

# Pushing The Limits in Cardiac Surgery: Aortic Valve Replacement in Severe Aortic Regurgitation in Severely Dilated Left Ventricle with Moderate Left Ventricular Dysfunction

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## ABSTRACT

Left ventricular dysfunction is a major prognostic factor in aortic valve replacement (AVR) for aortic regurgitation (AR). Patients with reduced left ventricular ejection fraction (LVEF) with dilated left ventricle (LV) are high risk surgical candidate and are treated medically. However, surgery may offer survival benefits over medical therapy. We report a 25-year-old male with severe AR with repeated admission for NYHA class IV heart failure. Despite the severe LV dysfunction and dilation, the cardiac surgeons pushed the boundaries and the patient underwent aortic valve replacement (AVR) with a mechanical valve via median sternotomy. The procedure was uneventful with smooth recovery. On follow up patient had good LV reverse remodeling, improved LVEF and better quality of life.

**Keywords:** aortic regurgitation; aortic valve replacement; LV dysfunction.

## INTRODUCTION

Aortic regurgitation (AR) is defined as the presence of a regurgitant flow from the aorta to the left ventricle during diastole. In patients with chronic AR, volume and pressure overloads lead to progressive dilation and remodeling of the LV. In the earlier stages of the disease, patients are asymptomatic as hemodynamics are preserved. However, these compensation mechanisms become inefficient in the long term, and LV dysfunction manifest with heart failure symptoms. Definitive treatment in case of severe AR is surgical intervention, which prevents heart failure and death and can significantly improve clinical outcome. In the current American Heart Association/American College of Cardiology 2020 guidelines AVR is recommended for chronic AR in patients with symptoms regardless of LV systolic function, asymptomatic patients with LV systolic dysfunction (LVEF  $\leq 55\%$ ) or when the LV is severely enlarged (LV end systolic dimension [LVESD]  $> 50$  mm or indexed LVESD  $> 25$  mm/m<sup>2</sup>) or when there is a progressive decline in LVEF on at least 3 serial studies to the low-normal range (LVEF 55% to 60%)

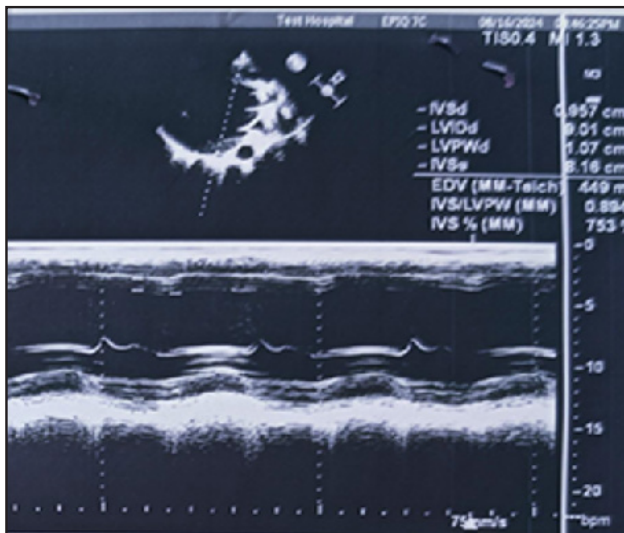
or a progressive increase in LV dilation into the severe range (LV end diastolic dimension [LVEDD]  $> 65$  mm).<sup>1</sup> Preoperative LV ejection fraction and LV end-systolic dimension index are predictive factors for reverse remodeling after surgery and are associated with late outcomes.<sup>2</sup> Therefore severely dilated LV with reduced EF in chronic AR is poor prognostic factor for surgery and are often treated medically. But these patients usually present with intractable heart failure with repeated admission for heart failure. The poor quality of life makes the individual distressed. In such cases of intractable heart failure the surgical boundaries should be pushed. The high risk surgery should be offered to these patients as they confer better survival and quality of life.

## CASE REPORT

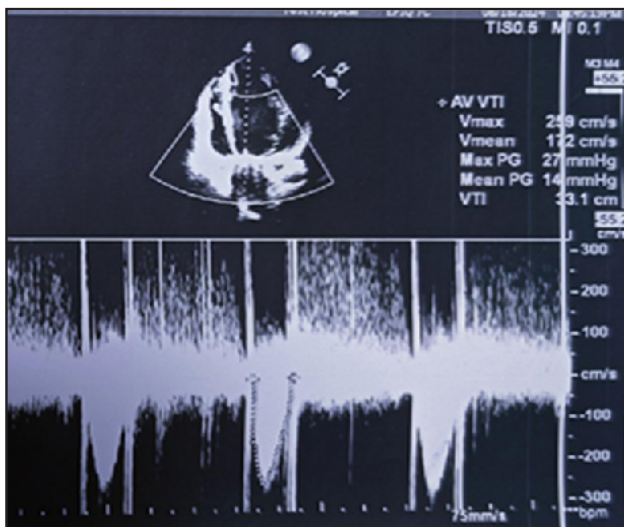
A 25-year-old man was referred to Shahid Gangalal National Heart Center with increased shortness of breath and non exertional chest pain aggravated for 2 weeks. On physical examination his vital were stable. Cardiovascular examination revealed diastolic murmur at aortic area. Transthoracic echocardiography (TTE) concluded severe aortic regurgitation (AR),

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mild mitral and tricuspid regurgitation with LV Systolic dysfunction (LVEF 35%) with dilated LA and LV, left ventricular internal dimensions [LVIDs] of 9 cm during diastole 8.1 cm during systole. On chest x-ray cardiomegaly was noted, pro BNP was more than 35000 pg/ml. The patient was treated with penicillin, diuretic and other supportive medication. Due to LV systolic dysfunction and severely dilated LV, patient was considered high risk for surgery and planned for medical management. But patient had intractable heart failure though he was in optimal medical therapy and had poor quality of life.



**Figure 1. TTE showing LV dimensions**



**Figure 2. TTE showing aortic regurgitation.**

Cardiac surgeon here decided to step beyond the bounds and planned for high risk aortic valve replacement with informed consent taken from the patient. All the prerequisites of procedures were pre-

checked by the anesthesiologist, cardiologist and cardiac surgeons. Standard anaesthesia and surgical techniques, cardiopulmonary bypass (CPB) and myocardial protection techniques were employed. CPB was instituted using ascending aortic cannulation and two-stage venous cannulation of the right atrium. Under mild systemic hypothermia (34.8C), cardiac arrest was induced and maintained using intermittent hyperkalaemic cold blood cardioplegia. Patient underwent mechanical aortic valve replacement. The procedure was uneventful and patient was shifted to surgical intensive care unit. Early postoperative TTE revealed normally functioning prosthetic aortic valve with a peak gradient of 22.0 mmHg and a mean gradient of 13.0 mmHg with LVEF of 35%, with LVID 8.7 cm on diastole and 7 cm on systole. Recovery phase went smoothly. On the sixth postoperative day, the patient was discharged and required a routine OPD follow-up with INR monitoring.

By the 3-month visit, the patient reported significant improvement in heart failure symptoms, including reduced shortness of breath and increased exercise tolerance. Echocardiographic monitoring revealed a slight improvement in LVEF to 40%, and LVIDs was reduced to 6.4 cm during diastole and 4 cm during systole with normal function of the prosthetic aortic valve (peak gradient 20 mm Hg and mean gradient 10 mm Hg with no evidence of residual aortic regurgitation. The mild mitral regurgitation remained stable. The reverse remodeling of LV has occurred in 3 months and indicates favorable long term outcome.

## DISCUSSION

Rheumatic heart disease is one of the most common cause for heart failure and associated mortalities/morbidities in the young population in developing countries like Nepal.<sup>3</sup> The time interval between the initial episode of RF and clinical evidence of valve disease varies, ranging from a few years to over 20 years<sup>4,5</sup> reflecting the cumulative effect of recurrent episodes of RF and the gradual immune-mediated cellular response. AV is the second most common valve after the mitral valve to be involved in RHD, almost always with associated mitral valve involvement.<sup>4</sup>

Isolated involvement of the AV is exceptionally rare and RHD of the AV almost exclusively leads to AR. Chronic AR causes both pressure and volume overload in LV imposing a combination of increased preload and afterload on the left ventricle. The excess regurgitant volume must be expelled into the high-pressure systemic circulation in early systole. Eccentric ventricular hypertrophy occurs in response to increased left ventricular end diastolic wall stress and the left ventricle compensates by means of a process called “afterload mismatch, preload reserve”.<sup>6,7</sup> Preload is increased so as to maintain forward flow according to the Frank-Starling relationship and the ventricle dilates. Once the limit of preload reserve is reached, left ventricular systolic function declines and as LVEF falls, left ventricular end systolic volume increases leading to an increase in systolic wall stress (afterload) which further depresses pump function.<sup>6,8</sup> The adaptive process leads to myocardial fibrosis, possibly as a result of myocardial ischaemia, which occurs because of decreased coronary flow in diastole combined with increased myocardial oxygen consumption.<sup>9</sup> The natural history of aortic valve disease associated with ventricular dysfunction is dismal.<sup>10</sup> Impaired left ventricular function has long been recognized as a predictor of adverse outcome after AVR.<sup>11</sup> Some previous studies have even suggested that impaired ventricular function should be considered a contraindication to AVR.<sup>12</sup> However other studies suggest surgery in reduced LVEF with dilated LV is high-risk and results in greater mortality and morbidity than in patients with preserved LVEF.<sup>13</sup> Our patient presented with severe symptomatic AR, an LVEF of 35%, and significant LV dilation, which would typically be considered high risk surgery. Aortic valve replacement in patients with chronic aortic regurgitation who have severe LV systolic dysfunction continues to be associated with a high

mortality risk despite surgical, cardiological and anesthetic improvements over time. (6) The patients with irreversible LV dysfunction have severe myocardial fibrosis and myocyte apoptosis and may not benefit from AVR.<sup>14</sup> But the procedure was successfully performed without any complication and follow-up revealed that despite persistent LV systolic dysfunction, the patient experienced significant symptomatic improvement including better NYHA functional class and stabilization of heart failure symptoms.

The success of this case supports the notion that, preoperative LV ejection fraction and LV dimension index are predictive factors for reverse remodeling after surgery. Earlier surgery may thus help to restore normal LV function and achieve better late outcomes after AVR for AR.<sup>15</sup> Surgical AVR in such patients can lead to improved long-term survival, reduction in heart failure symptoms, and an overall better quality of life. This case reinforces the importance of timely intervention and highlights the role of early surgical consultation in patients with severe AR and LV dysfunction, particularly in the context of rheumatic heart disease.

## CONCLUSION

LV dysfunction has been evaluated using LVEF as a variable. Patients with AR with decreased LVEF in dilated LV have a poor prognostic indication for AVR and are typically treated medically, albeit they are frequent flyers to hospitals for heart failure. The cardiac surgeons need to step out of their comfort zone and embrace the unconventional as it has been demonstrated that individuals who undergo AVR for severe AR and LV failure fare better than those who receive medical care.

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