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Estimation of pulmonary artery pressure by Doppler echocardiography

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Estimation of pulmonary artery pressure by Doppler echocardiography*

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Mean pulmonary artery pressures were estimated by continuous wave (CW) Doppler echocardiography and compared with those obtained from cardiac catheterization in 13 patients with congenital heart diseases. The acceleration time (AT)/ ejection time (ET) ration correlated with the mean pulmonary artery pressure; the regresssion equation is: mean PA pressure = 107.25 - 219.31 × AT/ET. The correlation coefficient (r) is - 0.75689 (p = 0.003). Estimation of pulmonary artery pressure by Doppler echocardiography is a non-invasive technique with acceptable accuracy. Use of this technique enable the avoidance of cardiac catheterization, which is an invasive procedure.

Key words: *Pulmonary artery pressure, Doppler Echocardiography*

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พีรวัฒน์ ลีประดิษฐารณ, วิโรจน์ สืบหลินวงศ์, จุฑ ทิสยากร, โชติมา ปัทมานันท์, ไพโรจน์ โชติวิทยารากร, พรเทพ เลิศทรัพย์เจริญ, ปรีชา เลาหคุณากร, สุนทร ม่วงมิ่งสุข. การใช้ ด็อพลอร์ เอกโคคาร์ดิโอกราฟฟี เพื่อประมาณค่าความดันของเส้นเลือดแดงสู่ปอด (pulmonary artery pressure) จุฬาลงกรณ์เวชสาร 2538 มกราคม; 37 (1): 7-12

Continuous Wave (CW) Doppler echocardiography เพื่อประมาณค่าเฉลี่ยของความดันของเส้นเลือดในปอดเปรียบเทียบกับการสวนหัวใจในผู้ป่วยเด็กที่เป็นโรคหัวใจพิการแต่กำเนิด 13 ราย ได้ความสัมพันธ์เชิงเส้นระหว่างค่า *acceleration time (AT)/ ejection time (ET)* ของ *pulmonary blood flow* กับค่าเฉลี่ยของความดันของเส้นเลือดในปอด โดยได้ความสัมพันธ์ : $mean\ PA\ pressure = 107.25 - 219.31 \times AT/ET$ โดยค่า *correlation coefficient (r) = -0.75689 (p = 0.003)* การใช้ *Doppler echocardiography* ในการประมาณค่าความดันของเส้นเลือดในปอดเป็น *non-invasive technique* ที่สามารถประมาณได้ถูกต้องพอสมควรโดยไม่ต้องสวนหัวใจ ซึ่งเป็นการตรวจที่ผู้ป่วยจะต้องเจ็บตัว

There have been several studies estimating pulmonary arterial (PA) pressures by Doppler echocardiography compared with PA pressures obtained from cardiac catheterization. M-mode echocardiography has been used for evaluating pulmonary hypertension by abnormal motion of the pulmonary valve, including a small or absent "a" dip,⁽¹⁻³⁾ decreased or negative diastolic slope, rapid opening velocity,^(1,2) partial closure of the valve in mid-systole⁽¹⁻³⁾ and prolongation of the ratio of the right ventricular pre-ejection period (RPEP) to right ventricular ejection time (RVET).^(2,4,5)

Later Doppler echocardiography was used to estimate PA pressures.⁽⁶⁻¹²⁾ Kitabatake⁽⁸⁾ and Kosturakis⁽⁹⁾ found that the acceleration time of right ventricular (RV) ejection flow or acceleration time/RV ejection time correlated well with PA pressure. However, their results differ in several respects. Kosturakis⁽⁹⁾ suggested that the best correlation was between acceleration time and systolic PA pressure, whereas Kitabatake⁽⁸⁾ reported that acceleration time/RV ejection time correlated well with the logarithm of PA mean pressure. In addition, PA pressure could be estimated by the use of the maximum tricuspid regurgitant flow velocity.⁽¹²⁾

The purpose of this study is to compare the PA pressures obtained from continuous Doppler estimation with those from direct measurements during cardiac catheterization.

Materials and methods

Patients : Thirteen patients with congenital heart diseases (3 males and 10 females) admitted to

the Department of Pediatrics, Chulalongkorn Hospital from July 1991 to June 1992, for echocardiography and cardiac catheterization were included in the study. Their ages ranged from 3 to 15 years (mean 8.4 + 3.7 years (standard deviation)). The categories of cases were as follows: secundum atrial septal defect (ASD) six cases, ventricular septal defect (VSD) four cases, secundum ASD and VSD one case, both primum and secundum ASD one case, and single ventricle with normal related great arteries one case.

Continuous Doppler technique : Continuous wave Doppler examinations were performed with Aloka SSD 860. A 3.5 MHz sector scanner was used to identify the main PA in the parasternal long axis view (right ventricular out flow tract). Acceleration time of pulmonary blood flow (AT) – the time to peak flow velocity from Doppler tracings and ejection time (ET) – and the time between the origin and the end of pulmonary blood flow were obtained five times (Figure 1). The data were then averaged. In all cases, the Doppler angle between the ultrasound beam and the long axis of blood flow was within 20 degrees. When the Doppler angle was less than 20 degrees, the error introduced into the peak blood flow velocity measurement was less than 6 per cent of the peak blood flow velocity.⁽¹³⁻¹⁴⁾ Echocardiography was performed on all patients within three days of cardiac catheterization. During this period, there was no change of drug therapy that could alter the hemodynamics of the patients.

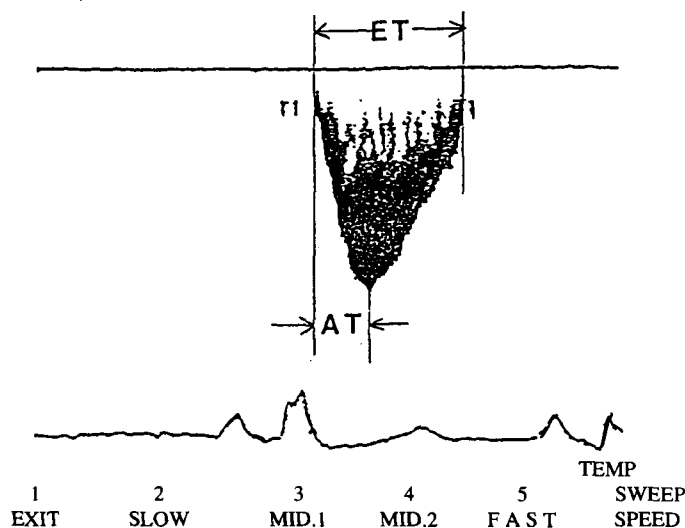


Figure 1. Continuous wave (CW) Doppler signal showed pulmonary blood flow. Acceleration time (AT) and ejection time (ET) of pulmonary blood flow were measured in the manner shown in this figure.

Cardiac catheterizations : Diagnostic right-sided cardiac catheterization was performed in the catheterization laboratory using a Shimadzu C-arm stand (MH 10). All intracardiac and pulmonary arterial pressures were measured with fluid-filled catheters (NIH catheter No.6 or 7, 80 or 100 centi-

meters) and pressure transducers. Mean pulmonary artery pressures were recorded in mm Hg. All of the patients were in sinus rhythm.

Statistical analysis : Simple linear regression analysis was used to assess the correlation between AT/ET and mean PA pressure.

Results

Table 1. Detailed data of each patient.

Diagnosis	Sex	Age (years)	MPAP (mmHg)	AT (sec)	ET (sec)	AT/ET
ASD 1, ASD 2	F	7	19	0.107	0.310	0.345
ASD 2	F	9	25	0.120	0.310	0.387
ASD 2	F	11	18	0.120	0.330	0.364
ASD 2	F	11	68	0.060	0.250	0.240
ASD 2	F	9	57	0.060	0.280	0.214
SV	F	4	54	0.080	0.240	0.333
VSD	M	3	40	0.110	0.340	0.324
VSD	F	7	54	0.080	0.300	0.267
VSD	M	5	52	0.060	0.236	0.254
ASD 2, VSD	F	4	60	0.063	0.257	0.245
ASD 2	F	11	26	0.127	0.323	0.393
VSD	M	14	20	0.130	0.340	0.382
ASD 2	F	15	22	0.093	0.261	0.261
Mean		8.4	39.62	0.093	0.297	0.308
S.D.		3.7	17.71	0.026	0.039	0.061

Abbreviations: ASD 1 = primum atrial septal defect; ASD 2 = secundum atrial septal defect; SV = single ventricle; VSD = ventricular septal defect; F = female; M = male; MPAP = mean pulmonary artery pressure; AT = acceleration time; ET = ejection time; S.D. = standard deviation.

Correlation was made between AT/ET and mean PA pressure using linear regression (Figure 2). The correlation coefficient (r) is -0.75689 ($p = 0.003$).

The standard error of the estimate (S.E.E.) is 12.582 mmHg. The regression equation is: mean PA pressure = $107.25 - 219.31 \times AT/ET$.

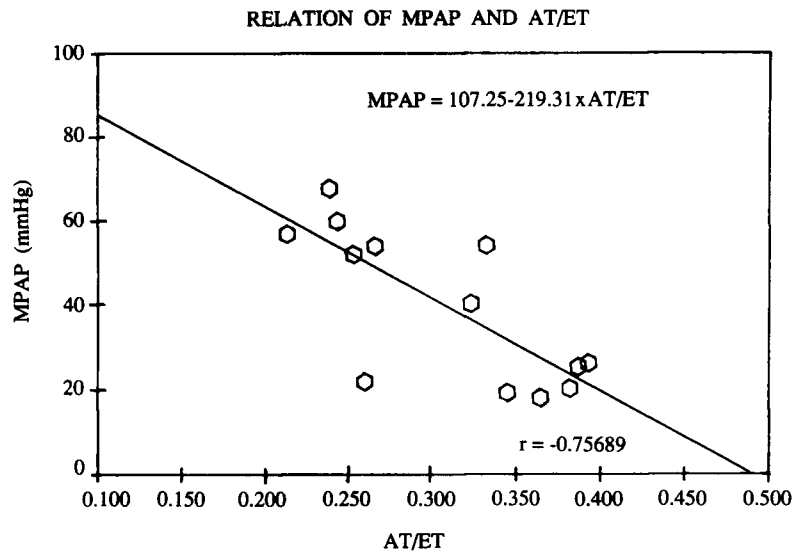


Figure 2. Correlation and linear regression analysis of mean pulmonary artery pressure (MPAP) and acceleration time (AT)/ ejection time (ET) ratio. The regression equation is: $MPAP = 107.25 - 219.31 \times AT/ET$. The correlation coefficient (r) is -0.75689 ($0 = 0.003$). The standard error of the estimate (S.E.E.) is 12.582 mmHg.

The correlation between AT/ET and the logarithm of mean PA pressure was decreased ($r = -0.73232$).

Discussion

The purpose of this study was to estimate PA pressures by continuous wave Doppler echocardiography and try to compare the values obtained to those from direct measurement by cardiac catheterization. In all of the patients studied, no one demonstrated flow velocity pattern with mid-systolic notching which indicated pulmonary hypertension.⁽¹⁵⁾

In this study, patients with pulmonic stenosis were excluded because of prolongation of ejection time leading to the change of AT/ET ratio. Those with d-transposition of the great arteries (d-TGA) were excluded because right and left ventricular activation time were not the same.

There was a negative linear regression correlation between AT/ET and mean PA pressure. Therefore when the value of AT/ET decreased, the value of mean PA pressure increased.

Quantitative evaluation of the severity of pulmonary hypertension by CW Doppler technique has potential advantages. It can be used to perform repeated examinations without any side effects; it can also be used to follow stages in the development of pulmonary hypertension complicating certain

disease processes and to evaluate the effects of therapeutic agents in addition to determine the correct timing for corrective surgery. Post-operative PA pressures can also be followed conveniently.

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References

1. Nanda NG, Gramiak R, Robinson TI, Shah PM. Echocardiographic evaluation of pulmonary hypertension. *Circulation* 1974 Sep; 50(3): 575-81
2. Lew W, Karliner JS. Assessment of pulmonary valve echogram in normal subjects and in patients with pulmonary arterial hypertension. *Br Heart J* 1979 Aug; 42(2): 147-61
3. Weyman AE, Dillon JC, Feigenbaum H, Chang S. Echocardiographic patterns of pulmonic valve motion with pulmonary hypertension. *Circulation* 1974 Nov; 50(5): 905-10
4. Hirschfield S, Meyer R, Schwartz DC, Korfhagen J, Kaplan S. The echocardiographic assessment

- of pulmonary artery pressure and pulmonary vascular resistance. *Circulation* 1975 Oct; 52(4): 642-50
5. Riggs T, Hirschfield S, Borket G, Knate J, Liebman J. Assessment of the pulmonary vascular bed by echocardiographic right ventricular systolic time intervals. *Circulation* 1978 May; 57(5): 939-47
 6. Senecal F, Weyman AE, Pyhel HJ, Dillon JC, Feigenbaum H, Stewart J. Estimation of pulmonary artery pressure by pulsed Doppler echocardiography (abst). *Circulation* 1977 Oct; 56(4): 25
 7. Hatle L, Angelsen BAL, Thremsdal A. Non-invasive estimation of pulmonary systolic pressure with Doppler ultrasound. *Br Heart J* 1981 Feb; 45(2): 157-65
 8. Kitabatake A, Inoue M, Asao M, Masuyama T, Tanouchi J, Morita T, Mishima M, Uematsu M, Shimazu T, Hori M, Abe H. Non-invasive evaluation of pulmonary hypertension by a pulsed Doppler technique. *Circulation* 1983 Aug; 68(2): 302-9
 9. Kosturakis D, Goldberg SJ, Allen HD, Loeber C. Doppler echocardiographic prediction of pulmonary arterial hypertension in congenital heart disease. *Am J Cardiol* 1984 Apr; 53(8): 1110-5
 10. Dabestani A, Mahan G, Gardin JM, Takenaka K, Burn C, Alifie A, Henry WL. Evaluation of pulmonary artery pressure and resistance by pulsed Doppler echocardiography. *Am J Cardiol* 1987 Mar; 59(6): 662-8
 11. Isobe M, Yazaki Y, Takaku F, Koizumi K, Hara K, Tsuneyoshi H, Yamaguchi T, Machii K. Prediction of pulmonary arterial pressure in adults by pulsed Doppler echocardiography. *Am J Cardiol* 1986 Feb; 57(4): 316-21
 12. Yoek PG, Popp RL. Non-invasive estimation of right ventricular systolic pressure by pulsed Doppler ultrasound in patients with tricuspid regurgitation. *Circulation* 1984 Oct; 70(4): 657-62
 13. Steingart RM, Meller J, Barovick J, Patterson R, Herman MV, Teichholz LE. Pulsed Doppler echocardiographic measurement of beat-to-beat changes in stroke volume in dogs. *Circulation* 1980 Sep; 62(3): 542-8
 14. Nishimura RA, Miller FA Jr, Callahan MJ, Benassi RC, Seward JB, Tajik AJ. Doppler echocardiography: Theory, instrumentation, technique, and application. *Mayo Clin Proc* 1985 May; 60(5): 321-43
 15. Tahara M, Tanaka H, Nakao S, Yoshimura H, Sakurai S, Tei C, Kashima T. Hemodynamic determinants of pulmonary valve motion during systole in experimental pulmonary hypertension. *Circulation* 1981 Dec; 64(6): 1249-55