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The Impact of Concomitant Pulmonary Hypertension on Immediate Post-operative ICU Stay Following Mitral Valve Surgery: (A Comparative Study)

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Abstract

Background: The management of patients with pulmonary hypertension undergoing mitral valve surgery is challenging. We sought to investigate the fate and short-term prognostic implications of pulmonary hypertension after surgery. **Patients and methods:** This was a comparative study conducted in the cardiovascular surgery department in the faculty of medicine Cairo University. From April 2021 to December 2021. A total of 100 patients who underwent mitral valve surgery with different degrees of pulmonary hypertension were screened. The degree of PHTN was evaluated by transthoracic echocardiography Pre & post-operative and the prognosis of patients during ICU stay. **Results:** Our study proved that the degree of pulmonary hypertension has an effect on the morbidity of patients post mitral valve surgery, The intensive care unit stay was short in cases with mild degree with a mean value of 3.00±0.82 days while in moderate group the mean duration was 2.92 ± 0.62 days while in severe group mean duration 3.80 ± 1.30 was showing a statistical significance across groups. **Conclusion:** Patients with severe mitral valve pathology should be operated as early as possible to avoid unintended consequences of severe degree of PHTN.

Keywords: Mitral valve surgery, Intensive care unit , Pulmonary hypertension, Al Kasr Alainy hospital

Introduction

The mitral valve is the most complex of the heart's valves and is the one most commonly associated with disease. There are 2 main conditions that affect the valve: Obstruction (stenosis), leakage (regurgitation).[1]

Globally, the prevalence of pulmonary hypertension is 1%; almost 80% of those affected reside in developing countries.[2]

Rheumatic heart disease is a substantial burden in developing countries where it is responsible for significant cardiovascular morbidity and mortality. [3]

Pulmonary hypertension frequently observed secondary to left-sided valve disease.[1]

PH with left heart disease develops as a consequence of impaired left ventricular relaxation and distensibility. Chronic sustained elevation of cardiogenic blood pressure in pulmonary capillaries leads to a cascade of undesired retrograde anatomical and functional effects that represent specific targets for therapeutic intervention. [4]

The pathophysiological and clinical importance of the hemodynamic consequences of left-sided heart disease, starting with lung capillary injury and leading to right ventricular overload and failure. [5]

Although increasing severity of pulmonary hypertension in mitral valve disease patients may be an indicator of advanced disease and thus poor long-term outcomes, the effect of pulmonary hypertension severity on early surgical outcomes of mitral valve surgery remains an interesting debate. [6]

Patients and Methods

This was a prospective comparative study aimed to determine early prognosis of cases suffering from different degree of pulmonary hypertension after mitral valve surgery were identified from the database of Kasr Alainy Hospital between April 2021 and December 2021.

Our study included 100 patients who underwent mitral valve surgery with different degrees of pulmonary hypertension before surgery, are reviewed and data analyzed regarding early ICU stay post-operative

Patient population: Patients were selected according to the following inclusion and exclusion criteria:

Inclusion criteria: Any patient undergoing mitral valve surgery suffering from any degree of pulmonary hypertension

Exclusion criteria: Patients requiring an concomitant cardiac surgical procedure as redo cardiac surgery, CABG or Aortic valve replacement

All patients in this study were evaluated by the following parameters:

PREOPERATIVE PARAMETERS: On hospital admission patients was subjected to the following Demographic data: Age, Sex, Residency, clinical data: DM, HTN, blood pressure, heart rate, Dyspnea (grade), syncope, generalizes edema and investigations: all patients received CXR ,echocardiography, ECG and labs was performed

Important ECHO data include: mitral valve pathology (pre op), estimated pulmonary artery pressure (grading) , The majority of data on the prevalence and prognostic impact of PH in valve disease are derived from echocardiographic studies where systolic PAP (sPAP) was estimated based on the peak tricuspid regurgitation velocity (TRV) using the Bernoulli equation, EF , LA and LV dimensions and TAPSE

OPERATIVE PARAMETERS: All patients were operated on through a median sternotomy on CPB with moderate general hypothermia (**30**°C–3**2**°C). Recording of the following data : Ischemic time (in mins). Bypass time (in mins), The type and size of mitral valve (mechanical or tissue valve)

POSTOPERATIVE PARAMETERS: Patients were transferred postoperative to surgical ICU on mechanical ventilation. monitoring of the vitals signs including (blood pressure, pulsations, ICTs drainage , urine output). Inotropic support specially the need of miliniron infusion. Weaning from mechanical ventilation and time needed for extubation is recorded. Post-operative ECHO is done and the following data is obtained (EF , TAPSE , ESPAP)

Statistical methods: Data were coded and entered using the statistical package for the Social Sciences (SPSS) version 28 (IBM Corp., Armonk, NY, USA). Data was summarized using mean and standard deviation for quantitative variables and frequencies (number of cases) and relative frequencies (percentages) for categorical variables. Comparisons between groups were done using analysis of variance (ANOVA) with multiple comparisons post hoc test.

Results

A comparative study design, conducted on 100 patients who underwent isolated mitral valve surgery for mitral stenosis or regurge with pulmonary hypertension before surgery, are reviewed and data analyzed regarding change in degree of pulmonary hypertension after mitral valve replacement or repair either mild (Group A) or moderate (Group B) or sever (Group C)

We divided 100 patients in to three groups: Mild PHTN group A (**4.0%**), Moderate PHTN group B (40.0%) and Severe PHTN group c (56%)**. Figure 1**

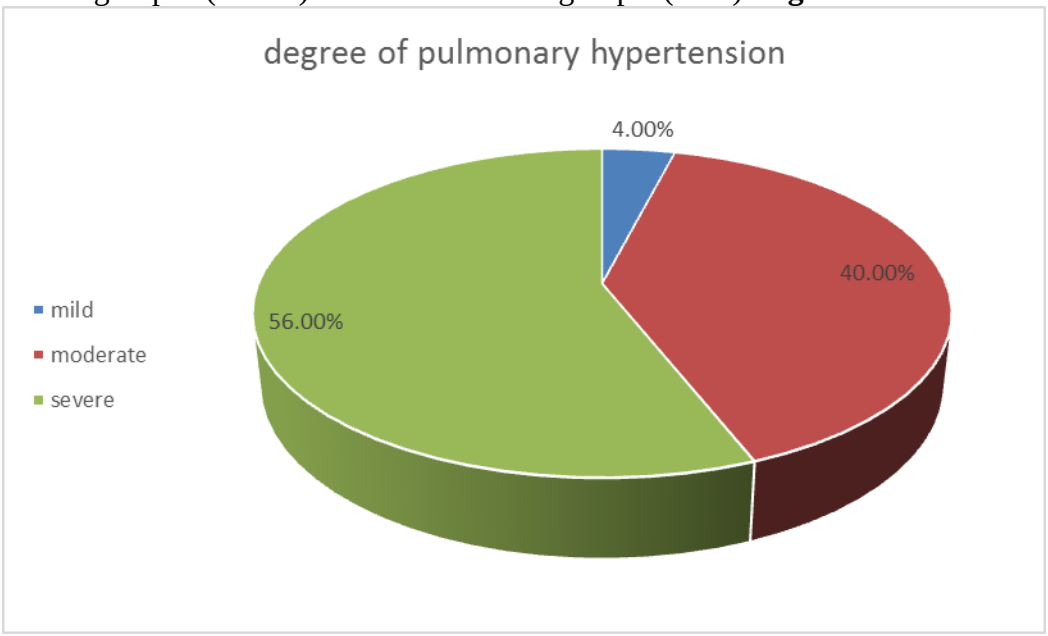

Figure 1: Distribution of degree of pulmonary hypertension

Table 1 distribution of patient according to age

	degree of pulmonary hypertension						
	Group A		Group B		Group C		P value
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	
Age	57.75	8.54	62.80	7.01	63.34	6.81	0.301

Regarding Associated diseases in our study there were 30 diabetic patient, 57 hypertensive patient and there was 55% of patients suffering from dyspnea class II and 45 % of patient suffering from dyspnea class III. **Table 2**

Table 2 distribution of patient according to associated diseases

		degree of pulmonary hypertension						P value
		Group A		Group B		Group C		
		Count	%	Count	%	Count	%	
DM	**yes**	1	25.0%	11	27.5%	18	32.1%	0.857
	no	3	75.0%	29	72.5%	38	67.9%	
HTN	**yes**	2	50.0%	22	55.0%	33	58.9%	0.939
	no	2	50.0%	18	45.0%	23	41.1%	
Dysnea (grade)	**II**	2	50.0%	26	65.0%	27	48.2%	0.266
	III	2	50.0%	14	35.0%	29	51.8%	

In our study there was 29 patients mitral regurge , 42 patients mitral stenosis and 29 patients with double valve pathology. Table 3

Table 3 Relation between mitral pathology and PHTN

		degree of pulmonary hypertension						P value
		Group A		Group B		Group C		
		Count	%	Count	%	Count	%	
MR	**yes**	1	25.0%	17	42.5%	11	19.6%	0.042
	no	3	75.0%	23	57.5%	45	80.4%	
MS	**yes**	3	75.0%	14	35.0%	25	44.6%	0.286
	no	1	25.0%	26	65.0%	31	55.4%	
double M.V pathology	**yes**	0	0.0%	9	22.5%	20	35.7%	0.190

Table 4: Mean values of preoperative echocardiography ,Age and HR

	degree of pulmonary hypertension						P value
	Group A		Group B		Group C		
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	
Age	57.75	8.54	62.80	7.01	63.34	6.81	0.301
HR	81.00	9.42	81.55	9.36	82.18	9.11	0.929
EF (ECHO Pre op)	55.25	8.62	52.15	5.83	52.50	5.75	0.605
LA (ECHO Pre op)	3.99	0.18	3.96	0.28	4.02	0.26	0.526

LVED(ECHO Pre op)	4.32	0.49	5.27	0.70	5.25	0.77	0.049
LVES(ECHO Pre op)	2.93	0.51	3.72	0.58	3.67	0.55	0.030
TAPSE (ECHO Pre op)	1.97	0.26	1.89	0.22	1.85	0.20	0.363
ESPAP (ECHO Pre op)	31.25	2.50	42.88	2.34	52.86	4.71	< 0.001

Left Ventricle Ejection Fraction: Mean value across study 52,47 ±5,86 . **group A** the mean EF was 55.25±8,62 while in **group B** the mean EF was 52.15±5,83 and in **group C** the mean EF was 52.50±5,75 (p value = 0.605)**there was no statistical significance** across groups. **left ventricular end-systolic dimension:** Mean value across study: 3.66±0,58 distributes as follow, in group A the mean LVES was 2.93±0.51 while in group B the mean LVES was 3.72±0,58 and in group C the mean LVES was 3.67±0,55 (p value = 0.030)there was **statistical significance** across groups. Table 4

In our study of 100 patient Mean Ischemia (cross-clamp) time was 44.77± 7.73, In **Group A** with a mean time of 40.00±6,78 minutes while in **group B** the mean ischemia time was 45.40±7,86 minutes and **Group C** the mean ischemia time was 44.66±7,70 showing **no statistical significance** across groups (p value = 0.410). Table 5

Table 5: Mean value of cross clamp time

	Mean	**Standard Deviation**	**Minimum**	**Maximum**
cross clamp (Intra op)	44.77	7.73	32.00	78.00

Mechanical Ventilation: The duration of mechanical ventilation was significantly shorter in **group A** with a mean value of 4,25±2.63 hours while in that of **group B** the mean duration was 4.35± 2.02 hours and in **group C** mean duration was 5.73 ± 2.57 and there was **a statistical significance** across groups (p value = 0.017). **Figure 2**

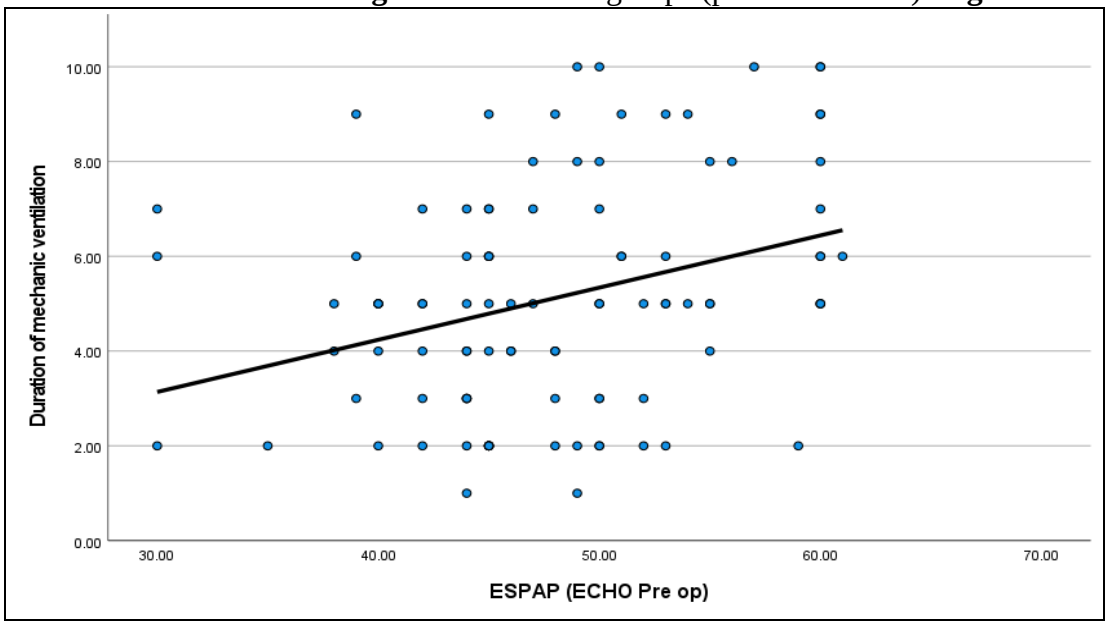

Figure 2: Chart between duration of MV and pre op PHTN

Estimated Systolic pulmonary pressure post op (ESPAP post op) : Mean value across study: 40.59±5,44 , in **group A** the mean post op ESPAP was 34.25 while in group B the mean post op ESPAP was 37.65 and in **group C** the mean post op ESPAP was 43.14 (p value = < 0.001),there was **statistical significance** across groups. **Table 6**

Table 6: Correlation between ECHO post op and ICU stay

	degree of pulmonary hypertension						**P value**
	Group A		**Group B**		**Group C**		
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**	
EF (Post Echo)	56.25	6.29	54.25	4.88	54.29	4.31	0.703
ESPAP (Post Echo)	34.25	9.88	37.65	4.61	43.14	4.12	< 0.001

Discussion

The mean age in our study was 62.90± 6.97 with no statistical difference between the three groups.

Our study population had female (51%) and male (49%) with no statistical difference between the three groups which was consistent with previous studies regarding the sex distribution.

In **2021** a similar study by **Farooq O,** was to evaluate the effect of pulmonary hypertension on ICU stay post mitral valve replacement surgery . The study population comprised 73 male (45.9%) and 86 female (54.1%) patients. The mean age of the sample population was 40.47 years (range: 12-70) with a standard deviation of 11.9. [7]

In 2013 a similar study by Mattia Glauber, a total of 1604 consecutive patients underwent M.V.S . The mean age was 63 ± 13 years, 770 (48 %) patients were female and 218 .[8]

A similar study in 2008 by **Surendra K Agarwal**, MCh studied 43 patients with severe pulmonary arterial hypertension who underwent mitral valve replacement between January 2000 and September 2001 were studied prospectively. The mean age was 30.6 years.[4]

In 2018 a study by Francisco Diniz Affonso da Costa, MD, PhD , 125 MVR patients , Mean patient age was 57±15 years (range: 9 - 87 years), 52 (42%) patients were males, and 23 (18%) were older than 70 years.[9]

Regarding Associated diseases in our study there were 30% diabetic patient, 57 %hypertensive patient.

In 2018 a study by Amrendra K Singh, MD There was mitral stenosis in 19 patients (44.1%), mitral regurgitation in 9 patients (20.9%), and mixed lesions in 15 patients (34.9%).[10]

In **2013 a study by Antonio Miceli** The most predominant pathology was degenerative disease (70 %), followed by functional mitral valve regurgitation (12 %), rheumatic disease (9.4 %), endocarditis (5 %) and prosthetic dysfunction (3.2 %) .[8]

The mean Left ventricular end-diastolic dimension preoperatively in our study was 5.22±0,75 mm, mean Left ventricular end-systolic dimension 3.66±0,58, mean EF 52,47 ±5,86, mean Left atrial diameter 3.99±0,72 with statistical significance between the three groups.

Mean TAPSE as recorded by echocardiography across our entire study was 1.87±0.21. There was no statistical significance regarding Tricusped annular plane systolic excursion across groups (p value = 0.363)

In 2018 a study by Francisco Diniz Affonso da Costa, MD, PhD, 125 MVR patients LVEF was 65.5±7.5% (range = 27 - 77), with only three being below 50%. diastolic dimension of the left ventricle (DDLV) was 48±6 mm (range = 37 - 74) and systolic dimension of the left ventricle (SDLV) was 31±6 mm (range = 22 - 68) there was no statistical significance between the three groups**.**[9]

In our study , Estimated systolic pulmonary pressure (ESPAP) Mean value across study: 48±7,07, in group A the mean ESPAP was 31.25±2,50 while in group B the mean ESPAP was 42.88±2,34 and in group C the mean ESPAP was 52.86 ±4,71 (p value = < 0.001) and there was statistical significance across groups.

in contrast in **2021** a study of **Jan A, Ghani** 28.30 % of patient had EF (40%-55%) and 69.81% of patients had EF above 55% and there was 32 patients had no PH, 14 had mild PH, 65 had moderate PH and 48 had severe PH and this study showed no increase in perioperative morbidity or mortality in patients with severe pulmonary hypertension as compared to those with no, mild or moderate pulmonary hypertension.

In 2017 a study by **BoYang,** Mitral valve surgery included mitral valve replacement (78%) and repair (22%). The severe PH group had more mitral valve replacement (81%) **(P = .04)**

In 2008 study by Michael C Walls 179 patients who underwent MVR or repair (33 after bioprosthetic valve replacement, 20 after mechanical valve replacement, 43 after physiological valve repair, 78 after undersized annuloplasty for functional regurgitation, and five after repair of rheumatic stenosis) there were no significant differences between groups.[13]

In 2008 a similar study by Mubeen, All patients underwent MVR with a mechanical prosthesis 20 cases , a Sorin bileaflet mechanical prosthesis in 18, and a St. Jude Medical in 2 patients there were no significant differences between groups The mean CPB time was 67.6 min (range, 32–137 min) and the mean aortic cross clamping time was 32.8 min (range, 17–85 min).[10]

In 2021 a study of Jan A, Ghani U , the mean Cross-clamp time was 59.3 ± 23.6 and there is not available data about inotropic support needed in this study[7]

The need of inotropic support in our study was (53.6%) who suffer from sever degree of PHTN needed milrinone infusion there was statistical significance across groups

In 2008 a similar study by A. K. Srivastava, Four patients in group 2 also needed milrinone infusion in the initial 24 hours. the mean PAP fell by 38% from a mean preoperative level of 59.8 to 37.1 mm Hg immediately following MVR . there was statistical significance across groups

In 2018 a similar study done by Waseim Atteya Nitroglycerine (NG) was used in 12 (60%) patients in Group A and 18 (90%) patients in Group B (p = 0.02).[14]

The mean duration of mechanical ventilation in mild cases 4.25±2.63 hours while in mod cases the mean duration was 4.35± 2.02 hours and in severe cases mean duration was 5.73 ± 2.57 and there was a statistical significance across groups.

In a similar study **in 2018 by Balaji Asegaonkar** Patients with severe PAH had higher incidence of prolonged ventilation (*P* = 0.007).[15]

In 2021 another study by **Michael V. Genuard**i the duration of MV in patients with mild degree of pulmonary hypertension was 3.5 (0 -7.1) hrs and for those with sever degree was 5.7 (3-17.9) **there was a statistical significance across groups** [16]

In contrast a study of **Jan A, Ghani U, et al.(2021)** the prolonged duration of mechanical ventilation >24 hrs found in 11.3% of cases and the mean duration of mechanical ventilation was 5.8 ± 7.2 intensive care unit stay was 3.42 ±1.14 days . the retrospective analysis of rheumatic heart disease patients revealed that severity of pulmonary hypertension does not reliably correlate with early complications in patients undergoing mitral valve surgery .patients undergoing mitral valve replacement have favorable early outcomes regardless of the severity of pulmonary hypertension.[17]

In 2008 contrast a study by Mubeen concluded that MVR is safe and effective even in the presence of severe PAH as long as the pulmonary arterial pressures are below systemic pressures. With supra-systemic PAP, MVR carries a high risk of mortality, and the patient continues to have persistent PAH in the postoperative period.[10]

In contrast to our study in 2018, a study by Deepak Prakash Borde was a retrospective observational study of 407 patients, In-hospital mortality was 24 (5.9%); and was not different in patients with severe, (9.1%), moderate (4.5%) or mild PAH (2.8%) (P = 0.09). [15]

In 2018 a similar study done by Waseim Atteya This study included 40 patients with rheumatic MS. The patients were divided into two equal groups according to mPAP, Group A (mild PH) included 20 patients with mPAP < 40 mmHg and Group B (severe PH) included 20 patients with mPAP > 55 mmHg. On comparing both groups regarding their hospital stay duration, the mean duration was 8.15 ± 0.87 days in Group A and 8.8 ± 0.76 days in Group B. The difference between both groups was statistically significant (p = 0.01).[14]

Conclusion:

Preoperative Echocardiography is essential not only to diagnose pulmonary hypertension, but also to provide prognostic information, such as RV structure and function. That gives surgeons an important prognostic value about post-operative ICU stay and morbidity. Late diagnosis of PHTN is a main problem causing more complications, so increasing awareness of all physicians in 1ry & 2ry centers regarding manifestations of PHTN is very important for early intervention , hence less complications.

Declarations:

Consent for Publication: I confirm that all authors accept the manuscript for submission

Availability of data and material: Available

Competing interests: None

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