

HEMODIALYSIS ACCESS FAILURE: VISCOELASTIC VASCULAR PROPERTIES AND INTIMAL HYPERPLASIA DEVELOPMENT

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Abstract — Intimal hyperplasia development is largely the most important cause of vascular access failure in patients submitted to hemodialysis.

Differences in the biomechanical properties between the vascular substitutes and the native vessels have been related to the development of intimal hyperplasia. This work aim was to characterize the biomechanical behavior of arteries, veins, cryopreserved arteries and ePTFE prostheses.

Fresh and cryopreserved human arteries and veins and ePTFE conduits were in-vitro studied in order to analyze their viscoelastic properties.

Our results show that ePTFE has an elastic index, which is significantly different from that of the other conduits. This determines a high elastic mismatch that has been involved as a cause of intimal hyperplasia development.

We conclude that the biomechanical study of tubular segments to be used as vascular accesses demonstrate viscoelastic differences that could be an important determinant of access viability.

Keywords — vascular access, biomechanical study, ePTFE, intimal hyperplasia, cryopreserved arteries and veins.

I. INTRODUCTION

The introduction of hemodialysis has determined a prolonged survival in patients with end stage renal disease. However, maintenance of permanent vascular access has limited the adequate use of chronic renal replacement therapy.

An ideal vascular access must be able to withstand a considerable flow to allow the hemodialysis procedure, cause minimal complications and have a high patency rate (Rodriguez *et al.*, 2000). Many techniques have been employed for the vascular access therapy. Among the most used are the native (Brescia-Cimino) fistula, and those that use synthetic prosthesis (Cernadas *et al.*, 2003). Nevertheless, up to date, none of the synthetic or biologic conduits used fulfills the ideal vascular access properties (Cinat *et al.*, 1999).

Vascular accesses have a high incidence of complications, in particular thrombotic occlusion, which determines the vascular access failure. The development

of intimal hyperplasia at the arteriovenous anastomosis, graft vein anastomosis or outflow vein have been described as a major cause of thrombosis (Tordoir *et al.*, 2004).

The development of intimal hyperplasia has been related, among other factors, to differences in viscoelasticity between the native vessels and the vascular substitutes. This work's aim was to analyze the elastic properties (E), viscous behavior (V) and pulse wave velocity (PWV) of synthetic conduits of ePTFE, and of human fresh and cryopreserved arteries and veins. Additionally, the intimal hyperplasia process, and its relationship with vascular accesses' mechanical behavior are described.

II. VASCULAR ACCESS

In end stage renal disease patients, the effort must be directed to obtain an arteriovenous fistula (AVF), while the use of grafts would be left as a second choice (Rodriguez *et al.*, 2000).

The common surgical procedure for the creation of a fistula consists in the anastomosis of the radial artery and cephalic vein in the forearm (Zarin *et al.*, 2004). This AVF is the vascular access of choice since it determines the lowest risk of dysfunction, infection, thrombosis and the longest patency rate (Añel *et al.*, 2003; Canaud, 2004). Additionally, problems concerning vascular steal syndrome and high output cardiac failure are least frequent in AVF performed in the forearm position. Finally, it preserves proximal vessels for future vascular accesses (Rodriguez *et al.*, 2000; Tordoir *et al.*, 2004).

Many patients do not have adequate veins to use for AVF. In these cases the use of an arteriovenous graft (AVG) is a valid alternative. The AVG, which consists of a prosthetic material in between the native artery and vein, should remain as a secondary option (Canaud, 2004). In these cases, the expanded polytetrafluoroethylene (ePTFE) is one of the materials used and its performance is lower than that of the AVF (Cinat *et al.*, 1999; Rodriguez *et al.*, 2000). However, those who prefer the AVG rather than the AVF usually point out that the AVG is easier to needle and has a faster maturation period (Young *et al.*, 2002) and that it is easily obtained in different diameters, making it an available tool at hand for a diverse number of vessel sizes (Cinat *et al.*,