

Evaluation of the feasibility to use novel tissue engineered grafts for right ventricular outflow tract reconstruction by magnetic resonance imaging

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Target audience: Radiologists, engineers and physicists with an interest in the development and non-invasive imaging of grafts of the right ventricular outflow tract (RVOT) in experimental studies.

Purpose: In various congenital heart diseases with impaired right ventricular (RV) function a reconstruction of the RVOT is necessary. Different materials have been investigated to improve long-term outcome. Currently, pericardium is used for surgical reconstruction but it is limited by its elastic properties, physiological remodeling and growth. Tissue engineering (TE) might offer alternative approaches by generating contractile myocardial tissue for replacement. In this project, we investigated RV function after reconstruction of RVOT with a new graft composed of an allogeneic TE pulmonary valve conduit combined with a patch of autologous vascularized small intestine segment (autologous vascularized matrix = AutoVaM).

Methods: In 6 minipigs a TE pulmonary valve conduit with an AutoVaM was implanted. Three minipigs received a TE valve conduit combined with an autologous pericardial patch and served as controls. To evaluate morphology and function of the graft, MRI (1.5 Tesla, Avanto, Siemens Healthcare) was performed within the first month, and 3 and 6 months after surgery. ECG-gated, breath-hold steady-state free precession (SSFP) gradient echo sequences (TrueFISP) in standard short axis view as well as aligned to the RVOT, contrast enhanced MR angiography (MRA), and 4D flow measurements were acquired. For quantitative evaluation of the RV endocardial and epicardial contours were traced manually in all end-systolic and end-diastolic short-axis slices between the atrioventricular plane and the apex of the heart using QMass 7.1 software. RV parameters were compared between minipigs with AutoVaM und controls. RVOT morphology was assessed by MRA and its functional properties were evaluated using cine SSFP of the RVOT and flow data in both groups.

Results: Cine SSFP and MRA showed better morphological results in animals with AutoVaM compared to pericardial patch graft (Fig.1). Quantitative evaluation of the RV demonstrated a higher ejection fraction in animals with AutoVaM compared to controls with pericardial patch graft at all time points (first month after surgery 46.3 ± 8.9 vs 43.3 ± 25.3 ; 3 months after surgery 63.8 ± 11.1 vs 32.7 ± 3.5 ; 6 months after surgery 59.4 ± 11.4 vs 46 ± 10.6). Regional wall thickening in the area of the RVOT and flow parameters at the level of the pulmonary valve were better in animals with AutoVaM compared to controls.

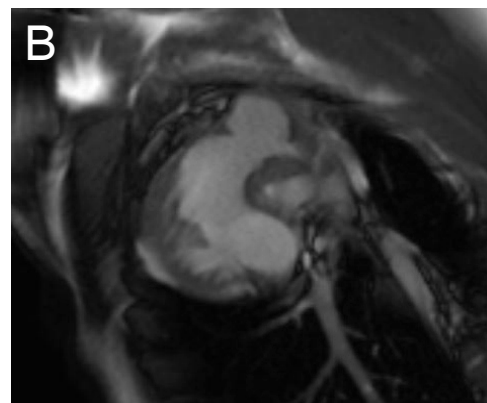


Figure 1: Morphological analysis of the combined RVOT graft by magnetic resonance imaging. Three-dimensional volume rendering of contrast enhanced MR angiography of the graft consisting of a TE pulmonary valve conduit and an autologous myocardial patch (AutoVaM) demonstrates a very good postoperative result (A). Cine SSFP aligned to the RVOT of a control animal (graft consisting of a TE pulmonary valve conduit and an autologous pericardial patch) shows a postoperative complication with an aneurismatic enlargement of the anastomosis (B).

Discussion and Conclusion: In pig models MRI represents an efficient investigational method after complex RVOT reconstruction. The new graft, composed of TE pulmonary valve conduit and an autologous vascularized matrix, showed superiority to conventional used material such as autologous pericardium.

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