting can be considered important causes of failure in textile arterial, whereas aneurysms failure, anastomotic rupture, bleeding through the interstices and infection are among the important causes of failure[Nunn]. Such failures not only render the textile graft ineffective, but also threaten the life of patient. Therefore, evaluation of both short and long term behaviors of textile arterial are necessary. Under this statement, fatigue and creep behaviors are among the first aspects worth of consideration.

Dilation of textile arterial, which is a result of fatigue and creep behavior of the structure in both short and long term, is the most reported cause of failure indicated in the literature[Pourdeyhimi 1986, Pourdeyhimi 1989] and perhaps the least understood. Data on bursting and other appropriate properties of textile arterial may explain the dilation phenomenon. Therefore, the purpose of the study reported in this paper has been to characterize dilation and bursting in several textile arteries.

2. MATERIALS AND METHODS

The materials tested were Hemasheild® Microvel® Double Velour and Cooley® Double Velour of Meadox Medical Inc, and USCI. DeBakey® Vasculour® II and USCI® Sauvage® Bionit™ II of C. R. Bard Inc. The data collected relate to only 20 mm grafts. All samples were tested in air. Each sample was lined with a latex balloon to prevent leaking. All samples were subjected to a constant tension of 125 grams.

2.1. The Equipment

Tubular bursting strength measurements and creep test were accomplished on a device built in Textile Laboratories of University of Maryland. An outline of the device is given in Figure 1. This device contains an air tank, a buffer tank and pressure regulators. The air tank is connected to the buffer tank with a needle valve. As the air from the air tank passes to the buffer tank first using a needle valve, it slows down considerably. The air then passes from the buffer tank to the specimen via another needle valve. At the other end of specimen holder, a release valve is kept closed. The test is started by opening the valve on the regulator attached to the air tank. The air slowly pressures the specimen. The settings on the needle valves are retained fixed. Therefore, it takes the same length of time