

## VASCULAR HETEROGRAFTS FOR HEMODYALYSIS ACCESS: ANALYSIS OF ELASTIC AND VISCOUS MATCHING FACTOR BETWEEN HUMAN AND OVINE VESSELS

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**Abstract**— Long-term vascular accesses are usually performed in patients submitted to renal replacement therapy using autologous vessels. When arterio-venous fistula creation is impossible, animal conduits have been used in order to obtain high patency rates. Bovine vessel heterograft has been introduced as a substitute for the construction of arterio-venous fistulas. However, when experimental research of graft failure is focused to vascular wall properties, the ovine model is one of the more frequently utilized instead of the study of bovine vessels. Biomechanical vessel wall properties study is very important, since the viscoelastic mismatch among the fistulae conduits has been pointed out as a determinant of intimal hyperplasia, a cause of access dysfunction.

In this work we have analyzed viscoelastic properties of arteries and veins harvested from human donors in brain death condition and healthy sheep. The elastic mismatch calculus revealed that the human brachial artery and the ovine jugular veins exhibit the best coupling accompanied by an optimal viscous matching.

**Keywords**— hemodialysis access, arterial elasticity, venous elasticity, vascular viscosity, elastic mismatch.

### I. INTRODUCTION

Renal replacement therapy is currently performed in uremic patients through long term vascular accesses usually confectioned using autologous vessels. Another choice is the used of synthetic conduits, such as expanded polytetrafluoroethylene (ePTFE), to obtain high patency rates of hemodialysis fistula. However this option is limited by the high degree of elastic mismatch, between the native vessel and the graft, an important determinant of intimal hyperplasia development. Intimal hyperplasia decreases the intra vascular lumen causing severe access dysfunction (Haruguchi and Teraoka, 2003; Hofstra *et al.*, 1995).

As was previously described, mechanical characteri-

zation of biomechanical wall properties of arteries, veins and prostheses is very important and usually performed in animal models. The ovine model is considered to be useful and widely used to mimic the human access function allowing the development of new graft designs and therapies (Kohler and Kirman, 1999; Fleiser *et al.*, 2004; Gleed *et al.*, 1997; Bia *et al.*, 2006a,b; Bia *et al.*, 2007; Zócalo *et al.*, 2006).

Animal heterograft has been introduced in clinical practice in order to provide of an adequate arterio venous fistula in patients in which a vascular access using native vessels is impossible. However, in the reported series the heterograft is harvested from bovine animals and, to the best of our knowledge, no ovine vessels have been recently employed to hemodialysis access in patients with end-stage renal failure (Haimov and Jacobson, 1974; Hatzibaloglou *et al.*, 2004).

Since the ovine model has been widely utilized to study arterio-venous performance, in this work we analyzed the viscoelastic properties of arteries and veins harvested from human donors and healthy sheep. Besides a comparative study using calculated values of elastic and viscous mismatch was performed.

### II. METHODS

#### A. *In Vitro* Studies

Human and animal vessel procurements were performed according to the Guides of the transplant program of the National Organ and Tissue Bank of Uruguay and the Guide for the Care and Use of Laboratory Animals published by the US National Institute of Health (NIH Publication N° 85-23, revised 1996); respectively.

Saphenous vein, Brachial and Femoral arteries were procured from 7 donors in brain death condition. Human donors age was 23-45 years (Mean = 29.6 years). All segments were removed and washed with saline solution and stored at 4°C. Each vessel was non-traumatically mounted on a circulating loop that mimics the human circulatory system and immersed and perfuse with a thermally regulated (37°C) and oxygenated Ty-