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An Evaluating Study Between Pulmonary Capillary Wedge Pressure and Left Atrial Pressure in Patients With Mitral Stenosis

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ABSTRACT

It has remained controversial ever since, with some investigators attesting to the concept that PCWP accurately reflects LAP but others disagreeing, particularly in the setting of mitral valve disease or raised pulmonary vascular resistance. Our study aimed at assessing the correlation between PCWP and LAP in patients with MS in normal sinus rhythm or atrial fibrillation. The trans-mitral gradients obtained with LAP and that obtained with PCWP were also compared. Evaluation were done both before and after the BMV. This analytical study involved Prior Consent from the patients and was found to be within ethical standards. Data was obtained and studied retrospectively. In this study, we included patients with MS admitted to a tertiary care hospital for BMV during a period of last 3 years. Exclusion criteria were significant chronic respiratory illness or aortic valve disease. Baseline data were collected regarding demographic and clinical characteristics, electrocardiogram, chest X-ray manifestations, and echocardiographic features. There was no significant difference between mean LAP -21.13(9.2 mmHg) and mean PCWP -22.21 (9.4 mmHg) before BMV. Post BMV also, similar result was obtained with a mean LAP 15.2 (7.8mm of Hg) and mean PCWP 17.18 (7.5 mm of Hg). There was good correlation between the mean PCWP and mean LAP before BMV ($r = 0.94$) ($p<0.001$) and after BMV ($r = 0.84$) ($p<0.001$). The phasic components of the pressures of LAP and PCWP also showed good correlation before and after BMV. Comparison of mean LAP, mean PCWP and phasic components is shown in Table 2. Furthermore, trans-mitral gradients assessed by LA–LV and PCWP–LV pressures showed excellent correlation before BMV ($r = 0.95$) ($p<0.001$) and after BMV (0.95) ($r = p<0.001$).In patients with MS, PCWP shows good correlation with LAP. Trans-mitral gradients obtained with phase-adjusted PCWP and LAP also correlate well before and after BMV. Hence, PCWP can be used for reliable measurement of trans-mitral gradient.

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Key Words
Pulmonary capillary wedge pressure, left atrial pressure, mitral stenosis, atrial fibrillation, BMV

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INTRODUCTION

It has been observed that simultaneous measurements of left atrial pressure (LAP) and left ventricular diastolic pressure (LVDP) is the ideal method for determination of the mean mitral valve gradient in patients with mitral stenosis (MS). But many invasive laboratories use pulmonary capillary wedge pressure (PCWP) instead of LAP because of the inherent risks of trans-septal catheterization[1,2]. It has remained controversial ever since, with some investigators attesting to the concept that PCWP accurately reflects LAP[3,4] but others disagreeing, particularly in the setting of mitral valve disease or raised pulmonary vascular resistance[5-8].

Two previous studies have argued against the use of PCWP in patients with MS and prosthetic mitral valves, because a clinically significant overestimation of true transmitral gradient may result[9,10]. This was attributed to inherent delay in PCWP traces[10]. In a subsequent study, it was observed that time-adjusted PCWP accurately reflects LAP; however, transmitral gradient was overestimated even after correcting the phase lag in PCWP traces[5]. Without correction for the delay in PCWP trace, there was 53% overestimation of transmitral gradient. Correction of this delay decreased the error, though some overestimation persisted[11]. However, recently in a study by Krishnamurthy *et al*. it was found that after correction for the phase lag, transmitral gradient obtained using PCWP was comparable to that obtained using LAP both before and after balloon mitral valvotomy (BMV)[12].

The accuracy of the pulmonary arterywedge pressure as a reflection of the left atrial pressure in man has been studied with conflicting results hence the present study was prompted by the disparities seen in various previous studies. Our study aimed at assessing the correlation between PCWP and LAP in patients with MS in normal sinus rhythm or atrial fibrillation. The trans-mitral gradients obtained with LAP and that obtained with PCWP were also compared. Evaluation were done both before and after the BMV.

MATERIALS AND METHODS

This Analytical study involved Prior Consent from the patients and as found to be within ethical standards. It was conducted among patients admitted to or attending to various Cardiac Units of tertiary medical care institutes/hospitals in C.G. Data was obtained and studied retrospectively. In this study, we included patients with MS admitted to a tertiary care hospital for BMV during a period of last 3 years. Exclusion criteria were significant chronic respiratory illness or aortic valve disease. Baseline data were collected regarding demographic and clinical characteristics, electrocardiogram, chest X-ray manifestations and echocardiographic features. It was observe that in all the selected cases procedure was done in fasting state. Through femoral vein access, a 6F Cournand catheter was positioned in the pulmonary artery under fluoroscopic guidance and pulmonary artery pressures were recorded. The catheter was then pushed into the left lower pulmonary artery in each case as far as possible during deep inspiration and PCWP was obtained. For measuring LVDP, A 6F pigtail catheter was placed retrogradely into the left ventricle. Catheter over-damping and under-damping were avoided and the shortest possible transducer connection was used. PCWP was accepted only when: (1) the pressure contour was distinctly different from that recorded in the pulmonary artery on a pullback determination and both the phasic and mean wedge pressures were lower than that of the pulmonary artery, (2) there was fluoroscopic demonstration of wedge position and (3) there were two separate a and v waves in the tracing.

It was observed that in the selected cases Trans-septal left heart catheterization was performed percutaneously through the right femoral vein using Brock- enbrough needle and a transseptal catheter introducer set. An 8F transseptal sheath was placed in the left atrium. Simulta- neous PCWP and LAP (mean and phasic) were recorded. Following this LA–LV and PCWP-LV gradients were recorded. Patients underwent MV by the method described by Inoue *et al*.[3] Similar measurements were repeated after BMV. To correct the phasic delay in PCWP trace, pressure tracing was manually shifted so that the peak of the v wave of

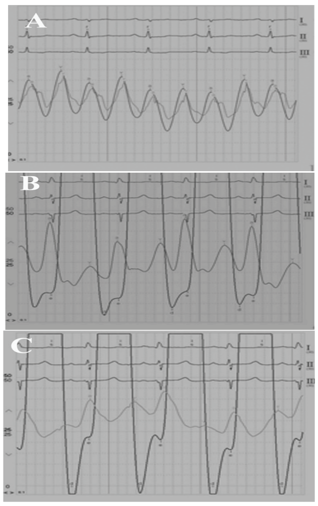

Fig. 1: Representative hemodynamic tracings. (A) Simultaneous left atrial and pulmonary capillary wedge pressure tracings (B) Simultaneous left atrial and left ventricular pressure tracings. (C) Simultaneous pulmonary capillary wedge and left ventricular pressure tracings

Table 1: Baseline characteristics(n = 50)

Age, years, mean (SD)	**44.5 (13.5)**
Male/female n (%)	20 (40)/30 (60)
Atrial fibrillation, n (%)	10 (20%)
Mitral valve area, cm2, mean (SD)	0.912 (0.143)
Left atrial diameter, mm, mean (SD)	45.18 (8.12)

SD: standard deviation.

Table 2: Comparison of PCWP and LAP

	LAP (mmHg)	PCWP (mmHg)	Correlation	p-value
Before BMV				
a wave mean (SD)	20.90 (14.8)	20.82 (13.8)	0.941	<0.001
v wave mean (SD)	27.52 (12.2)	27.70 (11.6)	0.921	<0.001
Mean (SD)	21.13 (9.2)	22.22 (9.4)	0.940	<0.001
After BMV				
a wave	14.4 (9.7)	17.27 (10.9)	0.848	<0.001
v wave	21.36 (10)	21.67 (8.3)	0.906	<0.001
Mean	15.20 (7.8)	17.18 (7.5)	0.840	<0.001

BMV: balloon mitral valvotomy, PCWP: pulmonary capillary wedge pressure corrected for phase lag; LAP: left atrial pressure, SD: standard deviation.

Table 3: Comparison of transmitral gradients assessed by PCWP and LAP

	LAP-LVDP (mmHg)	PCWP-LVDP (mmHg)	Correlation	p-value
Before BMV, MG (SD)	14.63 (6.7)	16.43 (6.3)	0.950	<0.001
After BMV, MG (SD)	10.21 (5.3)	11.53 (5.3)	0.951	<0.001

BMV: balloon mitral valvotomy, PCWP: pulmonary capillary wedge pressure corrected for phase lag, LAP: left atrial pressure, MG: mean gradient, LVDP: left ventricular diastolic pressure, SD: standard deviation.

PCWP coincided with the descending limb of the left ventricular pressure tracing. The mean transvalvular pressure gradients were determined from the measured diastolic filling periods after planimetry of three consecutive beats (in patients with sinus rhythm) or 5 consecutive beats (in patients with atrial fibrillation).

Data was filled in Microsoft Excel analyzed using the Statistical Package for Social Sciences (SPSS) for Windows version 23 and computer software Epi Info version 6.2 (Atlanta, Georgia, USA). Qualitative variables, expressed as numbers and percents, were compared by the Chi-square test. A $p<0.05$ was considered statistically significant. Correlation was assessed with Pearson's correlation coefficient. For unpaired observations quantitative and qualitative data were confirmed to be parametric and analyzed with student t test and Fisher exact test respectively. For paired observations (before and after treatment) paired t test was used for quantitative data and Mc Nemar's test was used for qualitative data.

RESULTS AND DISCUSSIONS

There were 50 patients with a mean age of 44.5 years [males 20 (40%), females 30 (60%)]. Baseline patient characteristics are listed in Table 1. There was no significant difference between mean LAP -21.13 (9.2 mmHg) and mean PCWP -22.21 (9.4 mmHg) before BMV. Post BMV also, similar result was obtained with a mean LAP 15.2 (7.8mm of Hg) and mean PCWP 17.18 (7.5 mm of Hg). There was good correlation between the mean PCWP and mean LAP before BMV ($r = 0.94$) ($p<0.001$) and after BMV ($r = 0.84$) ($p<0.001$). The phasic components of the pressures of LAP and PCWP also showed good correlation before and after BMV. Comparison of mean LAP, mean PCWP and phasic components is shown in Table 2. Furthermore, trans-mitral gradients assessed by LA-LV and PCWP-LV pressures showed excellent correlation before BMV ($r = 0.95$) ($p<0.001$) and after BMV (0.95) ($r = p<0.001$).

The concept of PCWP as a reflection of LAP was introduced half a century ago[4]. It has remained controversial ever since, with some investigators attesting to the accuracy of the relation3 4]but others disagreeing, particularly in the setting of mitral valve disease or raised pulmonary vascular resistance[5-8]. Luchsinger *et al*.[15] investigated[11] patients with mitral valve disease and found that mean PCWP consistently exceeded mean LAP. Other investigators also questioned the accuracy of the relation between PCWP and LAP.16 In a retrospective analysis of 700 cases by Walston and Kendell,17 it was found that correlation between PCWP and LAP was lower in MS than in other disorders. In our study, mean PCWP and mean LAP correlated well both before and after BMV. The correlation was good for the phasic components (a and v waves) also.

Two studies have argued against the use of PCWP in patients with MS and prosthetic mitral valves because a clinically significant overestimation of the true transmitral gradient may result. Hosenpud *et al*.[9] noted that when LVDP was measured against PCWP rather than transseptal LAP, mean diastolic transmitral gradient was overestimated. This difference, later by Shoenfeld *et al*.[10] was attributed to inherent delay in PCWP traces. Subsequently, Lange *et al*.[5] in a study of 10 patients tried to rectify this delay in PCWP trace. Here, the inherent delay in PCWP trace was compensated by using a time-adjusted PCWP. This study concluded that phase- adjusted PCWP accurately reflected LAP. However, transmitral gradient was overestimated even after correcting the phase delay. Hildick-Smith *et al*.[18] found that mean PCWP correlated well with LAP in MS. However, transmitral gradient assessed using PCWP varied significantly from that assessed using LAP due to the phasic delay in PCWP trace and the dampened post v-wave descent. Nishimura *et al*.[11] agreed with these findings and demonstrated that without correction for the delay in PCWP trace, there was 53% overestimation of transmitral gradient. Correction of this delay decreased the error, but still some overestimation persisted.

In contrast, a recent study by Krishnamurthy *et al*.[12] found that after correction for the phase lag, transmitral gradient obtained with PCWP was comparable to that obtained using LAP, both before and after BMV. Another recent study by Nagy *et al*.[19] found that PCWP accurately reflects both normal and elevated LAP. In our study, transmitral gradients obtained using phase lag adjusted PCWP was comparable to that obtained using LAP. This finding in our study agreed with the study by Krishnamurthy et al. We eliminated the phase lag of PCWP by time correction. Our study evaluated gradients both before and after BMV in the whole sample.

There were some limitations in our study. We did not use the ideal method of oximetric confirmation for the catheter wedging. Further studies are needed to demonstrate whether good correlation exists between phase lag adjusted PCWP and LAP in patients with MS and concomitant severe pulmonary hypertension.

CONCLUSION

In patients with MS, PCWP shows good correlation with LAP. Trans-mitral gradients obtained with phase-adjusted PCWP and LAP also correlate well before and after BMV. Hence, PCWP can be used for reliable measurement of trans-mitral gradient.

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REFERENCES

1. Grossman, W., 1986. Cardiac Catheterization and Angiography. 3rd Ed. Edn., Lea and Febiger, Philadelphia, Philadelphia, USA., Pages: 562.
2. Conti, C.R. and R.S. Ross, 1969. The risks of cardiac catheterization (editorial). Am. Heart J., 78: 289-291.
3. Ames, W.H., E.O. Theilen, J.L. Ehrenhaft and J.W. Culbertson, 1952. Study of left atrial pressures in relation to pulmonary capillary pressure waves in patients with mitral stenosis. J. Clin. Invest., 31: 614-619.
4. CONNOLLY, D.C., J.W. KIRKLIN and E.H. WOOD, 1954. The relationship between pulmonary artery wedge pressure and left atrial pressure in man. Circ. Res., 2: 434-440.
5. Lange, R.A., D.M. Moore, R.G. Cigarroa and L.D. Hillis, 1989. Use of pulmonary capillary wedge pressure to assess severity of mitral stenosis: Is true left atrial pressure needed in this condition? J. Am. Coll. Cardiol., 13: 825-829.
6. ANKENEY, J.L., 1953. Further experimental evidence that pulmonary capillary pressures do not reflect cyclic changes in left atrial pressure (mitral lesions and pulmonary embolism). Circ. Res., 1: 58-61.
7. HADDY, F.J., J.F. ALDEN, A.L. FERRIN, D.W. HANNON, W.L. ADAMS and I.D. BARONOFSKY, 1953. An evaluation of wedge pressures in dogs under conditions of normal and elevated pulmonary vascular pressures. Circ. Res., 1: 157-161.
8. MURPHY, J.P., 1958. Inaccuracy of wedge pressure as an index of pulmonary capillary pressure. Circulation, 17: 199-203.
9. Hosenpud, J.D., J.H. McAnulty and M.J. Morton, 1983. Overestimation of mitral valve gradients obtained by phasic pulmonary capillary wedge pressure. Cathet. Cardiovasc. Diagn., 9: 283-290.
10. Schoenfeld, M.H., I.F. Palacios, A.M. Hutter, S.S. Jacoby and P.C. Block, 1985. Underestimation of prosthetic mitral valve areas: Role of transseptal catheterization in avoiding unnecessary repeat mitral valve surgery. J. Am. Coll. Cardiol., 5: 1387-1392.
11. Nishimura, R.A., C.S. Rihal, A.J. Tajik and D.R. Holmes, 1994. Accurate measurement of the transmitral gradient in patients with mitral stenosis: A simultaneous catheterization and doppler echocardiographic study. J. Am. Coll. Cardiol., 24: 152-158.
12. Krishnamoorthy, K.M., S. Radhakrishnan and S. Shrivastava, 1999. Simultaneous echocardiographic and catheterisation gradients and mitral valve area during balloon mitral valvulolasty. Indian Heart J., 51: 410-413.
13. Inoue, K., T. Owaki, T. Nakamura, F. Kitamura and N. Miyamoto, 1984. Clinical application of transvenous mitral commissurotomy by a new balloon catheter. J. Thorac. Cardiovasc. Surg., 87: 394-402.
14. Hellems, H.K., F.W. Haynes, L. Dexter and T.D. Kinney, 1948. Pulmonary capillary pressure in animals estimated by venous and arterial catheterization. Am. J. Physiol., 155: 98-105.
15. Luchsinger, P.C., H.W. Seipp and D.J. Patel, 1962. Relationship of pulmonary artery wedge pressure and left atrial pressure in man. Circ. Res., 11: 315-318.
16. Verel, D. and N.H. Stentiford, 1970. Comparison of left atrial pressure and wedge pulmonary capillary pressure. pressure gradients between left atrium and left ventricle. Br. Heart J., 32: 99-102.
17. Walston, A. and M.E. Kendall, 1973. Comparison of pulmonary wedge and left atrial pressure in man. Am. Heart J., 86: 159-164.
18. Hildick-Smith, D.J.R., J.T. Walsh and L.M. Shapiro, 2000. Pulmonary capillary wedge pressure in mitral stenosis accurately reflects mean left atrial pressure but overestimates transmitral gradient. Am. J. Cardiol., 85: 512-515.
19. Nagy, A.I., A. Venkateshvaran, P.K. Dash, B. Barooah, B. Merkely, R. Winter and

A. Manouras, 2014. The pulmonary capillary wedge pressure accurately reflects both normal and elevated left atrial pressure. Am. Heart J., 167: 876-883.

20. Levin, R.I. and E. Glassman, 1985. Left atrial-pulmonary artery wedge pressure relation: Effect of elevated pulmonary vascular resistance. Am. J. Cardiol., 55: 856-857.