Mechanical Characteristics of Recellularized Blood Vessels

Einav Bezalel, Nufar Braunstein , Udi Nussinovitch MD PhD

MEIR MEDICAL CENTER
Tel Aviv University

INTRODUCTION

Tissue-Engineered Vascular Graft (TEVG) can be used in surgical procedures designated for revascularization of ischemic tissues. Yet, most TEVGs have shown poor mechanical durability. The optimal TEVG should have similar mechanical properties as the native tissue. Therefore, it is unknown whether scaffolds undergoing recellularization prior to implantation have improved mechanical properties.

OBJECTIVES

The main objective of the current study was to examine the mechanical impact of recellularization on TEVG, and to examine whether this approach confers structural advantages.

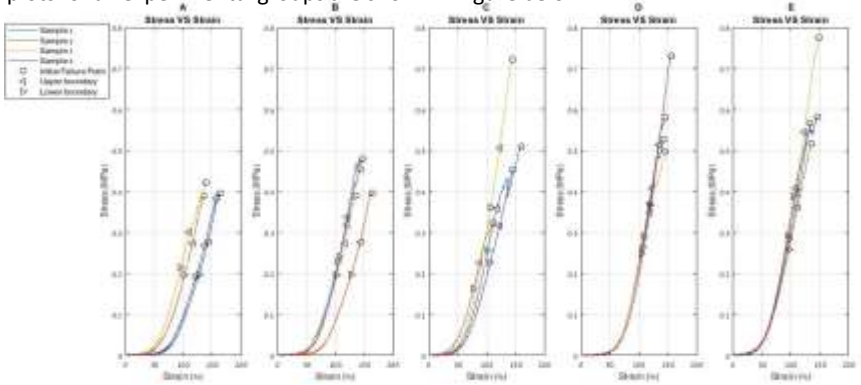
METHOD

We constructed an experiment in which human umbilical vein endothelial cells (UVECs) were cultured on the inner surface of a decellularized vessel with and without the addition of fibronectin and vascular endothelial growth factor (VEGF). Constructs underwent stretch-test using an Instron® testing system until mechanical failure occurred. Young's modulus, strain energy, initial failure stress and burst pressure were computed using MATLAB software.

RESULTS

Recellularized samples had mechanical characteristics that were superior to the fibronectin group, with the values of: E= 0.6118±0.0457 vs. 0.8508±0.596 MPa (p= 0.0095), Initial failure stress =0.4294±0.0023 vs. 0.5837±0.0519 MPa (p=0.017), Strain Energy Density= 17.6481±0.0007 vs. 23.5412±0.009 MPa (p=0.024), Strain Energy = 0.0088±0.0007 vs. 0.0118±0.0009 J (p=0.024).

All data points from the stretching experiment were collected and the stress-strain plots for all experimental groups are shown in figure below:



Stress as a function of strain for all experimental groups: (A) Control , (B) Fibronectin , (C) Cells, (D) Fibronectin and Cells, (E) Fibronectin, cells and VEGF. Graphs contain 4 colored curves; each representing a different sample. The circle on each curve represents the Initial Failure Point and the upper and lower triangles represent the boundaries surrounding the most linear regions of the curve, respectively

An image of the graft before the stretching experiment.

An image of the graft during the stretching experiment.

CONCLUSIONS

Samples of TEVG that were recellularized had higher resistance to tensile pressure and improved elasticity. This study suggests that recellularization of a vascular graft preimplantation, at predefined conditions enhances the graft's mechanical properties. It remains to be explored whether these superior properties will translate to improved graft survival following implantation.