CLASSIC TISSUE ENGINEERING AND REGENERATIVE APPROACHES IN CARDIOVASCULAR RESEARCH

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ABSTRACT

Background: Over the last decade cardiovascular tissue engineering (TE) became a major field in medical research. At the moment research is focusing on "classical" tissue engineering and regenerative approaches by using synthetic, biological and biohybrid polymeric scaffolds. Therefore we investigated the advantages and drawbacks of these approaches and materials to provide a guideline for further cardiovascular research.

Methods: Electrospun polyurethane and decellularized (DC) biologic materials were used as scaffolds. Fibroblasts and endothelial cells were obtained from human saphenous vein segments. Electrospun scaffolds were consecutively seeded with FB and EC. For representation of the "classical" TE (group 1/ G1), seeded polyurethane scaffolds were exposed to pulsatile flow. Subsequent crimping and reperfusion simulated the implantation procedure of a transcatheter heart valve. In the second group (G2) fibroblast-seeded polyurethane was cultivated statically 10d for extracellular matrix formation. Scaffolds of G2 and biological materials (group 3/ G3) were DC (0.5% desoxycholate, 0.5% dodecylsulfate) for 24h, washed for 6d and finally checked for successful DC. For evaluation of this regenerative approach the re-seeding efficiency was evaluated by endothelial cell application. Scanning electron microscopy, endoscopy, live-dead assays, fluorescence microscopy and standard histological staining were used for analysis.

Results: Isolated FB and EC enabled fast cultivation and demonstrated effective seeding characteristics. Pulsatile conditioning of G1 resulted in an intact cellular coverage and a strong extracellular matrix (ECM) formation. Subsequent crimping and reperfusion inflicted severe cellular damages and cell layer delamination. Cultivation of seeded G2 scaffolds resulted in comprehensive ECM formation. After DC, acellularity and preservation of fibrous ECM was proved for G2 and G3. Endothelial re-seeding revealed good cell adherence and viability.

Conclusions: Production of functional "classic" TE constructs as well as regenerative biohybrid and biologic scaffolds was possible. However manipulation – for example transcatheter heart valve implantation – of living TE constructs inflicts massive damage and can cause inflammation. Therefore we recommend to focus on regenerative approaches in future cardiovascular research.