CHAPTER II

BACKGROUND INFORMATION

Pulmonary artery pressure (PAP)

The pulmonary circulation in human serves many functions , the most important is to provide the blood phase of respiratory gas exchange. Elevation of pulmonary artery pressure can cause from a number and variety of pathological processes and pressure in the pulmonary venous system also plays an important role in determining pulmonary artery pressure. Pulmonary hypertension also is a prominent feature in many patients with mitral stenosis. Persistent elevation of the pulmonary artery pressure in children with VSD may lead to irreversible pulmonary vascular disease (Hoffman and Rudolph, 1965).

It has been shown that patients with severe pulmonary artery hypertension complicated their congenital heart lesion are high risk surgical candidates (Cartmill et al., 1966) and survive longer if corrective surgery is not undertaken (Hallidie et al., 1969). Therefore, it is important to select patients for surgery prior to the development of advanced pulmonary vascular changes.

The accurate measurement of the pulmonary artery pressure requires cardiac catheterization procedure which is invasive and highly specialized technique. This procedure

generally requires hospitalization and are relatively expensive, associates with known complications and not feasible for repeated study. The advantage of a noninvasive technique that can permit serial assessments of the pulmonary artery pressure is appreciated.

Noninvasive assessment of pulmonary artery pressure

Estimation of PAP using noninvasive technique is a major problem for cardiologists for many years. The presence of pulmonary artery hypertension had been assessed by abnormalities in the second heart sound (Haris, Leathem and Sutton , 1968) in electrocardiographic tracing , or in chest x-ray of patient with primary pulmonary hypertension or secondary from pulmonary embolism (Anderson, Reid and Simon, 1973).

Chetty, Brown and Light, 1982 demonstrated a good correlation between PAP and the hilar thoracic index from chest x-ray but the accuracy predicted was only $\pm$ 21 mmHg. Brumstark et al, 1983 reported a technique to determine PCW pressure that would reflect PAP in chronic heart diseases using routine chest x-ray. All of these methods provided only qualitative evaluation or relatively low accuracy and could be detected when there was markedly elevated of PAP.

Bouchard et al, 1985 suggested magnetic resonance imaging (MRI) could be used to evaluate the severity of pulmonary artery hypertension, however it is a very expensive technique and not available in all laboratories.

The development of echocardiography has allowed the investigators to assess the PAP by a noninvasive role and try to determine a quantitative value of PAP.

Echocardiographic determination of PAP

Used of M-mode echocardiography in pulmonic valve abnormalities started in 1972 by Gramiak, Nanda and Shah. After that M-mode echocardiography was widely investigated to measure the PAP. Study of the pulmonic valve motion in pulmonary artery hypertension appeared straight in diastole with rapid opening slopes and prolonged pre-ejection periods, while absence of "a" dip denoted more severe pulmonary artery hypertension (Nanda et al., 1974). Figure 1 shows M - mode echocardiogram in normal pulmonic valve and in pulmonary artery hypertension.

A reduced diastolic slope of the anterior mitral valve leaflet, simulating mitral stenosis was observed in primary pulmonary hypertension (Goodman, Harrison and Popp; 1974) but with normal motion of posterior leaflet. Midsystolic notching or fluttering of pulmonic valve was believed to be good criterias for pulmonary artery hypertension (Weyman, 1974). Others pulmonary artery features include changes in normalized RVPEP, maximal "a" wave excursion , and "b" to "c" slope (Lew and Karliner, 1978).

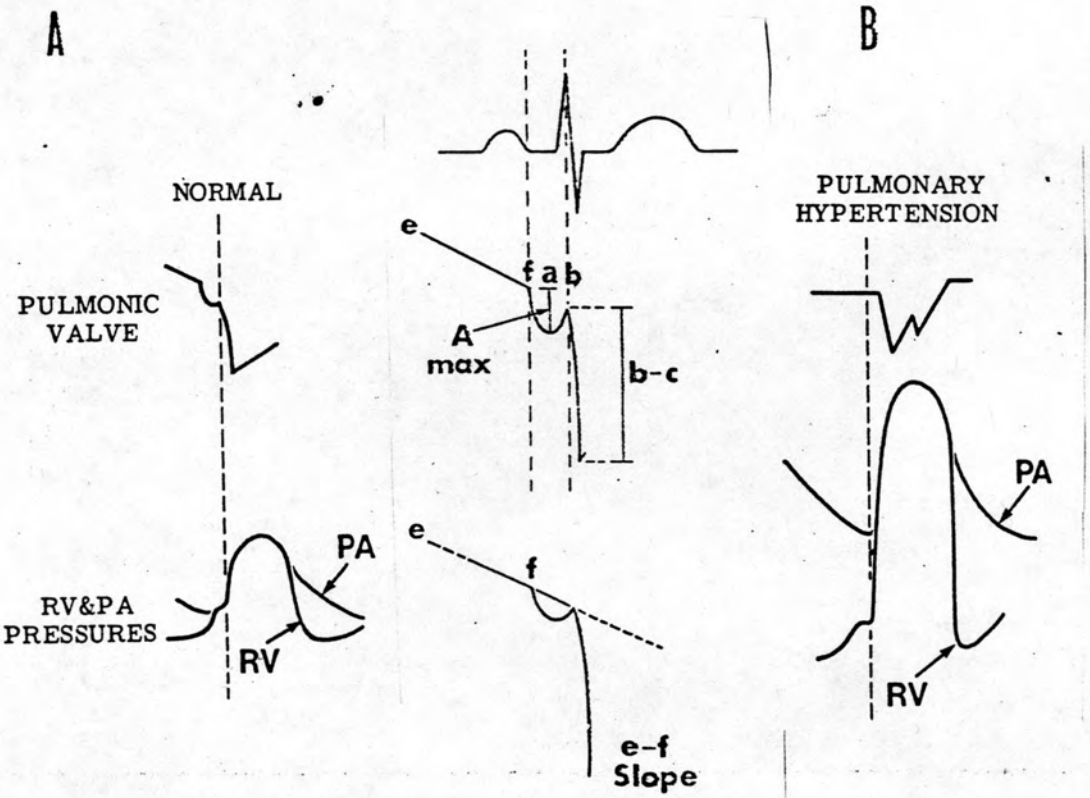

Fig. 1 Diagram of M-mode echocardiography

A. normal pattern

B. pulmonary artery hypertension

Hirschffld et al. (1975) used RVPEP/RVET ratio detected by M-mode echocardiography as the serial evaluation of pulmonary hemodynamic parameters in selected patients. Since then RVSTI was shown a significant correlation with diastolic PAP (Riggs et al, 1977), excepted in the present of CRBBB.

High correlation was again found between the ratio of (RVPEP/RVET)/(LPEP/LVET) and the ratio of pulmonary arteriolar resistance/systemic arteriolar resistance (Spooner et al, 1978).

Previous data had various kinds of parameter that would predict PAP but later on some studies demonstrated that some features in M-mode or 2-D echocardiogram could not indicate pulmonary artery hypertension. Buaman et al, 1979 reported systolic notching of pulmonic valve in the absence of pulmonary artery hypertension. The "a" wave amplitude, diastolic E-F slope or the systolic opening b-c slope were found no significant correlation with pulmonary hemodynamic measurements (Acquatella et al, 1979), but the combination of these features was observed in more advanced degree of pulmonary artery hypertension and was specific but not sensitive for that condition. In experimental animals and in some patients, RVPEP/RVET did not correspond well to simultaneous change in pulmonary artery pressure (Kerber et al, 1979) or compared to pulmonary artery pressure and pulmonary vascular resistance in VSD (Silverman, Snider and Rudolph, 1980).

However, M-mode and 2-D echocardiography may benefit in some entities such as pulmonary artery hypertension due to pulmonary embolism (Kasper et al, 1980), COPD (Zenker, Forche and Harnoncourt, 1985) and in experimental pulmonary artery hypertension (Tahara, 1981).

Contrast echocardiographic features is another technique that may be useful for evaluation of RV hemodynamics in patients with VSD (Server et al, 1978) or to detect pulmonary artery hypertension (Gullace et al, 1981 and Melzer et al, 1983), but this method requires injection of NSS into anticubital vein of the patients that can have pain or some discomfort.

The doppler principle states that the frequency of transmitted sound is shifted when the sound source is moving. The doppler can be used to detect blood flow velocity because blood contains predominantly red cells that reflect or scatter ultrasound and thus can be considered as a sound source, so the doppler shifted frequency detected from the transducer can be calculated to show the velocity of the red cells.

Available of pulsed doppler echocardiography permits evaluation of intracardiac blood flow (Pearlman, 1980) and was reported to be one of the most accuracy in quantitative measurement of pulmonary artery pressure and follow up the patients (Hatle, Angelsen and Tromsdal, 1981). AT and AT/ET were suggested as an indicator for PAP (Ktabatake et al, 1983) and RVPEP/RVAT as well (Isobe et al, 1986) but AT/ET

failed to demonstrated a good correlation in their studies.

The purpose of this study is to investigate various parameters from 2-D echocardiography and pulsed wave doppler technique and may develop an index or a formula that would permit quantitative evaluation of pulmonary artery pressure.