HYBRID MEMBRANE AS INNOVATIVE MATERIALS FOR BIOMEDICAL APPLICATIONS

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Introduction

Hybrid materials have been recently proposed to bypass the drawbacks of synthetic and biological grafts: they are obtained by coupling synthetic polymers with decellularized tissues to join the mechanical features of synthetic materials and the superior biocompatibility of biological tissues. In particular, when blood-contacting materials are requested, biological tissue are placed in contact with blood improving hemocompatibility [1].
In the present work, hybrid membranes (HYMEs) have been produced by assembling decellularized bovine pericardium and a polycarbonate urethane available in two formulations: Chronoflex AR (CF AR) and Chronoflex ARLT (CF ARLT) (AdvanSource Biomaterials, Wilmington, MA, USA). The second formulation differs from the first by the presence of 9% silica microparticles to reduce its tackiness [2].

Methods

Native bovine pericardium (NBP) was collected from a local slaughterhouse, isolated and decellularized following the TriCol procedure: alternate hypotonic and hypertonic solutions and two detergents, e.g. Tergitol and sodium cholate. Tissues were eventually treated with Benzonase™ to degrade nucleic acids chains.
HYMEs were realized by solution casting: decellularized bovine pericardium (DBP) was placed into an aluminum frame and the polymer solution was gently poured over the fibrous side. The material was dried in a vacuum oven at 40°C for 30 hours.
Two HYMEs were made by coupling DBP with CF AR (DBP AR) and with CF ARLT (DBP ARLT): they were analyzed in terms of structure and composition, and from the biomechanical and cytotoxicity points of view.
Mechanical characterization was carried out by uniaxial tensile tests evaluating HYMEs response to load until failure (strain rate of 1 mm/s). Fatigue tests were also performed to analyze the effect of repeated cycles on the material resistance. Test was conducted by imposing cycles up to 20% for 3600 seconds at a strain rate of 1.3 mm/s and, subsequently, the specimen was loaded to failure as previously described.
Tests were performed at room temperature and samples were immersed in saline solution (0.9% NaCl) to prevent dehydration.

In vitro tests were performed according to UNI EN ISO 10993-5 in order to check HYMEs cytotoxicity: human umbilical vein endothelial cells (HUVEC) were seeded over HYMEs. After 24 h and 7 days, cells vitality was analyzed and immunofluorescences were performed.

Results

HYMEs exhibited appealing features with regard to cytocompatibility: the absence of cytotoxic effects was ascertained, and after 7 days cell proliferation was improved. As to the mechanical tests, Young's modulus and ultimate tensile strength (UTS) values did not show significant differences comparing polymeric samples, and DBP AR and DBP CRLT. As shown in Figure 1, fatigue tests showed that cyclic loads affect material strength: failure strain (FS) decreased by 44.82% and 40.79% for DBP ARLT and DBP AR, respectively, UTS decreased by 64.8% and 30.62%, respectively.

Conclusions

Hybrid materials can usefully combine the mechanical resistance of synthetic polymers and the biocompatibility of biological tissues. These latter, once decellularized, are prone to in vivo recellularization.

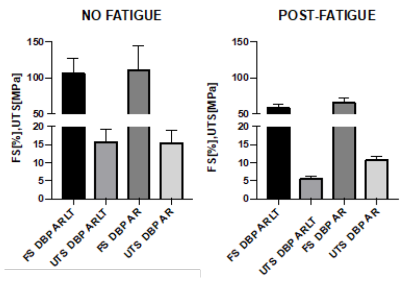

Figure 1: Failure Strain (FS) and Ultimate Tensile Strength (UTS) values before and after fatigue tests.

References

1. M. Todesco et al, J. Mater. Sci. Mater. Med., 32, 86, 2021.
2. M. Todesco et al, Biomater. Res. 25, 26, 2021.

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