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Peak pulmonary artery pressure may be determined by a multiple regression equation - a CE-CMR study

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Introduction

Historical studies have shown delay in transit of contrast agents from venous to arterial side in subjects with reduced left ventricular ejection fraction (LVEF) and elevated pulmonary artery pressure (PAP). Cardiopulmonary transit times from cardiac MRI and angiography have been shown to correlate inversely with LVEF.

Purpose

We performed this study to evaluate the utility of pulmonary transit times (**PTT**) in estimating PAP and correlating them with Doppler Echocardiography (DE).

Methods

We reviewed CMR studies from September 2005 to April 2009 done at a tertiary medical center. First-pass perfusion imaging was performed on 1.5-T Signa CV/I scanners (GE Medical Systems) using a segmented echo-planar imaging pulse sequence with the following parameters: repetition time, 7.7 to 8.1 ms; echo time, 1.3 to 1.8 ms; echo train length, 4 to 8; matrix, 128 × 96; and each slice thickness, 15 mm. All perfusion images were obtained after an intravenous dose of 0.5-1.0 mmol/kg of Gd-DTPA at a rate of 3.0 ml/s in short axis plane only. **PTT was calculated as the time difference from the first appearance of contrast in the LV to the first appearance of contrast in RV** (Figures 1 and 2). DE done within 26 ± 4 days either pre or post CE-CMR was used as reference standard.

Results

PTT (N = 54) showed significant univariate association with PAP, LVEF, systolic and diastolic blood pressure. With multivariate analysis, PTT remained a significant association in those with LVEF ($p < 0.007$). Subjects with LVEF < 50% had significant elevation in PAP and increased PTT compared with subjects with normal LVEF. Using multiple regression analysis, we derived an equation to calculate PAP using LVEF < 50% and PTT as shown in Figure 3. The PAP calculated using this equation correlates well (± 5 mm Hg) with the PAP recorded on echocardiography. We prospectively (N = 2) and retrospectively (N = 5) applied this CE-PTT equation with reproducible results in subjects with LVEF < 50% and normal right ventricular function. PTT with a cutoff > 10 secs was shown to have severe left ventricular dysfunction (LVEF < 20%) and pulmonary hypertension Tables 1 and 2.

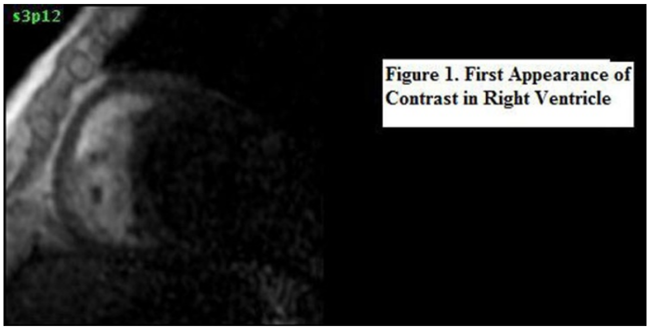

Figure 1
First appearance of contrast in right ventricle.

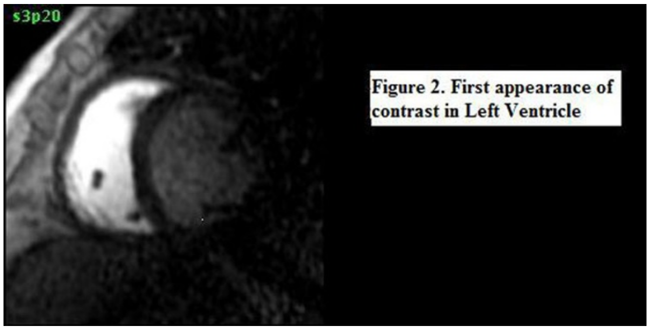

Figure 2
First appearance of contrast in Left Ventricle.

Conclusion

CE-PTT equation may be useful in estimating pulmonary artery pressures in subjects with decreased left ventricular function. We believe PAP measured using this CE-PTT equation is secondary to left ventricular dysfunction. This CE-PTT equation, useful in estimating PAP in subjects with reduced LVEF warrants additional prospective testing.

Table 1: Averages of Study Population (Mean ± SE)

Patient Characteristic	N = 54
Pulmonary artery pressures (mm Hg)	35 ± 1
Left Ventricular EF (%)	51 ± 2
Pulmonary transit time (sec)	6.5 ± 0.4

Figure 3. CE-PTT equation

Equation to calculate PAP based on LVEF < 50% and Cardiac MRI contrast pulmonary transit time in secs

$$* \text{ PAP (mm Hg)} = \frac{27.56 - 0.37(\text{LVEF in \%}) - \text{PTT in secs.}}{0.22}$$

* In subjects with normal right ventricular function

Figure 3
CE-PTT equation.

Table 2: Comparison analysis of subjects based on LVEF

Patient Characteristic	LVEF < 50 % (N = 15)	LVEF ≥ 50 % (N = 39)	P value
Left Ventricular EF (%)	27.3 ± 2.8	59.6 ± 0.8	< 0.0001
Systolic blood pressure (mm Hg)	123.2 ± 6.5	130.5 ± 3.2	0.2698
Diastolic blood pressure (mm Hg)	73.6 ± 3.1	75.8 ± 1.6	0.5032
Pulmonary artery pressures (mmHg)	42.1 ± 3.3	32.1 ± 1.3	< 0.0013
Pulmonary transit time (sec)	8.2 ± 1.2	5.9 ± 0.2	0.0071