University Heart Journal
Vol. 7, No. 1, January 2011

Validity of Estimation of Pulmonary artery Pressure Using Continuous wave Doppler Echocardiography in Patient with Patent Ductus Arteriosus (PDA)

CHAUDHURY MESHKAT AHMED[1], SOHEL MAHMUD ARAFAT[2], MUHAMMAD KHALED HASAN[3], ABED HUSSAIN KHAN[2], LIMA ASRIN SAYAMI[4], MD. ASHRAF UDDIN SULTAN[1], MD HARISUL HOQUE[1], MANZOOR MAHMOOD[1]

[1]Department of Cardiology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, [2]Department of Medicine, Bangabandhu Sheikh Mujib Medical University, Dhaka, [3]Departemnt of Neurology, Bangabandhu Sheikh Mujib Medical University, Dhaka, [4]National Institute of Cardiovascular Diseases, Dhaka

Address for correspondence: Dr. Chaudhury Meshkat Ahmed, Department of Cardiology, Bangabandhu Sheikh Mujib Medical University, E-mail: mausultan@yahoo.com

Abstract

Pulmonary artery pressure is one of the most important parameter for evaluating the status of pulmonary vascular bed for patients of PDA, which helps in formulating treatment strategy.

This study was carried out in National Institute of Cardiovascular Diseases and Hospital (NICVD) and National Centre for Control of Rheumatic Fever and Heart Diseases, Dhaka, Bangladesh. Pulmonary artery pressure was recorded noninvasively using Doppler echocardiography and the it was correlated with those obtained from haemodynamic studies done at cardiac catheterization. Estimation of pulmonary artery pressure using Doppler derived measurement of pressure gradient across patent ductus arteriosus correlated well with that of simultaneous catheterization measured values. Doppler echocardiography is a cheap, simple, non-invasive bedside test for measuring pulmonary artery systolic and diastolic pressure in patient with PDA.

Keywords: *Patent Duct Arteriosus (PDA), Pulmonary artery pressure, Doppler echocardiography*

Introduction:

Non invasive evaluation of pulmonary artery pressure is one of the most important concerns in clinical cardiology. Several studies have validated the use of Doppler echocardiography in estimating pulmonary artery pressure noninvasively.[1, 2, 3]

With the use of continuous wave Doppler echo-cardiography and modified Bernoulli principles, it has been possible to noninvasively estimate pressure gradients across the patent ductus arteriosus. Brachial artery systolic pressure and brachial artery diastolic pressure as measured by sphygmomanometry can be used as an estimation of aortic systolic pressure and aortic diastolic pressure respectively. Continuous wave Doppler echocardiography derived pulmonary artery systolic and diastolic pressure can, therefore, be evaluated by subtracting calculated systolic pressure gradient and diastolic pressure gradient across the patent ductus arteriosus by continuous wave Doppler echocardiography from brachial artery systolic and diastolic pressure, respectively. Subtraction will give the respective pulmonary artery pressure in patients with left-to-right shunt.

The aims of this study was to estimate pulmonary artery pressure in patients with PDA by Doppler echocardiography and to correlate the parameters obtained from Doppler echocardiography examination with those obtained from hemodynamic studies done at cardiac catheterization.

Materials and methods:

This study was carried out during the period from October, 1993 to July, 1998, at the department of cardiology of the National Institute of Cardiovascular Diseases and Hospital (NICVD), Dhaka, Bangladesh, and National Centre for Control of Rheumatic Fever and Heart Diseases, Dhaka, Bangladesh.

This study was performed on 14 patients who were suffering from PDA admitted to the Department of Cardiology for investigation and/or treatment purpose.

Patients with pulmonary stenosis were excluded from the study.

Echocardiographic studies were performed with ALOKA ECHO CAMERA SSD-870 in the National Centre for Control of Rheumatic Fever and Heart Diseases, Dhaka. Transducers of 2.5mHz and 3.5mHz were used for M-mode and two-dimensional echocardiography. All the patients were examined in supine and 30 degree left lateral decubitus with head elevated using normal pillow, using left

parasternal, apical, subcostal and suprasternal windows.

For obtaining systolic and diastolic pressure gradient across PDA cursor was placed along the ductus in parasternal short axis view. Maximum pressure gradient during systole as gated 12 lead ECG was taken as peak systolic pressure gradient. In the similar way diastolic pressure gradient was obtained from the spectral display.[4,5] Systolic and diastolic blood pressure was measured by sphygmomanometer.

Systolic and diastolic pulmonary pressure was estimated as follows-

PASP= BASP —SPG
PADP= BADP – DPG

Where, PASP= Pulmonary artery systolic pressure
BASP= Brachial artery systolic pressure
SPG= Systolic peak gradient
PADP= Pulmonary artery diastolic pressure
BADP= Brachial artery diastolic pressure
DPG= Diastolic pressure gradient

Right-sided cardiac catheterization was done in all patients. Modified Seldinger method using right or left femoral vein was used in most cases. In 2 patients with high systolic pulmonary artery pressure, right heart catheterization was done by using cutdown technique through right arm according to the procedure recommended by Grossman et al.(1980), L eft heart catheterization and angiography were done in patients by percutaneous modified Seldinger method from groin. All patients followed the formal protocol for cardiac catheterization carried out in the Catheterization Laboratory of NICVD. Pressures were measured by using transducers at the level of mid-axillary line with the patients in horizontal decubitus. Intracardiac pressures of different chambers and great vessels were recorded by a multipurpose biophysical monitoring and recording equipment of San-ei 140 system polygraph. The whole procedure was done under fluoroscopic control.[6]

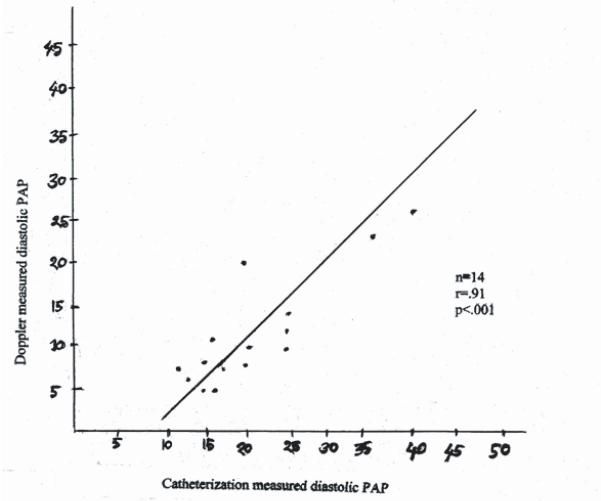
The numerical data obtained from the study were analyzed statistically. Standard error was taken as a measure of variation and the mean of data expressed as mean $\pm$ SE. Pearson simple correlation test was done to obtain correlation coefficient(r) and hence to evaluate significant positive correlation between quantitative parameters obtained by Doppler echocardiographic methods of investigation and haemodynamically derived correlates. Significance of 'r' was determined by finding 'p' value. Regression equation was done also when such significant correlation obtained.

Observations and Results:

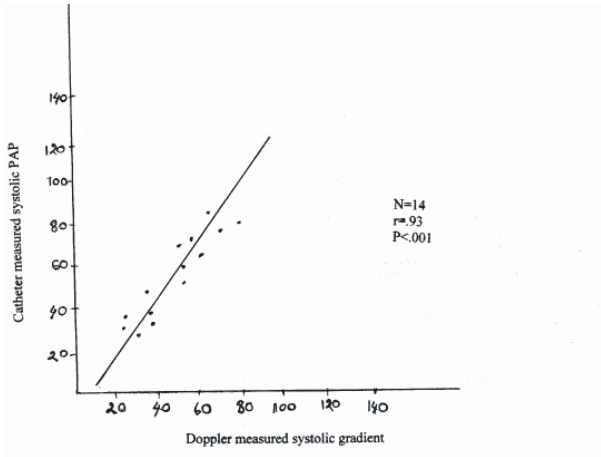
There were 14 patients, 10 male and 4 female, with a male to female ratio 5:2. The age of the patients ranged from 4 to 50 years, with mean of 24 years.

Using continuous wave Doppler echocardiography, we could measure the peak systolic and diastolic pressure gradient across PDA in all patients. The peak systolic and diastolic pressure gradient was correlated with pulmonary systolic and diastolic artery pressure, as measured by cardiac catheterization.

In figure-1 and figure-2 the correlation between Doppler measured pulmonary systolic and diastolic pressure and catheter measured pulmonary artery systolic and diastolic pressure shown there was an excellent correlation between the measurements.[r=0.93 & 0.91 respectively].



Correlation between cardiac catheterization measured diastolic pulmonary artery pressure and CWDE measured diastolic pulmonary regurgitant gradient.



Correlation between cardiac catheterization measured systolic pulmonary artery pressure and CWDE measured Systolic pressure.

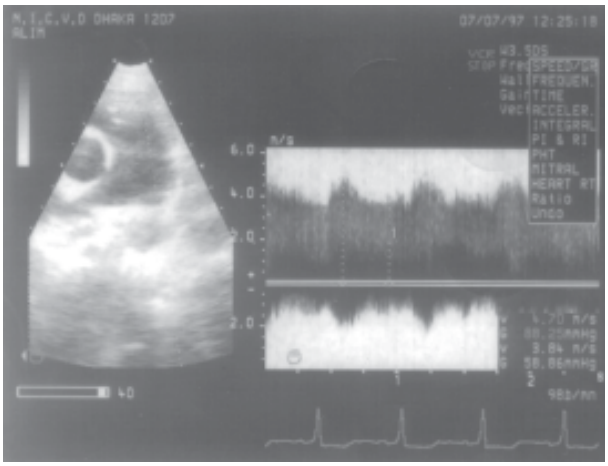


Figure: 2D guided Doppler echocardiography with cursor was placed along the ductus in parasternal short axis view

Discussion:

In our study we have found an excellent correlation between Doppler measured pulmonary pressure and catheter measured pulmonary pressure.

Musewe et al. (1987) with 29 patients having patent ductus arteriosus using ductal velocity as measured for pulmonary artery pressure found a good correlation. Peak instantaneous systolic aortic to main pulmonary arterial pressure gradient and maximum Doppler velocity across the patent ductus arteriosus had correlation coefficient of r=0.94 ($p<0.001$). It was r=0.96 between end diastolic aortic to main pulmonary pressure gradient and minimum Doppler velocity.[5]

While performing similar study in 37 newborns, Musewe et al. (1990) found a significant linear correlation between catheter measured SPAP and pulmonary artery systolic pressure derived from ductal Doppler velocities. In Patients with unidirectional ductal shunting the correlation coefficient was r=0.95($p<0.001$; SEE=8mmHg).[4]

In the same year Sinder (1990) on editorial comment, regarded Doppler spectral tracing obtained from ductus arteriosus especially useful for evaluating the status of pulmonary vascular bed.[7]

Zhiming et al.(1993) used colour Doppler transducer along with continuous wave Doppler to locate the direction of jet flow more accurately in ductus in 26 patients with patent ductus arteriosus. Their estimate of pulmonary artery pressure using Doppler derived measurement of pressure gradient across patent ductus arteriosus correlated well with that of simultaneous catheterization measured values. For systolic pulmonary artery pressure, the correlation coefficient between the Doppler and the catheterization values were r=0.92(SEE=10.3mmHg;Y=0.91 x +3.50) and for diastolic pulmonary artery pressure it was r=0.92(SEE=7.8;y=0.95 x +3.35).[8]

Our results are in concordance with the results of studies done previously.

In conclusion Doppler measured pulmonary systolic and diastolic pressure by using ductal pressure gradient is an useful tools for measuring pulmonary artery systolic and diastolic pressure in patient with PDA.

References:

1. Chan KL, Currie PJ, Seward JB, Hagler DG, Mair DD, Tarik AJ.Comparison of three Doppler ultrasound methods in the prediction of pulmonary artery pressure. J Am Coll Cardio 1987; 9: 549-54.
2. Marx GR, Allen HD, Goldberg SJ. Doppler echocardiographic estimation of Systolic Pulmonary artery pressure in pediatric patients with interventricular communications. J Am Coll Cardiol 1985; 6: 1132-37.
3. Masuyama T, Kodama K,Kitabatake A,Sato H,Nanto S,Inoue M.Continuous wave Doppler Echocardiographic detection of pulmonary regurgitation and its application to noninvasive estimation of pulmonary artery pressure. Circulation 1986;74:484-92.
4. Musewe NN, Smallhorn DPRJF, Hellmen J, Whyte H, Smith B, Freedom RM. Doppler echocardiographic measurement of pulmonary artery pressure from ductal Doppler Velocities in the new born . J Am Coll Cardiol 1990; 15: 446-56.
5. Musewe NN, Smallhorn JF, Benson LN, Burrows PE, Freedom RM. Validation of Doppler derived pulmonary arterial pressure in patients with ductus arteriosus under different hemodynamic states. Circulation 1987; 5: 1081-91.
6. Grossman W. Cardiac Catheterization by direct exposure of artery and vein: Cardiac Catheterization and angiography. 2nd ed. Philadelphia: Lee and Febiger, 1980:p.39.
7. Sinder AR. The Ductus Arteriosus: a window for assessment of pulmonary artery pressure(editorial). J Am Coll Cardiol 1990; 15: 457.
8. Zhiming G, Zhang Y, Fam D, Kong W, Hatle L, Duran C. Simultaneous measurement of pulmonary artery diastolic pressure by Doppler Echocardiography and catheterization in patient with patent ductus arteriosus. Am Heart Journal 1993; 125: 263-65