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New Frontiers in Tissue Engineering: Applications of Tissue Engineering in Cardiovascular Surgery

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Abstract: Objective: Tissue engineering (TE) is an approach by which cells are grown in vitro onto biodegradable polymers to construct tissues for implantation. Preliminary experimental applications of cardiovascular surgery in our laboratory for creating vascular grafts and valve leaflets through TE are presented and discussed. Material and Methods: Ovine artery and vein segments were harvested, separated into individual cells, expanded in tissue culture and seeded onto synthetic biodegradable tubular scaffolds in 20-day old lambs . After 7 days of in vitro culture, the autologous constructs were used to replace a 2 cm segment of pulmonary artery (N=8) and valve leaflet (N=6). One control animal received an acellular polymer structure in each study design. Animals were sacrificed at intervals of 11 to 24 weeks. Explanted TE conduits were assayed for collagen and calcium content, and a tissue deoxyribonucleic acid assay was used to estimate number of cell nuclei as an index of tissue maturity. Results: The acellular control constructs developed progressive obstruction and thrombosis. All TE constructs were patent and demonstrated a non-aneurysmall increase in diameter (18.3 $\pm$ 1.3 mm, 95.3%of native pulmonary artery). Collagen content was 73.9 $\pm$ 8% of adjacent pulmonary artery and showed a gradual increase. Elastic fibers were present in the media layer and deoxyribonucleic acid assay showed a progressive decrease in the number of cell nuclei, suggesting an ongoing tissue remodeling. Calcium content of TE grafts was elevated but no macroscopic calcification was found. Conclusion: Living vascular TE grafts and leaflets functioned well and demonstrated an increase in diameter, suggesting growth and development of endothelial lining and extracellular matrix. The TE approach may ultimately allow the development of viable autologous structures for clinical use.

Key Words: Cardiovascular suggery, heart valves, prosthesis, biomedical engineering.

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