INTERVENTRICULAR SYNCHRONY IN CHRONIC THROMBO-EMBOLIC PULMONARY HYPERTENSION RECOVERS AFTER ENDARTERECTOMY

G. J. Mauritz[1], J. T. Marcus[1], J. Bosboom[1], and A. Vonk Noordegraaf[1]
[1]VU University Medical Center, Amsterdam, Netherlands

Introduction Interventricular mechanical asynchrony has proven to be of significant importance in patients with pulmonary arterial hypertension. It is a major determinant related to right ventricular (RV) overload, leftward septal bowing, left ventricular (LV) underfilling, and decrease in stroke volume and it is an important measure in the evaluation of disease severity and functional class. This left-to-right (L-R) mechanical asynchrony is due to prolonged RV circumferential shortening and leads to inefficiency in both RV systole and LV diastole [1,2]. MRI tagging and strain analysis allow a detailed assessment of this L-R mechanical asynchrony.

Chronic Thrombo-Embolic Pulmonary Hypertension (CTEPH) is a category of pulmonary hypertension where surgical removal of the emboli in the large pulmonary arteries is a treatment option. Pulmonary endarterectomy is required because the thrombo-embolic material has become fibrotic and adherent to the vessel wall. For this invasive surgery, full circulatory arrest, cardiopulmonary bypass and hypothermia are necessary and the procedure is risky. If successful, A large reduction of pulmonary vascular resistance and subsequent reverse remodeling of the RV can be reached, back to normal *anatomical* RV mass and size [3]. If indeed the RV overload is the cause of L-R asynchrony, then it is reasonable to hypothesize that removal of the overload will also lead to *functional* recovery of L-R synchrony. Thus the aim of this study is to assess whether the L-R synchrony in CTEPH recovers after pulmonary endarterectomy.

Methods Nine CTEPH patients were included, and underwent MRI myocardial tagging at baseline before, and 1 year (±2 months) after endarterectomy . A 1.5 T Siemens 'Sonata' whole body MRI system, equipped with a 6-element phased-array coil, was used (Siemens Medical Solutions, Erlangen, Germany). MRI myocardial tagging with high temporal resolution (29 ms) was applied with Complementary Spatial Modulation of Magnetization (7 mm tag distance) and steady state free precession imaging. Parameters: Eight phase-encoding lines per beat, TR 3.6 ms, TE 1.8 ms, flipangle 20 deg, voxel size 1.2 x 3.8 x 6.0 mm^3. Image plane: the mid-ventricular short-axis plane. Circumferential strain curves of LV and RV free wall were calculated by the Harmonic Phase method. Peak values and peak times (Tpeak) of myocardial shortening were determined for LV and RV. The L-R delay was calculated as the difference of Tpeak-RV minus Tpeak-LV; the S-R delay as Tpeak-RV minus Tpeak-septum. Stroke volume was measured by MRI cine or flow imaging. Statistics was done by paired-samples t-testing, comparing post-surgery versus baseline.

Results Fig 1 a and b show for one patient the myocardial strain curves of RV, septum and LV before and after endarterectomy. Note the decrease in L-R delay and S-R delay, and increase in RV peak strain.

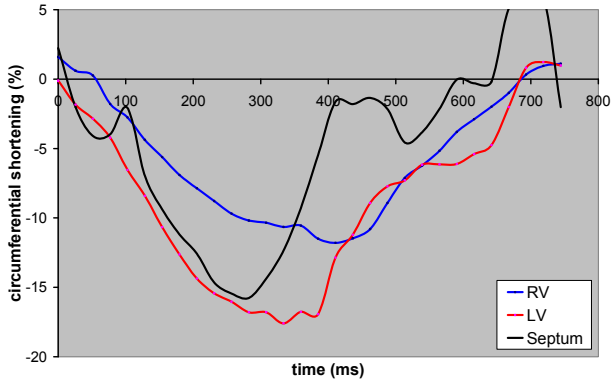

Fig 1a: Before endarterectomy

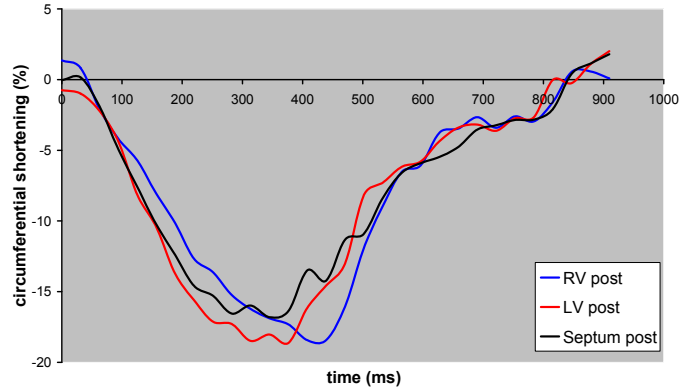

Fig 1b: After endarterectomy

The L-R delay in T peak decreased from 95 ± 61 ms at baseline, to 2 ± 47 ms after endarterectomy ($p < 0.05$).

The S-R delay decreased from 136 ± 48 ms, to 55 ± 58 ms ($p=0.01$). The peak RV strain increased from 12 ± 3 %, to 16 ± 3% ($p<0.05$). Cardiac output increased from 3.7 ± 0.9 lit/min, to 4.8 ± 0.6 lit/min ($p<0.01$). Heart rate was not different after endarterectomy.

Discussion As hypothesized, the L-R synchrony in CTEPH recovers after surgical removal of the emboli. The mechanical unloading of the RV leads to resynchronizing of the RV with the LV, and of the RV with the septum, leading to a more efficient pump function [1]. Also the RV free wall reaches a larger peak strain. This *functional* RV recovery is in line with the reverse RV anatomical remodeling after successful endarterectomy, as reported earlier [3]. A successful endarterectomy thus benefits not only the pulmonary circulation, but also the RV function and the L-R synergy. For the patient, these potential benefits are important when choosing for the risks of endarterectomy surgery.

The follow-up measurement was performed one year after surgery. Therefore the question still remains whether the resynchronization is an immediate effect of unloading the RV pressure overload, or a gradual recovery process that goes together with the reverse RV remodeling.

References [1] Beyar R. Heart Inefficiency in Pulmonary Hypertension: A Double Jeopardy. J Am Coll Cardiol 2008; 51: 758-9
[2] Marcus JT et al. J Am Coll Cardiol 2008;51:750-7. [3] Reesink HJ et al., J Thorac Cardiovasc Surg 2007;133;58-64.