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Persistent Transvalvular Gradients After Surgical Bioprosthetic Aortic Valve Replacement: An Institutional Observation in the Context of Contemporary Evidence

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Abstract

Background: Elevated transvalvular gradients after surgical bioprosthetic aortic valve replacement (SAVR) can be encountered despite apparently satisfactory valve implantation. Their interpretation is clinically important because an elevated Doppler gradient does not, by itself, establish structural valve stenosis. Potential explanations include prosthesis-patient mismatch (PPM), high-flow states, pressure recovery, measurement-related factors, leaflet thrombosis, and structural or non-structural prosthetic valve dysfunction.

Objective: To describe an institutional observation of persistent postoperative transvalvular gradients following bioprosthetic SAVR and to interpret the findings in the light of contemporary evidence.

Observation: Thirty patients aged over 50 years underwent bioprosthetic AVR during a two-year institutional period. St. Jude Epic and Carpentier-Edwards Perimount valves were predominantly used. Five patients developed hemodynamic instability on the first postoperative day and echocardiography demonstrated moderate-to-severe transprosthetic obstruction/gradients. These patients were treated conservatively and followed clinically and echocardiographically. Moderate residual gradients persisted in all five. Among the remaining 25 patients, six were subsequently noted to have moderate gradients with NYHA functional class II symptoms. The original clinical records reported no evidence of valve thrombosis or degeneration and stated that indexed effective orifice area was near normal.

Conclusion: Persistent gradients after bioprosthetic SAVR require systematic evaluation rather than being labeled automatically as recurrent aortic stenosis. The original observation raises clinically relevant questions, but the available dataset is insufficient to establish a single mechanism. Contemporary evaluation should integrate serial Doppler parameters, prosthesis size and reference hemodynamics, indexed effective orifice area, flow status, leaflet morphology and motion, and multimodality imaging when prosthetic dysfunction or thrombosis is suspected.

Keywords: Bioprosthetic Aortic Valve; Surgical Aortic Valve Replacement (SAVR); Elevated Transvalvular Gradient; Prosthesis–Patient Mismatch; Prosthetic Valve Dysfunction; Bioprosthetic Valve Thrombosis; Doppler Echocardiography; Effective Orifice Area; Structural Valve Deterioration; Aortic Valve Prosthesis

INTRODUCTION

Surgical aortic valve replacement remains an established treatment for patients with severe aortic valve disease who are appropriate surgical candidates. Bioprosthetic valves are widely used because they avoid lifelong vitamin K antagonist therapy in most patients and provide favorable hemodynamic performance. Nevertheless, residual or newly elevated gradients after implantation may complicate postoperative assessment.

A high Doppler gradient across a bioprosthetic aortic valve is a hemodynamic finding rather than a diagnosis. A normally functioning prosthesis may demonstrate a higher-than-expected gradient because of prosthesis-patient mismatch, high transvalvular flow, pressure recovery, or technical and measurement factors. Conversely, progressive elevation in gradient can signal leaflet thrombosis, pannus, structural valve deterioration, or other forms of prosthetic dysfunction. Interpretation therefore requires comparison with the early postoperative baseline and integration of multiple echocardiographic parameters.

The institutional observation described in the source manuscript involved 30 patients receiving surgical bioprosthetic AVR over two years. Persistent moderate gradients and NYHA class II symptoms in a subset of patients prompted concern because no obvious thrombosis or valve degeneration was identified. The purpose of this rewritten report is to present that observation more clearly and place it within the current conceptual framework for post-AVR hemodynamic assessment.

Institutional Observation

Thirty patients underwent bioprosthetic aortic valve replacement during a two-year period. All were older than 50 years. The prostheses used were predominantly St. Jude Epic and Carpentier-Edwards Perimount bioprosthetic valves.

Five patients developed hemodynamic instability on the first postoperative day. Postoperative echocardiography was interpreted as showing moderate-to-severe transvalvular obstruction. The patients were managed conservatively, discharged after stabilization, and kept under follow-up. The source manuscript reports that three of these patients had received a 21-mm St. Jude Epic valve, one a 19-mm St. Jude Epic valve, and one a 21-mm Carpentier-Edwards Perimount valve.

On follow-up echocardiography, moderate residual gradients were reported in all five patients. Of the other 25 patients, six were reported to have moderate gradients and NYHA class II symptoms. The source manuscript stated that there was no echocardiographic evidence of valve thrombosis or degeneration. It also stated that none of these patients was overweight and that the indexed effective orifice area was near normal.

Table 1. Summary of the original institutional observation

Characteristic	Reported finding
Total patients	30
Age	All >50 years
Study duration	2 years
Main prostheses	St. Jude Epic and Carpentier-Edwards Perimount
Early hemodynamic instability	5 patients
Persistent moderate gradient in the initial 5	5/5
Additional patients with moderate gradient	6/25
Symptoms reported	Predominantly NYHA class II
Valve thrombosis/degeneration in source report	Not identified
Indexed effective orifice area	Reported as near normal

Discussion

The most important interpretive issue is that a postoperative Doppler gradient should not be equated automatically with prosthetic valve stenosis. Contemporary literature emphasizes an integrated approach incorporating symptoms, valve morphology and motion, Doppler velocity, mean gradient, Doppler velocity index, effective orifice area, acceleration time, stroke volume or flow state, and comparison with the patient's baseline study.

Prosthesis-patient mismatch is a major consideration after SAVR. PPM occurs when the effective orifice area of an otherwise normally functioning prosthesis is too small relative to the patient's body size. A

large systematic review and meta-analysis involving 122,989 SAVR patients found PPM to be associated with worse long-term survival and greater risks of cardiac death, heart-failure hospitalization, and valve reintervention. In the bioprosthetic subgroup, both moderate and severe PPM were associated with increased all-cause mortality. A 2025 multi-institutional SAVR study has further reinforced continued contemporary interest in the prevalence and clinical consequences of PPM.

However, the source manuscript reports that indexed effective orifice area was near normal. If confirmed by standardized measurements, this would make conventional PPM a less complete explanation for the observed gradients. The original dataset does not provide the actual indexed effective orifice area values, body surface area, mean and peak gradients, Doppler velocity index, stroke volume index, acceleration time, left ventricular function, or serial change in these variables. It is therefore not possible to retrospectively establish or exclude PPM with confidence.

Another consideration is the distinction between an isolated high Doppler gradient and true prosthetic obstruction. Doppler and invasive gradients are not interchangeable, and discordance can occur because of pressure recovery and flow-related phenomena. Contemporary expert reviews recommend integrating clinical findings with serial echocardiography and, when uncertainty remains, multimodality imaging or invasive hemodynamic assessment before considering reintervention.

Bioprosthetic valve thrombosis is also part of the differential diagnosis when gradients rise unexpectedly. The source report states that thrombosis was not identified, but it does not specify how this was excluded. Modern evaluation may use transesophageal echocardiography or cardiac CT when transthoracic echocardiography is inconclusive or when leaflet thickening/restricted motion is suspected. CT can be particularly helpful for identifying hypoattenuated leaflet thickening and reduced leaflet motion.

Structural valve deterioration would be unusual as an explanation for a markedly elevated gradient on the first postoperative day, although later degeneration remains relevant during long-term follow-up. Early postoperative gradients instead warrant careful review of prosthesis size, implantation, flow conditions, ventricular function, Doppler acquisition, and the possibility of PPM or early leaflet dysfunction.

The valve sizes described in the five initially unstable patients are clinically relevant because smaller surgical prostheses may produce higher gradients. Nevertheless, prosthesis label size alone is insufficient to diagnose PPM. Valve-specific reference effective orifice areas and the patient's body surface area are needed, together with measured postoperative hemodynamics.

The persistence of NYHA class II symptoms also deserves cautious interpretation. Symptoms after AVR may result from residual valve hemodynamics, but they can also reflect left ventricular hypertrophy and diastolic dysfunction, pulmonary hypertension, coronary disease, arrhythmia, anemia, deconditioning, or other comorbidities. The original report does not provide enough information to determine whether the residual gradients were the principal cause of symptoms.

Suggested Contemporary Evaluation of an Unexpectedly High Post-SAVR Gradient

1. Confirm the Doppler measurements and exclude technical error, including inappropriate velocity sampling and suboptimal alignment.
2. Compare peak velocity, mean gradient, effective orifice area, Doppler velocity index, and acceleration time with the immediate postoperative baseline and valve-specific expected values.
3. Assess stroke volume and overall flow state; elevated flow can increase measured gradients without fixed prosthetic obstruction.
4. Calculate indexed effective orifice area using the patient's body surface area and apply contemporary criteria when evaluating possible PPM.
5. Assess leaflet morphology and mobility. If transthoracic echocardiography is inconclusive and obstruction is suspected, consider transesophageal echocardiography and/or gated cardiac CT.

6. Evaluate for thrombus, pannus, structural valve deterioration, paravalvular abnormalities, and other causes of prosthetic dysfunction.
7. If clinically important Doppler gradients remain unexplained and reintervention is being considered, invasive hemodynamic confirmation may be appropriate in selected patients.

Limitations

This report is based on a small, single-institution observational series of 30 patients followed over a relatively short period. The original manuscript does not provide patient-level demographic data, operative indications, native valve pathology, complete prosthesis specifications for all patients, baseline and serial numerical echocardiographic measurements, body surface area, detailed indexed effective orifice area values, Doppler velocity index, stroke volume index, acceleration time, left ventricular function, CT findings, anticoagulation status, or standardized definitions of prosthetic valve dysfunction. There is no control group and no statistical analysis of predictors or outcomes. Consequently, the observation can generate hypotheses but cannot establish the mechanism or clinical significance of the residual gradients.

Conclusion

Persistent transvalvular gradients after surgical bioprosthetic AVR are clinically relevant but should not be interpreted as recurrent stenosis on the basis of gradient alone. In this institutional series, a subset of patients demonstrated persistent moderate gradients and predominantly NYHA class II symptoms despite no reported evidence of thrombosis or structural degeneration. The mechanism cannot be determined from the available data. Contemporary assessment should distinguish PPM and flow-related high gradients from true prosthetic obstruction through serial quantitative echocardiography and, when necessary, multimodality imaging or invasive hemodynamic assessment. Larger prospective studies with standardized prosthetic-valve definitions and complete hemodynamic data are required.

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