Original Article

Relation Between Capillary Wedge Pressure Measured by Echocardiography Through Tissue Doppler Imaging (TDI) Method and Catheterism in Patients with Mitral Valve Stenosis

Afsoon Fazlinezhad, MD*, Farveh Vakilian, MD, Homa Falsoleiman, MD, Mashallah Dehghani, MD

Ghaem hospital, Mashhad University of Medical Sciences, Mashhad, Iran.

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Abstract

Background: *Considering suggested formula in the references and PCWP measured by catheterism, in the present study the relation between pulmonary capillary wedge pressure (PCWP) measured the flow velocity of mitral valve and mitral annulus motion through tissue doppler imaging is evaluated*

Methods: *52 cases of severe MS were admitted for Balloon Mitral Valvolotomy (BMV) are included in this study. Mean age was 35±5 years consisting of 40 females and 12 males. Valve area, Pulmonary artery systolic pressure (PAP), E (Maximum Velocity of mitral valve at the beginning of diastole) & Em (Maximum rate of mitral annular motion at the beginning of diastole which is recorded through septal or lateral wall annulus site) velocity and left atrial (LA) size were also measured by echocardiography and PCWP & PAP through catheterism. All patients had normal ejection fraction (EF) and coronary arteries; there was no other valvular diseases and shunts.*

Results: *There was a significant correlation between PAP in echocardiography and catheterism. Mean PAP was 53±19 mmHg in echocardiography and 53.9±17.8mmHg in catheterism. There wasn't any correlation between PCWP in echocardiography and catheterism (P=0.33) and also no relation between PCWP and mitral valve area (MVA) or LA size (P=0.2). E/Em ratio increased in severe MS cases.*

Conclusion: *E/Em ratio and suggested formula would overestimate the wedge pressure so echocardiography is not a reliable method for measuring PCWP in severe MS. Em velocity and E/Em ratio may be used for estimating MS severity.*

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Introduction

The prevalence of Valvular disease is changing with the health care promotion and technological progress, but in developing countries, valvular rheumatismal diseases such as mitral stenosis (MS) are still common.

According to the development of noninvasive methods, the evaluation of myocardial and valvular function or PAP is limited to those who are candidates for BMV.[1] Echocardiography is a noninvasive method for evaluating

Corresponding Author:** ***Afsoon Fazlinezhad, *Assistant professor of cardiology, fellowship of echocardiography, Ghaem hospital, Mashhad University of Medical Sciences, Mashad, Iran. P.O.Box: 91375-5636. Tel: +98-511-7298932. Fax: +98-511-8413338. E-mail: fafsoon@hotmail.com.*

myocardial and valvular function. The results of Doppler studies had good correlation with invasive methods such as catheterism.

New methods such as Echocardiography, (TDI) or Tissue Doppler echocardiography) are safe and acceptable. They are accurate methods for assessment of end diastolic pressure and valvular annular motion.[2,3]

The assessment of end diastolic pressure in left ventricle or LA pressure which reflects capillary wedge pressure and diagnosing myocardial systolic dysfunction is one of the TDI applications.[3,4]

Wedge pressure is calculated as follows:

PCWP= 1.9 + 1.24 × E/Em

E= Maximum Velocity of mitral valve at the beginning of diastole (cm/s)

Em= Maximum rate of mitral annular motion at the beginning of diastole which is recorded through septal or lateral wall annulus site (cm/s).[5] Similar findings about PCWP are reported by echocardiography and catheterism.[6]

E/Em ratio is also related to PCWP.[7] E/Em>10 predicts PWCP> 15 mmhg with the sensitivity and specificity of 92% and 80% respectively.[8]

The objective of this study is comparing echocardiography and catheterism findings in PCWP measurement, because PWCP has an important role in MS management.

PWCP has already been measured by catheterism, but nowadays, non invasive methods such as 2D or Doppler and TDI can assess PCWP.[9] But the question is, whether echocardiography can be an alternative for catheterism in PCWP measurement in MS patients or not?

Methods

52 severe MS cases, who were candidate for BMV by INOU balloon, were included in this study. They were 15-65 years old and their mean age was 35±5. This study was done during APR 2005 to Feb 2006. The female and male cases were 40(76.9%) and 12(23.1%) respectively. Demographic data and clinical signs were recorded (Table1). All the patients were studied after their own consent and obtaining the approval of Ethic Committee of Ghaem Hospital. Patients underwent 2D, M mode, Doppler and TDI echocardiography by (Norway ¨C Horton ¨C VIVID3) 24 hours before BMV and catheterism.

All parameters were assessed according to ASE guidelines. 64.4% of the patients had AF rhythm and 35.4% had sinusal rhythm. All factors that may alter PCWP or may increase LA pressure such as EF $\leq$45%, MR $\geq 3^{+}$, other valvular involvement, AI $\geq 3^{+}$, shunts and coronary artery diseases in angiography were excluded. Finally we selected severe MS cases who were candidate of BMV regardless to TR severity.

Echocardiography was done by VIVID3 with 2.5-3^{MHZ} probe in left lateral position and some parameters were evaluated including:

1. Mitral valve area (MVA) by PHT, planimetery, PISA method and continuity equation,as well as Peak E velocity.
2. Valvular anatomical study (PTMC score)
3. LA, LV and RV size and LV, RV function, and LA area by planimetry in 4-ch view
4. TR severity and pulmonary artery pressure (PAP)
5. TDI of mitral annulus and Peak velocity of Em at the medial-side of annulus were measured in 4- chamber view with real time online method, FPS 20-40 /s and evaluation of PCWP through the suggested formula in text.[7-10]
6. In AF patients, all parameters were measured 4-5 times and then for mean evaluation, average of all measures were obtained.
7. Sample volume size was the same at all measurements.

All patients underwent catheterism in 24 hours after echocardiography.

Table 1. Demographic and echocardiographic data

	AGE (Y)	MVA (cm^2)	E (cm/s)	Em (m/s)	LA (cm^2)	E/Em	PA.ECHO (mm Hg)	PA.CATH (mm Hg)	PCWP.ECHO (mm Hg)	PCWP.CATH (mm Hg)
N	52	52	49	51	47	47	52	52	47	49
Mean	38.9	0.9	21.3	6.4	55.6	40.7	53	53.9	53.8	28.7
Median	36	0.9	22	6	56	38	50	50	47.9	25
Mode	35	1	22	4	65	55				
Std. Deviation	13.3	0.3	7.7	2.5	12.3	22.2	19.3	17.8	28.4	15.1
Minimum	16	0.4	6	3	21	7.2	25	26	10.8	12
Maximum	76	2.5	51	12	80	103	130	100	129.6	70

MVA, mitral valve area; E, Early diastolic flow velocity of mitral valve; Em, Early diastolic flow velocity of mitral annular motion by tissue Doppler study; LA, left atrium; PA, pulmonary artery systolic pressure; ECHO, Echocardiography; CATH, Catheterization; PCWP, pulmonary capillary wedge pressure

Coronary angiography was also done in patients older that 40 years or those with more than two coronary artery disease risk factors or suspicious to coronary artery disease.

PCWP, PA pressure, Right ventricle (RV), LV and Aortic pressures were measured by right and left catheterism. LV and Aortic injection were aslo done.

Statistical analysis

Data are presented as mean±SD. Regression analysis is used to relate PCWP with echocardiography measurements. Chi square test was used for comparison of sex and age with our parameters. Levene test was performed for the equality of variances. Pair wise multiple comparison were preformed by Independent T test method and Pearson

Correlations were taken in to considerations. P<=0.05 was considered significant.

Results

52 cases were studied, among of which 40 cases were female (76.9%) and 12 were male (23.1%). So the number of females was significantly more than males (P<0.005). Mean age was 35±5 years (15-65). Mean mitral surface area was 0.9cm^2 (0.4-1.3). Mean E velocity was 210.3 cm/sec (60-510). Mean Em velocity was 6.4cm/sec (3-12). Mean E/Em ratio was 40.7 (7.2-103). Mean LA size in long axis parasternal view was 55^{mm} (21-80). Mean of EF was 55%. Mean LA area is about 28-34cm2

Mean echocardiographic wedge pressure was 53.8 mmHg (10.1-129). Mean catheterism wedge pressure was 23.5 (12-35). Mean echocardiographic PA pressure was 53 mmHg

(25-130) and mean catheterism PA pressure was 53.9 mmHg (26-100) (Table 2).

Comparing PA pressure in echocardiography and catheterism had got a meaningful correlation.

Also, there wasn't any relation between wedge pressure in echocardiography and catheterism (P=0.167).

There was a significant statistical correlation between age and wedge pressure in catheterism but it was lower in older patients. (P<0.05)

Mean E/Em ratio was 40.7 (7-103) and there was a significant relation between the E/Em ratio and mitral valve area. Less MVA was reported in those with more E/Em ratio. (P=0.05)

There wasn't any significant relation between E/Em ratio and LA size (P=0.78), but there was significant correlation between LA area and E/Em (p=0.00). Em was significantly related with MVA (P=0.05) and less Em was seen in those with less MVA.

There wasn't any correlation between LA size and wedge pressure in catheterism (P=0.13), but there was significant relation between LA area and wedge pressure in catheterism (p=0.004) and wedge pressure in echocardiography (P=0.00).

There was a negative correlation between aging and PA pressure in echocardiography.

(P=0.05) There wasn't any significant difference between PA pressure in catheterism in men and women (53±15.7 in men and 51.6±9.6 in women) (Table 3).

There wasn't any significant correlation between Em and LA size (P=0.34).

pressure in catheterism and a higher incidence of AF rhythm was reported in those with upper PA pressure (P=0.005).

There wasn't any correlation between MVA and wedge pressure in catheterism (P=0.5) as

A meaningful correlation was reported between cardiac arrhythmia and wedge well as between PA pressure and PCWP (P=0.33).

Table 2. Evaluation of correlation between PCWP and PAP in echocardiography and catheterism

	echocardiography		Catheterism		t-test for equality of means		
	n	mean±SD	n	mean±SD	t	df	P value
Wedge pressure (mm Hg)	47	53.8±28.4	49	28.7±15.1	5.37	69.4	<0.0001
PA pressure (mm Hg)	52	53±19.3	52	53.9±17.8	0.25	102	0.80

PCWP, pulmonary capillary wedge pressure; PAP, pulmonary artery systolic pressure; PA, pulmonary artery; df, degree of freedom

Discussion

Wedge pressure of MS cases in catheterism and echocardiography were not the same in this study but we can accurately predict PA pressure by echocardiography.

Higher E/Em ratio indicates more severe MS. PCWP was also correlated significantly with E/Em ratio.[10,11]

Table 3. Data analysis according to P. value and Pearson correlation

	Pearson	P. value
Correlation Cath Wedge, Em	0.20	0.167
Cath Wedge, age	-0.239	0.04
Echo Wedge, MVA	-0.279	0.05
MVA, Cath Wedge	0.97	0.50
Cath Wedge, Cath PA	0.141	0.33
Cath Wedge, LA size	0.221	0.136
Cath Wedge LA area	-0.24	0.004
E/Em ,Echo Wedge	0.962	0.00
E/Em ,MVA	-0.27	0.05
E/Em ,LA size	0.43	0.789
E/Em LA area	-0.26	0.00
Em, MVA	0.328	0.19
Em, LA	-0.142	0.34

Cath, Catheterization; Echo, Echocardiography; MVA, mitral valve area; E, Early diastolic flow velocity of mitral valve; Em, Early diastolic flow velocity of mitral annular motion by tissue Doppler study; LA, left atrium; PA, pulmonary artery systolic pressure; PCWP, pulmonary capillary wedge pressure

They considered E/Em>10 as a predictor of PCWP>15 (PCWP=1.55±1.47 E/Em), but in this study, ischemic heart disease and heart failure (HF)cases without mitral valve involvement were assessed.

Patients with HF (NYHA III, IV) were studied in the other trial and better correlation was reported in patients without significant mitral stenosis.[12-13]

No there wasn't any difference between PA pressure and PCWP in both genders. This had also been reported in previous studies.[12] No significant correlation between E/A ratio, deceleration time (Dct) and LVEDP was reported in the other studies for patients with severe mitral regurgitation (MR).[13,14,15] In our study, there was also a non-significant correlation between PCWP and mitral valve flow velocities in severe MS cases (with or without AF).

The lack of such correlation may be due to the LV relaxation, stiffness and dismotility of basal portion of LV in rheumatismal MS and the influence of mitral valve area.

The higher E velocity and lower Em velocity in these cases cause higher E/Em ratio and overestimation of PCWP by using the suggested formula.

But E/Em ratio, PHT and DT are used to predict MS severity. This has been proven in a trial done in Jun 2005[14] but MR wasn't reported in our patients. All of them had moderate to severe rheumatismal MS.

In this study, we found that in older patients, PCWP increased less may be due to greater compliance of LA. Previous studies reported limits for assessment of LA pressure in multi valvular disease by using E/Em[14] and this was also proven in patients with MR.[14,15]

In the other comparison made in 2005,[15,16] it was also mentioned that in organic or primary MR cases we can not predict filling pressure by E/Em ratio because it's so difficult to estimate LV filling pressure in patients with severe MR and normal EF.

Comparing PA pressure in catheterism and echocardiography, significant correlation was seen. We may use PA pressure in echocardiography to estimate accurately PA systolic pressure, even in rheumatismal MS cases with tricuspid insufficiency.

Age and PCWP hadn't already been compared.

In this study, we suggested that E/Em ratio predicts MS severity. E/Em>40±7 was reported in severe MS cases but there wasn't any relation between E/Em and PCWP or LVEDP.

In this article, lower Em was also reported in those with more severe MS.

Almost similar results were reported for patients with AF in other articles. It was found that the raise of PA pressure may increase AF incidence.

This may be explained by the increase of RVEDP and RAP that may be led to atrial repolarisation abnormalities.

This study was done on MS cases only because catheterism was routinely done in candidates of BMV. So we missed MR cases with LV dysfunction. We have studied annular motion in the medial side of septum to assess Em, but it also deems necessary to study lateral septal Em in severe MS cases.

Conclusion

We may estimate MS severity by using E and E/Em ratio but we can't predict PCWP accurately which needs further studies on larger populations.

We saw that PCWP measured by TDI method of echocardiography is overestimated with respect to catheterism data.

On the other hand, Echocardiography is an appropriate method to predict systolic PA pressure in MS cases and may be an alternative for catheterism.

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