Ventricular septal defect Doppler peak gradient underestimates right ventricular systolic pressure in the presence of right bundle branch block

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ABSTRACT

Estimation of the right ventricular systolic pressure (RVSP) using echocardiographically derived maximal instantaneous gradient across the ventricular septal defect is a well-utilized tool, which can potentially underestimate the RVSP in patients with conduction abnormalities as such its utility in these patients is questionable.

Keywords: Right bundle branch block, right ventricular systolic pressure, tricuspid regurgitation, ventricular septal defect

REPORT

A 15-year-old girl with a cardiac diagnosis of tetralogy of Fallot, pulmonary atresia, and major aortopulmonary collateral arteries initially underwent right-sided unifocalization and right modified Blalock–Taussig shunt placement, followed by left-sided unifocalization, ventricular septal defect (VSD) repair using a fenestrated patch technique, and a right ventricular (RV) to pulmonary artery (PA) conduit a year later. Postoperative RV systolic pressure (RVSP) was suprasystemic and required multiple catheterizations to stent and dilate the branch PAs. Right bundle branch block (RBBB) with a QRS duration of 142 ms was noted following the second surgery.

Transesophageal echocardiogram (TEE) during the catheterization, estimated the RVSP at 60 mm Hg + right atrial "v-wave" pressure based on the continuous wave (CW) Doppler interrogation of the tricuspid regurgitation (TR) jet, simultaneous blood pressure was 79/47 mmHg. The VSD peak gradient by CW Doppler interrogation underestimated RVSP at ~40 mmHg [Figure 1]. A repeat transthoracic echocardiogram following day showed similar results. During the cardiac catheterization under TEE guidance, the VSD was small and showed better in the long axis views [Figure 2]. Simultaneous direct RV and left ventricular (LV) pressure measurement shown a 15 mm Hg peak-to-peak pressure gradient. Interestingly, the cath peak-to-peak gradient correlated with the Doppler-derived VSD mean gradient [Figure 3 and Table 1].

DISCUSSION

Estimation of the RVSP based on the peak CW Doppler interrogation of the VSD gradient is validated and routinely used in clinical practice.[1-4] It is important to understand the shortcomings of such a technique, especially in patients with conduction abnormalities,

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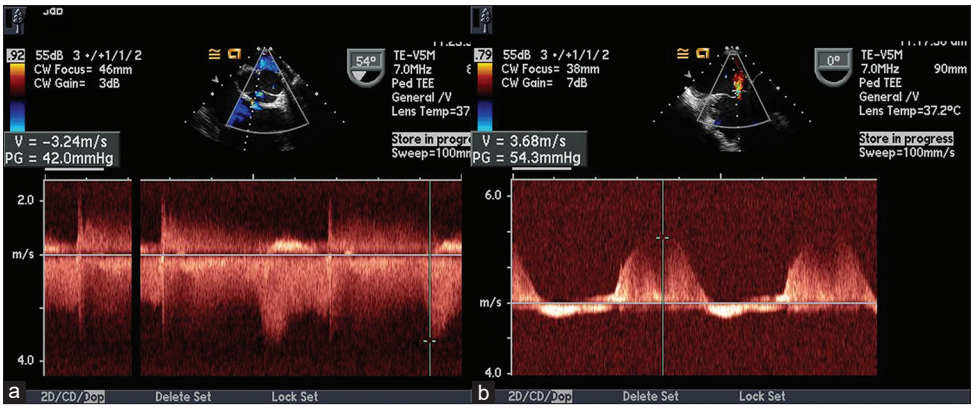

Figure 1: Simultaneous continuous wave Doppler tracings showing the ventricular septal defect (a) and tricuspid regurgitation jet (b) obtained by transesophageal echocardiogram during the cardiac catheterization. The right ventricular systolic pressure estimated using the ventricular septal defect gradient is lower than that of the estimate using the tricuspid regurgitation jet

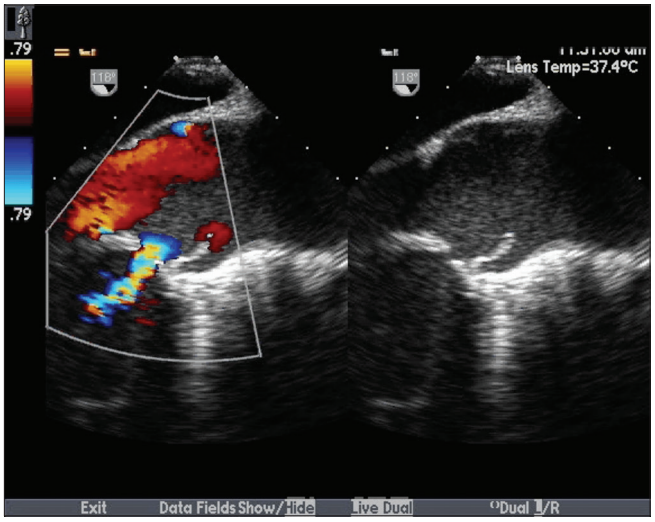

Figure 2: Transesophageal color compare echocardiogram showing the residual small ventricular septal defect in long axis just below the aortic valve with left-to-right shunting (blue jet)

such as our patient. It has been observed that most VSD flow patterns have either a "Plateau" or a "sloped" profile with early or late peak velocity. Those with "sloped" patterns are thought to result from asynchronous peaking of the LV and RV pressures as such Doppler peak instantaneous echo gradient is unreliable. In these subjects, a mean Doppler or end-systolic gradients correlated well with the cath-derived peak-to-peak gradients. Interestingly, some of the subjects in this study had normal QRS duration.[5]

Table 1: Table comparing Catheterization and Echocardiography derived hemodynamic data

	Pressure (mmHg)
Catheterization derived hemodynamic data	
RA mean pressure	5
Systemic blood pressure	85/63
RVSP	70
Peak-to-peak gradient	15
Maximal instantaneous gradient during early systole	50
TEE derived hemodynamic data	
RVSP estimated by VSD gradient	43
Echocardiogram derived mean VSD gradient	14

RA: Right atrium, VSD: Ventricular septal defect, TEE: Transesophageal echocardiogram, RVSP: Right ventricular systolic pressure

The RBBB in our patient results in the delayed activation of the RV compared to LV, as such there is a period in systole when the maximal instantaneous gradient measured by the echocardiogram is falsely high and thus underestimating the true RVSP. In the absence of other ways to confirm RVSP such as interrogation of the TR jet, one might be falsely reassured. We hypothesize that in subjects with left bundle branch block a similar phenomenon might be observed with a "sloped" profile but likely lower VSD peak gradient secondary to delayed LV pressure peaking. Falsely elevated VSD Doppler peak instantaneous gradient might be observed in those with LV flow obstruction. The correlation of cath peak-to-peak gradient with the mean Doppler VSD gradient observed in our patient needs further study in a larger sample and might have a potential role in patients with conduction abnormalities.

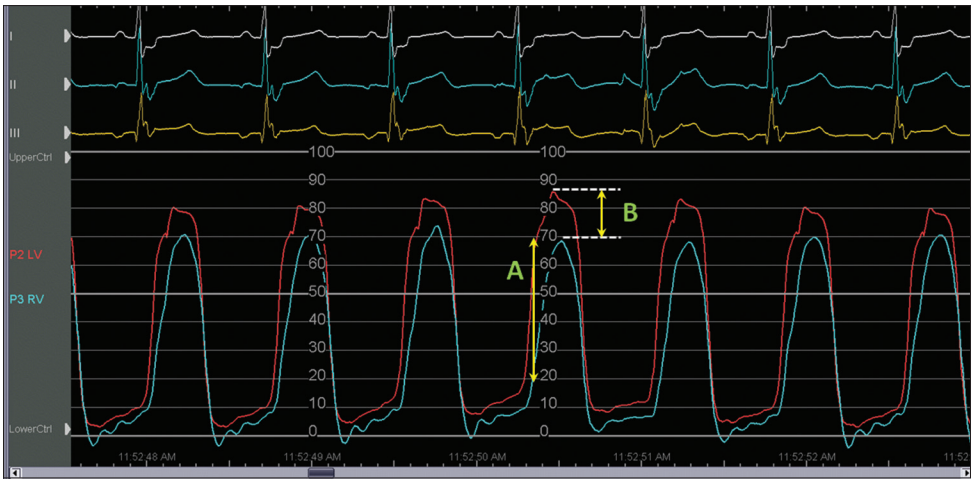

Figure 3: Invasive hemodynamic measurements showing simultaneous right (blue) and left (red) ventricular intracardiac pressure tracings with electrocardiogram (EKG) shown on the top of the image and pressure scale along the y-axis. Peak-to-peak gradient is 15 mmHg (b) and the maximal instantaneous gradient during the early part of the ventricular systole is 50 mmHg (a) that can explain the higher ventricular septal defect gradient obtained on the echocardiogram. The right ventricular systolic pressure was 70 mmHg

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Conflicts of interest

There are no conflicts of interest.

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