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On the decellularization process of human umbilical arteries: Implications for small-diameter tissue-engineered vascular grafts

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Successful development of a functional small-diameter vascular graft for medical interventions remains a challenge. A variety of tissue engineering strategies have been developed for creating small-diameter vascular grafts. Decellularized matrix has been used as a scaffold; however, the time-consuming decellularization process and poor cell infiltration to the matrix remain the main obstacles for its use in tissue engineering applications. We designed and made a mechano-active bioreactor to investigate mechanical treatments on decellularization of human umbilical arteries, aiming at using the decellularized matrix to engineer a small-diameter vascular graft. The human umbilical arteries were selected because of its extracellular matrix contains abundant growth factors that may facilitate cell proliferation and differentiation. Three concentrations of sodium dodecyl sulfate (SDS) were tested under four mechanical schemes: static, rotary agitation, perfusion, and perfusion with cyclic axial stretching. H&E and picro-sirius red staining were used to examine the efficacy of decellularization and matrix preservation, respectively. We found that 1% wt SDS was the optimal concentration and that perfusion with cyclic axial stretching was most efficient in terms of cell removal. Complete cell removal was achieved within 12 hours at the condition. Using the bioreactor not only shortened the decellularization process but also increased the porosity of the matrix, which potentially enhances subsequent cell infiltration. Our preliminary experiments on matrix recellularization confirmed that the increased porosity enhanced cell infiltration. In the future, cell-seeded constructs will be cultured in the same mechano-active bioreactor to examine multi-axial mechanical conditioning on the maturation of the construct in vitro.

Biography

Ho-Yi Tuan-Mu received his Bachelor degree in Physical Therapy and Master Degree in Physical Therapy and Assistive Device. He is currently a PhD student in Department of Biomedical Engineering at National Cheng Kung University. His research interest focuses on soft tissue biomechanics and soft tissue engineering.

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