CHARACTERIZATION OF AN EX-VIVO PORCINE MODEL OF FUNCTIONAL TRICUSPID REGURGITATION

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Introduction

The emerging treatments for Tricuspid Valve (TV) pathologies leads to the need for realistic pathological models of TV, aimed at studying these new approaches. The most common TV pathology is Functional Tricuspid Regurgitation (FTR) where annulus and right ventricle dilation leads to valve incontinence. Defrosted porcine hearts were used in pulsatile mock loops as an experimental model of FTR [1], but a systematic characterization of the experimental model is lacking. In this work we compared the TV geometrical morphology in fresh and defrosted porcine hearts to assess the porcine heart as an ex-vivo model of FTR.

Methods

Five porcine hearts were collected from a local abattoir. Pulmonary valves were sealed, the ventricles were pressurized at 15 mmHg, and the backflow through the TV was measured. To assess the TV morphology the hearts were connected to a pulsatile mock loop [1] (working parameter were 60 bpm, 70ml of stroke volume, and 15 mmHg of mean pulmonary pressure). 3D-volumetric echocardiographic and endoscopic images of the TV were acquired. The hearts were then kept frozen (–18°C) for 14 days, defrosted, and tested again with the same test protocol. Based on echocardiography, 3D anatomies of the TV in peak systole were segmented and reconstructed by a custom semi-automatic software [2]. The following parameters were obtained: tenting volume, maximum diameter, perimeter, and area of TV annulus.

Results

Figure 1 represents endoscopic views of the TV both in fresh and defrosted hearts. Table1 reports the overall results (mean ± standard deviation). Sample freezing induced significant ($p<0.05$) increase in annulus size (10% and 5% of annulus area and perimeter, respectively). The treatment induced right ventricle dilation, as highlighted by 114% increase in tenting volume. The morphologic alterations were reflected in the significant 7-fold increase of backflow.

Discussion

Fresh hearts can be used to replicate the physiological behavior of the valve, while defrosted porcine TV can be considered a realistic ex-vivo model to reproduce FTR pathology.

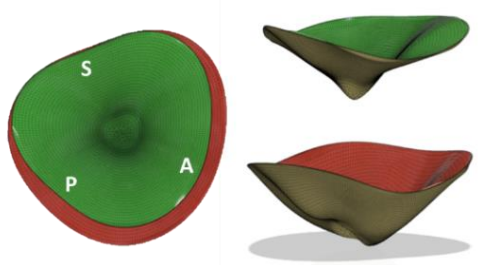

Figure 2: 3D reconstruction of the valve profile during peak systole. Fresh valve in green, defrosted valve in red. A: anterior leaflet, P: posterior leaflet; S: septal leaflet.

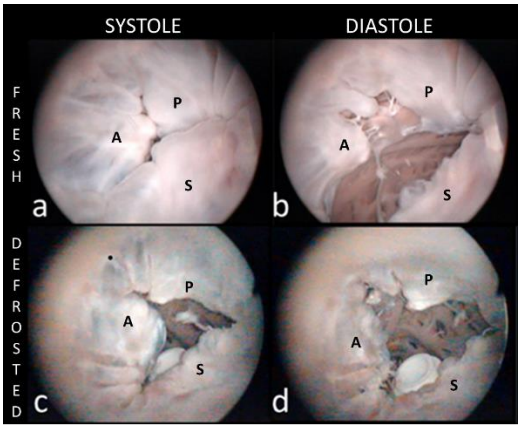

Figure 1: Endoscopic views of the TV:(a) fresh heart in systole;(b) fresh heart in diastole; (c) defrosted heart in systole; (d)defrosted heart in diastole. A: anterior leaflet, P: posterior leaflet; S: septal leaflet.

Parameter	**Fresh Hearts**	**Defrosted Hearts**	p-value
Backflow [l/min]	0.3 ± 0.02	2.3 ± 0.8	0.002
Maximum diameter [mm]	48.9 ± 4.5	51.0 ± 2.8	0.01
Annulus perimeter [mm]	144.9 ± 1.2	151.0 ± 8.7	0.02
Annulus area [mm^2]	1617 ± 231	1784 ± 217	0.006
Tenting volume [ml]	6.2 ± 0.9	13.3 ± 3.6	0.005

Table 1: Characteristic parameters evaluated on fresh and defrosted hearts. Paired t-test was performed.

References

1. Jaworek et al., ASAIO J, 63(4):438-444, 2017
2. Pappalardo et al., J Cardiovasc Comput Tomogr, 14:520-523,2020