Comparison of regurgitation and variation of in-plane flow speed in branch pulmonary arteries after repair of tetralogy of Fallot : A phase-contrast MR imaging study.

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Introduction

Pulmonary regurgitation has been regarded as an important feature for long-term clinical outcome after repair of tetralogy of Fallot (TOF). The interest of applying phase-contrast cine magnetic resonance (PCMR) as an accurate method for evaluating flow velocity, volume and pattern has also been increasing [1]. In this work, we investigated the correlation between regurgitation fraction and coefficient of variation (CV) of in-plane flow speed in the branch pulmonary arteries.

Materials and Methods

A total of nine patients (age: 4.54±4 y/o, 3 female and 6 male) with after repair of tetralogy of Fallot (TOF) were included in this study. All patients underwent MR studies performed on a 1.5T system (General Electric Signa CVi, Milwaukee, WI). Phase-contrast (PC) MR imaging of main pulmonary artery (MPA), right (RPA) and left (LPA) pulmonary arteries was acquired by double-oblique method to obtain true perpendicular plane of long axis of the pulmonary artery with retrospective ECG gating. Flow velocity of twenty different time phases was measured in three dimensions throughout the cardiac cycle with upper velocity limit (Venc) set at 200 cm/sec. Region of interest (ROI) was manually defined from anatomic MR images of thorax accordingly. Quantitative flow analysis was achieved by the built-in software of commercially workstation (GE Medical System). Regurgitation fraction was calculated from division of backward flow by forward flow. The coefficient of variation (CV) of in-plane flow speed within the ROI for each time phase was calculated according to the definition [2]: *CV=[(standard deviation of speed)/(mean of speed)]×100*. The average of CV from the total 20 phase (CV-mean) was afterwards taken into account for the turbulent flow pattern. We used SPSS software package for statistical analysis.

Results and Discussion

Values of net flow, regurgitant fraction and CV-mean for RPA and LPA were listed in Table 1. Figure 1 shows the comparison between RPA and LPA of regurgitant fraction and CV-mean respectively. Regurgitant fraction (Fig.1(a)) was greater in the LPA (38.2 ± 28.0%) than in the RPA (27.9 ± 14.0%) (P=0.0413). In the meanwhile, the net forward flow in the LPA (793.7 ± 684.1 mL/min) was smaller than in the RPA (1699.4 ± 995.8 mL/min). The CV-Mean value shows significant difference between RPA and LPA (P=0.0153). There was a linear relationship between the CV-mean and net forward flow in the RPA (R^2=0.728, P=0.003) but not in the LPA (R^2=0.250, P=0.170) (Fig. 2).

Our preliminary result demonstrates the regurgitant fraction is able to evaluate the flow behavior after repair of TOF, which is consistent with previous reports [1]. CV-mean value was found to be correlated with net forward flow while the regurgitation fraction is relative small. CV-mean may reflect the turbulence of flow which results from regurgitation, although there is weak correlation with regurgitant fraction. In conclusion, the regurgitant fraction is a useful hemodynamic indicator in branch pulmonary arteries after repair of Tetralogy of Fallot, while CV-mean of in-plane flow speed may reflect the severity of turbulent flow which deserves further investigation for its clinical implication.

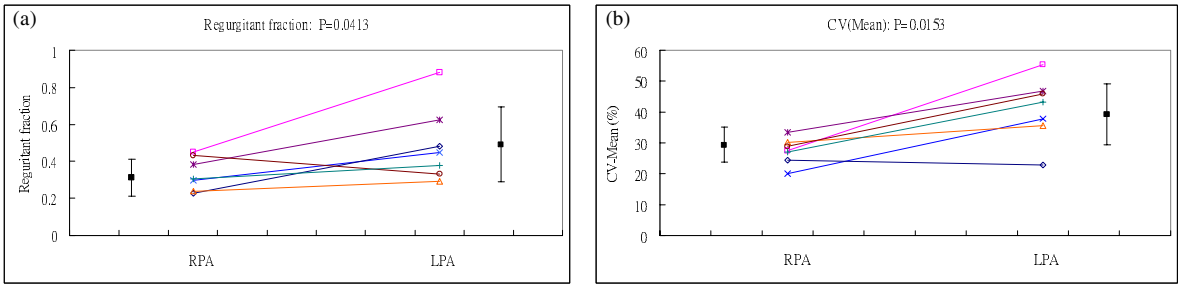

Figure 1. (a) the comparison of regurgitant fraction in the RPA and LPA. (b) the comparison of CV-mean in the RPA and LPA. CV-mean in the LPA was greater than in the RPA, which is consistent with the comparison of regurgitation fraction in (a).

Table 1. Summary of the analysis values for PRA and LPA.

	RPA (n=9)	LPA (n=9)
Net forward flow (mL/min)	1699.4 ± 995.8	793.7 ± 684.1
Regurgitant fraction(%)	27.9 ± 14.0	38.2 ± 28.0
CV-mean (%)	29.4 ± 5.6	39.3 ± 9.9

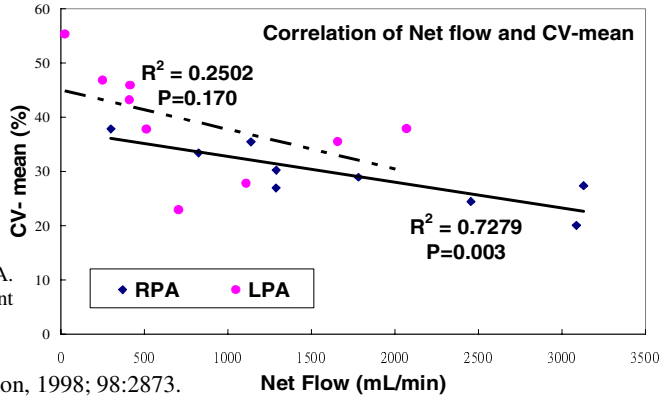

Figure 2. Linear correlation analysis of CV-mean and net forward flow for RPA and LPA. CV-mean shows great correlation with net flow in the RPA while there is no significant correlation in the LPA.

References

1. Kang et al., Circulation, 2003; 107:2938.
2. Be'eri et al., Circulation, 1998; 98:2873.