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Case Reports

Acute Mitral Valve Regurgitation Caused by Left Ventricular Pacing Wire During Transcatheter Aortic Valve Replacement

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Abstract

Transcatheter aortic valve replacement is quickly becoming the standard of care for patients with severe aortic stenosis thanks to its minimally invasive nature and favorable outcomes. Recently, left ventricular pacing has been proposed as a safer alternative to traditional right heart pacing, which could simplify the transcatheter aortic valve replacement procedure overall, although procedural complications may still occur. This report describes a rare case of left ventricular pacing wire–induced acute severe mitral valve regurgitation during transcatheter aortic valve replacement.

Keywords: Transcatheter aortic valve replacement; aortic valve stenosis; mitral valve insufficiency; shock, cardiogenic

Case Report

Presentation and Physical Examination

An 83-year-old female patient presented at a local medical center with exertional chest pain over the previous 10 days.

Medical History

The patient had a medical history of dyslipidemia, osteoporosis, and type 2 diabetes.

Differential Diagnosis

The aforementioned symptoms were assessed at a local medical center. Coronary angiography revealed a 50% luminal narrowing in the distal left circumflex artery, which indicated the degree of coronary stenosis. However, the fractional flow reserve test indicated a value greater than 0.8. Nonetheless, the patient was referred for further evaluation and consideration of transcatheter aortic valve replacement (TAVR) after transthoracic echocardiography (TTE) confirmed the presence of severe aortic stenosis.

Laboratory results were unremarkable except for a slight elevation of N-terminal pro–brain natriuretic peptide at 82.7 pmol/L (699 pg/mL), with cardiac enzymes such as creatine kinase at 2.5 μg/L (2.5 ng/mL) and troponin I at 0.012 μg/L (0.012 ng/mL). An electrocardiogram showed sinus rhythm with first-degree atrioventricular block.

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The patient underwent TTE and transesophageal echocardiography, which revealed normal Left ventricular (LV) ejection fraction with no regional wall motion abnormalities. The LV end-diastolic dimension was normal at 48 mm, but there was basal septal hypertrophy with an intraventricular septal thickness of 10 mm. Severe aortic stenosis was diagnosed, with an aortic valve area of 0.67 cm^2 and a mean transaortic systolic pressure gradient of 47.7 mm Hg. The patient also underwent cardiac computed tomography, which indicated that the left coronary artery ostium measured 12.5 mm in height, while the right coronary artery ostium measured 14.6 mm. The annular angulation was normal at 39°, but the patient had a small annulus, with a mean diameter of 20.6 mm and an area of 318.7 mm^2. In addition, the ascending aorta was dilated, with a mean diameter of 31.4 mm.

Although the patient's Society of Thoracic Surgeons score was 3.74%, given her advanced age and the risk of complications associated with surgery, TAVR was performed using a balloon-expandable valve (Edwards Sapien 3 Ultra 20 mm; Edwards Lifesciences), as determined by the heart team.

Key Points

- In cases of acute hemodynamic collapse following valve implantation during TAVR, if the cause is unclear, consider acute mitral regurgitation caused by the Safari wire.
- In patients with small annulus, small LV cavity, septal hypertrophy, and other related conditions, meticulous intraoperative echocardiography monitoring during TAVR can contribute to successful outcomes.
- Adequate risk stratification is essential when considering the use of LV rapid pacing for TAVR.

Abbreviations and Acronyms

LV	left ventricular
TAVR	transcatheter aortic valve replacement
TTE	transthoracic echocardiography

Technique

Transcatheter aortic valve replacement was performed via the right femoral artery with percutaneous access while the patient was under monitored anesthesia care. The LV and aortic pressures were measured, with the LV systolic peak pressure recorded at 170 mm Hg and the aortic systolic peak pressure at 97 mm Hg.

A small Safari2 Pre-Shaped TAVI Guidewire (0.035 in × 275 cm; Boston Scientific) was inserted into the left ventricle, and a balloon-expandable valve (Edwards Sapien 3 Ultra 20 mm) was delivered through the right femoral artery using the 14-F Axela sheath (Edwards Lifesciences). Blood pressure remained stable up to this point (100/60 mm Hg) (Fig. 1A). The cathode was linked to an external pacing box using sterile cables and an alligator clip attached to the free end of the Safari wire. The Sapien valve was successfully deployed under LV rapid pacing (heart rate, 180/min) via the Safari wire with blood pressure maintained below 30 mm Hg, as confirmed by catheterization. After LV rapid pacing was stopped, a continuous low systolic blood pressure under 40 mm Hg was observed, along with a complete atrioventricular node block that resulted in a heart rate of 10/min (Fig. 1B). Left ventricular pacing via the Safari wire (pacing rate, 60/min) was reinitiated; however, systolic blood pressure remained below 40 mm Hg (Fig. 1C).

Aortic trauma, acute aortic regurgitation, paravalvular leakage, valve malposition, pericardial effusion, regional wall motion abnormality, coronary ischemia, and other common potential causes of low blood pressure were excluded because no obvious findings of complications from valve deployment were identified through TTE or angiography.

Previously undetected severe eccentric mitral valve regurgitation, however, was observed in the TTE. An eccentric regurgitant jet was visualized in color Doppler and consistent with severe mitral valve regurgitation (vena contracta width, 0.74 cm) (Fig. 2A). The dense, holosystolic, and triangular-shaped waveforms observed in the continuous-wave Doppler signal further corroborated the severity and acute nature of the mitral valve regurgitation (Fig. 2B). The restriction of the anterior mitral leaflet was suggestive of compression of the posterior papillary muscle by the Safari wire (Fig. 2C).

When the cause of the low blood pressure had been recognized, the Safari wire was withdrawn from the LV cavity. After the Safari wire was withdrawn, the severe mitral valve regurgitation was immediately resolved and blood pressure was restored to 80/40 mm Hg.

The peak pressure gradients of the aorta and left ventricle were confirmed to have decreased from 74 mm Hg to 4 mm Hg through cardiac catheterization (Fig. 3). The procedure was finished after additional TTE and aortography examinations, which confirmed the absence of issues such as valve expansion, paravalvular

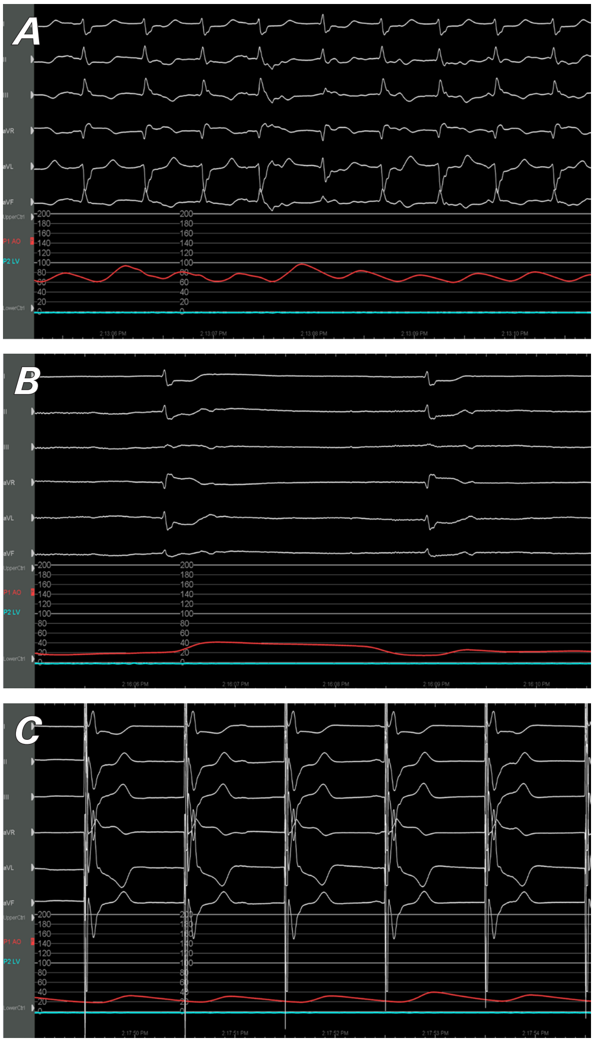

Fig. 1 Pressure graphs of the left ventricle and aorta with electrocardiographic tracings. (**A**) The electrocardiogram and pressure tracing show normal results during the Safari wire insertion into the left ventricular cavity. (**B**) Complete atrioventricular node block is observed, and the blood pressure drops to under 40 mm Hg following valve implantation. (**C**) Despite left ventricular pacing after valve implantation, a drop in blood pressure is still observed on the electrocardiogram and pressure tracing.

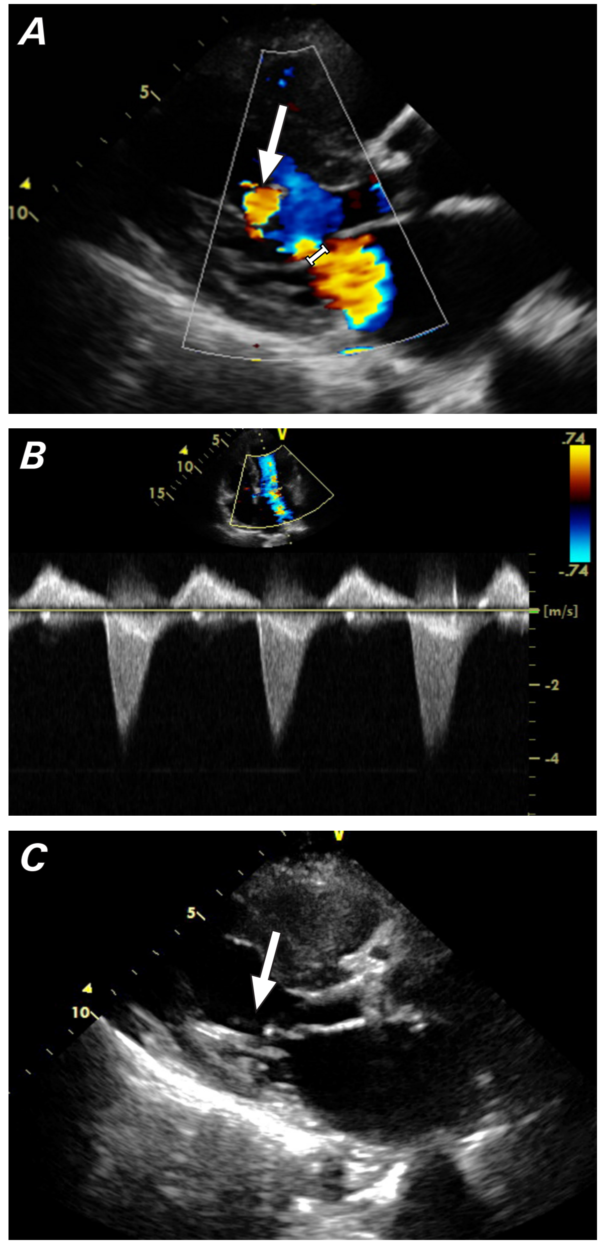

Fig. 2 Transthoracic echocardiography findings after valve implantation reveal the following: (**A**) Acute eccentric severe mitral valve regurgitation is observed in the parasternal long-axis view using color Doppler (vena contracta width, 0.74 cm, indicated by the white arrow); (**B**) the continuous-wave Doppler signal displays a dense, holosystolic, triangular waveform; and (**C**) presence of a regurgitant gap is attributed to the restriction of the anterior papillary muscle, caused by the compression of the posterior papillary muscle by the Safari wire (indicated by the white arrow).

leakage, mitral valve regurgitation, regional wall motion abnormality, and pericardial effusion.

Outcome

Postprocedural TTE performed the next day indicated an indexed effective orifice area of 0.69 cm^2/m^2, confirming a moderate prosthesis-patient mismatch. Considering the patient's concentric LV hypertrophy and small body size, the use of a self-expanding valve was contemplated to address concerns about this mismatch, but the decision was made to proceed with the Edwards Sapien 3 Ultra, a balloon-expandable valve that could allow for feasible future percutaneous

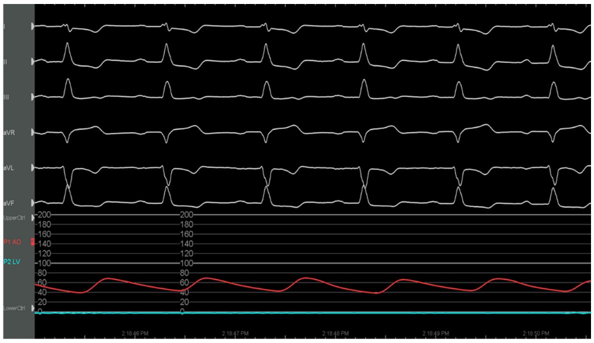

Fig. 3 Pressure graph of the left ventricle and aorta with electrocardiographic tracing shows a restoration of blood pressure following the removal of the Safari wire from the left ventricular cavity.

coronary intervention for existing moderate stenosis in the left circumflex artery. This choice led to concerns about moderate prosthesis-patient mismatch. Despite the occurrence of moderate mismatch, the mean transaortic systolic pressure gradient decreased from 47.7 mm Hg to 32 mm Hg, which resulted in an improvement in the patient's symptoms. Consequently, the patient underwent a 1-day monitoring period in the intensive care unit and was discharged 4 days after the TAVR procedure.

Latest Follow-Up

During the 6-month follow-up TTE, the indexed effective orifice area displayed a minor decrease, from 0.69 cm^2 to 0.65 cm^2, and the mean transaortic systolic pressure gradient slightly increased from 32 mm Hg to 38 mm Hg. Despite these alterations, the patient reported sustained improvement in symptoms. Furthermore, the patient sustained dual-antiplatelet therapy for an additional 6 months before transitioning to aspirin monotherapy.

Discussion

Transcatheter aortic valve replacement is rapidly becoming the standard of care for the treatment of aortic stenosis in patients with an increased surgical risk thanks to its minimal invasiveness and good short-term and midterm outcomes.[1] Meta-analysis and registry data suggest that minimalist TAVR may provide lower mortality, lower morbidity, shorter intensive care unit and hospital stays, and shorter procedure times with local anesthesia. On this basis, minimalist TAVR has become a recent trend in such procedures.[2]

As part of this trend, LV rapid pacing is being implemented for transcatheter heart valve deployment because some studies suggest that it is safe, efficacious, and cost-effective compared with traditional right heart pacing and may represent a step forward in the overall simplification of TAVR procedures.[3,4] Apprehensions persist, however, regarding the safety of LV pacing, especially concerning potential issues such as loss of contact leading, the risk of embolization, and the possible increased risk of LV free-wall rupture.

This article reports on a rare case of LV pacing wire–induced acute severe mitral valve regurgitation during the TAVR procedure with LV rapid pacing. Specifically, TTE and angiography were conducted to differentially diagnose the cause of transient mitral valve regurgitation. The examinations confirmed the absence of regional wall motion abnormality and intact coronary flow, allowing the surgeons to rule out mitral valve regurgitation resulting from papillary muscle ischemia.[3] It was also confirmed that acute severe mitral valve regurgitation was related to the LV pacing wire because the regurgitation improved immediately after the pacing wire was retrieved, and stable blood pressure was restored.

Previous studies have reported complications during the TAVR procedure, such as aortic trauma, coronary occlusion, acute hemodynamic collapse, and malposition of the prosthetic valve.[5,6] Other, previous reports have also shown that 5% to 17% of patients require conversion to general anesthesia during the procedure to manage unexplained hemodynamic instability.[7,8]

Acute mitral valve regurgitation is a serious complication that can cause cardiogenic shock and pulmonary edema. Acute mitral valve regurgitation can be exacerbated during TAVR for several reasons, including direct mechanical damage to the mitral valve leaflets or subvalvular apparatus by the guidewire or prosthetic valve. Secondary mechanisms include new-onset left bundle-branch block, myocardial ischemia, and systolic anterior motion of the mitral valve leaflet.[9]

Therefore, prompt diagnosis and appropriate management according to the specific mechanisms are essential. A previous study by Ito et al[10] evaluated echocardiographic parameters used to predict acute hemodynamically significant mitral valve regurgitation during TAVR; in that study, smaller LV dimensions; larger wire-width/LV dimensions; indexes of aortic stenosis severity; and Wilkins score, which represents the extent of mitral apparatus calcification, were significantly associated with hemodynamically significant acute mitral valve regurgitation.[10] Another previous study emphasized the importance of the Safari wire positioning to avoid injury or entanglement in the mitral apparatus, which can lead to malcoaptation of the mitral valve leaflets.[5]

Moreover, unlike TAVR with right heart pacing or self-expandable valves, LV rapid pacing requires advancing the Safari wire closer to the LV endocardium to establish good contact.[11] Although this approach may reduce the threshold and output requirement, it also increases the risk of LV pacing wire–induced acute mitral valve regurgitation,[10] as observed in this case. Therefore, caution must be exercised, and the aforementioned information should be closely monitored when performing TAVR with LV rapid pacing in patients with a small LV cavity, small annulus, and septal hypertrophy, as in this case. As previously mentioned, a larger wire-width/LV dimension corresponds to a higher incidence of wire-induced mitral valve regurgitation.[10] Therefore, using a smaller wire size in patients with small LV cavities can reduce the risk of wire-induced mitral valve regurgitation.

Several previous studies have reported the superiority of using transesophageal echocardiography compared with TTE in detecting the degree and mechanism of new or worsening mitral valve regurgitation.[9,12] Hence, when performing TAVR through LV rapid pacing in patients with a high possibility of LV pacing wire–induced acute mitral valve regurgitation, appropriate risk stratification and careful monitoring of any change in mitral valve morphology and the severity of mitral valve regurgitation using intraoperative transesophageal echocardiography can help achieve successful outcomes.

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