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Short Term Effect of Percutaneous Mitral Commissurotomy on P Wave Dispersion in Patients with Mitral Stenosis

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Abstract

Background: Percutaneous mitral commissurotomy now has emerged as the treatment of choice for severe pliable rheumatic mitral stenosis with good immediate hemodynamic outcome, low complication rates, and clinical improvement. P-wave dispersion (PWD) is a noninvasive (ECG) marker for atrial remodeling and predictor for atrial fibrillation. Effect of PMC on risk of atrial fibrillation is not well studied.

Aim of Study: To evaluate the effect of percutaneous mitral commissurotomy on P wave dispersion to assess the risk of atrial fibrillation.

Patients and Methods: This study is a prospective study which was on 36 patients with significant mitral stenosis (MV Area less than 1.5cm ^{2}) presenting to Cardiology Department at Ain Shams University Hospital at 2022, all patients underwent PMC and ECG before PMC, 24 hours after PMC and two months after PMC.

Results: The comparison of MVA, PWD and LA volume before, 24 hours postoperatively and at two months follow-up after PMC, showed that there was significant increase in MVA at 24 hours postoperatively from (0.87 ±0.2cm^2) to (2.01 ±0.21cm^2) p-value <0.001. P wave dispersion (PWD) showed significant decrease 24 hours after PMC from (63.33 ±11.71ms) to (51.39±9.23ms) after 24 hours and to (39.31 ±11.03ms) two months after PMC p-value <0.001. Also, left atrial volume (LA volume) showed significant decrease from (113.19 ± 21.6ml) to (102.22±21.87ml) 24 hours after PMC and to (88.75±21.04ml) two months after PMC p-value <0.001. P wave dispersion (PWD) decreased in 27 patients (75%) 24 hours after PMC and in 33 patients (91.7%) after two months after PMC among suited patients.

Conclusion: Percutaneous mitral commissurotomy was safe and effective in the treatment of mitral stenosis, it was associated with significant reduction in P-wave dispersion and left atrial volume and increase in mitral valve area as well as reduced risk of atrial fibrillation.

Key Words: *Mitral stenosis (MV) – Atrial fibrillation (AF) – Percutaneous Mitral Commissurotomy – P Wave Dispersion (PWD).*

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Introduction

RHEUMATIC heart disease remains a considerable cause of cardiovascular morbidity and mortality in developing countries where two thirds of world's population lives.

Millions of children and young adults have rheumatic heart disease and nearly a third of these have mitral stenosis. Rheumatic heart disease is the etiology of mitral stenosis in most of the patients **[1]**.

Patients with mitral stenosis have prolonged P-wave duration and increased P-wave dispersion (PWD). P-wave duration and PWD increase progressively in accordance with the progression of mitral stenosis **[2]**.

P-wave dispersion (PWD) is a noninvasive electrocardiographic (ECG) marker for atrial remodeling and predictor for atrial fibrillation (AF) **[3]**.

The prolongation of intraatrial and interatrial conduction time and the inhomogeneous propagation of sinus impulses have been shown in patients with atrial fibrillation. These are well known electrophysiologic characteristics in patients with paroxysmal atrial fibrillation (AF) **[4]**.

Atrial fibrillation is a complication of mitral valve stenosis that causes several adverse neurologic outcomes **[5]**.

Percutaneous mitral commissurotomy (PMC) has been used successfully as an alternative to open or closed surgical mitral commissurotomy in the treatment of symptomatic rheumatic mitral stenosis. PMC produces good immediate hemodynamic outcome, low complication rates, and clinical improvement in the majority of patients. Percutaneous mitral commissurotomy is safe and effective

and provides clinical and hemodynamic improvement in rheumatic mitral stenosis. Percutaneous mitral commissurotomy is the preferred form of therapy for relief of mitral stenosis for a selected group of patients with symptomatic mitral stenosis **[6]**.

In this study, we aimed to evaluate the effect of percutaneous mitral commissurotomy on P wave dispersion to assess the risk of atrial fibrillation .

Patients and Methods

This study was a prospective study which was conducted on 36 patients with significant mitral stenosis (MV Area less than 1.5cm^2) presenting to Cardiology Department at Ain Shams University Hospital.

Inclusion criteria:

Moderate to severe mitral valve stenosis, mitral valve area less than 1.5cm^2, pliable mitral valves, symptomatic patients, patients with sinus rhythm.

Exclusion criteria:

Patient of history of paroxysmal atrial fibrillation, patients who developed atrial fibrillation and underwent cardioversion, left atrial thrombus, patients with mild mitral stenosis, more than mild mitral regurgitation, sever or bi-commissural calcification, absence of commissural fusion, concomitant aortic valve disease or tricuspid valve disease requiring surgery, concomitant coronary artery disease requiring CABG and unfavorable characteristics for PMC.

All patients were subjected to the following:

History taking:

Proper history taking was done to document patient's age, weight, and height, past history of rheumatic fever, presence of symptoms such as shortness of breath, palpitation, chest pain and hemoptysis, medications taken by the patient including anticoagulation.

Clinical examination:

Proper clinical examination was done to detect vital data including heart rate, rhythm and presence of murmurs.

12 Lead Surface ECG:

It was performed to exclude patients with arrhythmias or evidence of previous myocardial infarction.

12 leads of ECG on paper speed of 50mm/s amplitude at 20mm/mV was done before PMC, 24 hours after PMC and two months after PMC to measure PWD in each phase.

It was obtained from each patient in supine position following 15min of rest and room temperature and lighting kept constant.

Echocardiographic Assessment: The following measurements were obtained:

1- LV end diastolic diameter (EDD) and LV end systolic diameter (ESD).

2- LV end diastolic volume (EDV) at onset of QRS complex, and LV end systolic volume (ESV).

3- Left ventricular ejection fraction (LVEF).

4- Left Atrial dimensions and volumes: The anteroposterior diameter of the left atrium was measured in the parasternal long-axis view using M mode perpendicular to the aortic root long axis at the level of the aortic sinuses by using the leading-edge to leading-edge convention. 2D volumetric measurements were done via tracings of the blood tissue interface on apical four- and two-chamber views **[7]**. At the mitral valve level, the contour is closed by connecting the two opposite sections of the mitral annulus with a straight line. Endocardial tracing excluded atrial appendage and pulmonary veins. left atrial volume was measured before PMC, 24 hours after PMC and two months after PMC.

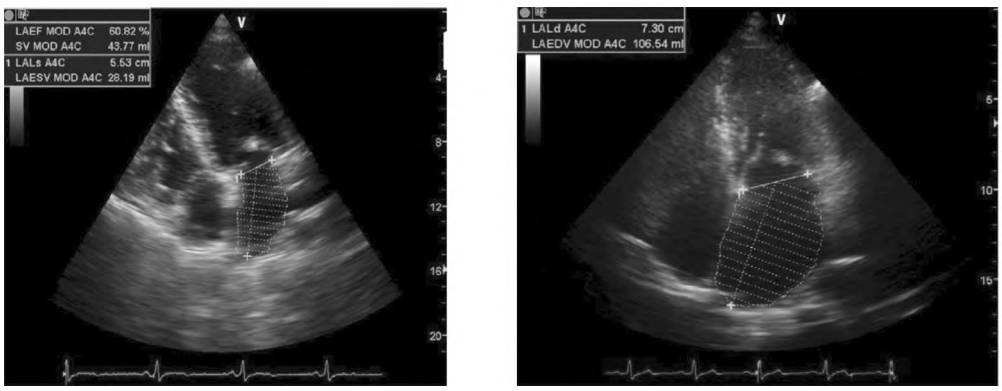

Fig. (1): Left atrial (LA) assessment. LA volume was measured from B-mode recordings in apical 4-chamber view (left) and 2-chamber view right.

5- Wall motion abnormality: Using 2D echocardiography in apical and parasternal windows, all patients with resting segmental wall motion abnormalities were excluded from the study.

6- Assessment of mitral valve: Mitral valve assessment with echocardiography included the pattern of valve involvement and calcification, severity of stenosis, associated mitral regurgitation and other co-existent valve lesions and atrial chamber dilatation and function. Echocardiography assessed the Subvalvular apparatus changes such as thickening, shortening, fusion of chordal and calcification (Fig. 2) **[8]**.

A- *Evaluation of the Degree of Mitral Stenosis:*

1- Planimetry:

Direct planimetry of mitral valve area was our reference method to evaluate mitral stenosis severity. 2D planimetry was performed in the parasternal short-axis view. It involves tracing the inner edge of the mitral valve orifice in mid diastole. The measurement has to be made at the leaflet tips, ensuring the narrowest valve orifice **[9]**. (Fig. 3).

2- Pressure Half-Time (PHT):

PHT refers to the time required for the peak mitral gradient to drop by one half. The more severe the stenosis, the slower the left ventricle will fill and the longer the time required for the transmitral gradient to decrease. PHT has been empirically correlated with mitral valve area with the Hatle formula: mitral valve area = 220/PHT. From the practical point of view, PHT is obtained by tracing the deceleration slope of the E wave. Thus, an accurate recording of the continuous wave Doppler diastolic mitral inflow should be obtained **[10]** (Fig. 4).

3- Mean pressure gradient across the mitral valve:

Mean pressure gradient across mitral valve was measured in apical views. The gradient was measured by tracing the dense outline of mitral diastolic inflow and the mean pressure gradient is automatically calculated. The severity can be assessed as mild (<5), moderate (5-10) and severe (>10) **[11]**.

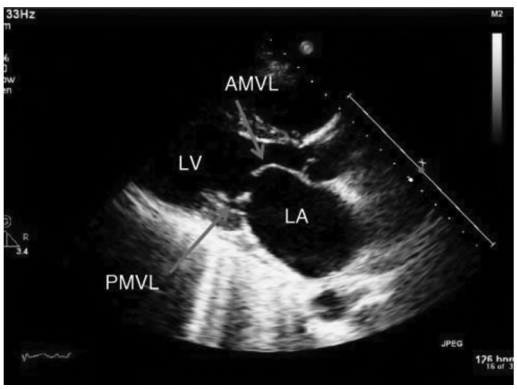

Fig. (2): Parasternal long axis view in diastole, showing diastolic doming (hockey-stick shape) of anterior mitral valve leaflet (AMVL) and thickened, restricted posterior mitral valve leaflet (PMVL). RV = Right ventricle, LV = Left ventricle, LA = Left atrium.

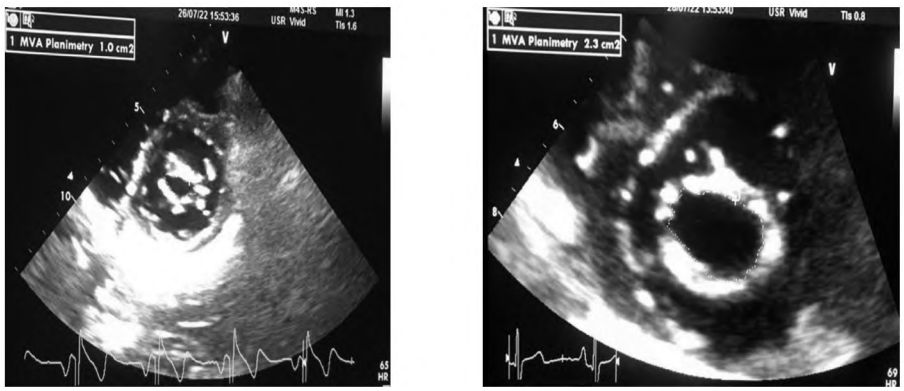

Fig. (3): Parasternal short axis view of the mitral valve at the level of the tips to measure mitral valve area (MVA) by planimetry before (right) and after (left) PMC.

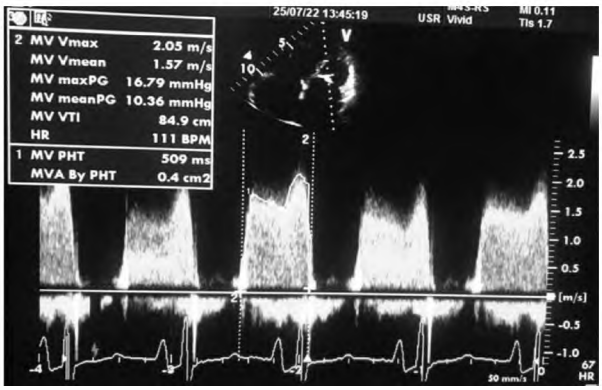

Fig. (4): Calculation of the mitral valve area (MVA) by the method of pressure half-time (P1/2t).

B- *Assessment of Wilkins score:*

Suitability of mitral valve for percutaneous mitral commissurotomy is based on echocardiographic findings. Scoring systems have been developed to help with this task. The Wilkins score was the accepted score for criteria for patient selection. Wilkins score. The total score is the sum of the items (ranging from 4 to 16) (Table 1) **[12]**.

Table (1): Grading of mitral valve characteristics from the echocardiographic examination according to Wilkins score.

Grade	Mobility	Thickening	Subvalvular thickening	Calcification
1	- High mobile valve with only leaflet tips restricted	- Leaflets near normal in thickness (4-6mm)	- Minimal thickening just below the mitral leaflets	- A single area of increased echo brightness
2	- Leaflet mid and base portions have normal mobility	- Mid leaflets normal, considerable thickening of margins (5-8mm)	- Thickening of chordal structures extending to one third of the chordal length	- Scattered areas of brightness confined to leaflet margins
3	- Valve continues to move forward in diastole, mainly from the base	- Thickening extending through the entire leaflet (5-8mm)	- Thickening extended to distal third of the chords	- Brightness extending into the mid portions of the leaflets
4	- No or minimal forward movement of the leaflets in diastole	- Considerable thickening of all leaflet tissue (>8-10mm)	- Extensive thickening and shortening of all chordal structures extending down to the papillary muscles	- Extensive brightness throughout much of the leaflet tissue

Trans Esophageal Echocardiographic Assessment (TEE):

In the TEE there was precise scanning of LAA at angles: 30/60/90/120 degrees and transgastric 2-chamber 90 degrees with careful adjustment of gain and frequency in search of thrombus and dense spontaneous echo contrast (sludge) **[13]**. Sludge was defined, as already described in the literature, as an intracavitary echodensity with viscid gelatinous qualities giving the impression of impending precipitation but without a discrete organized mass **[14]**. There were also other TEE assessments: Significant valvular pathology, presence of any spontaneous echo contrast (recognized as dynamic, swirling, smoke-like echoes) **[15,16]**. Measuring of mitral valve annulus was also done.

Results

This study is a prospective study which was conducted on 36 patients with significant mitral stenosis (MV Area less than 1.5cm^2) presenting to cardiology department at Ain Shams University Hospital. 27 patients underwent successful PMC by double balloon technique and the rest (9) patients by Inoue technique.

I- Demographic data and characteristics of the studied patients.

Table (2): Demographic characteristics of the patients.

	No.=36
Age (years):	
Mean ± SD	40.58±10.4
Range	25-59
Gender:	
Females	32 (88.9%)
HTN:	
Yes	2 (5.6%)
DM:	
No	36 (100.0%)
Smoker:	
Yes	4 (11.1%)
Dyslipidemic:	
Yes	1 (2.8%)

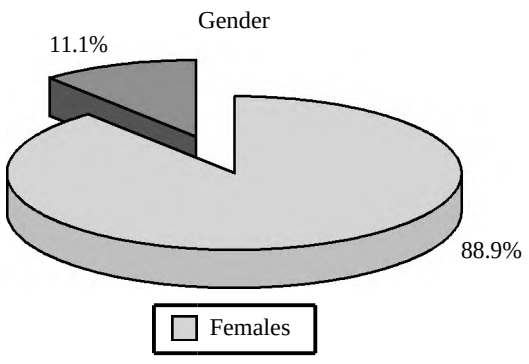

Fig. (5): Gender distribution among the studied patients.

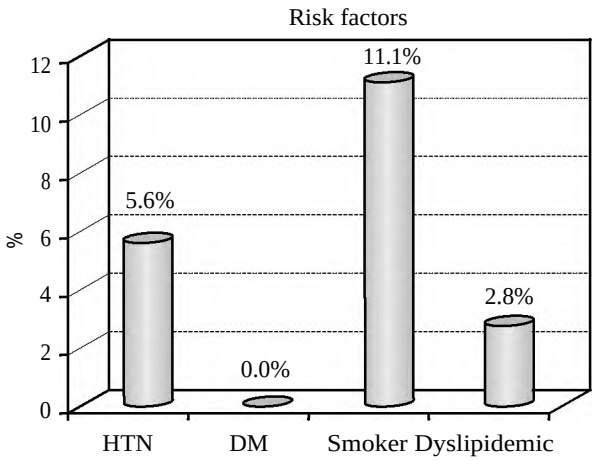

Fig. (6): Risk factors among the studied patients.

II- Follow-up parameters of successful procedure:

a- Follow-up immediate invasive parameters after PMC.

III- Follow-up ECG and Echocardiographic parameters:

a- Follow-up PWD and LA volume after PMC.

b- Follow-up risk of atrial fibrillation after PMC.

c- Correlation between decrease P wave dispersion and basic demographic data:

d- Comparison between patients with decrease PWD and those without decrease PWD regarding invasive and non invasive parameters:

e- Comparison between inoue balloon and double balloon techniques regarding ECG and Echocardiographic parameters.

IV- Correlation between PWD and other studied parameters:

a- Correlation between PWD and other studied parameters before PMC.

b- Correlation between PWD 24 hours after PMC and other studied parameters.

c- Correlation between PWD two months after PMC and other studied parameters.

d- Correlation between PWD and LA volume.

e- Correlation between decrease of PWD the change of LA volume.

Table (3): Follow-up for MVA before and 24 hours after PMC.

	Before PMC	24 After PMC	Test value	*p*-value	Sig.
	No.=36	No.=36			
MVA (cm ^{2}):					
Mean ± SD	0.87±0.2	2.01±0.21	26.624•	<0.001	HS
Range	0.4-1.2	1.6-2.5			
Difference from before:					
Mean ± SD	–	1.14±0.26			

p>0.05: Non significant (NS).
p<0.05: Significant (S).
p<0.01: Highly significant (HS).

• : Paired *t*-test.
••: Repeated Measures ANOVA.

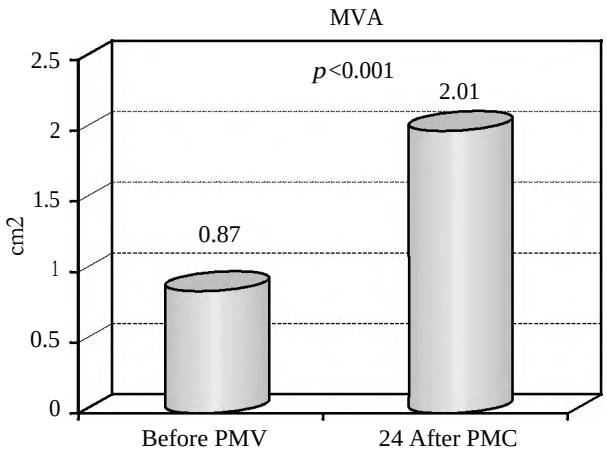

Fig. (7): Follow-up for MVA before and after 24 hours of PMC among the studied patients.

Table (4): Follow-up for the invasive immediate studied parameters before and after PMC among the studied patients.

	Before PMC	After PMC	Difference	Test value•	*p*-value	Sig.
	No.=36	No.=36	Mean ± SD			
SPAP:						
Mean ± SD	46.17±17.45	36.19±11.34	–9.97±7.21	–8.295	0.000	HS
Range	25-90	22-65				
DPAP:						
Mean ± SD	20.53±8.12	17.92±5.82	–2.61±3.16	–4.964	0.000	HS
Range	13-35	13-33				
MPAP:						
Mean ± SD	28.44±11.25	23.44±7.73	–5.00±4.38	–6.847	0.000	HS
Range	15-65	14-45				
RV SP:						
Mean ± SD	47.72±18.37	86.89±11.83	–10.83±8.20	–7.924	0.000	HS
Range	24-100	20-65				
RV DP:						
Mean ± SD	14.11±4.13	12.03±3.45	–2.08±2.21	–5.659	0.000	HS
Range	6-21	6-19				
Mean RA pressure:						
Mean ± SD	11.89±2.65	11.28±2.25	–0.61±1.55	–1.219	0.351	NS
Range	7-16	7-15				
Mean LA pressure:						
Mean ± SD	25.92±5.79	15.58±2.98	–10.33±4.50	–13.766	0.000	HS
Range	19-40	10-22				
LV SP:						
Mean ± SD	115.36±17.82	110.42±23.75	–4.94±16.67	–1.779	0.084	NS
Range	88-150	11-140				
LV DP:						
Mean ± SD	14.33±1.43	14.03±1.36	–0.31±1.26	1.454	0.155	NS
Range	11-17	12-17				
AO SP:						
Mean ± SD	115.47±17.2	114.83±16.65	0.64±4.16	0.923	0.363	NS
Range	90-145	89-140				
AO DP:						
Mean ± SD	73.97±10.19	73.86±10.48	–0.11±3.13	–0.213	0.833	NS
Range	59-93	58-100				
AO MP:						
Mean ± SD	86.47±13.14	85.94±12.06	–0.53±3.84	–0.826	0.415	NS
Range	67-115	69-109				

p>0.05: Non significant (NS). *p*<0.05: Significant (S). *p*<0.01: Highly significant (HS). •: Paired *t*-test.

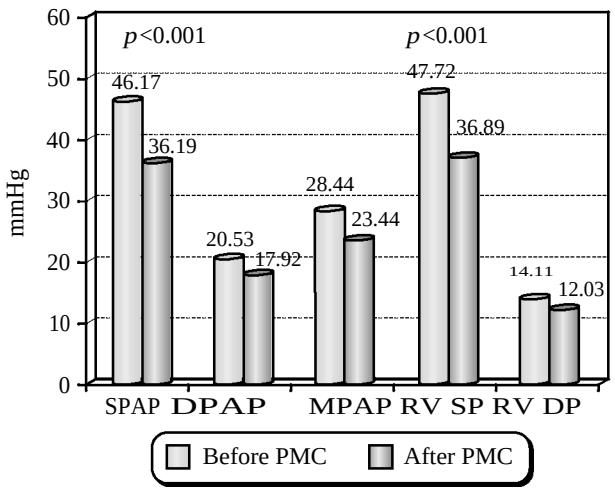

Fig. (8): Follow-up for SPAP, DPAP, MPAP, RVSP, RVDP before and after PMC.

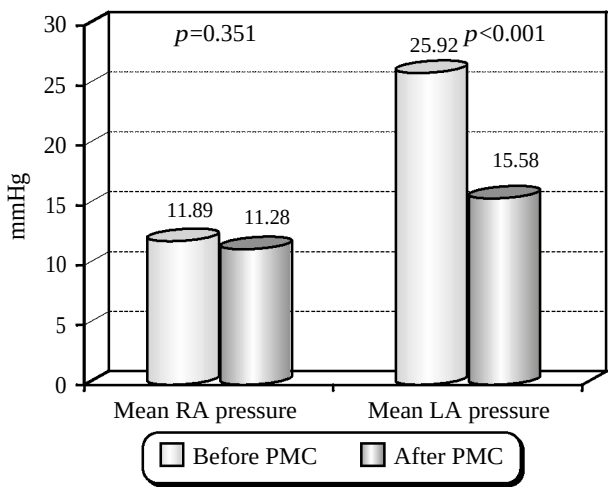

Fig. (9): Follow-up for mean RA pressure and mean LA pressure before and after PMC.

Table (5): Follow-up PWD and LA volume before PMC, at 24 hours and at two months follow-up after PMC.

	Before PMC	24 After PMC	Two months after PMC	Test value	*p*-value	Sig.
	No.=36	No.=36	No.=36			
PWD (ms):						
Mean ± SD	63.33±11.71	51.39±9.23	39.31±11.03	84.433••	<0.001	HS
Range	40-80	30-70	25-60			
Difference from before:						
Mean ± SD	–	11.94±10.64	24.03±14.08			
LA Volume (ml):						
Mean ± SD	113.19±21.6	102.22±21.87	88.75±21.04	210.3••	<0.001	HS
Range	61-159	46-149	40-140			

p>0.05: Non significant (NS). *p*<0.05: Significant (S). *p*<0.01: Highly significant (HS). •: Paired *t*-test. ••: Repeated measures ANOVA.

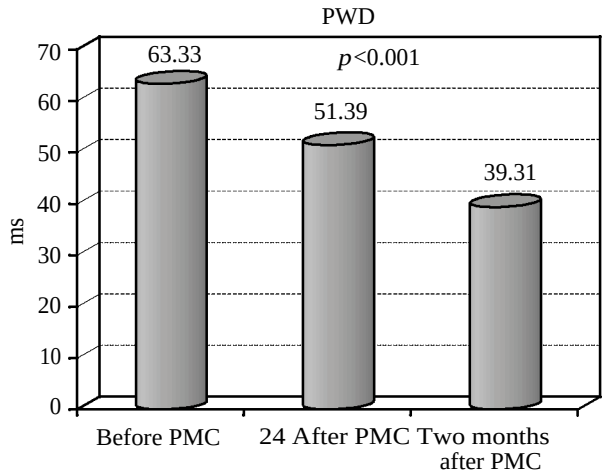

Fig. (10): Follow-up for PWD before, after 24 hours and after two months of PMC.

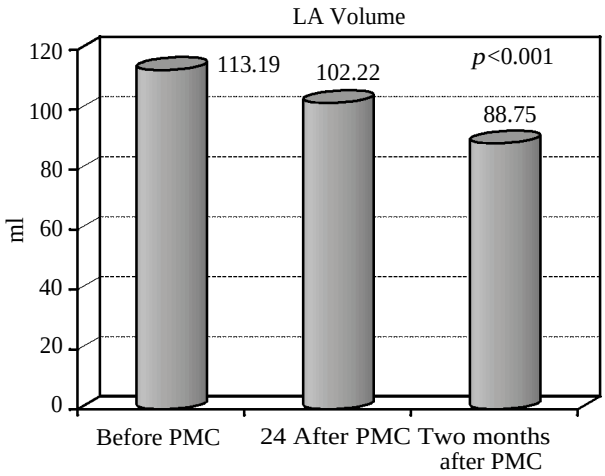

Fig. (11): Follow-up for LA volume before, after 24 hours and after two months of PMC.

Table (6): Follow-up risk of atrial fibrillation (PWD ≥38mm) before PMC, 24 hours after PMC and two months after PMC.

PWD ≥38ms	Before PMC	After 24 hours	After 2 months	Test value	*p*-value	Sig.
	No. (%)	No. (%)	No. (%)			
Normal PWD	0 (0.0%)	7 (19.4%)	24 (66.7%)	41.354*	<0.001	HS
Prolonged PWD	36 (100.0%)	29 (80.6%)	12 (33.3%)			

p-value >0.05: Non significant. *p*-value <0.05: Significant. *p*-value < 0.01: Highly significant. *: Chi-square test. •: Independent *t*-test.

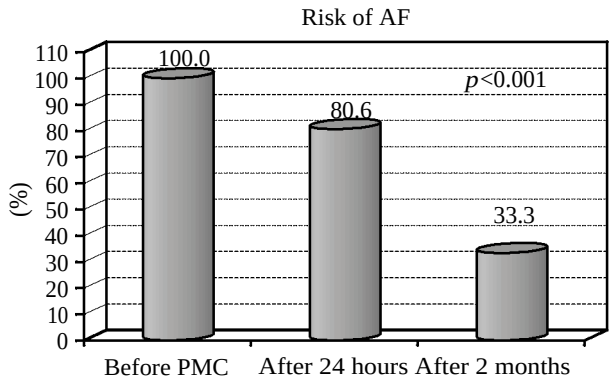

Fig. (12): Follow-up for risk of AF (PWD ≥38ms) before, after 24 hours and after two months of PMC among the studied patients.

Table (7): Number of patients with decrease PWD 24 hours and two months after PMC.

	No. (%)
Decreased PWD after 24hrs:	
No	9 (25.0%)
Yes	27 (75.0%)
Decreased PWD after 2 months:	
No	3 (8.3%)
Yes	33 (1.7%)

Table (8): Comparison between patients with no decrease in PWD and those with decrease in PWD regarding demographic data and co-morbidities.

	Decreased in PWD		Test value	*p*-value	Sig.
	No.	Yes			
	No.=9	No.=27			
Age (years):					
Mean ± SD	40.11±12.51	40.74±9.87	–0.155•	0.878	NS
Range	25-56	25-59			
Gender:					
Females	9 (100.0%)	23 (85.2%)	1.500*	0.221	NS
Males	0 (0.0%)	4 (14.8%)			
HTN:					
No	8 (88.9%)	26 (96.3%)	0.706*	0.401	NS
Yes	1 (11.1%)	1 (3.7%)			
DM:					
No	9 (100.0%)	27 (100.0%)	–	–	–
Yes	0 (0.0%)	0 (0.0%)			
Smoker:					
No	9 (100.0%)	23 (85.2%)	1.500*	0.21	NS
Yes	0 (0.0%)	4 (14.8%)			
Dyslipidemic:					
No	9 (100.0%)	26 (96.3%)	0.343*	0.558	NS
Yes	0 (0.0%)	1 (3.7%)			

p-value >0.05: Non significant. *: Chi-square test.
p-value <0.05: Significant. •: Independent *t*-test.
p-value <0.01: Highly significant.

Table (9): Comparison between patients with no decrease in PWD and those with decrease in PWD regarding invasive and noninvasive parameters.

Difference after 24 hrs	Decreased in PWD after 24 hrs		Test value	*p*-value	Sig.
	No.	Yes			
	No.=9	No.=27			
MVA (cm):					
Mean ± SD	1.09±0.30	1.16±0.24	–0.278#	0.781	NS
Range	0.6-1.5	0.8-1.8			
LA Volume (ml):					
Mean ± SD	–8.89±7.15	–11.67±7.05	–1.487#	0.137	NS
Range	-22-5	-27-10			
SPAP:					
Mean ± SD	–3.71±3.50	–11.39±7.20	–2.376#	0.018	S
Range	-8-0	-25-0			
DPAP:					
Mean ± SD	-2.44±3.40	–2.67±3.14	–0.112#	0.911	NS
Range	-11-0	-11-1			
MPAP:					
Mean ± SD	-3.33±4.03	–5.56±4.42	–1.801#	0.072	N
Range	-13-0	-20-0			
RV SP:					
Mean ± SD	-8.33±9.27	–11.67±7.83	–1.263#	0.207	NS
Range	-27-0	-35-0			
RV DP:					
Mean ± SD	-1.44±1.88	–2.30±2.30	–0.935#	0.350	NS
Range	-6-0	-8-0			

Table (9): Count.

Difference after 24 hrs	Decreased in PWD after 24 hrs		Test value	*p*-value	Sig.
	No.	Yes			
	No.=9	No.=27			
Mean RA pressure:					
Mean ± SD	–1.22±0.83	–1.74±1.72	–0.691#	0.489	NS
Range	-2-0	-6 – 1			
Mean LA pressure:					
Mean ± SD	–6.57±2.44	–11.29±4.51	2.636#	0.008	HS
Range	-9 – -2	-21 – -3			
LV SP:					
Mean ± SD	–1.22±2.11	–6.19±19.15	–0.531#	0.595	NS
Range	-4 – 2	-99 – 2			
LV DP:					
Mean ± SD	-0.33±0.50	–0.30±1.44	–0.460#	0.646	NS
Range	-1 – 0	-3 – 3			
AO SP:					
Mean ± SD	-0.56±2.07	–0.67±4.68	–0.868#	0.385	NS
Range	-4 – 2	-10 – 10			
AO DP:					
Mean ± SD	0.89±2.89	–0.44±3.19	–1.016#	0.310	NS
Range	-2 – 6	-5 – 10			
AO MP					
Mean ± SD	1.00±3.84	–1.04±3.77	–1.030#	0.303	NS
Range	-2 – 10	-10 – 6			

p-value >0.05: Non significant. *p*-value <0.01: Highly significant.
p-value <0.05: Significant. #: Mann-Whintey test.

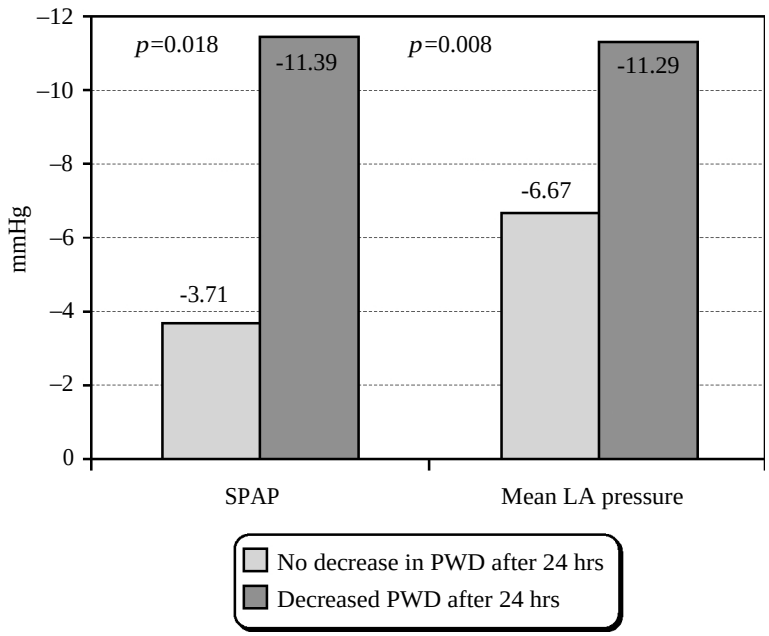

Fig. (13): Correlation with the decrease PWD and the change of SPAP and mean LA pressure.

Table (10): Comparison between inoue balloon and double balloon techniques regarding MVA, PWD and LA volume before and after PMC.

	Inoue balloon No.=9	Double balloon No.=27	Test value•	*p*-value	Sig.
After 24 hours of PMC:					
MVA (cm):					
Mean ± SD	2.04±0.18	1.99±0.22	0.637	0.528	NS
Range	1.7-2.2	1.6-2.5			
PWD (ms):					
Mean ± SD	55.56±8.46	50.00±9.20	1.598	0.119	NS
Range	45-70	30-65			
LV Volume (ml):					
Mean ± SD	11533±22.49	97.85±20.23	2.186	0.036	S
Range	85-140	46-149			
After 2 months of PMC:					
PWD (ms):					
Mean ± SD	41.11±11.12	38.70±11.15	0.562	0.578	NS
Range	30-60	25-60			
LA Volume (ml):					
Mean ± SD	101.56±23.03	84.48±18.90	2.224	0.033	S
Range	73-140	40-130			

p>0.05: Non significant (NS). *p*<0.05: Significant (S). *p*<0.01: Highly significant (HS). •: Independent *t*-test.

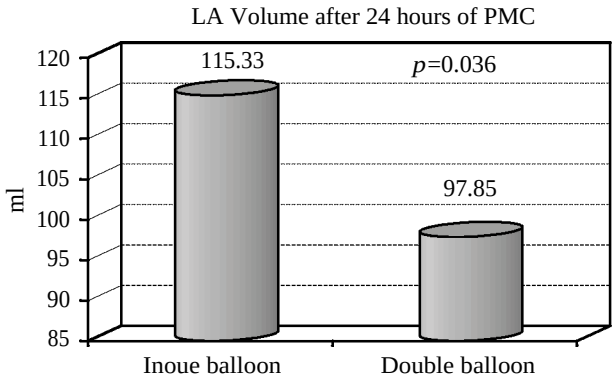

Fig. (14): Comparison between inoue balloon and double balloon techniques regarding PWD and LA volume after 24 hours follow-up.

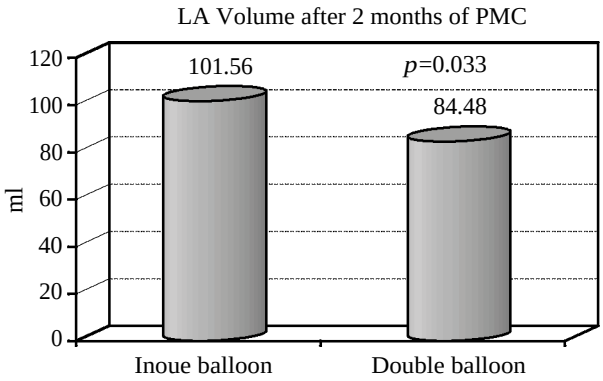

Fig. (15): Comparison between inoue balloon and double balloon techniques regarding PWD and LA volume after 2 months follow-up

Table (11): Correlation of PWD with the other studied parameters before PMC .

	PWD (ms)		Significance
	r	*p*-value	
Age (years)	0.069	0.690	NS
MVA (cm)	–0.035	0.840	NS
SPAP	0.446* *	0.006	S
DPAP	0.392*	0.018	S
MPAP	0.408*	0.014	S
RV SP	0.450* *	0.006	S
RV DP	0.262	0.123	NS
Mean RA pressure	0.210	0.220	NS
Mean LA pressure	0.369*	0.027	S
LV SP	0.096	0.579	NS
LV DP	–0.242	0.155	NS
AO SP	0.127	0.461	NS
AO DP	0.207	0.227	NS
AO MP	0.224	0.190	NS

p>0.05: Non significant (NS). *p*<0.05: Significant (S). *p*<0.01: Highly significant (HS).
Spearman correlation coefficients .

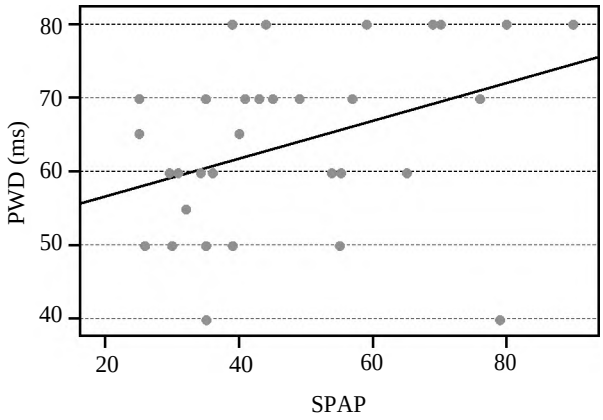

Fig. (16): Correlation between PWD and SPAP before PMC.

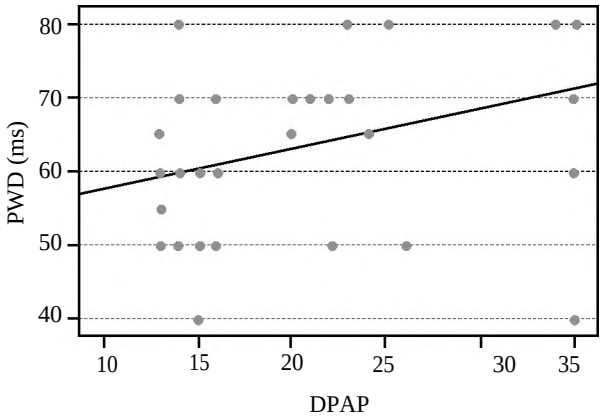

Fig. (17): Correlation between PWD and DPAP before PMC.

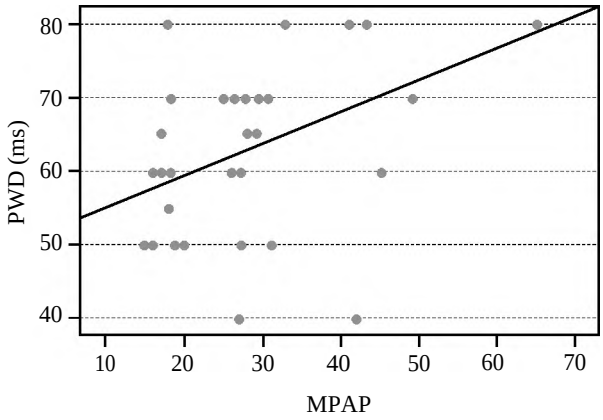

Fig. (18): Correlation between PWD and MPAP before PMC.

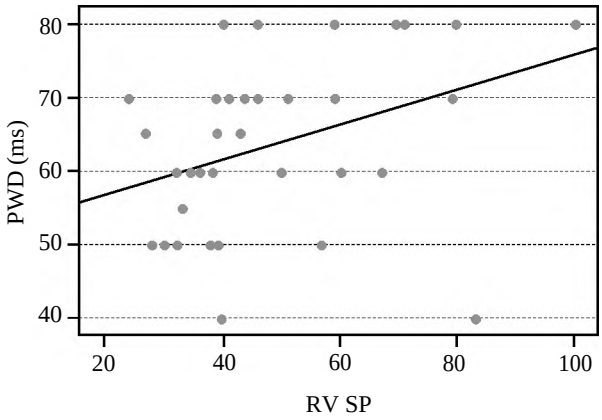

Fig. (19): Correlation between PWD and RV SP before PMC.

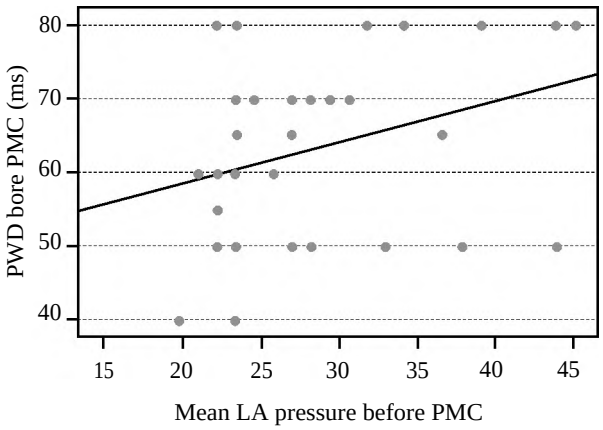

Fig. (20): Correlation between PWD and mean LA pressure before PMC.

Table (12): Correlation of PWD after 24 hours of PMC with the other studied parameters after PMC.

	PWD (ms)		Significance
	r	*p*-value	
Age (years)	0.034	0.846	NS
Before PMC:			
SPAP	0.261	0.124	NS
DPAP	0.198	0.247	NS
MPAP	0.190	0.267	NS
RV SP	0.234	0.169	NS
RV DP	–0.059	0.733	NS
Mean RA pressure	0.148	0.388	NS
Mean LA pressure	–0.005	0.978	NS
LV SP	0.219	0.200	NS
LV DP	–0.102	0.415	NS
AO SP	0.190	0.266	NS
AO DP	0.177	0.301	NS
AO MP	0.161	0.349	NS
After PMC:			
SPAP	0.222	0.192	NS
DPAP	0.205	0.230	NS
MPAP	0.240	0.158	NS
RV SP	0.226	0.186	NS
RV DP	0.094	0.56	NS
Mean RA pressure	0.109	0.527	NS
Mean LA pressure	–0.028	0.870	NS
LV SP	0.231	0.175	NS
LV DP	0.000	0.998	NS
AO SP	0.164	0.338	NS
AO DP	0.059	0.733	NS
AO MP	0.075	0.663	NS

p>0.05: Non significant (NS).
p<0.05: Significant (S).
p<0.01: Highly significant (HS).
Spearman correlation coefficients .

Table (13): Correlation of PWD after two months of PMC with the other studied parameters after PMC.

	PWD (ms)		Sign.
	r	*p*-value	
Age (years)	0.125	0.469	NS
Before PMC:			
SPAP	0.268	0.114	NS
DPAP	0255	0.133	NS
MPAP	0.197	0.250	NS
RV SP	0.242	0.155	NS
RV DP	0.003	0.985	NS
Mean RA pressure	0.055	0.752	NS
Mean LA pressure	0.020	0.907	NS
LV SP	0.249	0.143	NS
LV DP	–0.134	0.247	NS
AO SP	0.223	0.191	NS
AO DP	0.121	0.482	NS
AO MP	0.109	0.527	NS
After PMC:			
SPAP	0.319	0.058	NS
DPAP	0.264	0.120	NS
MPAP	0.219	0.199	NS
RV SP	0.252	0.139	NS
RV DP	0.111	0.518	NS
Mean RA pressure	0.142	0.409	NS
Mean LA pressure	0.059	0.732	NS
LV SP	0.325	0.053	NS
LV DP	0.043	0.802	NS
AO SP	0.225	0.186	NS
AO DP	0.047	0.787	NS
AO MP	0.056	0.744	NS

p>0.05: Non significant (NS).
p<0.05: Significant (S).
p<0.01: Highly significant (HS).
Spearman correlation coefficients .

Table (14): Correlation between PWD and LA volume before PMC.

	PWD before PMC (ms)		Sign.
	r	*p*-value	
LA volume before PMC (ml)	0.168	0.329	NS

p>0.05: Non significant (NS). *p*<0.01: Highly significant (HS).
p<0.05: Significant (S). Spearman correlation coefficients.

Table (15): Correlation between PWD and LA volume 24 hours after PMC.

	PWD after 24 hours (ms)		Sign.
	r	*p*-value	
LA volume after 24 hours (ml)	0.228	0.181	NS

p>0.05: Non significant (NS). *p*<0.01: Highly significant (HS).
p<0.05: Significant (S). Spearman correlation coefficients.

Table (16): Correlation between PWD and LA volume two months after PMC.

	PWD after 2 months (ms)		Sign.
	r	*p*-value	
LA volume after 2 months (ml)	0.272	0.110	NS

p>0.05: Non significant (NS).
p<0.05: Significant (S).
p<0.01: Highly significant (HS).
Spearman correlation coefficients .

Table (17): Correlation between the decrease of PWD and LA volume difference after 24 hrs and two months.

	PWD reduction after 24 hours		Sign.
	r	*p*-value	
LA reducation after 24 hours	0.159	0.354	NS
	PWD reduction after 2 months		Sign.
	r	*p*-value	
LA volume reducation after 2 months	–0.009	0.960	NS

p>0.05: Non significant (NS). *p*<0.01: Highly significant (HS).
p<0.05: Significant (S). Spearman correlation coefficients.

Discussion

Rheumatic mitral stenosis (MS) is frequently seen in developing countries and causes significant morbidity and mortality **[17]**. Percutaneous mitral commissurotomy (PMC) has become an effective and safe procedure for symptomatic or hemodynamically significant MS with favorable valve anatomy **[18]**. This procedure is highly successful with a low complication rate and significant short- and long-term improvement in hemodynamics and symptoms **[19,20]**. P wave dispersion (PWD) is an electrocardiographic (ECG) marker of non-uniform and heterogeneous atrial conduction with ECG leads of different orientation **[21]**. It can be defined as the difference between maximum and minimum P wave duration. Previous investigations have shown that P max and PWD are increased in patients with rheumatic MS and decreased with PMC **[22]**. In addition, the prolongation of intraatrial and interatrial conduction time and the inhomogeneous propagation of sinus impulses are well known electrophysiologic characteristics of the atrium prone to fibrillate. Prolonged P-wave duration and increased PWD have been reported to carry an increased risk for atrial fibrillation (AF) **[21]**.

The comparison of MVA before and 24 hours postoperatively after PMC, showed that there was significant increase in MVA at 24 hours postoperatively. Our success rate was 100% without any mitral regurge (moderate or severe) among the studied patients.

In concordance with the current study Mahfouz et al., **[23]** revealed that there was significant increase in MVA post-PMC.

Also, Agus& Kahraman, **[24]** revealed that the PMC procedure resulted in significant increase in MVA.

Also, in agreement with the current study Beig et al., **[25]** showed that there was significant increase in MVA.

In the present study follow-up for invasive hemodynamics revealed that all pulmonary artery pressures [systolic pulmonary artery pressure (SPAP) diastolic pulmonary artery pressure (DPAP) and mean pulmonary artery pressure (MPAP)] showed significant improvement in the studied patients after PMC. Also right ventricular systolic pressure (RVSP) and right ventricular diastolic pressure (RVDP) showed significant improvement in the studied patients after PMC.

The current study also showed that mean left atrial pressure (MLAP) showed significant improvement in the studied patients after PMC. Mean right atrial pressure (MRAP) showed non-significant change in the studied patients after PMC.

In agreement with the current study Beig et al., **[25]** showed that there was significant improvement in PASP among 25 patients with severe mitral stenosis (MS) treated with PMC. Also, in concordance with the current study Mahfouz et al., **[23]** enrolled 85 patients undergoing percutaneous mitral commissurotomy and revealed that there was statistically significant reduction in PASP after the procedure. The same result was reported by Agus & Kahraman, **[24]**.

Also, Vijayvergiya et al., **[26]** enrolled 47 consecutive patients with symptomatic critical mitral stenosis who underwent PMC, the study showed that there was significant improvement in Mean LA pressure and Pulmonary artery peak systolic pressure.

The comparison of PWD and LA volume before, 24 hours postoperatively and at two months follow-up after PMC, P wave dispersion (PWD) showed significant decrease 24 hours after PMC and two months after PMC. Also, left atrial volume (LA volume) showed significant decrease 24 hours and two months after PMC.

In accordance with the current study Mahfouz et al., **[23]** revealed that there was significant decrease in PWD post-PMC.

Also, Agus& Kahraman, **[24]** revealed that the PMC procedure resulted in significant decrease in LA diameter and PWD.

Also, in agreement with the current study Beig et al., **[25]** showed significant decrease in LA volume post-PMC but in contrast to the current study there was no significant difference was found in PWD post-PMC. The disagreement may be due to the difference in patients' severity his study range of mitral valve area from 0.74 to 0.13cm2 and our study range of mitral valve area was from 0.4 to 1.2cm^2 and also our study was conducted on relatively larger sample size (our sample size was 36patients and his sample size was 25).

Chronic MS causes prolongation of intraatrial and interatrial conduction time and the inhomogeneous propagation of sinus impulses.

Also the resulting anatomical abnormalities with MS will lead to electrical heterogeneity, heterogeneous transmission speeds, and heterogeneous refractory phases within the atrial myocar-

dium. It may also be accompanied by the atrial wall fibrosis and discordance of the atrial bundle, which was manifested as the increase of the P-wave duration and the PWD in ECG [17].

So PWD decreases with the decrease of atrial stretch and the reversal of atrial remodeling after successful PMC.

It was reported that prolonged P-wave duration and increased PWD have been reported to carry an increased risk for atrial fibrillation [27].

The current study showed that all studied patients were in risk of atrial fibrillation (PWD ›-38mm) [28] before PMC. P wave dispersion returned to normal range in 7 patients (19.4%) 24 hours after PMC and 24 patients (66.7%) after two months after PMC among suited patients.

P wave dispersion (PWD) decreased in 27 patients (75%) 24 hours after PMC and in 33 patients (91.7%) after two months after PMC among suited patients.

To assess the potential risk for atrial fibrillation, a comparison between patients with and without decreased PWD was performed and showed that age, gender and comorbidities showed non-significant relation with the change of PWD.

In concordance with the current study Koren et al., [29] enrolled 417 patients underwent percutaneous mitral commissurotomy, the success rate was 93%. The study showed that there was no significant association between outcome (technical success) with age, sex, diabetes, HTN and smoking.

Also, Kazemi et al., [30] showed that there was no significant association between percutaneous mitral commissurotomy success with age.

Comparison between Inoue balloon and double balloon techniques regarding MVA, PWD and LA volume before PMC, after 24 hours and after 2 months of PMC, showed that left atrial (LA) volume 24 hours after PMC showed more decrease in patient who was underwent PMC by double balloon technique rather than whose was underwent PMC using Inoue technique, but other outcomes were non-significantly differed between both techniques.

Our results were supported by Sharieff et al., [31] who compared the three different techniques for percutaneous mitral commissurotomy (PMC) using Inoue balloon (IB), metallic commissurotomy (PMC), or multi-track double balloon (MTDB) in patients with MS, and revealed that the overall success rate was 97.3% (n=473); 95.7% for IB, 97.6% for PMC, and 98.3% for MTDB. There was no significant difference between all techniques in mitral valve area (MVA), transmitral gradient, Left atrial pressure and pulmonary arterial pressure.

Also, Palacios, [32] compared the immediate procedural and the long-term clinical outcomes after PMC using the double-balloon technique (n=659) and Inoue technique (n=233). There were no statistically significant differences in baseline clinical and morphologic characteristics between the double-balloon technique and Inoue technique patients. In conclusion, both the Inoue and the double-balloon techniques are equally effective techniques of PMC.

The comparison between patients with no decrease in PWD and those with decrease in PWD showed that there was no significant difference between the groups with and without decrease in PWD regarding mean difference of MVA, LA volume, DPAP, MPAP, RV SP, RV DP, mean RA pressure, LV SP, LVDP, AoSP, Ao DP and Ao MP after 24 hours. But there was a significant positive relation between both the change of SPAP and mean LA pressure and PWD changes after PMC.

In concordance with the current study Mahfouz et al., [23] revealed that there was significant correlation between PWD and PASP.

Correlation of PWD with the other studied parameters:

Before PMC, PWD shows significant relation with (SPAP), (MPAP) and (DPAP). There also highly significant relation between PWD and (RVSP). Also PWD showed significant relation with left atrial pressure (mean LA pressure).

However, P wave dispersion (PWD) 24 hours and two months after PMC didn't show any significant relation with any studied parameters before or after PMC.

In concordance with the current study Mahfouz et al., [23] revealed that there was significant correlation between PWD and PASP. In addition, significant decrease in P-wave dispersion was associated with significant improvement of RV dysfunction and regression of pulmonary artery pressure during follow-up.

As well, Agus et al., [24] revealed that there was negative correlation was detected between pre-MVA and pre-PWD (r=–0.097, p=0.047). PWD (1-3 days after PMC) was positively correlated with pre-PAPs and pre-LA pressure (1-3 days after

PMC). Furthermore, PWD (long term after PMC) was also correlated with pre-LA pressure (long term after PMC), PAPs (long term after PMC), MVA (long term after PMC) positively.

Moreover, Chandrasekar et al., **[33]** demonstrated that acute hemodynamic changes following mitral valvuloplasty with a balloon produce changes in the electrocardiogram, indicative of an important hemodynamic benefit resulting from the procedure. In their study patients who had changes in the P-wave patterns had a significant decrease in the left atrium average pressure.

However, Aguş& Kahraman, **[24]** showed that PWD was significantly correlated with severity of MS (MVA (r=–0.8, p<0.0001) PAP (r=0.79, p<0.0001), and LA pressure (r=0.76, p<0.0001).

Chronic MS results in left atrial 'stretch' due to elevated left atrial pressure this results in significant electrical remodeling and causes an increase of max p wave duration (Pmax) and increases P wave dispersion.

The longstanding increase of left atrial pressure causes an increase of pulmonary artery pressure and subsequently increases PWD.

In the current study correlation analysis was done between P wave dispersion (PWD) and left atrial volume (LA volume) before PMC, 24 hours after and two months after PMC and showed non-significant relation.

Also, correlation analysis was done between the decrease of PWD and LA volume difference after 24 hours and two months and showed non-significant relation.

In concordance with the current study Turhan et al., **[27]** showed that there was no correlation between the P-wave dispersion and arterial enlargement.

In line with the current study Rezaian et al., **[34]** showed that there was no correlation between the P-wave dispersion and the transmitral valve gradient, left atrial size or the mitral valve area.

Also, in concordance with the current study Chávez-González & Donoiu, **[35]** showed that there was no correlation between the P-wave dispersion and left atrial volume.

Theoretically, it was expected that the change of PWD will be correlated with the change of LA volume after successful PMC as the surface area of impulse transmission will decrease. Because we depend on 2D Echocardiography measurement of LA volume which doesn't give the actual change of left atrial volume.

Also, PWD and risk of atrial fibrillation decrease is correlated more with the drop of mean LA pressure and subsequently with the decrease of the left atrial wall stretch, and didn't correlate with drop of left atrial size and volume and this according to our study, but larger number of patients and longer period of follow-up might show more correlation between the decrease of PWD and left atrial volume. Also reversal of mechanical remodeling takes more time than hemodynamics improvement.

Conclusion:

The present study showed that percutaneous mitral commissurotomy was safe and effective in the treatment of mitral stenosis; it was associated with significant reduction in P-wave dispersion and reduced risk of atrial fibrillation.

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التأثير قصير المدى لتوسيع الصمام التاجى بالبالون عن طريق الجلد على تباين الموجة P فى المرضى الذين يعانون من ضيق الصمام التاجى

يعد تضيق الصمام التاجى الروماتيزمى، وهو أحد المضاعفات المتأخرة للحمى الروماتيزمية، من أكثر المسببات شيوعاً لمرض ضيق الصمام التاجى فى جميع أنحاء العالم. إن المرضى الذين يعانون من تضيق الصمام التاجى لديهم زمن طويل للموجة P وزيادة تباين الموجة P (PWD). تزداد مدة الموجة P وتباين الموجة P بشكل تدريجى وفقاً لتطور تضيق الصمام التاجى. إن تباين الموجة P (PWD) هى علامة تخطيط القلب الكهربائى لإعادة تشكيل الأذين والتنبؤ بالرجفان الأذينى. تم استخدام توسيع الصمام التاجى عن طريق الجلد بنجاح كبديل للشق التاجى الجراحى المفتوح أو المغلق فى علاج أعراض تضيق الصمام التاجى الروماتيزمى. تنتج الشق التاجى عن طريق الجلد نتائج ديناميكية فورية جيدة ومعدلات مضاعفات منخفضة وتحسناً سريرياً فى غالبية المرضى. فى هذه الدراسة، كنا نهدف إلى تقييم تأثير توسيع الصمام التاجى عن طريق الجلد على تباين الموجة P لتقييم خطر الإصابة بالرجفان الأذينى. هذه الدراسة هى دراسة استطلاعية أجريت على ٣٦ مريضاً يعانون من تضيق تاجى كبير مقدمة لقسم أمراض القلب فى مستشفى جامعة عين شمس.

أظهرت النتائج الرئيسية للدراسة ما يلى :

أظهرت النتائج أن توسيع الصمام التاجى بالبالون عن طريق الجلد يؤدى إلى إنخفاض ملحوظ فى تباين الموجة بعد يوم وإنخفاضاً أكبر بعد شهرين من توسيع الصمام، وبالتالى يساهم فى تأخير أو منع حدوث الإرتجاف الأذينى.

بناءً على نتائجنا، نوصى بإجراء مزيد من الدراسات الأكبر حجماً وذات فترة أطول من المتابعة للتأكيد على استنتاجنا.