In Vivo Assessment of Electrospun Vascular Scaffolds: A Feasibility Study

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Statement of Purpose: Numerous scaffolds for vascular applications have been fabricated for clinical use. However, many of these scaffolds do not show consistent properties when they are exposed to physiologic vascular environments that include high pressure and flow, and they may eventually fail due to unexpected rapid degradation and low resistance to shear stress. We previously have shown that vascular scaffolds composed of poly(ε-caprolactone) (PCL) and collagen possess biomechanical properties that resist high degrees of pressurized flow *in vitro*. In this study we investigated whether these scaffolds could withstand physiologic hemodynamic conditions while maintaining patency in a rabbit aortoiliac bypass model.

Methods: Electrospun grafts were prepared as previously described using a 1:1 blend of poly (3-caprolactone) and collagen type I. Sheep endothelial cells (EC) and vascular smooth muscle cells (SMC) were used for cell adherence evaluation. Electrospun scaffolds lined internally with EC and externally with SMC were physiologically conditioned using a pulsatile bioreactor system. Conditioned scaffolds were either evaluated histologically with and without exposure to circulating blood. Electrospun scaffolds not lined with cells were sutured in an end-to-end fashion to the iliac artery and then to the aorta in end to side fashion. (Figure 1 A,B) Bioengineered grafts were examined by Duplex ultrasound and representative CT angiography (Figure C). One month explanted grafts underwent staining with H&E for presence of perigraft inflammatory infiltrate.

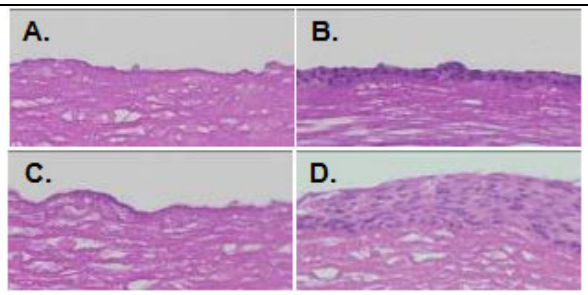

Figure 1: EC (B) and SMC (D) adhere to an electrospun scaffold after exposure to physiologic flow prior to evaluation by H&E and compared to scaffolds that had not been seeded with cells (A, C) .

Results: Seeded endothelial cells formed a confluent monolayer on the inner lumen of the scaffold, while SMC showed a multi-layer on the exterior surface of the vascular graft. Endothelium lined scaffolds exposed to blood resisted adherence of blood elements when compared to bare scaffolds by SEM. Duplex assessment revealed upwards of 85% of grafts (n=7) remained patent (Figure 2). Evidence of structural integrity was provided by ultrasound graft dimensions, CT scan and confirmed by biomechanical testing of explanted scaffold rings (Figure 3). Histologically, there was no significant evidence of inflammatory cells within the scaffold or adjacent to the PCL/collagen composite scaffold.

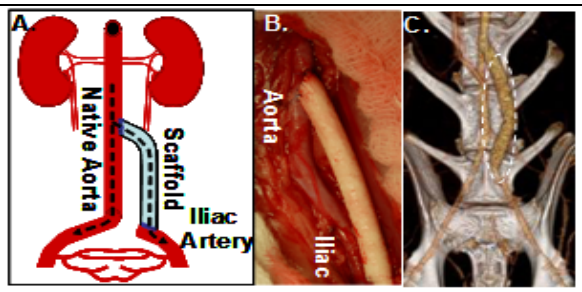

Figure 2. Composite scaffolds were sutured to native rabbit aorta and to the iliac artery (A). A representative operative photo is shown (B). A representative CT image of a 1 month electrospun implant is shown (dashed line).

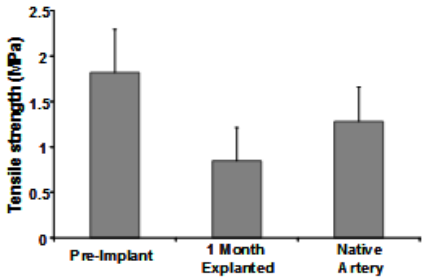

Figure 3. Tensile strength was comparable between pre-implant electrospun, one month explanted electrospun scaffold and native aortic rings (n=4).

Conclusions: This study has demonstrated that in the context of *in vivo* implantation, PCL/collagen electrospun grafts maintain a high degree of patency, and structural integrity without eliciting a histologic inflammatory response over the course of one month period. This feasibility study indicates that electrospun grafts may eventually become an alternative to traditional prosthetic vascular graft material.

References:

1. Veith FJ, et al. J Vasc Surg 1986 Jan; 3(1):104-114.
2. Lee SJ, et al. Biomaterials 2008 Jul;29(19):2891-2898.