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Cover Page Footnote

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ORIGINAL ARTICLE

Impact of Effective Orifice Area Index of Mitral Valve Prosthesis on Postoperative Pulmonary Artery Pressure and Functional Tricuspid Valve Regurgitation

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Abstract

Background: **One of the common complications following mitral valve replacement (MVR) is patient-prothesis mismatch (PPM). This problem can lead to unfavorable consequences that mimic residual mitral stenosis.**

Aim: **Evaluating the incidence of PPM, its associated predictors, and how it can influence pulmonary hypertension (PH) and late tricuspid valve regurge.**

Methods: **From September 2020 to December 2022, 100 consecutive patients (75 females), underwent MVR. The mean age was 46.78 ± 9.59 years and the mean ejection fraction (EF) was 61.84 ± 7.68 %. The patients were divided according to the effective orifice area index (EOAI) into nonmismatch group (54 %), moderate mismatch group (32 %), and severe mismatch group (14 %).**

Results: **PPM was diagnosed in 46 % of the patients after MVR. They were divided into a moderate mismatch group (32 %) with a mean EOAI was 1.04 ± 0.08 cm^2/m^2 and severe mismatch group (14 %) with a mean EOAI was 0.75 ± 0.09 cm^2/m^2. There was significant statistical difference in the size of implanted prostheses ($P = 0.023$) with sizes 25 and 27 accounting for 58.6 % of the implanted prostheses in mismatch groups. The univariate and multivariate analyses of the postoperatively inadequate regression of mean pulmonary artery pressure (PAP) and deterioration of tricuspid valve regurgitation revealed that the EOAI was the only predictive factor [(OR = 0.113, $P = 0.047$), (OR = 0.052, $P = 0.040$), respectively].**

Conclusion: **The results revealed a high incidence of mitral valve prosthesis mismatch in our patients. Also, they support that mitral PPM may prohibit the amelioration of both functional TR and PH in patients undergoing isolated MVR.**

Keywords: Effective orifice area, Functional tricuspid regurgitation, Mitral valve replacement, Patient prosthesis mismatch, Pulmonary artery pressure

1. Introduction

The patient−prosthesis mismatch (PPM) is a condition that occurs due inappropriate proportion between the effective orifice area (EOA) and body surface area (BSA); it results from the fact that the new valve is relatively small compared with BSA.[1]

The degree of PPM can be classified according to the spectrum of EAOI into normal, moderate, and severe forms. Patients' sufficient EAOI lies above 1.2 cm^2/m^2, while moderate Mitral PPM lies between 1.2 and 0.9 cm^2/m^2. Meanwhile, a severe form of is overt below 0.9 cm^2/m^2.[2,3]

Following aortic valve replacement, research on PPM referred to its unfavorable effects on

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hemodynamics, LVH, and mortality rates.[4,5] Nevertheless, the postoperative PPM associated with mitral valve replacement (MVR) is far less studied. Mitral valve PPM was first reported by Rahimtoola and Murphy in 1981; their patient continued to show cardiac symptoms, pulmonary hypertension (PH), and advancement of right heart failure despite having MVR.[6]

Mitral PPM is a commonly reported condition in the literature; its incidence ranged between 30 and 85 % after *in-vivo* assessment of EOA.[3,7,8] In addition, it significantly mimics residual mitral stenosis with its all complications that include higher *trans*-mitral gradients, higher LA pressure, and higher pulmonary blood pressure. Right-sided heart problems can occur on top of these mentioned factors like RV dilation and dysfunction, and AF that, in turn, can cause annular dilation and functional regurgitations of the tricuspid valve. Those patients are susceptible to have grade III of IV NYHA classification[9]; in addition, they show poorer outcomes due to persistent fTR following MVR.[10]

Calculation of EOA was managed by Cho and colleagues by three different methods; they included continuity equation, pressure half time, and reference EOA. Those methods enabled them to highlight the differences among previous studies; however, the continuity equation was regarded as the sole predictor of hemodynamic parameters postoperatively.[11]

The aim of this study is to evaluate the incidence of PPM, its associated predictors, and how it can influence the PH and late tricuspid valve regurge.

2. Patients and methods

This is an observational case series prospective study on 100 patients with prosthetic mitral valve replacement at El-Hussien University Hospital and National Heart Institute from September 2020 to December 2022. The patients were sorted with regard to the EOAI into: nonmismatch group (54 %), moderate mismatch group (32 %) and severe mismatch group (14 %). Patient demographic and preoperative data are summarized in Table 1. 75 % of the patients were females. The average age was 46.78 ± 9.59 years, the average weight was 79.71 ± 15.47 Kg, the mean height was 163.33 ± 7.68 cm and the mean BSA was 1.89 ± 0.20 m^2. The preoperative echocardiogram [as shown in Table 2] revealed that the mean left ventricu end-diastolicolic diameter (LVEDD) was 5.19 ± 0.74 cm, the mean left ventricular end-systolic diameter (LVESD) was 3.39 ± 0.62 cm, the mean ejection fraction (EF) was 61.84 ± 7.68 %, the mean LA diameter was 5.43 ± 1.11 cm and the mean pulmonary artery pressure (PAP) was 52.25 ± 16.83 mmHg. The main mitral valve lesions were stenosis (43 %), regurgitation (37 %), and mixed lesion (20 %). The degrees of severity of tricuspid valve regurgitation were trivial (4 %), mild (44 %), moderate (28 %) and severe (24 %). There were significant variations of statistical importance between the groups regarding preoperative average LVEDD ($P = 0.029$) and mean LVESD ($P = 0.016$).

We exclude patients who had organic tricuspid valve disease, ischemic or congenital heart disease, low EF less than 50 %, significant aortic valve disease and early failure of tricuspid valve repair. A thorough medical history was recorded for each patient; in addition, thorough general and local examinations were conducted. Intraoperative and postoperative date were collected. All patients experienced preoperative and a follow-up (after 6 months) echocardiograms.

Surgical techniques: Standard ones were deployed via a median sternotomy or minimal invasive with CP bypass and mild generalized

Table 1. Patient demographic and preoperative data.

	Nonmismatch ($n = 54$)	Moderate mismatch ($n = 32$)	Severe mismatch ($n = 14$)	P value
Female sex	39 (72.2 %)	28 (87.5 %)	8 (57.1 %)	0.071
Age (y)	47.90 ± 10.60	45.18 ± 8.42	46.07 ± 7.80	0.431
Weight (kg)	79.82 ± 15.53	77.59 ± 14.19	84.17 ± 18.07	0.417
Height (cm)	164.51 ± 7.81	161.39 ± 5.25	164.50 ± 10.15	0.143
BSA (M^2)	1.90 ± 0.20	1.85 ± 0.17	1.95 ± 0.23	0.252
Hypertension	6 (11.1 %)	2 (6.3 %)	1 (7.1 %)	0.723
Diabetes Mellitus	4 (7.4 %)	2 (6.3 %)	0	0.604
Smoking	5 (9.3 %)	1 (3.1 %)	2 (14.3 %)	0.386
Rhythm				
Sinus	25 (46.3 %)	17 (53.1 %)	10 (71.4 %)	
AF	28 (51.9 %)	15 (46.9 %)	3 (21.4 %)	0.101
Atrial flutter	1 (1.8 %)	0	0	
Pacemaker	0	0	1 (7.2 %)	

AF, atrial fibrillation; BSA, body surface area.

Table 2. Preoperative ECHO data.

	Nonmismatch ($n = 54$)	Moderate mismatch ($n = 32$)	Severe mismatch ($n = 14$)	*P* value
Preoperative Echo				
LVEDD (cm)	5.29 ± 0.72	4.91 ± 0.63	5.42 ± 0.88	0.029
LVESD (cm)	3.49 ± 0.63	3.14 ± 0.47	3.60 ± 0.75	0.016
EF (%)	61.31 ± 7.73	63.53 ± 6.96	60.00 ± 8.79	0.273
LA (cm)	5.60 ± 1.19	5.29 ± 1.02	5.12 ± 0.96	0.243
PAP (mm Hg)	51.34 ± 12.26	54.61 ± 21.58	50.28 ± 19.64	0.614
Mitral valve lesion				
Stenosis	23 (42.6 %)	15 (46.9 %)	5 (35.7 %)	
Regurge	24 (44.4 %)	8 (25.0 %)	5 (35.7 %)	0.262
Mixed	7 (13.0 %)	9 (28.1 %)	4 (28.6 %)	
Tricuspid valve regurge				
Trivial	3 (5.5 %)	4 (12.5 %)	1 (7.1 %)	
Mild	23 (42.6 %)	9 (28.1 %)	8 (57.1 %)	0.597
Moderate	15 (27.8 %)	10 (31.3 %)	3 (21.4 %)	
Severe	13 (24.1 %)	9 (28.1 %)	2 (14.3 %)	

EF, ejection fraction; LA, left atrium diameter; LVEDD, left ventricular end diastolic diameter; LVESD, left ventricular end systolic diameter; PAP, pulmonary artery pressure.

hypothermia. Protective myocardial measures were taken via cardioplegia, either warm or cold antegrade blood manner. Both the posterior valve leaflet and its associated subvalvular apparatus were either preserved or not preserved after the valvular excision. The choice of prothesis brand was determined by the surgeon, meanwhile, valvular size was determined by manufacturers' guidelines. Valvular sewing was carried out via interrupted horizontal-pledgetted mattress sutures with 2/0 Ethibond (Ethicon, Inc., Somerville, NJ, USA). Valves that were involved in the study included the following: On-X (Medical Carbon Research Institute, Austin, TX, USA), St. Jude Medical (St. Jude Medical, Inc., St. Paul, MN, USA), and Carbomedics (Sorin Biomedica, Saluggia, Italy). Whenever indicated, valvular repairing was done to the tricuspid simultaneously. Warfarin was firstly given to the patints on day 1 postoperatively to maintain their INR between 2.5 and 3.5. Prior to patients' discharge, an echocardiogram was performed. Both follow-up and warfarin dosing amendments had taken place in the outpatient clinics in a periodic manner. A follow-up echo was performed 2 years later.

The PAP was calculated via the addition of RV systolic BP to RA pressure.[12,13] PA hypertension cutoff measure was considered at the 40 mm Hg.[14] In AF patients, we considered the average values via calculation of the average of 5 cycles that showed the least R–R interval, and was close enough to normal HR. The EOA of prosthetic mitral valve was calculated with the continuity equation[15]:

$$\mathrm{EOA} = (CSA_{LVOT} * VTI_{\mathrm{LVOT}}) / (VTI_{\mathrm{PrMV}})$$

CSA_{LVOT}: cross-sectional area of the LVOT obtained from diameter measurement just close the prosthesis.

VTI_{LVOT}: velocity-time integral obtained by pulsed wave Doppler in the LVOT,

$\mathrm{VTI_{PrMV}}$: velocity-time integral obtained by continuous wave Doppler through the mitral prosthesis.

The endpoints of this research were determining of both PPM incidence following MV surgery, and possible prosthetic and patient-related risk factors. In addition, to study the impact of MV PPM on both PAP and fTR.

2.1. Limitations

Our study design did not depend on randomization. Also, being an observational cohort design, those results might not be generalized to other samples or the general population. Additionally, the prosthetic valves were only of three different brands, and the there was one predominant brand; the selection of the type depended completely on surgeon's choice. Regarding the follow-up period, it was not sufficient to detect the variations of in PAP severity and fTR. Also, bioprosthesis was not included in this study. Finally, we recommend carrying on other study to extend and test those results.

2.2. Statistical analysis

Data were thoroughly handled via Statistical Package for Social Science (IBM SPSS) version 20. The description of the qualitative data is in the form of numbers and percentages while the description of normally-distributed quantitative data is in the form of mean, SD, and ranges. Comparing more than two independent groups regarding normally-distributed quantitative data was achieved by One-way ANOVA.

Continuous dependent variables were analyzed by linear regression while binary dependent variables were analyzed by logistic regression. The χ^2 test, Fisher exact test, and unpaired *t*-test were deployed in univariate analysis. Independent variables with a *P*-value of 0.2 in the univariate analysis were deployed in the multivariate model. Odds ratios and their 95 % CI were calculated for independent variables included in the multivariable model. A *P*-value below 0.05 is considered statistically significant.

3. Results

Tables 3 and 4 show the operative and post-operative outcomes. The average CP bypass time was 84.89 ± 24.23 min while the average cross-clamping time was 58.54 ± 18.97 min. The brands of valvular prosthesis deployed in this study included Saint Jude Medical (91 %), Sorin carbomedics (5 %) and On-X (4 %). The sizes of the prosthetic valve were 25 (3 %), 27 (48 %), 29 (38 %), 31 (7 %), and 33 (4 %). The tricuspid valve surgeries were De Vega (27 %), patch annuloplasty (5 %), ring (3 %), and replacement (3 %), and no tricuspid surgery in 62 (62 %) patients.

The mean volume of drained blood was 590.81 ± 531.01 ml. The mean duration of mechanical ventilation was 10.21 ± 5.98 h and the mean ICU care was 67.42 ± 41.79 h. The mean ward care was 7.01 ± 5.08 days and the mean total hospital stay was 9.87 ± 5.26 days. All the following variables showed remarkable variation of statistical importance between the groups: the average cardiopulmonary bypass (CPB) time showed ($P = 0.009$), the mean cross-clamping time ($P = 0.038$), the prosthesis' size ($P = 0.023$), the mean of ward-staying duration ($P = 0.009$) and the mean hospital-staying duration ($P = 0.043$).

The mean follow-up time was estimated as 24.86 ± 5.42 months. The follow-up echo [as shown in Table 5] revealed that the average LVEDD was 4.95 ± 0.67 cm while the average LVESD was 3.41 ± 0.68 cm. Mean EF was 57.95 ± 9.95 %; meanwhile, mean LA diameter was 4.70 ± 0.77 cm. Reported average PAP was 32.96 ± 10.93 mm Hg, the mean MPG was 6.11 ± 2.13 mm Hg, the mean PPG was 13.30 ± 3.97 mm Hg, the mean EOA was 2.34 ± 0.71 cm^2 and the mean EOAI was 1.23 ± 0.34 cm^2/M^2. The mean RV basal diameter was 3.42 ± 0.77 cm and the mean TAPSE was 1.74 ± 0.31 cm. The degrees of severity of fTR were trivial (15 %), mild (57 %), moderate (22 %) and severe (6 %). There were statistically significant differences between the groups regarding the mean MPG ($P = 0.013$), mean EOA ($P < 0.001$), and mean EOAI ($P < 0.001$).

Univariate linear regression analysis of EOAI revealed that size of prosthesis (Coefficient = 0.054, $P = 0.009$) and EOA (Coefficient = 0.466, $P < 0.001$). Multivariate linear regression analysis revealed that EOA (coefficient = 0.460, $P < 0.001$) was a predictive factor [as shown in Table 6].

Table 3. Operative outcomes.

	Non-mismatch ($n = 54$)	Moderate mismatch ($n = 32$)	Severe mismatch ($n = 14$)	*P* value
CBP time (min)	78.03 ± 22.38	92.58 ± 23.58	92.85 ± 26.21	0.009
ACC time (min)	54.01 ± 17.40	63.87 ± 20.23	63.21 ± 18.66	0.038
Type of prosthesis				
Saint Jude	51 (94.4 %)	27 (84.4 %)	13 (92.9 %)	
Sorin Carbomedics	3 (5.6 %)	2 (6.2 %)	0	0.208
On-X	0	3 (9.4 %)	1 (7.1 %)	
Size of prosthesis				
25	0	1 (3.1 %)	2 (14.3 %)	
27	24 (44.4 %)	17 (53.1 %)	7 (50.0 %)	
29	19 (35.2 %)	14 (43.8 %)	5 (35.7 %)	0.023
31	7 (13.0 %)	0	0	
33	4 (7.4 %)	0	0	
Tricuspid valve surgery				
No	31 (57.4 %)	18 (56.3 %)	13 (92.9 %)	
De Vega	16 (29.6 %)	10 (31.2 %)	1 (7.1 %)	
Annuloplasty	1 (1.8 %)	4 (12.5 %)	0	0.052
Ring	3 (5.6 %)	0	0	
Replacement	3 (5.6 %)	0	0	

ACC, aortic cross clamp; CPB, cardiopulmonary bypass.

Table 4. Postoperative outcomes.

	Nonmismatch (n = 54)	Moderate mismatch (n = 32)	Severe mismatch (n = 14)	P value
Drains (ml)	515.09 ± 332.32	590.81 ± 531.01	692.30 ± 804.37	0.449
Bleeding incidence	2 (3.7 %)	2 (6.2 %)	3 (21.4 %)	0.067
Re-exploration for bleeding	1 (1.8 %)	1 (3.1 %)	1 (7.1 %)	0.585
Mechanical ventilation (hrs)	10.97 ± 7.07	8.73 ± 4.13	10.76 ± 4.44	0.231
ICU stay (hrs)	67.49 ± 34.04	71.06 ± 56.88	58.23 ± 24.68	0.633
Wound Infection	7 (13.0 %)	6 (18.7 %)	5 (35.7 %)	0.141
Ward stay (days)	5.86 ± 3.50	7.53 ± 5.76	10.38 ± 7.17	0.009
Total hospital stay (days)	8.77 ± 3.65	10.59 ± 6.17	12.42 ± 7.26	0.043

ICU, intensive care unit.

Univariate logistic regression analysis of post-operatively inadequate regression of mean PAP revealed that height (OR = 1.080, P = 0.051), BSA (OR = 17.298, P = 0.079), and EOAI (OR = 0.104, P = 0.057). Multivariate logistic regression analysis revealed that EOAI (OR = 0.113, P = 0.047) was the only predictive factor [as shown in Table 7].

Univariate logistic regression of post-operatively deterioration of tricuspid valve regurgitation analysis revealed that weight (OR = 0.953, P = 0.048), EOAI (OR = 0.111, P = 0.053) and TAPSE (OR = 0.751, P = 0.006). Multivariate logistic regression analysis revealed that EOAI (OR = 0.052, P = 0.040) was the only predictive factor [as shown in Table 8], Figs. 1 and 2.

4. Discussion

In our research, the incidence of significant mismatch comprised almost half of the patients (46 %); cases were distributed as a moderate degree which comprised almost one third of cases (32 %), and severe mismatch comprised 14 %. There was predominance in favor of male gender (P = 0.071). Both preoperative LVEDD and LVESD varied significantly between groups (P = 0.029 and 0.016, respectively).

After searching the literature, mitral PPM turned out to range from 17.71 % to 69 %.[3,7,16−20] This wide spectrum of incidence was attributed to the technique EOAI calculation; hence some researchers[3,16,17] preferred calculation with the help of manufacturers' guideline without depending on ECHO. This technique shows less efficacy as long as overestimation of the EAOI.[11]

In our investigation, the average participant's age was younger as compared with the western countries.[3,7,16] However, it was comparable with the average age in the eastern countries.[17−19] This can be explained by the main aetiological pathology of mitral valve disease. As rheumatic fever is more common in the eastern countries which tends to

Table 5. Postoperative echocardiogram data (Follow-up).

	Non-mismatch (n = 54)	Moderate mismatch (n = 32)	Severe mismatch (n = 14)	P value
Parameters				
LVEDD (cm)	5.05 ± 0.67	4.77 ± 0.56	5.00 ± 0.85	0.167
LVESD (cm)	3.46 ± 0.66	3.25 ± 0.66	3.59 ± 0.82	0.227
EF (%)	57.74 ± 9.96	59.98 ± 9.89	54.16 ± 9.50	0.185
LA (cm)	4.84 ± 0.75	4.55 ± 0.84	4.48 ± 0.59	0.126
PAP (mm Hg)	33.18 ± 10.89	35.58 ± 6.99	39.38 ± 13.02	0.138
MPG (mm Hg)	5.74 ± 2.35	6.08 ± 1.85	7.60 ± 0.99	0.013
PPG (mm Hg)	12.69 ± 4.10	13.80 ± 3.97	14.42 ± 3.28	0.238
EOA (cm^2)	2.80 ± 0.62	1.94 ± 0.25	1.46 ± 0.17	<0.001
EOAI (cm^2/M^2)	1.47 ± 0.27	1.04 ± 0.08	0.75 ± 0.09	<0.001
RV basal diameter (cm)	3.54 ± 0.78	3.34 ± 0.79	3.14 ± 0.58	0.170
TAPSE (cm)	1.81 ± 0.29	1.65 ± 0.27	1.69 ± 0.43	0.541
Tricuspid valve regurge				
Trivial	11 (20.3 %)	3 (9.4 %)	1 (7.1 %)	
Mild	28 (51.9 %)	18 (56.2 %)	11 (78.5 %)	0.451
Moderate	13 (24.1 %)	8 (25.0 %)	1 (19.0 %)	
Severe	2 (3.7 %)	3 (9.4 %)	1 (10.0 %)	

EF, ejection fraction; EOA, effective orifice area; EOAI, effective orifice area index; LA, left atrium diameter; LVEDD, left ventricular end diastolic diameter; LVESD, left ventricular end systolic diameter; MPG, mean pressure gradient; PAP, pulmonary artery pressure; PPG, peak pressure gradient; RV, right ventricle; TAPSE, tricuspid annular plane systolic excursion.

Table 6. Linear regression analysis of the predictors of effective orifice area index.

	Coefficient	*P* value	95 % Confidence of interval	
Age	0.005	0.158	−0.002	0.012
BSA	−0.040	0.814	−0.380	300
Pre-op LVEDD	0.074	0.112	−0.018	0.166
Pre-op LVESD	0.096	0.081	−0.012	0.204
Pre-op LA	0.058	0.058	−0.002	0.119
Size of prosthesis	0.054	0.009	0.014	0.094
Post-op MPG	−0.027	0.094	−0.059	0.005
EOA	0.446	<0.001	−0.410	0.482
Multi-variate				
Age	−0.002	0.105	−0.005	0.0004
Pre-op LVEDD	−0.037	0.321	−0.110	0.036
Pre-op LVESD	0.008	0.861	−0.079	0.095
Pre-op LA	0.005	0.696	−0.019	0.028
Size of prosthesis	−0.004	0.640	0.021	0.013
Post-op MPG	−0.008	0.223	−0.021	0.005
EOA	0.460	<0.001	0.421	0.499

BSA, body surface area, Pre-op = pre-operative; EOA, effective orifice area; EOAI, effective orifice area index; LA, left atrium diameter; LVEDD, left ventricular end diastolic diameter; LVESD, left ventricular end systolic diameter; MPG, mean pressure gradient, Post-op = post-operative.

Table 7. Logistic regression analysis of the predictors of post-operatively inadequate regression of mean pulmonary artery pressure.

	Odds ratio	*P* value	95 % Confidence of interval	
Male sex	2.875	0.108	−0.231	2.343
Weight	1.030	0.148	−0.010	0.069
Height	1.080	0.051	−0.000	0.154
BSA	17.298	0.079	−0.333	6.034
EOAI	0.104	0.057	−4.593	0.063
Multivariate				
Male gender	1.342	0.757	−1.569	2.157
Weight	0.965	0.933	−0.875	0.803
Height	1.040	0.873	−0.447	0.526
BSA	118.361	0.898	−68.093	77.640
EOAI	0.113	0.047	−4.340	−0.025

BSA, body surface area; EOAI, effective orifice area index.

cause valve disease in younger patients than degenerative which is more common in the western countries. In addition, the mean BSA was higher than that in the literature.[7,16,17,19]

All the following variables varied significantly among the studied groups: CPB time, cross-clamping time, length of ward stay, and the total hospital care time ($P = 0.009$, $P = 0.038$, $P = 0.023$, $P = 0.009$, $P = 0.043$, respectively). The explanation of longer hospital stay among PPM patients in the findings may be due to their longer recovery time than non-mismatch participants.

In this study, univariate and multivariate linear regression analyses for mismatched EOAI revealed

Table 8. Logistic regression analysis of the predictors of postoperatively deterioration of tricuspid valve regurgitation.

	Odds ratio	*P* value	95 % Confidence of interval	
Weight	0.953	0.048	−0.097	0.000
BSA	0.041	0.063	−6.569	0.168
EOAI	0.111	0.053	−4.431	0.027
Post-op RV basal	1.064	0.116	−0.015	0.139
Post-op TAPSE	0.751	0.006	−0.489	−0.083
Multi-variate				
Weight	0.922	0.498	−0.315	0.153
BSA	21.782	0.719	−13.709	19.871
EOAI	0.052	0.040	−5.764	−0.135
Post-op RV basal	1.090	0.055	−0.002	0.174
Post-op TAPSE	0.825	0.111	−0.428	0.044

BSA, body surface area; EOAI, effective orifice area index, Post-op = post-operative; RV, right ventricle; TAPSE, tricuspid annular plane systolic excursion.

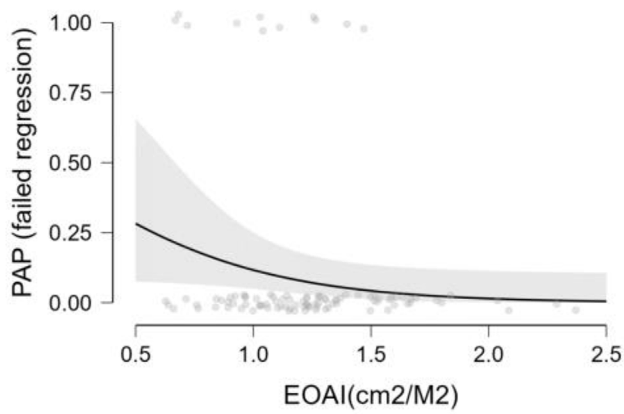

Fig. 1. A Plot described relationship between failed regression of mean pulmonary artery pressure (yes = 1) and the effective orifice area index (cm^2/M^2).

that lesser EOA was the only predictive factor. In the literature, there were many variable factors associated with mitral PPM including larger BSA,[3,7,16,17,19] older age,[7,17] male gender,[7,17] bioprosthesis[7,16,17] and small size prosthesis.[7,19]

In this study, univariate and multivariate logistic regression analyses for inadequate post-operative regression of PAP and postoperative functional tricuspid regurgitation revealed that lesser EOAI was the only predictive factor for both.

Ammannaya et al. revealed a significant relation between PPM and higher PAP. While the improvement of PAP was significant in the non-PPM group (76.26 %), it was markedly lower in the PPM patients (20.64 %).[19] Another study revealed that smaller EOAI and larger LVEDD independently associated with poor improvement in fTR and smaller EOAI and lower EF independently associated with poor regression of PH.[20]

Li and colleagues evaluated the impact of PPM on pulmonary arterial pressure after MVR. They

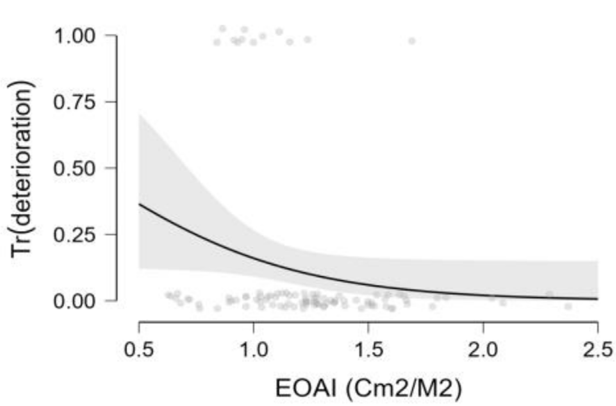

Fig. 2. A Plot described relationship between deterioration of regurgitation of tricuspid valve (yes = 1) and the effective orifice area index (cm^2/M^2).

demonstrated that 71 % patients had mitral PPM and there was a significant correlation between PAP and EOAI.[21] In another study, Angeloni showed that prevalence of fTR greater than grade 2 and PH were significantly higher in patients with PPM.[20] In meta-analysis review, PPM following MVR resulted in an almost six fold increase in the probability of residual PH.[22]

In accordance with the mentioned studies, another study emphasized on the strong and independent ability of severe PPM to predict survival in MVR participants. Actually, severe PPM tripled the mortality risk in this group in comparison with the non-PPM group.[7] Nevertheless, other studies found no difference of statistical importance between both PPM (by EAOI), and nonmismatch participants.[16–18]

4.1. Conclusion

Our findings provided higher incidence rates of MV prosthesis mismatch among the study's participants. They also supported the claim of association between MV PPM and hindered improvement of both fTR and PAP.

Hence, surgeons should be aware of the consequences of postoperative PPM and the importance of developing effective preventive measures to avoid this condition. This could be achieved through patients' BSA calculation with choosing the appropriate larger size of prosthetic valve that suits their annular size as much as possible.

Authorship

First author is responsible for data collection and writing the manuscript.

Second, third and fourth authors are responsible for guiding, revising and providing assistance.

All authors have participated in (a) conceptualization and designing, or analyzing and drawing conclusions of the data; (b) modification and revision of the article for necessary intellectual content; and (c) approving on the final version.

There are no other submissions or reviews of this manuscript by any other publishing entities.

All authors are not affiliated with any entity with any financial interest in the previously mentioned subject matter.

Conflicts of interest

All authors have participated in (a) conceptualization and designing, or analyzing and drawing conclusions of the data; (b) modification and revision of the article for necessary intellectual content;

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