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Original Article

Intraoperative Measurement of the Pulmonary Artery Pressure: Is It Reliable?

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ABSTRACT

Background: Measurement of pulmonary artery pressure (PAP) is important for therapeutic planning in most types of structural heart diseases. The standard route for measuring PAP is cardiac catheterization. Nevertheless, in some cases, abnormal cardiac structures do not allow for advancing the catheter into the pulmonary artery. Measurement of pulmonary venous wedge pressure is another way, but it is not possible in some cases. During cardiac surgery, it is possible to measure PAP by directly entering a small needle into the pulmonary artery. This study aimed to evaluate the accuracy of PAP measurement during cardiac surgery in patients in a surgical environment.

Methods: The study enrolled 105 consecutive patients with congenital heart defects in whom cardiac catheterization was done before cardiac surgery. Systolic and diastolic pressures of the aorta and the pulmonary artery were measured and recorded both during catheterization and during cardiac surgery, and their correlations were assessed.

Results: Most of the pressures measured during cardiac surgery were lower than those measured during catheterization; nevertheless, no linear or other clear associations were found between them. There was no meaningful correlation concerning the amount of change between systemic and pulmonary pressures.

Conclusions: PAP significantly changes during general anesthesia and with an opened chest cage. PAP measured during surgery could not be relied upon for critical decisions such as univentricular approaches. ***(Iranian Heart Journal 2022; 23(1): 192-197)***

KEYWORDS: Congenital heart, Children, Pulmonary artery pressure, Cardiac surgery

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The accurate estimation of pulmonary artery pressure (PAP) is important for therapeutic planning in congenital and structural heart diseases. This estimation is crucial in patients with univentricular hearts for specific approaches. [1,2]

The essential and standard route for measuring PAP is cardiac catheterization; however, some conditions make PAP measurement through catheterization almost impossible. The examples are patients with pulmonary atresia, tricuspid valve atresia, and abnormal ventriculoarterial connections. For those

patients, PAP can be estimated using pulmonary vein wedge pressure.[3] Furthermore, there are conditions like vena caval interruption that make this method very difficult or even impossible. Indirect methods for estimating PAP such as echocardiography, cardiac computed tomography (CT), and magnetic resonance imaging are the other tools with uncertain reliability, especially when the precise measurement of PAP is desired. The last method for PAP measurement in complex cases requires the entrance of a needle or small catheter into the pulmonary artery during surgery. In the current study, we sought to evaluate the accuracy of this method.

METHODS

The study was conducted in Rajaie Cardiovascular Medical and Research Center, an Iranian referral center of pediatric cardiology, within 1 year. All procedures contributing to this work comply with the ethical standards of the Iranian guideline on human experimentation of 1999, as revised in 2004, and with the Helsinki Declaration of 1975, as revised in 2008, and was approved by the Ethics Committee of Rajaie Cardiovascular Medical and Research Center. Children with congenital heart disease for whom diagnostic cardiac catheterization had been performed up to 1 month prior to cardiac surgery were enrolled. Patients with known syndromes and those with non-sinus rhythms were excluded. During cardiac catheterization, systolic and diastolic PAPs were measured, as well as systolic and diastolic pressures of the aorta. PAP was measured using 5F side-hole catheters, 100 cm in length (Cordis, USA), positioned in the main pulmonary artery. Aortic pressures were measured using 5F pigtail catheters, 110 cm in length (Cordis, USA, PendraCare-Netherlands), positioned in the ascending aorta. All the catheterization procedures were done under sedation with intravenous midazolam (0.1 mg/kg) and propofol drips (50–100 μg/kg/min). The pressures were recorded with a standard monitoring system.

In the operating room, PAP was measured by a cardiac surgeon, who was blind to the recorded data in the catheterization laboratory. Intraoperative PAP was measured after endotracheal intubation, general anesthesia, and the surgical opening of the chest cage. The measurement was done by directly entering a 23-gauge needle into the main pulmonary trunk. The systolic and diastolic pressures of the aorta were measured with a central arterial cannula.

The results were presented as the mean ± the standard deviation (SD) for numeric variables and categorical variables are summarized as numbers (percentages). The Pearson correlation coefficient was used to assess the association between pressures measured in the catheterization laboratory and the operating room. Statistical analysis was performed using the SPSS software, version 22 (IBM SPSS, Chicago, IL), and Excel version 2016 was applied to depict figures.

RESULTS

This study enrolled 105 patients (59 males). The age range of the patients was 1 month to 14 years (mean =3.60±3.77 y). The patients' weight ranged between 4 and 47 kg (mean =13.55±8.74 kg). In total, 79 surgical operations were performed to repair atrial and/or ventricular septal defects, and the rest were performed to correct more complex cases.

There was no linear or other meaningful association between the pressures measured in the operating room and those measured in the catheterization laboratory (Fig. 1). In general, the pressures measured in the operating room were lower than those measured in the catheterization laboratory; nonetheless, in a few cases, the intraoperative pressures were greater than those measured in the catheterization

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laboratory. No association was detected between PAP changes and aortic pressure changes in the 2 environments (Fig. 2).

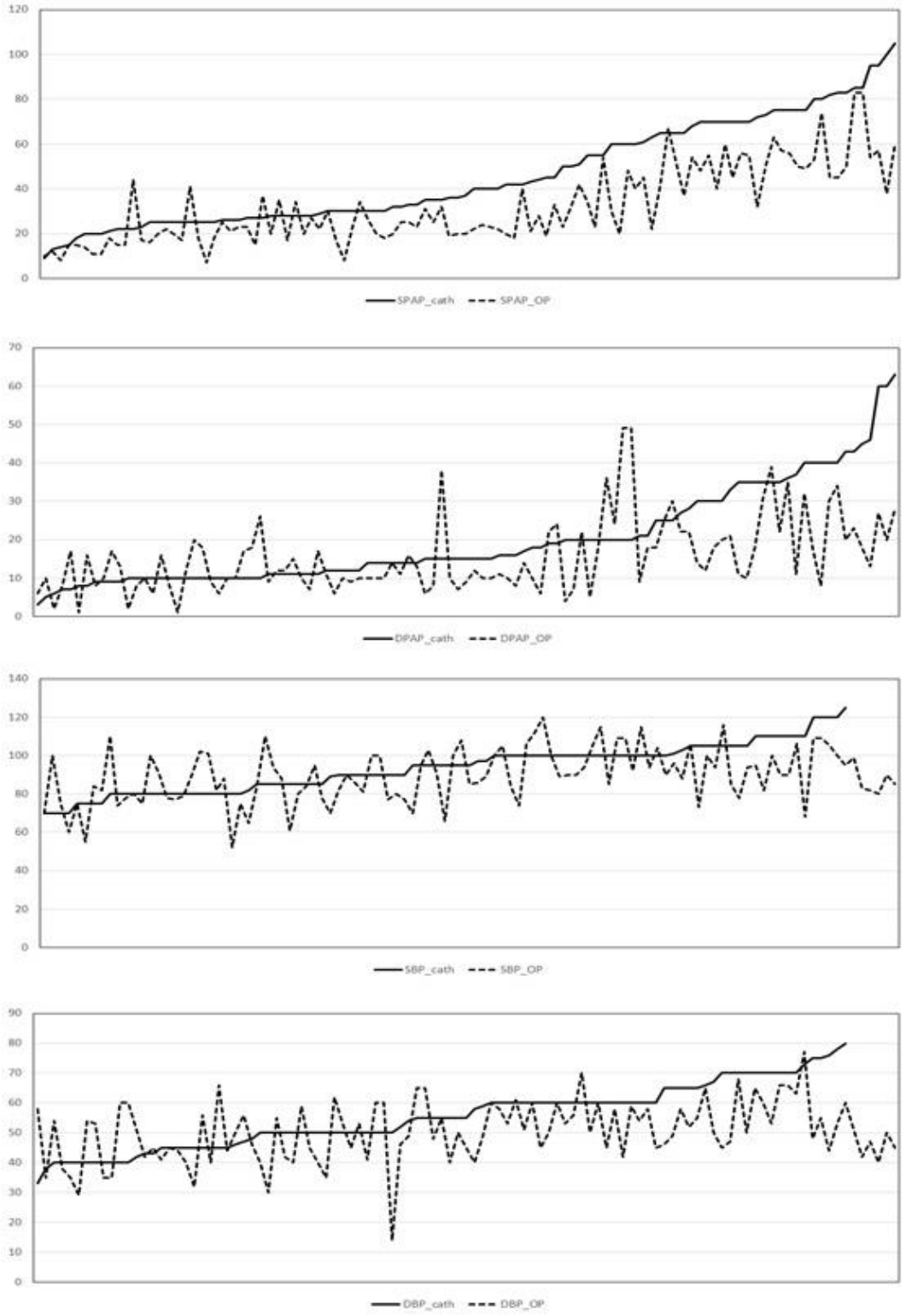

Figure 1. The diagrams show no significant correlation between the pressures measured in the operating room and those measured during catheterization.

SPAP_Cath, Systolic pulmonary artery pressure measured during catheterization; SPAP_OP, Systolic pulmonary artery pressure measured during surgery; DPAP_cath, Diastolic pulmonary artery pressure measured during catheterization; DPAP_OP, Diastolic pulmonary artery pressure measured during surgery; SBP_cath, Systolic blood pressure measured during catheterization; SBP-OP, Systolic blood pressure measured during catheterization; DBP_cath, diastolic blood pressure measured during catheterization; DBP_OP, Diastolic blood pressure measured during surgery

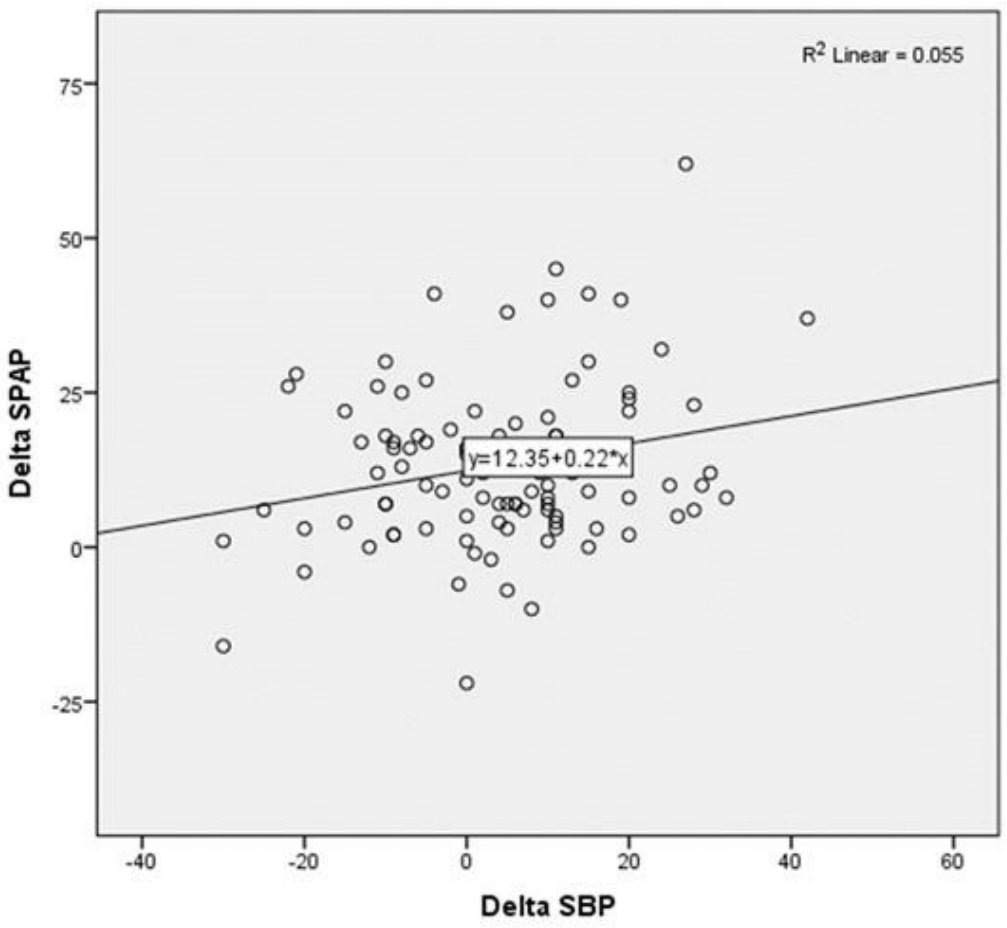

Figure 2. The diagram shows no association between the degree of pulmonary artery systolic pressure changes and aortic systolic pressure changes. The association is less than 1%.

Delta SBP, Difference between the aortic systolic pressure measured in the operating room and the catheterization laboratory; Delta SPAP, Difference between the pulmonary artery systolic pressure measured in the operating room and the catheterization laboratory

DISCUSSION

The measurement of PAP is a critical part of management in several types of structural heart diseases. Such measurements are vital in children with univentricular hearts. [4,5] As significant improvements in the outcomes of this group of patients are being reported, the amounts of PAP and pulmonary artery resistance remain crucial factors for case selection. [6–8]

Although the estimation of PAP is possible by some noninvasive methods, the gold-standard way for measuring PAP is through cardiac catheterization. [9–11] The invasive measurement of PAP in the catheterization laboratory is usually done under sedation or even under general anesthesia. Nevertheless,

the obtained data are used for guideline recommendations; thus, they should be assumed as the standard value. In complex cases, while the direct measurement of PAP is not possible by cardiac catheterization, some surgeons try to measure PAP during surgery. The effects of general anesthesia on systemic venous pressure and PAP have been shown by a few authors, [12] who have concluded that the ratio of systemic venous pressure to PAP could be used as a helpful hemodynamic variable in cardiac surgery. [13] Based on those studies, it is thought that the surgical environment could lead to pressures lower than those in the catheterization laboratory; still, actual data are not available to confirm this impression. In the present study, although we found pressure changes, we detected no correlations between the values for PAP measured in the catheterization laboratory and the operating room. Our findings revealed that the intraoperative measurement of PAP could not be relied upon for critical decision-makings such as univentricular approaches.
It seems that the factors affecting PAP changes in the operating room are different from those affecting changes in systemic pressure.

CONCLUSIONS

PAP measured during open-heart surgery is different from that measured in the catheterization laboratory, and there is no clear correlation between the 2 measurements.
The intraoperative measurement of PAP should not be relied upon for decision-making, especially with respect to univentricular approaches.

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Conflict of Interest
None to declare

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