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Fibrin-Based Tissue-Engineered Heart Valves: Results of a First In Vivo Evaluation

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Objectives:

Our group has previously demonstrated the synthesis of dynamically-conditioned tissue-engineered heart valves based on an autologous fibrin scaffold. The present study aims to evaluate the structure and mechanical stability of fibrin-based heart valves following implantation in a sheep model.

Method:

Autologous tissue-engineered heart valves were moulded using a fibrin scaffold, ovine carotid artery-derived myofibroblasts and endothelial cells, before subjection to 28 days of mechanical conditioning in a bioreactor. Following conditioning, tissue-engineered valves were implanted in the pulmonary trunk of the same animals (n=4) from which the cells had been harvested; identical valves conditioned in parallel served as in vitro controls. Valves were explanted after 1 and 2 months and analysed using routine histology, immunohistochemistry, electron microscopy (EM) and extracellular matrix (ECM) assay.

Results:

Explanted valve conduits had excellent tissue consistency after 2 months in vivo. Routine histology showed notable tissue development and excellent cell distribution, functional blood vessel ingrowth in the conduit wall, with no evidence for inflammation. Immunohistochemistry and ECM assay demonstrated almost complete resorption of fibrin gel components and replacement with ECM proteins. A monolayer of vWf-positive endothelial cells lined the valve surface, and was shown to be completely confluent using scanning EM. The resident valve tissue cells were in excellent health, as evidenced by transmission EM.

Conclusions:

The first results of implanted fibrin-based tissue engineered heart valves are encouraging, with excellent tissue remodelling and mechanical stability after 2 months in vivo. The results suggest that it may be possible to construct truly “autologous” tissue-engineered heart valves on a patient-to-patient basis.