CMR markers for early right ventricular dysfunction in precapillary pulmonary hypertension

J. Vos[1], T. Leiner[2], A.P.J. Van Dijk[1], F.J. Meijboom[3], G.T. Sieswerda[3], R.J. Snijder[4], M.C. Post[5], R. Nijveldt[1], M.M.P. Driessen[2]

[1]Radboud University Medical Centre, Department of Cardiology, Nijmegen, Netherlands (The); [2]University Medical Center Utrecht, Department of Radiology, Utrecht, Netherlands (The); [3]University Medical Center Utrecht, Cardiology, Utrecht, Netherlands (The); [4]St Antonius Hospital, Department of Pulmonology, Nieuwegein, Netherlands (The); [5]St Antonius Hospital, Cardiology, Nieuwegein, Netherlands (The)

Funding Acknowledgement: Type of funding source: None

Introduction: Precapillary pulmonary hypertension (pPH) causes right ventricular (RV) pressure overload inducing RV remodeling, often resulting in dysfunction and dilatation, heart failure, and ultimately death. The ability of the right ventricle to adequately adapt to increased pressure loading is key for patients' prognosis. RV ejection fraction (RVEF) by cardiac magnetic resonance (CMR) is related to outcome in pPH patients, but this global measurement is not ideal for detecting early changes in RV function. Strain analysis on CMR using feature tracking (FT) software provides a more detailed assessment, and might therefore detect early changes in RV function.

Aim: 1) To compare RV strain parameters in pPH patients and healthy controls, and 2) to compare strain parameters in a subgroup of pPH patients with preserved RVEF (pRVEF) and healthy controls.

Methods: In this prospective study, a CMR was performed in pPH patients and healthy controls. Using FT-software on standard cine images, the following RV strain parameters were analyzed: global, septal, and free wall longitudinal strain (GLS, sept-LS, free wall-LS), time to peak strain (TTP, as a % of the whole cardiac cycle), the fractional area change (FAC), global circumferential strain (GCS), global longitudinal and global circumferential strain rate (GLSR and GCSR, respectively). A pRVEF is defined as a RVEF >50%. To compare RV strain parameters in pPH patients to healthy controls, the Mann-Whitney U test was used.

Results: 33 pPH-patients (55 [45–63] yrs; 10 (30%) male) and 22 healthy controls (40 [36–48] yrs; 15 (68%) male) were included. All RV strain parameters were significantly reduced in pPH patients compared to healthy controls (see table), except for GCS and GCSR. Most importantly, in pPH patients with pRVEF (n=8) GLS (–26.6% [–22.6 to –27.3] vs. –28.1% [–26.2 to –30.6], p=0.04), sept-LS (–21.2% [–19.8 to –23.2] vs. –26.0% [–24.0 to –27.9], p=0.005), and FAC (39% [35–44] vs. 44% [42–47], p=0.02) were still significantly impaired compared to healthy controls. The RV TTP was significantly increased in pPH patients compared to healthy controls (47% [44–57] vs. 40% [33–43], p≤0.001).

Conclusions: Several CMR-FT strain parameters of the right ventricle are impaired in pPH patients when compared to healthy controls. Moreover, even in pPH patients with a preserved RVEF multiple RV strain parameters (GLS, sept-LS, and FAC) remained significantly impaired, and TTP significantly prolonged, in comparison to healthy controls. This suggests that RV strain parameters may be used as an early marker of RV dysfunction in pPH patients.

Table.

	Healthy controls (n=22)	pPH patients (n=33)	pPH patients with pRVEF (n=8)
Age (years)	40 (36-48)	55 (45-63) *	57 (46-61) **
Male (n)	15 (68%)	10 (30%) *	4 (50%) **
TAPSE (cm)	2,3 (16-21)	2,0 (1,8-2,2) *	2,2 (1,9-2,4)
RVSP (mmHg)	19 (16-21)	56 (41-71) *	38 (32-48) **
RVEF (%)	54 (51-57)	42 (34-49) *	51 (50-57)
RV GLS (%)	-28,1 (-26,2 – -30,6)	-19,5 (-15,1 – -24,1) *	-26,6 (-22,6 – -27,3) **
RV free wall-LS (%)	-28,3 (-23,1 – -29,9)	-19,3 (-13,5 – -25,4) *	-28,2 (-24,6 – -29,1)
RV sept-LS (%)	-26,0 (-24,0 – -27,9)	-17,6 (-12,5 – -19,6) *	-21,2 (-19,8 – -23,2) **
RV GLSR (S^{-1})	-1,2 (-0,9 – -1,3)	-0,9 (-0,6 – -1,1) *	-1,1 (-1,0 – -1,2)
RV FAC (%)	44 (42-47)	33 (26-38)	39 (35-44) **
RV TTP (%)	40 (33-43)	50 (43-53)	47 (44-57) **

pPH, precapillary pulmonary hypertension; pRVEF, preserved right ventricular ejection fraction; TAPSE, tricuspid annular plane systolic excursion; RVSP, right ventricular systolic pressure; RV, right ventricular; RVEF, right ventricular ejection fraction; GLS, global longitudinal strain; free wall-LS, free wall longitudinal strain; sept-LS, septal longitudinal strain; GLSR, global longitudinal strain rate; TTP, time to peak strain (as a % of whole cardiac cycle). Continuous variables are expressed as median with lower and upper interquartile range, categorical variables as total number (percentage).

* Statistically significant differences between healthy controls and pPH patients (p<0,05)

** Statistically significant differences between healthy controls and pPH patients with pRVEF (p<0,05)