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# Prognostic Role of Preoperative Tricuspid Annular Plane Systolic Excursion (TAPSE) in Mitral Valve Replacement (MVR) for Rheumatic Mitral Stenosis Patients

**Satyajit Sharma[1], Muhit Abdullah[1], Md. Noor-E-Elahi Mozumder[2*], Munjerin Refat Synthee[1], Md. Zafar-Al-Nimari[1], Anowarul Azim[1], Saikat Das Gupta[3], Dewan Iftakher Raza Chowdhury[1], Siddhartha Shankar Howlader[4], Noel Crypian Gomes[1], Saleh Ahmed[1], Samir Kumar Biswas[1]**

[1]Department of Cardiac Surgery, National Heart Foundation Hospital & Research Institute (NHFH & RI), Dhaka, Bangladesh
[2]Department of Cardiac Surgery, National Institute of Cardiovascular Diseases & Hospital, Dhaka, Bangladesh
[3]Department of Cardiothoracic and Vascular Surgery, Square Hospital, Dhaka, Bangladesh
[4]Department of Cardiothoracic and Vascular Surgery, Evercare Hospital, Chattogram, Bangladesh
Email: *dr.nooreelahiraju@gmail.com

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## Abstract

Tricuspid annular plane systolic excursion has been proposed as a simple and reproducible parameter for quantitative assessment of the right ventricular ejection fraction. The prognostic importance of preoperative TAPSE in patients with mitral valve replacement for rheumatic mitral stenosis patients is still under focused. Therefore, the objective of the study was to predict the outcome after MVR in rheumatic mitral stenosis patients in relation to preoperative TAPSE. This comparative cross-sectional study was conducted at the Department of Cardiac Surgery, National Heart Foundation Hospital and Research Institute. A total of 72 patients of rheumatic mitral stenosis patients who underwent mitral valve replacement were included in the study. They were divided into two groups: Group A and B. Group A included 36 patients with TAPSE < 16 mm and Group B included 36 patients with TAPSE ≥ 16 mm. MVR was performed and postoperative care at ICU was given as per hospital protocol. Demographic, preoperative and postoperative data were analyzed using SPSS software to assess the hypothesis. The preoperative findings including demographic, anthropometric and cardiac factors were similar among the groups ($p > 0.05$) except for the preoperative TAPSE. Mean TAPSE of Group A was 13.17 (±1.40) and Group B was 18.61 (±1.57), the difference was statistically significant ($p < 0.05$). In respect to per-operative findings, cardiopulmo-

nary bypass time compared was significantly higher in Group A ($p < 0.05$), whereas the aortic cross-clamp time was not significantly different between the groups ($p > 0.05$). Among the postoperative complications, including postoperative atrial fibrillation was higher in Group A (30.56%) than Group B (11.11%), mean ventilation time was higher in Group A (27.78%) than Group B (5.56%), length of intensive care was higher in Group A (33.33%) than Group B (11.12%), and hospital stay was higher in Group A (25.0%) than Group B (5.56%), ($p < 0.05$). Higher preoperative TASPE could be used as a prognostic tool for MVR in rheumatic mitral stenosis patients in our settings.

## Keywords

Tricuspid Annular Plane Systolic Excursion, Mitral Valve Replacement, Rheumatic Heart Disease, Mitral Stenosis, Right Ventricular Ejection Fraction, Postoperative Complications

## 1. Introduction

Mitral stenosis (MS) is a disabling and eventually lethal disease. Untreated progressive disease can lead to significant symptoms and serious complications. The great majority of cases in adults are due to rheumatic heart disease, with symptoms usually appearing 16 to 40 years after the episode of acute rheumatic fever [1]. According to the annual report by the World Heart Federation, an estimated 12 million people are currently affected by rheumatic fever and rheumatic heart disease worldwide [2]. Prevalence of rheumatic heart disease is reporting 0.14/1000 in Japan [3], 1.86/1000 in China [4], 0.5/1000 in Korea [5], 4.5/1000 in India [6] and 1.3/1000 in Bangladesh [7]. Among the rheumatic heart disease patients, mitral valve is affected in 75% of cases. Abnormalities of right ventricular function (RVF) play an important role in the development of clinical symptoms and the overall prognosis of the patients with mitral valve stenosis (MS). The right ventricular function is an important determinant of clinical symptoms, exercise capacity, preoperative survival and postoperative outcome in patients with mitral stenosis [8]. In cardiac surgery, although there is sufficient evidence in favor of a routine preoperative assessment of the right ventricle, the main surgical risk score systems do not take into account either dysfunction or dilatation of the RV [9]. On the contrary, pulmonary arterial systolic pressure (PASP) is considered a strong predictor for mortality after cardiac surgery; but, as already demonstrated in patients with HF, pulmonary hypertension (PH) does not always mirror RV dysfunction, which has an independent and additive prognostic value. In addition, RV dysfunction seems to be a better predictor of postoperative circulatory failure rather than pulmonary hypertension (PH), in patients undergoing mitral valve replacement (MVR). Echocardiographic parameters of RV function are RV ejection fraction (RVEF), RV fractional area change (RVFAC), RV outflow tract fractional shortening (RVOTFS), RV total ejection isovolume index (RV Tei index) and tri-

cuspid annular plane systolic excursion (TAPSE) [10]. Radionuclide ventriculography, cardiac catheterization, cardiac magnetic resonance imaging (MRI), a new tissue Doppler imaging (TDI) and 3-dimensional echocardiography could be used for the assessment of RV function. However, these methods are time-consuming, costly and not widely available [11]. Tricuspid annular plane systolic excursion (TAPSE) is a simple M-mode echocardiographic measure of distance of lateral tricuspid annular movement from end diastole to end systole along the long axis of right ventricle [12]. TAPSE is not only determined by RV systolic function, but also appears to depend on LV systolic function and a value of TAPSE > 20 mm suggests normal biventricular systolic function [13] and for every 1 mm decrease in TAPSE, the risk of death increased by 17% [14]. It has been established that RV function can be impaired in valvular heart disease and be a major determinant of clinical outcomes as well [15]. Management of the patients with mitral stenosis largely depends upon medical, interventional and surgical management. Medical management is largely symptomatic. MVR was the definitive treatment for symptomatic mitral stenosis [16]. The aim of the study was to evaluate tricuspid annular plane systolic excursion (TAPSE) in patients with rheumatic mitral stenosis and the prognostic role of TAPSE on the early outcome after mitral valve replacement.

## 2. Rationale of the Study

Impaired left ventricular (LV) function has been recognized as an independent risk factor for morbidity and mortality. However, data on impact of right ventricular (RV) function, like TAPSE on morbidity and mortality in mitral valve surgery is scarce. Most data on RV function in mitral valve surgery were limited to small-sized populations selected for well-known hemodynamic features already associated with RV failure. Pulmonary hypertension has been recognized as a risk factor for RV dysfunction with subsequent prognostic value. At present, NHFH & RI is a high-volume center in Bangladesh operating mitral valve replacement surgery for rheumatic mitral stenosis, which is about more than 10% of total surgery. In our country including NHFH & RI, we are performing mitral valve replacement in patients with right ventricular dysfunction, however, no study has been yet done to evaluate the impact of TAPSE in overall outcome following mitral valve replacement (MVR) surgery. This study attempted to evaluate the impact of TAPSE in the early outcome of patients following MVR in terms of selected variables, which play a major role in developing morbidity and maximization of resource utilization in the post-operative period. The outcome of this study significantly helps to avoid such complications and minimize morbidity, resource utilization and eventually financial burden of the patient.

## 3. Research Hypothesis

Preoperative TAPSE is associated with the prognostic role of early outcome after mitral valve replacement in rheumatic mitral stenosis patients.

## 4. Objectives

### 4.1. General Objective

To assess the prognostic role of TAPSE on the early outcome after mitral valve replacement (MVR) in rheumatic mitral stenosis patients.

### 4.2. Specific Objectives

1) To compare socio-demographic, BMI and risk factors among the groups.

2) To evaluate the occurrence of postoperative atrial fibrillation among the groups.

3) To compare the mechanical ventilation time among the groups.

4) To compare the duration of inotropic support among the groups.

5) To compare the duration of ICU and hospital stay among the groups.

6) To compare the postoperative TAPSE, RV and LV performance among the groups.

## 5. List of Variables

**1) Variables related to demographic and anthropometric characteristics:**

- Age (years).
- Sex.
- Weight.
- Height.

**2) Variables related to pre-operative investigations:**

- TAPSE.
- Atrial fibrillation.
- Pulmonary hypertension
- NYHA class ≥ 3.

**3) Variables related to per-operative findings:**

- CPB time.
- Aortic cross-clamp time.

**4) Variables related to post-operative findings:**

- Post-operative atrial fibrillation.
- Mechanical ventilation time in hours.
- Requirement of Inotropic support (>24 hours).
- Length of ICU stay.
- Length of hospital stay.
- Reoperation for any reason.
- Neurological deficit.
- Pulmonary complications.
- Renal dysfunction.
- Post-operative IABP requirement.
- TAPSE on the 7$^{th}$ postoperative day and 1$^{st}$ month follow-up.
- Mortality (within 30 days).

## 6. Materials and Methods

### 6.1. Study Design

Comparative cross-sectional study.

### 6.2. Study Period

The period of study was from July 2017 to August 2019.

### 6.3. Place of Study

The study was conducted at the Department of Cardiac Surgery, National Heart Foundation Hospital & Research Institute, Dhaka, Bangladesh.

### 6.4. Study Population

Two groups of patients with rheumatic mitral stenosis who underwent elective MVR.

### 6.5. Sampling Unit

Each patient with rheumatic mitral stenosis was admitted under the Department of Cardiac Surgery for elective MVR.

### 6.6. Selection Criteria

**1) Inclusion criteria:**

- Rheumatic mitral stenosis patients who underwent elective mitral valve replacement.

**2) Exclusion criteria:**

- Patients underwent combined valvular and congenital cardiac procedures or congenital cardiac disease.
- Patients with systemic diseases such as end-stage renal disease, hepatic failure, and respiratory failure.
- Patients with previous history of cardiac surgery.
- Patients underwent emergency cardiac surgery for valvular lesions.
- Patients underwent redo mitral valve surgery.

### 6.7. Sample Size

Patients who underwent MVR for rheumatic mitral stenosis were included in this study. A total number of 72 patients (36 in Group A and 36 in Group B) were evaluated.

### 6.8. Grouping of Patient

- **Group A:** Patients with TAPSE < 16 mm who underwent MVR.
- **Group B:** Patients with TAPSE ≥ 16 mm who underwent MVR.

### 6.9. Sampling Technique

Purposive sampling technique was adopted.

### 6.10. Study Procedures

All relevant data was collected from each respondent by use of interview schedule, measured parameters and investigations in a predesigned format. Data collection also focused on echocardiographic evaluation based on the TAPSE (Tricuspid annular plane systolic excursion).

1) Patients admitted in cardiac surgery department with rheumatic mitral stenosis for MVR (without exclusion criteria) were taken for study population.

2) Patients who fulfilled the inclusion criteria and were willing to enroll were included in this study after receiving the proper consent.

3) Detailed history, clinical examination and relevant investigation reports of all patients were recorded in the data collection sheet preoperatively.

4) Patients were taken to the operating room. Peripheral venous catheterization and central venous catheterization in the internal jugular vein and arterial line were done aseptically.

5) Standard anesthetic techniques of induction and maintenance were followed for all procedures.

6) Standard surgical techniques were used for all patients. Surgical corrections of all patients included in the study were done through standard median sternotomy and using cardiopulmonary bypass (CPB). A standard CPB circuit was used. Myocardial protections were achieved with intermittent cold blood cardioplegia with moderate systemic hypothermia (30˚C to 32˚C).

7) After mitral valve replacement, the competence of the mitral valve was tested by injecting saline through the mitral valve into the left ventricle under pressure from a 250 ml bulb syringe. In case of mitral valve replacement, mechanical valve was used.

8) After completing operative procedure, protamine was used to reverse the heparinization.

9) Peroperative total CPB time, aortic cross-clamp time, ACT was recorded.

10) Following the surgical procedure, the entire patients were brought to the cardiovascular intensive care unit where they were monitored until the patients are extubated and stabilized the hemodynamic status.

11) Then, the patients were transferred to the post-ICU and then post-operative ward whenever appropriate according to the ICU consultant's judgment.

12) Echocardiography was taken for measurement of variables during post-operative stay in hospital. The patients were discharged from post-operative ward and were advised for subsequent follow-up.

13) During follow-up, patients were contacted directly and individually requested to make an appointment with the primary surgeon and referring cardiologist to evaluate TAPSE and mitral valve status. All ECHO during follow-up visits were performed at this institution.

14) Echocardiographic findings were recorded into the computerized database of the hospital. Echocardiographic evaluation of the patients during the study period was performed by the Vivid 8 Pro (GE Health care; Wausheka, Wisc) ultrasonography system.

## 7. Results

### 7.1. Demographic and Anthropometric Findings

Table 1 shows the comparison of age, gender and BMI between the two groups. No statistically significant difference was found between the groups ($p > 0.05$).

Table 1. Comparison of age, gender and BMI between the groups (n = 72).

| Variables | Group A (n = 36) No. (%) | Group B (n = 36) No. (%) | Total (n = 72) No. (%) | p-value |
|---|---|---|---|---|
| Age (in years) | | | | |
| 30 - 40 | 20 (55.56) | 22 (61.11) | 42 (58.3) | $0.406^{ns}$ |
| 41 - 50 | 16 (44.44) | 14 (38.89) | 30 (41.7) | |
| Mean ± SD | 39.78 ± 5.87 | 39.83 ± 5.90 | 39.81 ± 5.84 | $0.968^{ns}$ |
| Gender | | | | |
| Male | 15 (41.67) | 14 (38.89) | 29 (40.28) | |
| Female | 21 (58.33) | 22 (61.11) | 43 (59.72) | $0.50^{ns}$ |
| BMI | 23.35 ± 3.79 | 25.52 ± 2.78 | 24.43 (2.23) | $0.10^{ns}$ |

Note: ns: not significant. s: significant. Same below.

### 7.2. Average Preoperative TAPSE of the Patients

The mean TAPSE in Group A was 13.17 (±1.40) mm and in Group B, the mean was 18.61 (±1.57) mm. The overall mean was 15.89 (±3.12) mm. The minimum TAPSE was 11 mm and the maximum TAPSE was 21 mm. The difference of preoperative TAPSE between the groups is statistically significant ($p < 0.001$) (Table 2).

Table 2. Comparison of the average preoperative TAPSE of the patients (n = 72)

| Attribute | Group A (n = 36) No. (%) | Group B (n = 36) No. (%) | Total (n = 36) No. (%) | p-value |
|---|---|---|---|---|
| TAPSE (mm) | | | | |
| 30 - 40 years | 14 (38.89) | 28 (77.77) | 42 (58.33) | |
| 41 - 50 years | 22 (61.11) | 8 (22.23) | 30 (41.66) | $<0.009^{s}$ |
| Mean ± SD (mm) | 13.17 (±1.40) | 18.61 (±1.57) | 15.89 (±3.12) | $<0.001^{s}$ |

### 7.3. Cardiac Factors of the Patients before Operation

Table 3 shows the distribution of preoperative qualitative attributes of the study subjects. Before operation, there was no significant difference between two groups regarding atrial fibrillation ($p > 0.42$), NYHA class ≥ 3 ($p > 0.53$), and pulmonary hypertension ($p > 0.629$).

### 7.4. Peroperative Attributes

Table 4 shows cardio-pulmonary bypass (CPB) time was 109.43 ± 7.01 minutes in Group A and 79.94 ± 8.47 minutes in Group B. The difference of CPB time

between the two groups was found statistically significant ($p < 0.05$).

Aortic cross-clamp time of Group A was 57.92 ± 5.32 and in Group B, it was 56.74 ± 7.81 minutes and the difference between the groups was not statistically significant ($p < 0.05$).

**Table 3.** Comparison of the cardiac factors of the patients before operation (n = 72).

| Attributes | | Group A (n = 36) No. (%) | Group B (n = 36) No. (%) | Total (n = 72) No. (%) | p-value |
|---|---|---|---|---|---|
| Atrial fibrillation | Yes | 10 (27.77) | 7 (19.44) | 17 (23.61) | 0.42[ns] |
| | No | 26 (72.23) | 29 (80.55) | 55 (76.38) | |
| NYHA class ≥ 3 | Yes | 32 (88.88) | 29 (80.55) | 61 (84.72) | 0.53[ns] |
| | No | 4 (11.12) | 7 (19.44) | 11 (15.27) | |
| Pulmonary Hypertension | Yes | 23 (63.88) | 21 (58.33) | 44 (61.11) | 0.629[ns] |
| | No | 13 (36.12) | 15 (41.67) | 28 (38.89) | |

**Table 4.** Comparison of the peroperative cardio-pulmonary bypass time and aortic cross-clamp time among the patients (n = 72).

| Peroperative attributes | Group A (n = 36) No. (%) | Group B (n = 36) No. (%) | Total (n = 72) No. (%) | p-value |
|---|---|---|---|---|
| CPB time (min) | | | | |
| (<90 minutes) | 21 (58.33) | 30 (83.33) | 51 (70.83) | <0.009[s] |
| (>90 minutes) | 15 (41.67) | 06 (16.67) | 21 (29.17) | |
| Mean ± SD | 109.43 ± 7.01 | 79.94 ± 8.47 | 94.71 ± 4.51 | <0.001[s] |
| Aortic cross-clamp time (min) | | | | 0.62[ns] |
| (<60 minutes) | 30 (83.33) | 32 (88.88) | 62 (86.11) | 0.43[ns] |
| (>60 minutes) | 6 (16.67) | 4 (11.12) | 10 (13.89) | |
| Mean ± SD | 57.92 ± 5.32 | 56.74 ± 3.81 | 56.33 ± 9.67 | |

## 7.5. Distribution of Patients in Relation to Post-Operative Findings

Table 5 shows the comparison of postoperative findings between the groups. Occurrence of postoperative AF was higher in Group A than Group B and the difference was statistically significant between the groups ($p < 0.05$). There were also differences in duration of mechanical ventilation and duration of inotropic support between the two groups. The difference was statistically significant ($p < 0.001$).

## 7.6. Distribution of Patients in Relation to Duration of Stay

Table 6 shows the comparison of length of postoperative stay between the groups. Duration of ICU stay and hospital stay following surgery was longer in Group A patients compared to Group B patients with statistical significance ($p < 0.05$).

**Table 5.** Comparison of postoperative findings between the groups (n = 72).

| Postoperative parameters | Group A TAPSE < 16 mm (n = 36) | Group B TAP TAPSE ≥ 16 mm (n = 36) | p-value |
|---|---|---|---|
| Atrial fibrillation | | | |
| Yes | 11 (30.56) | 4 (11.11) | <0.04[s] |
| No | 25 (69.44) | 32 (88.89) | |
| Mechanical ventilation time | | | |
| Normal (<24 hr) | 26 (72.22) | 34 (94.44) | 0.009[s] |
| Prolonged (>24 hr) | 10 (27.78) | 2 (5.56) | |
| Mean ± SD | 10.42 ± 4.82 | 5.85 ± 1.27 | 0.001[s] |
| Duration of inotropic support | | | |
| <24 hours | 8 (22.22) | 20 (55.55) | <0.001[s] |
| >24 hours | 28 (77.78) | 16 (44.45) | |
| Mean ± SD | 69.20 ± 12.98 | 30.42 ± 9.82 | <0.001[s] |

**Table 6.** Comparison of the postoperative stay between the groups (n = 72).

| Postoperative attributes | Group A (n = 36) No. (%) | Group B (n = 36) No. (%) | Total (n = 72) No. (%) | p-value |
|---|---|---|---|---|
| Length of ICU stay (days) | | | | |
| Normal (<3 days) | 24 (66.66) | 32 (88.88) | 56 (77.77) | 0.001[s] |
| Prolonged (>3 days) | 12 (33.34) | 4 (11.12) | 16 (22.23) | |
| Mean ± SD | 58.67 ± 19.41 | 33.33 ± 10.39 | 46.73 ± 9.39 | 0.001[s] |
| Postoperative hospital stay (days) | | | | |
| Normal (<14 days) | 27 (75.0) | 34 (94.44) | 61 (84.72) | 0.01[s] |
| Prolonged (>14 days) | 9 (25.0) | 2 (5.56) | 11 (15.28) | |
| Mean ± SD | 9.78 ± 4.29 | 7.42 ± 2.16 | 8.61 ± 3.2 | 0.009[s] |

### 7.7. Distribution of Patients in Relation to Post-Operative Attributes of the Cases (n = 72)

There were no incidences of neurological deficit, renal failure, and postoperative IABP requirement in the two groups. In Group A, 3 patients had developed pulmonary complications and 2 patients needed re-operation and in Group B, 1 patient had developed pulmonary complications and 1 patient needed re-operation. Although p-value is not significant between two groups but postoperative outcomes were found relatively better in Group B than Group A (Table 7).

### 7.8. Distribution of Patients in Relation to Postoperative RV and LV Performance

Table 8 shows postoperative TAPSE in Group A was 16.28 ± 2.54 and Group B

**Table 7.** Comparison of the patients according to other post-operative outcomes between the two groups (n = 72).

| Attributes | | Group A (n = 36) No. (%) | Group B (n = 36) No. (%) | Total (n = 72) No. (%) | p-value |
|---|---|---|---|---|---|
| Re-operation for any reason | Yes | 2 (5.5) | 1 (2.7) | 3 (4.17) | 0.58$^{ns}$ |
| | No | 34 (94.44) | 35 (97.22) | 69 (95.83) | |
| Neurological deficit | Yes | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0.05$^{ns}$ |
| | No | 36 (100) | 35 (97.22) | 71 (98.61) | |
| Pulmonary complications | Yes | 3 (8.3) | 1 (2.7) | 4 (5.56) | 0.37$^{ns}$ |
| | No | 33 (91.67) | 35 (97.22) | 68 (94.44) | |
| Renal dysfunction | Yes | 0 (0.0) | 0 (0.0) | 0 (0.0) | >0.05$^{ns}$ |
| | No | 36 (100) | 36 (100) | 72 (100) | |
| Postoperative IABP requirement | Yes | 0 (0.0) | 0 (0.0) | 0 (0.0) | >0.05$^{ns}$ |
| | No | 36 (100) | 36 (100) | 72 (100) | |

**Table 8.** Comparison of postoperative RV and LV performance between the two groups (n=72) distribution of patients in relation to postoperative mortality.

| Postoperative Parameters | Group A TAPSE < 16 mm (n = 36) | Group B TAPSE ≥ 16 mm (n = 36) | p-value |
|---|---|---|---|
| TAPSE | 16.28 ± 2.54 | 20.12 ± 1.26 | <0.05$^{s}$ |
| RVEF | 58.39 ± 5.02 | 62.10 ± 2.77 | <0.05$^{s}$ |
| LVEF | 59.59 ± 2.75 | 64.59 ± 2.75 | <0.05$^{s}$ |

**Table 9.** Comparison of postoperative mortality between two groups (n = 72).

| Postoperative attributes | | Group A (n = 36) No. (%) | Group B (n = 36) No. (%) | Total (n = 72) No. (%) | p-value |
|---|---|---|---|---|---|
| Postoperative mortality | Yes | 2 (5.56) | 1 (2.78) | 3 (4.16) | 0.55$^{ns}$ |
| | No | 34 (94.44) | 35 (97.22) | 69 (95.83) | |

was 20.12 ± 1.26. and the difference was statistically significant ($p < 0.05$). Post-operative RVEF was 58.39 ± 5.02 in Group A, while in Group B was 62.10 ± 2.77 and the difference was also statistically significant ($p < 0.05$). The postoperative LVEF in Group A was 59.59 ± 2.75 and in Group B, it was 64.59 ± 2.75. The difference was found statistically significant ($p < 0.05$).

Table 9 shows the mortality in Group A was 5.56% and 2.78% in Group B was 2.78%. Though the difference is statistically not significant but mortality rate was relatively higher in Group A than Group B.

## 8. Discussion

Rheumatic heart disease (RHD) is still a major problem affecting people all over

the world. It is a major problem especially for the middle income and low-income countries [17]. Rheumatic MS is a major cause of valve disease in developing countries. Mitral stenosis (MS) is the most common valvular involvement in rheumatic heart disease [18]. Previously, many prognostic factors were studied in the short and long-term outcome of mitral valve repair [19]-[22]. But few studies have assessed the impact of right ventricular function in repair of rheumatic mitral valve [23] [24]. This study was an attempt to assess the impact of right ventricular function in the repair of mitral stenosis in rheumatic heart disease. We used TAPSE as a measure of right ventricular function in the mitral stenosis patients in this study. Tousignant and colleagues have shown TAPSE to be a modest indicator of right ventricular dysfunction [25]. Also, in heart failure patients, TAPSE was found to decrease with decreased left ventricular function [26]. Previously, Ragab *et al.* found an average TAPSE of 17.11 ± 2.1 in patients with mitral stenosis and determined a cut-off value of 16 as predictor of outcome [27]. In accordance with those findings, total 72 mitral stenosis patients were subdivided into two groups (Group A, Group B). Group A patients had TAPSE < 16 mm and Group B patients had TAPSE ≥16mm. The overall mean age of our patients was 39.81 ± 5.8 years. Husain *et al.* in a study detecting outcome of mitral valve replacement noted a mean age of 32 ± 8 years among patients undergoing surgery in BSMMU [21]. This probably indicates a late arrival of mitral valvular patients to hospital as studies surveying prevalence of rheumatic fever and rheumatic heart disease among children and adolescents aged 5 to 19 years have detected a prevalence of 0.3 per 1000 people [28]. In this study, maximum (58.3%) of our patients was in 30 - 40 years age group. This finding is similar to the finding of Rodriguez-Fernandez and associates [29]. In their study, the mean age was found 39.6 ± 12.5 years and maximum 32 (38.55%) patients had age between 30-39 years. Among our 72 patients, 43 (59.72%) were female and the number of male patients were 29 (40.28%). This finding is similar to the finding of Mynt *et al.*, (2018) who found 73% female patients in their study. Malla and her colleagues also found similar result (59.9% female) in their study [18]. This high proportion female is explainable as mitral valve disease due to rheumatic heart disease is significantly more common in female than male [30]. Regarding body mass index of patients distribution, there was no significant difference between two groups ($p = 0.204$). Here, maximum patients were at normal BMI category. The overall mean TAPSE of our patients before operation was 15.89 ± 3.12 mm. In Group A, the mean was 13.17 ± 1.40 mm and in Group B, the mean was 18.61 ± 1.57 mm. Islam *et al.* found mean TAPSE 13 mm among their rheumatic mitral stenosis patients [31] while Ragab *et al.* reported a mean TAPSE of 17.11 ± 2.1 mm in their study [27]. Another study conducted by Felix and his colleagues found mean TAPSE 20.21 ± 5.92 mm among patients with left sided valvular heart disease [32]. The variation may have been influenced by the observational study and inclusion criteria of patients in these studies. There were no significant differences of pre-operative qualitative attributes regarding atrial fibrillation, NYHA class and pulmonary hypertension, which was similar in previous study too. Re-

quired cardio-pulmonary bypass time was 109.43 ± 7.01 minutes for Group A and 79.94 ± 8.47 minutes for Group B. Group A required significantly higher CPB time than Group B ($p < 0.001$). Although higher time required for lower TAPSE group than higher TAPSE group, this extra period was well tolerated without any residual effect by the advancement of improved myocardial protection. This result was also consistent with the study of Pande and colleagues [31]. Aortic cross-clamp (XCL) time required for Group A was 57.92 ± 5.32 and 56.74 ± 3.81 minutes for Group B. There was no significant difference of aortic cross-clamp time between the groups ($p = 0.43$). A study conducted by Vohra *et al.* found mean aortic cross-clamp time 72 ± 12 min in their study [33]. Mkalaluh *et al.* found mean aortic cross-clamp time 78 ± 9 min in their study [22], which also was similar in this study. Regarding postoperative outcome variables in this study, postoperative atrial fibrillation was observed in 15 (20.83%). Among them 11 (30.56%) were in Group A and 4 (11.11%) were in Group B. The incidence was statistically significant ($p = 0.04$). Duration of inotropic support found in 69.20 ± 12.98 hours in Group A and 30.42 ±.9.82 hours in Group B. Which was also found statistically significant ($p = 0.001$). These postoperative outcome variables were significantly higher among patients with lower TAPSE (<16 mm) in comparison those with higher TAPSE (≥16 mm) in this study. A similar finding was reported by Ragab and his colleagues in their study [27]. They found that MS patients with adverse events had significantly lower TAPSE than those without adverse event. The mean mechanical ventilation time was significantly higher in patients with TAPSE < 16 mm. p-value is <0.001. The mean was 10.42 ± 4.82 in Group A and 5.85 ± 1.27 in Group B. Sun *et al.* also reported a similar finding in their study where patients with lower TAPSE required significantly higher ventilation time [34]. Lower TAPSE indicates lower right ventricular stroke volume [25] and therefore lower perfusion to lung, which may have resulted increase in mean ventilation time. The mean length of ICU stay of the patients was also significantly higher in patients with lower TAPSE in this study. Previously, Sun *et al.* have shown that mitral valve surgery patients with right ventricular dysfunction had to stay significantly longer duration in the hospital [24], which was concordant with our finding.

Regarding the change of TAPSE, RV and LV performance within the groups, in Group A, TAPSE was 16.28 ± 2.54 and Group B was 20.12 ± 1.26. The difference was statistically significant ($p < 0.05$). A similar finding was reported by Ragab and his colleagues in their study [27]. Postoperative RVEF was 58.39 ± 5.02 in Group A, while in Group B was 62.10 ± 2.77 and the difference was also statistically significant ($p < 0.05$). The postoperative LVEF in Group A found 59.59 ± 2.75 and in Group B, it was 64.59 ± 2.75. The difference was found statistically significant ($p < 0.05$). Forfia and his colleagues also reported a similar finding in their study where patients with lower TAPSE improvement in RV and LV performance were less than patients with higher TAPSE [14]. Among our 72 MVR patients 3 patients had died after operation. So, overall mortality rate was 4.17%. The mortality rate was 5.56% in Group A while 2.78% in Group B. Though

the difference is statistically not significant, it was relatively higher in Group A than Group B. A study conducted by Ismeno *et al.* also found almost same mortality rate in their study on MVR patients [35].

Therefore, post-operative outcome after MVR in rheumatic valve replacement patients was relatively better in those patients with higher TAPSE (TAPSE ≥ 16 mm) in relation to those patients with lower TAPSE (TAPSE < 16 mm).

## 9. Conclusion

Patients with lower TAPSE had higher rate of complications in terms of occurrence of POAF, deep sternal wound infection, duration of mechanical ventilation time, duration of inotropic support, duration of ICU and hospital stay following MVR in rheumatic mitral stenosis patients compared to higher TAPSE. So, the preoperative TAPSE could be a prognostic tool for the assessment of postoperative outcome after MVR in rheumatic mitral stenosis patients.

## 10. Limitations of the Study

Although the result of this study supports the hypothesis, there are some facts to be considered which might have affected the result of the current study.

1) The sample size was small in number.

2) Observation was done only in one hospital and no long-term outcome was observed.

3) Unavailability of 3D RV reconstruction software leading to underestimation of RV volume.

## 11. Recommendations

1) Preoperative evaluation of tricuspid annular plane systolic excursion (TAPSE) is recommended in rheumatic mitral stenosis patients who are undergoing mitral valve replacement (MVR) routinely to mitigate the chances of increased postoperative complications and minimize the resource utilization.

2) Multiple centers based on larger sample studies and long-term studies should be performed, including other aspects of cardiac surgery are needed to validate the findings of this study and determine whether it affects the survival of the procedure.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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