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Original Article

Prediction of Left Ventricle Function from Pre-Operative Left Ventricle End-Systolic Dimension in Mitral Valve Replacement

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ABSTRACT

Rheumatic heart disease is an endemic in developing countries. The most common valve affected is the mitral valve for which mitral valve replacement is done. Left Ventricle Function (LVEF) is used to measure the prognosis of patients after MVR. Patients with a good LVEF perform better with less morbidity and mortality in comparison to patients with low post-operative EF. Therefore, prediction of post-operative EF is mandatory in patient's selection and post-operative management. **Objective:** To determine the effect of pre-operative left ventricular end-systolic dimension in predicting postoperative LV function in mitral valve replacement. **Methods:** A total of 100 patients with mitral valve replacement were selected for the research. The study was conducted at the cardiac surgery department of National Institute of Cardiovascular Diseases, Karachi from April 2022 to October 2022. **Results:** The mean age of patients was 37 ± 10 years, LVESD: 34.7 ± 8.4mm, LVEDD: 51.1 ± 9.1mm, PASP: 44 ± 11mmHg, and EF of 55 ± 9%. Patients having Left ventricular end-systolic dimension (LVESD)> 38 mm had a significant post-operative left ventricular dysfunction after mitral valve replacement than patients having a pre-operative LVESD < 38mm (p= 0.003). Moreover, patients having a pre-operative LV dysfunction (EF <55%) were more prone to post-operative LV dysfunction(p=0.02). However, pre-operative LVESD is a more sensitive predictor of post-operative LV dysfunction than pre-operative LVEF (0.003<0.02). **Conclusion:** Left Ventricular End-Systolic Dimension (LVESD) is a more sensitive parameter as compared to pre-operative LV ejection fraction (LVEF) in predicting post-operative LV ejection fraction (LVEF) after mitral valve replacement (MVR).

INTRODUCTION

Rheumatic Heart Disease (RHD) makes up about 20% burden of heart disease in the endemic population. It results from acute rheumatic fever as a result of infection by Group A Streptococci; M-protein cross-reacts with the cardiac myosin which causes T-cell-induced injury of heart valves [1]. Rheumatic fever occurs 2-3 weeks after infection by Group A streptococci and individuals present with rheumatic heart disease in their 20's and 30's [2]. According to an estimation, 50 to 80 million are suffering from Rheumatic heart disease worldwide [3]. The most common heart valve affected by rheumatic heart disease is the mitral valve followed by the aortic valve. Isolated mitral stenosis occurs in about 40% of patients with RHD and 60% of patients give a history of suffering from rheumatic fever [4, 5]. The common presentation is dyspnea precipitated by exercise, emotional stress, pregnancy, infection, sexual intercourse, and rapid atrial fibrillation. The echocardiographic findings of rheumatic heart disease include anterior leaflet thickening, chordal thickening, chordal fusion restricted leaflet motion, excessive leaflet motion, and leaflet prolapse [6, 7]. Mitral valve replacement is the preferred surgical option in case of RHD due to an

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ongoing disease process which can lead to failure of mitral repair [4, 8]. Mitral valve replacement (MVR) can be done through standard sternotomy, lateral thoracotomy (minimally invasive) incisions, or small ports (robotic valve surgery [9]. The postoperative left ventricular systolic contractile function is a major determinant of the prognosis and recovery of patient after mitral valve replacement [10]. Ejection fraction in post-operative echocardiography can accurately tell the function of heart after mitral valve replacement. We normally use pre-operative ejection fraction as a predictor of post-operative ejection fraction. However, end-systolic dimension is less dependent on left ventricle loading condition than is pre-operative ejection fraction. It is therefore a better measure of postoperative left ventricular systolic function [11].

METHODS

This is a retrospective study of 100 patients from April 2022 to October 2022. The study was conducted at National Institute of Cardiovascular Diseases, Karachi. It was an observational cross-sectional study. A randomized, non-probability sampling technique was utilized. Inclusion criteria included all ages, either gender, only mitral valve surgeries, and all patients which come under class 1 of American Heart Association guidelines for mitral valve replacement [12]. Exclusion criteria included double valve replacements, concomitant coronary artery bypass surgery, aortic valve replacements, moderate to high risk-surgery on Euro score, redo operations, and all those who refused to participate in the study. All patients with missing pre-operative and post-operative LVESD and Ejection Fraction (EF) were excluded from the sample. All the pre-operative data of patient was taken with a special focus on echocardiography report and echocardiographic images. Pre-operative echocardiography was performed within 3 months of operative and post-operative echocardiography within 1 month after the valve replacement. The per-operative details of patients were noted and then post-operative echocardiographs and early recovery of patient. All post-operative echocardiographs were done by FCPS consultants. All patients having cardiopulmonary bypass times of >150 mins and aortic cross-clamp times > 100 minutes were excluded from the study to avoid the discrepancy in the results due to long cardiopulmonary bypass (CPB) and cross-clamp times. Informed verbal consent from patients was taken from all patients. All the data was taken from cardiac surgery department of NICVD. All the mitral valve surgeries were performed by experienced surgeons having more than 10 years post-fellowship experience in mitral valve replacements. The data was collected and analyzed via SPSS version 23 (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp). Frequency calculated by standard methods. Mean ± standard deviation was obtained for quantitative variables like age (years), LVESD (mm), LVEDD (mm), PASP (mmHg), and EF (%). Frequencies and percentages were calculated for categorical variables like types of mitral valve disease and size of prosthetic mitral valves used for replacement. The non-parametric chi-square test is applied to the data. Statistical significance is kept at p<-0.05.

RESULTS

A total of 100 patients were included; 70% of our sample consisted of females and 30% males. The mean age of our patients was 37 ± 10 years (minimum: 17 years and maximum: 68 years), LVESD of 34.7 ± 8.4mm, LVEDD of 51.1 ± 9.1 mm, PASP of 44 ± 11mmHg, and pre-operative ejection fraction of 55 ± 9 and 47 ± 12 % (Table 1).

Parameters	Mean ± SD
Age (years)	37 ± 10
LVESD (mm)	34.7 ± 8.4
LVEDD (mm)	51.1 ± 9.1
PASP (mmHg)	44 ± 11
PRE-OP EF (%)	55 ± 9
POST-OP EF (%)	47 ± 12

Table 1: Patients Characteristics

All patients were suffering from Rheumatic heart disease of mitral valve. Other types of degenerative or ischemic mitral valve diseases were excluded from the sample. We divided the sample on basis of valvular pathology: 31% of patients had severe mitral regurgitation, 8% had severe mitral regurgitation and moderate mitral stenosis, 17% had severe mitral stenosis (Wilkin score more than 8, not candidates of PTMC), 31% had severe mitral stenosis and moderate mitral regurgitation, 3% had severe mitral stenosis and mild mitral regurgitation and 2% had severe mitral regurgitation and severe mitral stenosis (Figure 1).

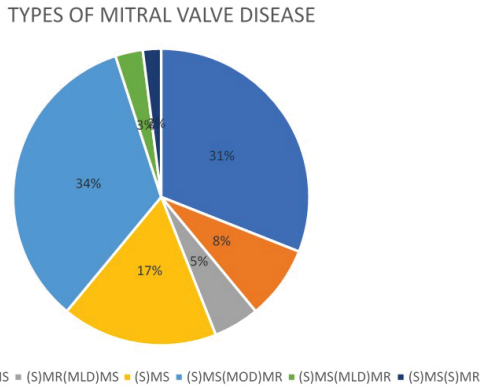

Figure 1: Types of Mitral Valve Diseases

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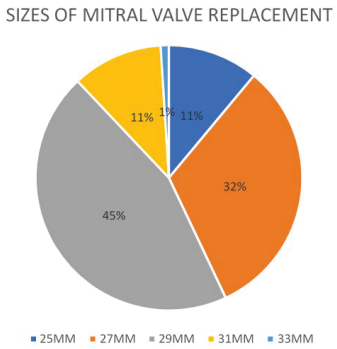

Figure 2: Sizes of Mitral Valve Replacement

The data set of patients was divided to check for significance level. The LVESD was broadly divided into > 38 mm and less than 38 mm. It was found that patients whose left ventricular end-systolic dimension was greater than 38 mm had a drop in their post-operative Ejection Fraction after mitral valve replacement (p = 0.003) (Table 2).

LVESD	Preserved Post-Op LV Function		p-value
	Yes	No	
< 38 mm	55 (35.38) [10.88]	6 (25.62) [15.03]	0.003
>38mm	3 (22.62) [17.02]	36 (16.38) [23.5]	

Table 2: Relationship between LVESD and preserved postoperative LVEF

Ejection fraction of patients was also divided into short sets to increase accuracy level. Patients with a pre-operative Ejection Fraction of less than 55% suffered from post-operative LV dysfunction and patients with a pre-operative ejection fraction of more than 55% suffered less from LV dysfunction after mitral valve replacement (p = 0.02) (Table 3). However, if we intend to find a more reliable parameter to predict post-mitral valve replacement, we can deduce that LVESD is a more sensitive parameter as p value of 0.003 < 0.02.

Pre-Op EF	Preserved Post-Op LV Function		p-value
	Yes	No	
<55%	11 (16.25) [1.7]	14 (8.75) [3.15]	0.02
>55%	54 (48.75) [0.57]	21 (26.25) [1.05]	

Table 3: Relationship between pre-operative EF and preserved postoperative LVEF

Age of the patient, LVEDD, and PASP played no direct role in determination of post-operative LV function in mitral valve patients (Table 4).

Parameter	Preserved Post-Op LV Function		p-value
	Yes	No	
AGE	36.56	40.55	0.8
LVEDD	47.63	59.72	0.7
PASP	65	29	0.3

Table 4: Relationship of age, LVEDD, and PASP with preserved postoperative LVEF

DISCUSSION

Ejection Fraction post-operatively is a predictor of all-cause mortality [13]. A higher ejection fraction is associated with a better prognosis [14,15]. Our results have shown that LVESD is a definitive parameter to predict post-operative LV function in mitral valve patients. The research also proved the role of pre-operative Ejection fraction in predicting post-operative Ejection Fraction. However, in comparison to pre-operative LVESD, pre-op EF has an inferior predictability value for post-operative LV function after mitral valve replacements. Wang et al., studied the role of pre-operative LVESD and EF in determining postoperative EF in CABG patients. They included a sample of 939 patients. They concluded that smaller LVESD and lower ejection fraction have a greater potential for postoperative improvement in ejection fraction and outcomes [16]. In retrospective research by Tribouilloy et al., studied the additive value of LVESD to EF and collected a sample of 335 patients to predict the association between these pre-operative parameters and postoperative left ventricular dysfunction after mitral valve repair surgery done for severe mitral regurgitation. They concluded that pre-operative EF > 64% and LVESD <37 mm incurred a lower postoperative risk of LV dysfunction [17]. Quintana et al., studied the sample of 1705 patients suffering from severe mitral regurgitation but preserved left ventricular function and discussed that a normal pre-operative EF is a misleading criterion to predict postoperative left ventricular dysfunction and found that it is not uncommon for patients having a preserved pre-operative EF to suffer from LV dysfunction after the surgery [18]. Wu et al., studied the combined association between high inferior vena cava diameter and LVESD in the causation of major adverse cardiovascular events and overall mortality in patients undergoing hemodialysis. They concluded that high LVESD is directly linked to higher all-cause mortality and major adverse cardiovascular adverse events [19]. Starling et al., in their study divided the sample into 3 groups; one with normal contractile function, 2nd with impaired contractile function but preserved ejection fraction, and 3rd with impaired contractile function. The LV function was assessed after the mitral valve surgery and found that left ventricular elastance is a better predictor to determine post-operative LV function than LVEF [20]. These studies add an additive value to our research and testify to the global applicability of our results on patients of rheumatic mitral valve disease undergoing mitral valve replacements.

CONCLUSIONS

Left ventricular end-systolic dimension (LVESD) is a reliable parameter to predict post-operative left ventricular ejection function. It can be regarded as a more

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sensitive pre-operative criterion as compared to pre-operative ejection fraction to plan the post-operative management of the patient. Patients expected to have a more drop in left ventricular function post-mitral valve replacement can be planned meticulously with a multi-team approach to reduce the morbidity and mortality of the patients.

Conflicts of Interest

The authors declare no conflict of interest.

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REFERENCES

[1] Watkins DA, Beaton AZ, Carapetis JR, Karthikeyan G, Mayosi BM, Wyber R, et al. Rheumatic heart disease worldwide: JACC Scientific Expert Panel. Journal of American College of Cardiology. 2018 Sep; 72(12): 1397–416. doi: 10.1016/j.jacc.2018.06.063

[2] Coffey PM, Ralph AP, Krause VL. The role of social determinants of health in the risk and prevention of group A streptococcal infection, acute rheumatic fever and rheumatic heart disease: a systematic review. PLoS neglected tropical diseases. 2018 Jun; 12(6): e0006577. doi: 10.1371/journal.pntd.0006577

[3] Weinberg J, Beaton A, Aliku T, Lwabi P, Sable C. Prevalence of rheumatic heart disease in African school-aged population: Extrapolation from echocardiography screening using the 2012 World Heart Federation Guidelines. International Journal of Cardiology. 2015 Sep; 202: 238-9. doi: 10.1016/j.ijcard.2015.08.128

[4] Fu G, Zhou Z, Huang S, Chen G, Liang M, Huang L, et al. Mitral valve surgery in patients with rheumatic heart disease: Repair vs. replacement. Frontiers in cardiovascular medicine. 2021 May; 8: 685746. doi: 10.3389/fcvm.2021.685746

[5] Elgyoum AM. Characterizaton of Heart Valves in Rheumatic Heart Disease Patient Using Echocardiography. Scholars Journal of Applied Medical Sciences. 2021 Jun; 6: 954-9. doi: 10.36347/sjams.2021.v09i06.026

[6] Chen SW, Chen CY, Wu VC, Chou AH, Cheng YT, Chang SH, et al. Mitral valve repair versus replacement in patients with rheumatic heart disease. The Journal of thoracic and cardiovascular surgery. 2020 Aug; 164(1): 57-67. doi: 10.1016/j.jtcvs.2020.07.117

[7] de Loizaga SR, Beaton AZ, Nascimento BR, Macedo FV, Spolaor BC, de Pádua LB, et al. Diagnosing Rheumatic Heart Disease: where are we now and what are the challenges? Expert Review of Cardiovascular Therapy. 2021 Sep; 19(9): 777-86. doi: 10.1080/14779072.2021.1970531

[8] Adem A, Mulatu HA. Echocardiographic pattern of rheumatic heart disease among adults at St. Paul's Hospital Millennium Medical College cardiac unit, Addis Ababa, Ethiopia: a cross-sectional study. Millennium Journal of Health. 2022 Jul; 1(2): 2790-1378.

[9] Vo AT, Nguyen NT, Le KM, Vuong NL, Nguyen TT, Vu TT, et al. Mitral prosthetic size predictor in minimally invasive mitral valve replacement. Journal of Cardiothoracic Surgery. 2020 Dec; 15(1): 147. doi: 10.1186/s13019-020-01197-w

[10] Jiang GY, Xu J, Manning WJ, Markson LJ, Khabbaz KR, Garan AR, et al. Mitral regurgitation and mortality risk in Medicare beneficiaries with heart failure and preserved ejection fraction. The American Journal of Cardiology. 2022 Nov; 183: 40-7. doi: 10.1016/j.amjcard.2022.07.025

[11] Suri RM, Schaff HV, Dearani JA, Sundt III TM, Daly RC, Mullany CJ, et al. Determinants of early decline in ejection fraction after surgical correction of mitral regurgitation. The Journal of thoracic and cardiovascular surgery. 2008 Aug; 136(2): 442-7. doi: 10.1016/j.jtcvs.2007.10.067

[12] Otto CM, Nishimura RA, Bonow RO, Carabello BA, Erwin III JP, Gentile F, et al. 2020 ACC/AHA guideline for the management of patients with valvular heart disease: executive summary: a report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. Journal of the American College of Cardiology. 2021 Feb; 77(4): 450-500. doi: 10.1016/j.jacc.2020.11.018

[13] Tabane TM, Leonard T, Kleyenstuber T. Peri-operative outcomes of mitral valve surgery at Charlotte Maxeke Johannesburg Academic Hospital. SA Heart. 2021 Jul; 18(2): 118-25. doi: 10.24170/18-2-4884

[14] Zaroff J, Aronson S, Lee BK, Feinstein SB, Walker R, Wiencek JG. The relationship between immediate outcome after cardiac surgery, homogeneous cardioplegia delivery, and ejection fraction. Chest. 1994 Jul; 106(1): 38-45. doi: 10.1378/chest.106.1.38

[15] Solomon SD, Anavekar N, Skali H, McMurray JJV, Swedberg K, Yusuf S, et al. Influence of ejection fraction on cardiovascular outcomes in a broad spectrum of heart failure patients. Circulation. 2005 Dec; 112(24): 3738–44. doi: 10.1161/circulationaha.105.561423

[16] Wang S, Lyu Y, Cheng S, Zhang Y, Gu X, Gong M, et al. Smaller left ventricular end-systolic diameter and lower ejection fraction at baseline associated with

DOI: https://doi.org/10.54393/pjhs.v3i06.339

greater ejection fraction improvement after revascularization among patients with left ventricular dysfunction. Front Cardiovascular Medicine. 2022 Nov; 9 :967039. doi: 10.3389/fcvm.2022.967039

[17] Tribouilloy C, Rusinaru D, Szymanski C, Mezghani S, Fournier A, Levy F, et al. Predicting left ventricular dysfunction after valve repair for mitral regurgitation due to leaflet prolapse: additive value of left ventricular end-systolic dimension to ejection fraction. European Journal of Echocardiography. 2011 Sep; 12(9): 702-10. doi: 10.1093/ejechocard/jer128

[18] Quintana E, Suri RM, Thalji NM, Daly RC, Dearani JA, Burkhart HM, et al. Left ventricular dysfunction after mitral valve repair—the fallacy of "normal" preoperative myocardial function. Journal of Thoracic Cardiovascular Surgery. 2014 Dec; 148(6): 2752–60. doi: 10.1016/j.jtcvs.2014.07.029

[19] Wu CK, Yar N, Kao ZK, Chuang MT, Chang TH. High Inferior Vena Cava Diameter with High Left Ventricular End Systolic Diameter as a Risk Factor for Major Adverse Cardiovascular Events, Cardiovascular and Overall Mortality among Chronic Hemodialysis Patients. Journal of Clinical Medicine. 2022 Sep; 11(18): 5485. doi: 10.3390/jcm11185485

[20] Starling MR, Kirsh MM, Montgomery DG, Gross MD. Impaired left ventricular contractile function in patients with long-term mitral regurgitation and normal ejection fraction. Journal of the American College of Cardiology. 1993 Jul; 22(1): 239-50. doi: 10.1016/0735-1097(93)90840-W