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Bioresorbable reinforcement induces histological rearrangement of pulmonary autograft in an experimental model of Ross operation

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The Ross procedure has emerged as a popular choice for aortic valve replacement in infants and children. However, pulmonary artery (PA) autograft dilation remains the major concern; hence, several modifications of the valve implantation techniques, such as reinforcing the autografts with a tubular synthetic mesh, have been reported.

With the aim to prevent dilation and permit the normal growth of the neo-aortic root following pulmonary autograft implantation, we assessed the biological effect and long term performance of an external bioresorbable reinforcement for PA autograft in an experimental Ross model in growing animals.

An experimental model of translocation of the pulmonary trunk as autograft in aortic position, funded on the Hook's law and Laplace equilibrium, has been developed and performed under cardiopulmonary bypass in young lambs. The PA without reinforcement (n=5) was compared to PA reinforced with new scaffold polymer with an external armour of Polytetrafluoroethylene. The PA autograft diameter was measured using transoesophageal echography at day 0 and at 6 months and compared to the distal aortic diameter. Pathological analysis of the PA autograft reinforced was performed at 6 months and the results were compared to those of a control group with no reinforcement (n=5)

Animal weight was 25±5 kg at day 0 and 58±10 kg at 6 months and the reference aortic diameter increased from 14±1mm at day 0 to 17±2mm at 6 months. With no reinforcement, an instantaneous PA graft distension (27,4±2mm) was noted followed by an aneurysmal formation at 6 months (38±3mm). Reinforcement with scaffold polymer on polidioxanone allowed maintaining the PA graft diameter close to the reference value (17±2mm at day 0). Immunohistochemistry revealed MMP-9 overexpression indicating the induction of a matrix remodeling process that are not detectable in the control group. Mallory staining revealed elastin deposition in the reinforced PA in comparison to the collagen present in the non-reinforced group, reliably suggesting a shift towards an elastic remodeling and arterialization. PicroSirius red staining reveled in the control group collagen fibers non- homogeneously distributed with a increased cellularity indicating inflammatory infiltrates. The reinforced PA displays more organized and dense collagen fibers in the "elastic zone" of the vessel and less pronounced cellular infiltrate.

In conclusion, bioresorbable external polydioxanone-based reinforcement allowed a structural rearrangement of PA autograft consisting of media reorganization with an increase in the elastic wall component. Such histological outcome arguably prevented autograft dilation and conferred enhanced mechanical properties on the PA wall.