A comparison of echocardiography and pulmonary artery catheterization for evaluation of pulmonary artery pressures in pregnant patients with suspected pulmonary hypertension

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OBJECTIVE: This study was undertaken to compare the accuracy of echocardiography versus pulmonary artery catheterization to estimate pulmonary artery pressures in pregnant women with suspected pulmonary hypertension.

STUDY DESIGN: A retrospective chart review was performed between January 1990 and February 2000 for all pregnant patients with cardiac disease. Patients with pulmonary artery pressure values estimated by cardiac catheterization and echocardiography during pregnancy were included. Pulmonary hypertension is defined as pulmonary artery systolic pressure >30 mm Hg.

RESULTS: Twenty-seven patients were included in the study. There was a significant overestimation of the mean pulmonary artery pressure with echocardiography compared with catheterization (55.4 vs 51.1 mm Hg; \( P < .005 \)). Of the 20 patients, pulmonary artery pressure was significantly greater when estimated by echocardiography than when measured by catheterization (59.6 vs 54.8 mm Hg; \( P < .004 \)). Thirty-two percent (8/25) of the patients had pulmonary hypertension when estimated by echocardiography but had normal pulmonary artery pressures on subsequent catheterization.

CONCLUSION: Echocardiography significantly overestimated pulmonary artery pressures compared with catheterization in pregnant patients with suspected pulmonary hypertension. Patients with structural cardiac defects appear to have a significantly greater difference in pulmonary artery pressures. Thirty-two percent of pregnant patients with normal pulmonary artery pressures may be misclassified as having pulmonary artery hypertension when measured by echocardiography alone. (Am J Obstet Gynecol 2001;184:1568-70.)

Key words: Pulmonary hypertension, echocardiography, cardiac catheterization, pregnancy

Pulmonary hypertension is an uncommon complication of pregnancy that carries a risk of significant maternal morbidity and mortality. When pulmonary hypertension is associated with an intracardiac shunt (Eisenmenger’s syndrome), mortality rates approach 50%.1, 2 Pregnancy termination is still recommended for patients with documented pulmonary hypertension. Because of the possibility of serious complications during pregnancy, an accurate diagnosis is essential in counseling the pregnant patient.

Cardiac catheterization remains the criterion standard for the measurement of pulmonary artery pressures. In the nonpregnant patient, noninvasive echocardiography provides a reasonable estimate of pulmonary artery pressures.3-5 Significant hemodynamic changes occur in pregnancy, including increased blood volume, decreased systemic vascular resistance, and decreased blood pressure, which may affect the ability to estimate pulmonary artery pressures by echocardiography. However, cardiac catheterization is an invasive procedure that carries a 1% to 5% risk of complications such as pneumothorax, bleeding, and infection.6, 7 In addition, the presence of structural cardiac defects may also affect the ability to reliably predict pulmonary artery pressures by echocardiography. To date, the accuracy of echocardiography compared with cardiac catheterization in assessing pulmonary artery pressures in the pregnant patient with suspected pulmonary hypertension has not been reported.

Material and methods

Approval for the study was obtained from the Institutional Review Board of the University of California, Irvine. A retrospective chart review was performed for all pregnant patients diagnosed as having cardiac disease admitted to the University of California, Irvine medical center between January 1990 and February 2000. Patients were included if they had documented pulmonary artery pressures by echocardiography and cardiac catheterization in the same pregnancy.
Pulmonary artery pressure was calculated by measuring the peak regurgitant tricuspid Doppler velocity and converting it to a right ventricular to right atrial gradient by the modified Bernoulli equation: Right Ventricular Pressure – Right Atrial Pressure = 4Velocity^2. Mean right atrial pressure was estimated from the degree of collapse of the inferior vena cava with inspiration. Approximately 5 to 10 mm Hg was added if a nondilated (<2 cm) inferior vena cava with complete collapse was seen, 10 to 15 mm Hg was added for a dilated vessel with partial collapse, and 15 to 20 mm Hg was added if no inspiratory collapse was seen.8, 9 Pulmonary hypertension was defined as pulmonary artery systolic pressure >30 mm Hg. Data were analyzed by 2-tailed paired Student \( t \) test with a \( P \) value < .05 considered significant.

Results

One hundred fifty-nine patient charts were reviewed and 33 patients were identified who underwent cardiac catheterization in addition to echocardiography in pregnancy. Five patients could not be included because the pulmonary artery pressure was not quantified by echocardiography. One patient was excluded because a pulmonary artery pressure was not recorded on catheterization. This patient subsequently died of Eisenmenger’s syndrome during her hospitalization. Twenty-seven patients remained for analysis.

Average maternal age was 28.6 years with mean gravidity and parity of 3.2 and 1.5, respectively. The mean gestational age for all patients at delivery was 35.5 weeks’ gestation. The mean gestational age at delivery for patients with confirmed pulmonary hypertension was 34.9 weeks compared with 37.1 weeks for those with normal pulmonary artery pressures (\( P < .005 \)). The mean gestational age at echocardiogram was 27.4 weeks compared with 31.7 weeks at catheterization (\( P < .001 \)). Mean pulmonary artery pressure estimated by echocardiography was significantly higher than values obtained on pulmonary artery catheterization (55.4 ± 25.7 mm Hg vs 51.1 ± 32.2 mm Hg; \( P < .001 \)). In the 20 patients who had structural cardiac defects, echocardiography also significantly overestimated mean pulmonary artery pressures as compared with catheterization (59.6 ± 28.4 mm Hg vs 54.8 ± 35.4 mm Hg; \( P < .004 \)). However, in the 7 patients who had no structural cardiac defects, no significant difference was noted between the 2 measurements (43.4 ± 8.9 mm Hg vs 40.7 ± 18.3 mm Hg).

Twenty of the 27 patients (76%) had structural cardiac defects. Only 4 of these patients had mitral stenosis caused by rheumatic heart disease, the remainder consisted of congenital structural defects. The list of cardiac diagnoses is presented in Table I. Nine of the 27 patients underwent elective cardiac catheterization before labor. Twelve underwent elective catheterization for delivery and the remaining 6 required emergency catheterization for deteriorating maternal status. Two of the 27 patients died during their admission; both had Eisenmenger’s syndrome.

Of the 27 patients included in the study, 25 had evidence of pulmonary artery hypertension on echocardiogram. Of these 25 patients, 8 (32%) had normal pulmonary artery pressures on subsequent catheterization. Two of the 27 patients (7%) had normal pulmonary artery pressures on echocardiography and elevated pulmonary artery pressures on subsequent catheterization. In the subgroup of patients who had structural cardiac abnormalities (\( n = 20 \)), 19 had abnormal pulmonary artery pressures on echocardiogram. Six of these 19 pa-
tients (32%) had no evidence of pulmonary hypertension on catheterization. Similarly, in the group of 7 patients who did not have structural cardiac defects, 6 had elevated pulmonary artery pressures on echocardiography. Two of the 6 patients (33%) had subsequent normal pulmonary artery pressures on catheterization. No complications of pulmonary artery catheterization were identified in any of the 27 patients.

Comment

Pulmonary hypertension in pregnancy is associated with a 30% to 50% chance of maternal death. Therefore accurate diagnosis of pulmonary hypertension in pregnancy is essential to appropriately counsel patients and manage the pregnancy and delivery. The criterion standard for the diagnosis of pulmonary hypertension remains right heart catheterization. However, this is an invasive procedure that carries a 1% to 5% risk of complications such as pneumothorax, bleeding, or infection. Echocardiography is a noninvasive, reliable technique used commonly in nonpregnant patients to assess pulmonary artery pressures.

In this study population, however, echocardiography significantly overestimated actual pulmonary artery systolic pressures. Thirty-two percent of patients were misdiagnosed as having pulmonary hypertension by echocardiography when, in fact, pulmonary artery pressures were normal by catheterization.

Several factors may explain why echocardiography may be less accurate than catheterization in this study. Although pulmonary artery pressures do not change appreciably during pregnancy, other cardiovascular changes have the potential to alter results of tests. The method used in this study to calculate pulmonary artery systolic pressure assumes that the vena cava size is an accurate reflection of right atrial pressure. Doppler echocardiography has been demonstrated to correlate reasonably with catheterization in the nonpregnant patient. However, the increase in blood volume and decrease in systemic vascular resistance that accompany pregnancy may lead to an increase in the size of the vena cava and inflate the estimated right atrial pressure and pulmonary artery systolic pressure. Additionally, many obstetric patients who have elevated pulmonary artery pressures may have coexistent structural cardiac defects that may affect the accuracy of echocardiography by increasing the size and volume load of the right atrium. In fact, 76% of patients in this study had structural cardiac defects and demonstrated a significantly greater difference between echocardiographically estimated and actual pulmonary artery pressures.

Although this is the largest series reported comparing echocardiography and right heart catheterization to estimate pulmonary artery pressures, it is limited by the small sample size of 27 patients. The retrospective nature of the study also affects the reliability of the data collected. The decision to perform invasive monitoring on these pregnant patients was subjective and may not have represented a uniform approach to management. This may represent a selection bias because patients who underwent catheterization may be different from those who were not catheterized. The number of patients who had pulmonary hypertension who did not undergo invasive monitoring is unknown. The effect of gestational age on the accuracy of echocardiography is not known and could not be assessed in this small study. Additionally, it is important to note that the procedures were not performed simultaneously.

This study suggests that echocardiography alone may be unreliable in estimating pulmonary artery pressures in pregnant patients who have cardiac disease. In these patients in whom accurate diagnosis of pulmonary hypertension is crucial to the management of the pregnancy, particularly if termination is to be considered, perhaps cardiac catheterization should be used more liberally.

REFERENCES