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Original Research Article

A unique study of post mitral valve surgery status of patients in pre and intra COVID-19 era

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ABSTRACT

Background: In this study we have studied the change of pulmonary artery pressure after mitral valve replacement and closed mitral commissurotomy. We have also correlated pulmonary artery pressure before and after operation with postoperative outcome.
Methods: This study was conducted at Department of CTVS of NRS Medical College and Hospitals from August 2019 to September 2021. All 81 patients had rheumatic mitral valve disease. Among these 73 patients underwent mitral valve replacement (MVR) and 8 patients underwent closed mitral commissurotomy (CMC). Group 1 (n=35) consisted of patients who underwent MVR having preoperative systolic PAP measured by TTE was less than 50 mmHg. Group 2 patients (n=38) had preoperative systolic PAP more than or equal to 50 mmHg measured by TTE. Group 3 patients (n=8), consists of patients who underwent CMC. Compared the results between group 1 and 2 and documented the results of group 3 separately.
Results: Our results showed a significant decrease in SPAP after MVR, and further fall of SPAP in the immediate and late postoperative period.
Conclusions: In conclusion, PAP returns to near-normal values after MVR in patients with severe preoperative PAH and to normal values in patients with mild preoperative PAH. Reductions in PAP in patients with preoperative PAH occur immediately after MVR. Postoperative period of patients with severe PAH may be hectic. CMC may be a valid option in isolated MS in selected patients and is very much cost-effective. There were no differences noted among the types of valves used.

Keywords: Hemodynamic, Mitral valve disease, Mitral valve replacement, Pulmonary hypertension

INTRODUCTION

Functions of the right and left sided hearts are interrelated. Left sided heart diseases can affect the right heart and likewise right sided diseases can affect the normal functions of the left heart. Pulmonary artery hypertension results in right ventricular hypertrophy and right ventricular enlargement. When the pulmonary artery systolic pressure increases more, both right ventricular end-diastolic pressure and volume rise gradually, leading to right ventricular dilatation. This will be further complicated by the dilatation of the tricuspid valve annulus. The circumference of the annulus lengthens primarily along the attachments of the anterior and posterior leaflets.[1] The septal leaflet is fixed between the fibrous trigones, preventing lengthening. Dilation of the tricuspid annulus therefore occurs primarily in its anterior/posterior (mural) aspect, which can result in significant functional tricuspid regurgitation (TR) as a result of leaflet mal coaptation. Pulmonary arterial (PA) hypertension is a frequent and serious complication of mitral valve disease, and it is a major risk factor for poor outcome after surgery for mitral stenosis or mitral regurgitation.[2-5] Not surprisingly, the impact of PA hypertension on morbidity and mortality is highly dependent on its degree of severity. Severe PA hypertension is associated with a high risk of perioperative mortality (10% to 15%) in patients undergoing mitral valve replacement (MVR) as well as with increased mortality in the long term.[2-5] Nonetheless, mild PA hypertension is not necessarily benign because it is associated with significantly worse exercise capacity and higher morbidity and mortality. Therefore, the normalization of PA pressure is a crucial goal of MVR.[2-5] Unfortunately, the regression of PA hypertension after operation varies extensively from one patient to the other and is often incomplete.[6,7] In this study we have evaluated the change of pulmonary artery pressure after mitral valve replacement and closed mitral commissurotomy. We have also correlated pulmonary artery pressure before and after operation with postoperative outcome.

Aims and objectives of the study

To document the change of PA pressure after mitral valve replacement and also after closed mitral commissurotomy. To document the postoperative outcome of all these patients and correlate it with the PA pressure.

Specific objectives of this study

To find out the change of PA pressure after mitral valve replacement. To find out the change of PA pressure after closed mitral commissurotomy (CMC). To correlate the PA pressure with per-operative data (CPB and Aortic cross clamp time) and postoperative outcome such as ICU stay, requirement of inotropes, duration of mechanical ventilation, ABG parameters, hospital stay and mortality.

METHODS

Study area

This study was conducted at the Department of Cardiovascular and Thoracic Surgery, N. R. S. medical college and hospital, Kolkata, West Bengal following all ethical protocols and rules and regulations taking due consents.

Inclusion criteria

Patients who underwent mitral valve replacements or closed mitral valvotomy or commissurotomy were included.

Exclusion criteria

Aortic valve dysfunction, reoperation, coronary artery disease, COPD (FEV1/FVC <0.70), renal dysfunction (serum creatinine >2 mg/dl), hepatic dysfunction (serum bilirubin >3 mg/dl), CHF (presence of basal crepitation and peripheral edema).

Eighty-one (81) patients were involved in this non-randomized prospective observational study for a period of August 2019 to September 2021.

Parameters to be studied

The following parameters have been noted-

Preoperative PA pressure: by echocardiography and Doppler study (Figure 1).

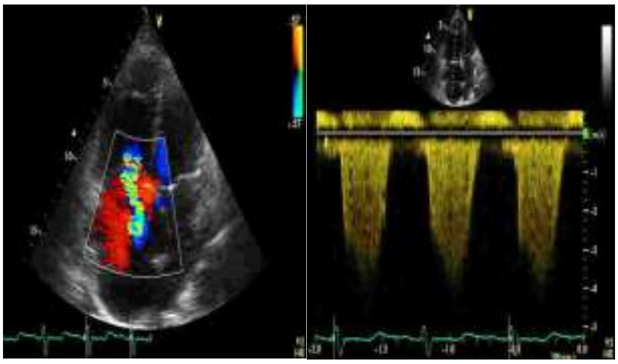

Figure 1: 2D echocardiography with colour Doppler mode used in rendering tricuspid regurgitation jet maximization and measurement for tricuspid valve pressure gradient measurements via CWD techniques.

Peroperative PA pressure: By needle insertion in PA and transoesophageal echocardiography before and after mitral valve surgery (Figure 2).

Postoperative PA pressure: By echocardiography and Doppler study after 24 hours, seven days and three months of surgery.

To correlate the PA pressure before and after operation with postoperative outcome, duration of mechanical ventilation, arterial blood gas (ABG) analysis, duration of ICU stays, requirements of inotropes and central venous pressure monitoring, hospital stay and mortality.

Study tools

History and physical examination; liver function test (LFT), renal function test (RFT), pulmonary function test (PFT); preoperative echocardiography and Doppler study BY SIEMENS ACUSON CV 70 Echocardiography machine; preoperative PA pressure measurement by TEE and needle insertion; postoperative echocardiography and Doppler study. Nellcor Puritan Bennett 760 Ventilator. Hemodynamic monitoring by L and T star 55 monitor; ABG analysis by Nova Biomedical ABG machine.

Normally distributed numerical variables between two groups were analysed by independent sample Student ‘t’ test. Intra-group comparison was done with paired ‘t’ test. Variables which were not normally distributed (by Kolmogorov-Smirnov goodness-of-fit test) were analysed by Mann-Whitney 'U' test. Categorical variables were analysed by Fisher exact test. All data were 2 tailed and a p value <0.05 were taken as statistically significant.

Study technique

There were seventy-three (n=73) MVR operations performed during this period for severe rheumatic mitral valve disease. Only eight (8) patients underwent closed mitral commissurotomy (CMC). Those patients preoperatively planned for Mitral valve repair but underwent MVR on the basis of preoperative valve assessment, were also excluded from the study. Patients more than 40 years of age underwent pulmonary function test to rule out cases of COPD. Cardiac catheterization was not undertaken in less than 40 years aged patients as per institutional protocol. Patients more than 40 years of age underwent coronary angiography to rule out coronary artery disease. Pulmonary artery pressure (PAP) was measured by TTE in all patients within ten days before surgery.

All routine medications consisting of one or more loop diuretics, digoxin, beta blocker, and calcium channel blocker were continued until the morning of surgery except angiotensin-converting enzyme inhibitor which was stopped 48 hours before surgery.

On arrival in the operating room, 5 lead electrocardiography leads were connected. A small dose of fentanyl (25-50 microgram) was administered, and an 18G peripheral venous catheter and 22G radial artery catheter were placed under local anaesthesia. Baseline (control) hemodynamic and arterial blood gas (ABG) measurements were obtained before the induction of anaesthesia.

General anaesthesia was induced with fentanyl, 8 to 10 µg/kg, and thiopental, 1.0 mg/kg. Muscle relaxation was provided with rocuronium, 0.6 to 0.9 mg/kg, except in patients with basal heart rate (HR)>100/minute in whom vecuronium, 0.15 mg/kg, was used. Appropriate size endotracheal tube was used for intubation after manual bag-mask ventilations. Thereafter, patients were mechanically ventilated using a Nellore Puritan Bennett 760 ventilator (tidal volume 7-10 ml/kg, rate 14-18/minute, and positive end expiratory pressure 5 cmH_2O, inspiratory: expiratory 1:2). Hemodynamics were noted 5 minutes after intubation and arterial blood gas analysis were done again. From the induction period until the end of the surgery, anaesthesia was maintained with intermittent doses of fentanyl, midazolam, isoflurane and muscle relaxant. FIO_2 1.0 was maintained throughout the surgical period.

After median sternotomy, pericardiotomy and aorto-bicaval cannulation, PAP was measured by inserting 26G needle in pulmonary artery and also by transoesophageal echocardiography (TEE). MVR was performed using standard cardiopulmonary bypass (CPB) techniques with aortocaval cannulation, activated coagulation time above 400 seconds (initial heparin dose 300 U/kg), antegrade cold (4°C) blood cardioplegia into the aortic root every 20 to 25 minutes, membrane oxygenator, pump flows of 2.0 to 2.4 l/minute/m^2, moderate core hypothermia (30-32°C), topical hypothermia, and haematocrit above 25%. Mean arterial pressure (MAP) was maintained between 50 and 70 mmHg, and patients were re-warmed to 36°C before weaning from CPB. Aortic cross clamp and CPB time noted for all patients. All patients received either a mono-leaflet valve (TTK Chitra) or a bi-leaflet valve (St. Jude Mechanical or Bioprosthetic-Epic). After weaning from CPB, PAP was again measured by inserting 26G needle in pulmonary artery (Figure 2) and also by TEE. TEE was used after the termination of CPB to confirm the valve function in all patients. Norepinephrine and nitro-glycerine infusions were started at rewarming in all patients. Dopamine and dobutamine were used in the postoperative period. Doses were calculated and titrated according hemodynamic parameters. Hemodynamic measurements noted arterial blood gases were repeated. Protamine was infused once hemodynamic becomes stable and CPB was terminated. Pharmacologic and ventilatory management of PAH was continued with nitro-glycerine infusion, maintenance of normocarbia or mild hypocarbia, FIO_2 of 1.0, and prolonged elective ventilation (for at least 12 hours). Intermittent boluses of fentanyl, and midazolam were used as sedation. After this period, weaning was initiated if patients were comfortable, obeying commands, and maintaining satisfactory hemodynamic. Patients were put on pressure support ventilation (15-20 cmH_2O pressure support), and the support gradually decreased to 5 cmH_2O before giving a T-piece trial. Extubation was accomplished if the extubation criteria (Presence of deglutition reflex, breathing minute volume >80 ml/kg/minute, breathing frequency >10/minute and <20/minute and oxygen saturation >94% with fraction of inspired oxygen ≤40%) was reached. Fluid administration was based on maintaining satisfactory hemodynamic, and electrolytes were maintained within normal limits.

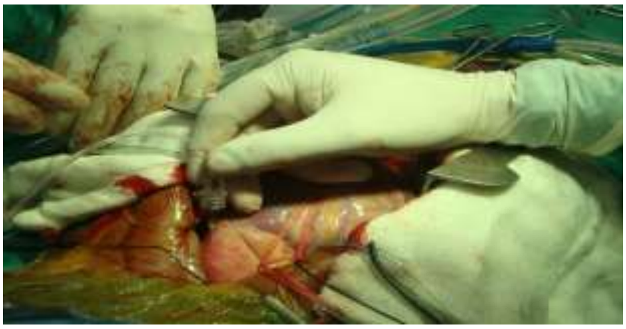

Figure 2: Operative picture showing measurement of PAP by needle insertion method.

The hemodynamic and ABG parameters were repeated 60 minutes after extubation, and 72 hours postoperatively. Hemodynamic parameters that were recorded included HR, MAP and central venous pressure

(CVP). PAP was measured by TTE after 24 hours, 7 days and 3 months. Duration of ICU stay, hospital stay, inotrope used and duration and mortality were recorded.

RESULTS

All 81 patients had rheumatic mitral valve disease. Among these 73 patients underwent mitral valve replacement (MVR) and 8 patients underwent closed mitral commissurotomy (CMC). Group 1 (n= 35) consisted of patients who underwent MVR having preoperative systolic PAP measured by TTE was less than 50 mmHg. Group 2 patients (n=38) had preoperative systolic PAP more than or equal to 50 mmHg measured by TTE. Group 3 patients (n=8), consists of patients who underwent CMC. We have compared the results between group 1 and 2 and documented the results of group 3 separately. Group 1 had 35 patients whereas 38 patients were in group 2. Mean age of group 1 patients were 30.17 and in group 2 were 33.05. 22 patients (62.85%) and 21 patients (55.26%) were female in group 1 and group 2 respectively (Table 1). Combined mitral stenosis (MS) and mitral regurgitation (MR) was the most common lesion and were present in a total of 37 patients. In group 1, the valvular lesion was mitral stenosis (MS) in 6 (17.14%) patients, mitral regurgitation (MR) in 11 patients (31.43%), and mixed lesions in 18 (51.43%) patients. In group 2, 10 patients (26.32%) had MS, 9 patients (23.68%) had MR and 19 patients had mixed lesions (50%). 15 patients in group 2 (39.47%) and 6 patients in group 1 (17.14%) were in NYHA III; others were in NYHA II. Group 3 consisted of 8 patients who underwent CMC.

Table 1: Patient characteristics.

	Group 1 (n=35)	Group 2 (n=38)	P value
AGE (years)	30.17±7.86	33.05±7.94	0.124
Sex	M=13	M=17	0.510
	F=22	F=21	
NYHA II	29	23	0.35
NYHA III	6	15	
MS	6	10	--
MR	11	9	--
Mixed lesion	18	19	--

Decrease in SPAP is most striking immediately after surgery and it decreases further in postoperative period. SPAP decreased in group 1 from preoperative value 42.94±4.46 to 28.37±5.02 mmHg at 24 hours. Postoperatively and in group 2 from preoperative value 65.18±7.82 to 37.55±3.33 mmHg. In group 1, the SPAP fell by 46.51% from a mean preoperative level of 42.94±4.46 to 23.57±4.79 mmHg, 3 months following MVR. In group 2 the SPAP decreased by 56.92% from a mean preoperative level of 65.18±7.82 to 28.18±8.91 mmHg, 3 months following MVR as shown in Figure 3.

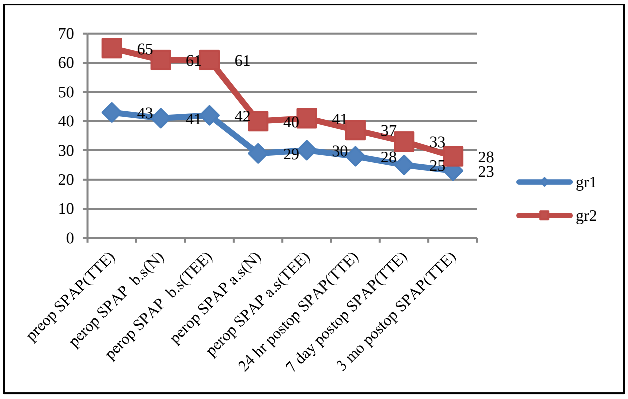

Figure 3: Graphical presentation of change of SPAP in two groups.

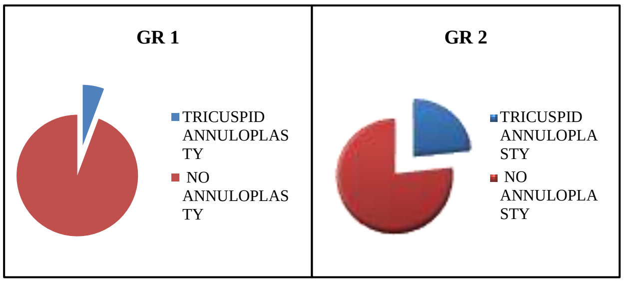

Figure 4: Requirement of tricuspid annuloplasty in two groups.

CVP was significantly lower in group 1 patients at baseline (11.68±1.62 versus 13.68±2.11, p<0.0001) and postintubation (11.34±1.08 versus 12.52±2.05). The baseline HR was 98.17±14.04 and 99.44±14.47 beats/minute in group 1 and 2 respectively, and it remained stable throughout the study period. MAP increased from 71.17±6.41 and 69.57±5.96 at baseline to 81.60±15.59 and 79.03±20.41 mmHg at 72 hour postoperatively in group 1 and 2 respectively as shown in Figure 5 and Figure 6. Group 2 patients required more number of tricuspid annuloplasty than group 1 as shown in Figure 4.

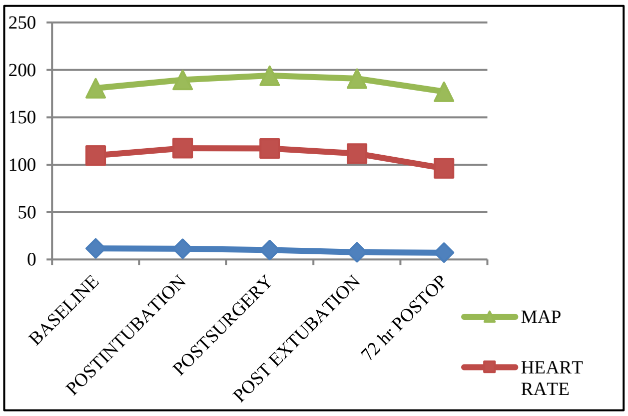

Figure 5: Graphical presentation of change of CVP, HR, MAP in different stages in group 1.

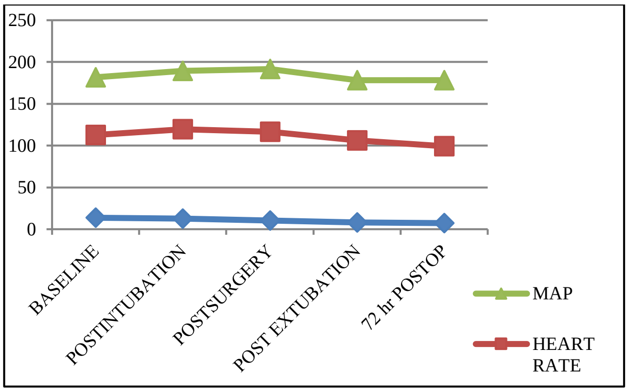

Figure 6: Graphical presentation of change of CVP, HR, MAP in different stages in group 2.

At follow-up after 3 months patients were assessed for symptomatic improvement and by echocardiography (to measure SPAP by echo also). Follow up was 100% complete in the 69 patients. At three months follow-up, 49 patients (71.01%) were in NYHA class I, 16 patients (23.18%) in NYHA class II and 4 patients (5.79%) were in NYHA class III as described in Figure 7.

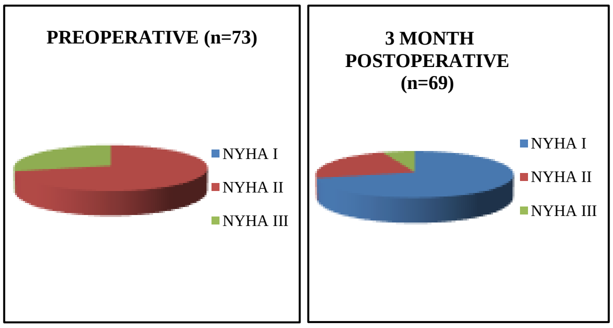

Figure 7: Comparison of New York Heart Association class.

DISCUSSION

In our study, SPAP decreased significantly immediately after CMC/CMV/MVR and continued to decrease in postoperative period. NYHA class, PO_2, CVP and MAP improved after surgery. There was no morbidity and mortality in this particular series. However, we have lost few patients during follow-ups due to socio-economic conditions and covid related lockdown restrictions. So, CMC/CMV may be a valuable option in suitable valve morphology in some selected patients and very much cost-effective.

Limitations of the most of the previous studies include potential selection of heterogenicity bias, retrospective study design, the limited numbers of patients in pulmonary hypertension group cohorts, the lack of pre-operative pulmonary arterial pressure collected, and not accounting for preoperative symptoms of right heart failure or postoperative vasodilator medications.[8,9,16-31]

The researcher concluded that though concomitant PH at MVR is associated with poor long-term survival, adequate SPAP and RVSP reduction can prevent (tricuspid regurgitation) progression even in patients with severe PH preoperatively.[10-15,31]

There are several reports published regarding the change in pulmonary pressure after balloon mitral valvotomy and few reporting are available after extensive online search regarding changes in pulmonary pressure after closed mitral valvotomy or closed mitral commissurotomy however immediate, intermediate and post-operative outpatient departments follow-ups and without any mortality are lacking in these studies.[10-20] As there was no specific indication for determination of prognosis in case lung biopsy in these scenarios, we have not attempted for such. There was no report of post-operative covid infection or RT-PCR for COVID-19 positivity during these periods. Few posts operative patients were even vaccinated based on criteria led down by government of India. All patients, who has undergone MVR received either a mono-leaflet valve (TTK Chitra) or a bi-leaflet valve (St. Jude Mechanical or Bioprosthetic-Epic). There were no differences noted among the types of valves used.

CONCLUSION

All patients, who have undergone MVR received either a mono-leaflet valve (TTK Chitra) or a bi-leaflet valve (St.Jude Mechanical or Bioprosthetic-Epic). There were no differences noted among the types of valves used. No such study available who has tested and compared all forms of mitral valve surgery done under umbrella of Cardiothoracic and Vascular Surgery Departments (BMV is done by Cardiology). This study advances and understanding in this field as it proves that whatever the condition of pulmonary hypertension due to mitral valve pathology, MVR may be helpful though in a case of severe PAH post operative period may be hectic and CMC/CMV may be an alternative cheap option.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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