

## From Paravalvular Leak to Transvalvular Regurgitation: A Case of Persistent Symptoms After Transcatheter Aortic Valve Implantation Requiring Redo Transcatheter Aortic Valve Implantation

### Paravalvüler Kaçak'tan Transvalvüler Regürjitasyona: Transkateter Aort Kapak İmlante Edilmesinin Ardından Tekrar Transkateter Aort Kapak İmlantasyonu Gerektiren Süregen Semptomlar Bir Vaka

#### ABSTRACT

Transcatheter aortic valve implantation (TAVI) is a cornerstone treatment for severe aortic stenosis; however, complications such as paravalvular leak (PVL), hypoattenuated leaflet thickening (HALT), and hypoattenuation affecting motion (HAM) can lead to persistent symptoms requiring reintervention. We report the case of a 70-year-old man with symptomatic severe aortic stenosis who underwent TAVI with a 27.5-mm Myval™ transcatheter heart valve (Meril Life Sciences, Vapi, Gujarat, India). Post-procedure, moderate PVL was identified, followed by persistent dyspnea at three months. Multimodal imaging, including transthoracic echocardiography, transesophageal echocardiography, and computed tomography, revealed HALT, HAM, and moderate-to-severe transvalvular leakage (TVL). Despite balloon post-dilation and anticoagulation therapy, symptoms persisted, necessitating a valve-in-valve redo TAVI with a 26-mm Myval™ transcatheter heart valve (Meril Life Sciences, Vapi, Gujarat, India). Follow-up imaging confirmed the absence of significant PVL or TVL, with complete resolution of symptoms. This case underscores the importance of multimodal imaging and individualized management strategies, including redo TAVI, in the treatment of complex post-TAVI complications.

**Keywords:** Hypoattenuated leaflet thickening, hypoattenuation affecting motion, multimodal imaging, paravalvular leak, transcatheter aortic valve implantation, valve-in-valve procedure

#### ÖZET

Transkateter aort kapak implantasyonu (TAVI), şiddetli aort stenozunun temel tedavisidir; ancak paravalvüler kaçak (PVL), hipointans yaprak kalınlaşması (HALT) ve hipointansiyon nedeniyle hareket kısıtlaması (HAM) gibi komplikasyonlar, yeniden müdahale gerektiren süregen semptomlara yol açabilir. 70 yaşında, semptomatik şiddetli aort stenozu olan bir erkek hasta, 27,5 mm Myval™ transkateter kalp kapakçığı (Meril Life Sciences, Vapi, Gujarat, Hindistan) ile TAVI geçirdi. Prosedür sonrasında, orta düzeyde PVL tespit edildi ve üç ay sonra süregen dispne görüldü. Transtorasik ekokardiyografi, transözofageal ekokardiyografi ve bilgisayarlı tomografi dahil olmak üzere multimodal görüntüleme, HALT, HAM ve orta-şiddetli transvalvüler kaçak (TVL) tespit etti. Balonla post-dilasyon ve antikoagülasyon tedavisine rağmen, semptomlar devam etti ve 26 mm Myval™ transkateter kalp kapakçığı (Meril Life Sciences, Vapi, Gujarat, Hindistan) ile valve-in-valve yeniden TAVI yapılması gerekti. Takip görüntülemesi, anlamlı bir PVL veya TVL olmadığını ve semptomların tamamen çözüldüğünü doğruladı. Bu vaka, multimodal görüntülemenin ve bireyselleştirilmiş yönetim stratejilerinin, TAVI sonrası karmaşık komplikasyonların tedavisindeki önemini vurgulamaktadır.

**Anahtar Kelimeler:** Hipointans yaprak kalınlaşması, hipointansiyon nedeniyle hareket kısıtlaması, multimodal görüntüleme, paravalvüler kaçak, transkateter aort kapak implantasyonu, valve-in-valve prosedürü

Transcatheter aortic valve implantation (TAVI) has become a cornerstone therapy for severe aortic stenosis (AS), offering outcomes comparable to surgical aortic valve replacement (SAVR) even in lower-risk patients.<sup>1</sup> However, complications such as paravalvular leak (PVL) and transvalvular leak (TVL) remain clinically significant, affecting up to 22% of cases and increasing long-term mortality.<sup>2</sup>

#### CASE REPORT OLGU SUNUMU

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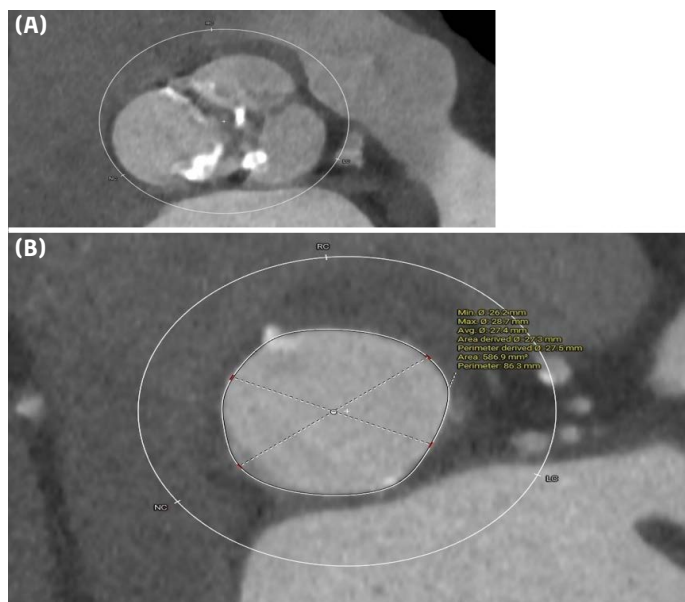
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**Figure 1. (A) Computed tomography (CT) measurement demonstrating a bicuspid aortic valve with an area of 565 mm<sup>2</sup> and an average derived diameter of 27.3 (B).**

Balloon post-dilation (BPD) is commonly performed to reduce PVL and improve valve apposition.<sup>3</sup> However, other post-TAVI complications—such as hypoattenuated leaflet thickening (HALT) and hypoattenuation affecting motion (HAM)—require multimodal imaging for diagnosis and tailored management. These conditions may present variably, ranging from asymptomatic findings to heart failure symptoms, and may sometimes necessitate redo TAVI.

We present the case of a 70-year-old man with persistent dyspnea after TAVI due to HALT and HAM, ultimately requiring redo valve-in-valve (ViV) implantation. This case underscores the role of multimodal imaging and individualized strategies in the management of post-TAVI complications.

### Case Report

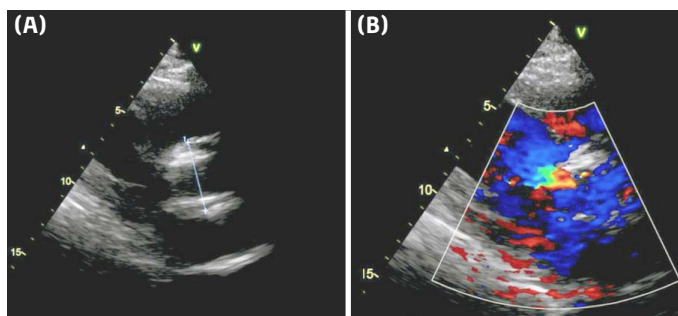
A 70-year-old man with symptomatic severe AS and a history of prior transcatheter coarctoplasty was referred for TAVI. Pre-procedural computed tomography (CT) confirmed suitable anatomy, and a 27.5-mm Myval™ transcatheter heart valve (Meril Life Sciences, Vapi, Gujarat, India) was implanted via transfemoral access (Figure 1). Standard procedural steps included femoral artery and vein access, placement of a pigtail catheter, and right ventricular pacing. Hemostasis was achieved using two Perclose ProGlide™ suture-mediated closure systems (Abbott Laboratories, Abbott Park, Illinois, USA).

Postprocedural transthoracic echocardiography (TTE) revealed moderate PVL. As the patient was clinically stable, BPD was deferred pending follow-up evaluation (Figure 2).

At three months, the patient presented with New York Heart Association (NYHA) class III dyspnea. Repeat TTE demonstrated moderate-to-severe PVL, prompting CT imaging, which revealed HALT with a calcified nodule involving the noncoronary and left cusps. Apixaban 5 mg twice daily was initiated, with reassessment planned in three months.

### ABBREVIATIONS

CT	Computed tomography
DOACs	Direct oral anticoagulants
HALT	Hypoattenuated leaflet thickening
HAM	Hypoattenuation affecting motion
NYHA	New York Heart Association
PTA	Percutaneous transluminal angioplasty
PVL	Paravalvular leak
SAVR	Surgical aortic valve replacement
TAVI	Transcatheter aortic valve implantation
TEE	Transesophageal echocardiography
THV	Transcatheter heart valve
TTE	Transthoracic echocardiography
TVL	Transvalvular leakage
VARC	Valve Academic Research Consortium
ViV	Valve-in-valve



**Figure 2. Parasternal long-axis view of the valve (A), with color flow mapping showing regurgitant flow consistent with paravalvular leak (B).**

At six months, the patient's symptoms persisted. The decision to maintain full-dose apixaban for six months was tailored to the patient's anatomy and individual thrombotic and bleeding risks. Transesophageal echocardiography (TEE) demonstrated moderate-to-severe TVL and persistent moderate PVL. High-resolution CT showed grade I HALT on the right leaflet and grade II HALT on the left leaflet. HALT was assessed on cardiac CT according to established criteria and graded using the Valve Academic Research Consortium (VARC) consensus definitions, with grade I HALT defined as involvement of <25% of the leaflet surface and grade II as involvement of 25–50%. Additionally, HAM and incomplete leaflet coaptation were observed, indicating leaflet dysfunction as the primary cause of the patient's symptoms (Figure 3).

The patient subsequently underwent balloon post-dilation using a 26 × 40 mm Atlas Gold™ percutaneous transluminal angioplasty (PTA) dilatation balloon catheter (Becton Dickinson, Franklin Lakes, New Jersey, USA) inflated to 22 atm, resulting in temporary improvement. However, follow-up imaging demonstrated persistent moderate TVL and mild PVL, with CT revealing underexpansion of the transcatheter heart valve (THV). Based on these findings, a redo TAVI procedure was planned.

A 26-mm Myval™ transcatheter heart valve (Meril Life Sciences, Vapi, Gujarat, India) was implanted via a transfemoral approach



**Figure 3. (A) Computed tomography (CT) demonstrating an underexpanded transcatheter heart valve (THV) with a mean derived diameter of 25. (B) CT image obtained three months after the procedure demonstrating hypoattenuated leaflet thickening (HALT). Follow-up CT confirming hypoattenuation affecting motion (HAM) (C).**

(Figure 4). Valve deployment and hemostasis were uneventful, achieved using one Perclose ProGlide™ suture-mediated closure system (Abbott Laboratories, Abbott Park, Illinois, USA) and one Angio-Seal™ vascular closure device (Terumo Corporation, Tokyo, Japan). Postprocedural echocardiography confirmed the absence of significant PVL or TVL. The patient experienced complete resolution of symptoms and remained asymptomatic at subsequent follow-up visits.

### Discussion

This case illustrates the diagnostic and therapeutic challenges of post-TAVI complications when PVL, TVL, and leaflet dysfunction coexist. Persistent dyspnea despite technically successful implantation requires systematic reassessment using multimodal imaging to identify the underlying mechanism of regurgitation.

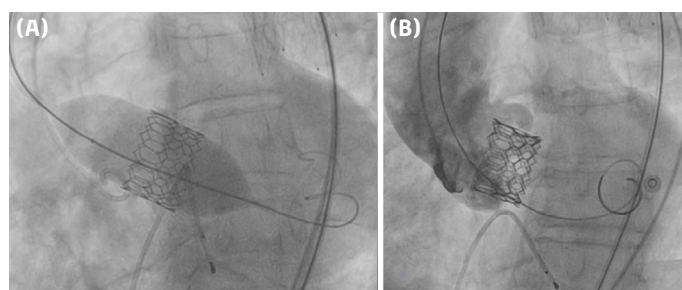
#### Paravalvular Leak (PVL)

Paravalvular leak is a frequent finding after TAVI, particularly in the presence of heavily calcified annuli or suboptimal valve expansion, with an incidence of up to 22% in early-generation valves.<sup>2,4</sup> Moderate or severe PVL has been associated with increased late mortality. BPD remains a mainstay intervention;<sup>3</sup> however, its success depends on valve alignment, annular compliance, and the pattern of calcification. In our case, initial BPD was deferred, but later attempts resulted only in transient improvement, suggesting the presence of additional underlying mechanisms.

#### Transvalvular Leak (TVL) and Hypoattenuation Affecting Motion (HAM)

Transvalvular leak is less common and may result from leaflet injury, restricted leaflet motion, or incomplete leaflet coaptation.<sup>5</sup> In this case, multimodal imaging confirmed HALT and HAM, which are recognized manifestations of subclinical leaflet thrombosis.<sup>6,7</sup> HALT appears on CT as areas of hypoattenuation and, when extensive, leads to HAM, characterized by restricted leaflet motion and resultant regurgitation.

Clinical presentation is variable. Many cases are asymptomatic, whereas others may manifest with heart failure symptoms. TTE may underestimate these findings, whereas 3D TEE and high-resolution CT provide critical insights into leaflet thickening, motion restriction, and valve expansion. In our patient, these imaging modalities were instrumental in guiding management.



**Figure 4. Post-dilation of the previously implanted transcatheter heart valve (THV) followed by redo transcatheter aortic valve implantation (TAVI).**

#### Anticoagulation in HALT and HAM

Anticoagulation is currently the preferred management strategy for suspected leaflet thrombosis. Direct oral anticoagulants (DOACs) have demonstrated efficacy in resolving HALT and restoring normal leaflet motion.<sup>8</sup> However, the optimal duration of treatment and appropriate patient selection remain subjects of debate.<sup>9</sup> Despite six months of apixaban therapy, our patient showed no improvement, emphasizing that HALT-related dysfunction may not always be reversible and may ultimately require structural intervention.

#### Redo TAVI as a Rescue Strategy

When medical therapy or BPD fails, redo TAVI has emerged as an alternative strategy for managing residual regurgitation,<sup>10</sup> valve underexpansion, or valve degeneration. Careful CT-based assessment of annular dimensions, coronary heights, and valve geometry is essential to minimize procedural risk. In this case, implantation of a second 26-mm valve corrected the initial underexpansion, eliminated regurgitation, and resulted in the resolution of symptoms.

Redo TAVI can be technically challenging, with potential risks including coronary obstruction or valve malposition. However, with meticulous preprocedural planning and multimodality guidance, procedural outcomes are generally favorable. This case supports redo TAVI as a safe and effective option for complex post-TAVI complications that are refractory to conservative management.

## Management Strategies in Published Case Reports of Post-TAVI HALT

Although high-quality evidence remains limited, thrombolytic therapy has been reported as a successful treatment for HALT in several recent case reports.<sup>11,12</sup> With accumulating clinical experience and further clarification of optimal treatment protocols, its use may become more widespread in carefully selected cases.

### Role of Multimodal Imaging

This case reinforces the diagnostic value of multimodal imaging after TAVI. While TTE is the standard initial diagnostic tool, TEE (particularly 3D imaging) and high-resolution CT provide superior visualization of regurgitant mechanisms and structural valve dysfunction. Routine CT follow-up has been proposed to facilitate early detection of subclinical HALT; however, its cost-effectiveness remains to be determined.<sup>13</sup>

In our patient, the combined use of TTE, TEE, and CT enabled differentiation between PVL and TVL, identification of HALT and HAM, and guided the decision to perform redo TAVI. Such integrated imaging is essential for optimal management and improved long-term outcomes.

### Conclusion

Since the first successful human implantation in 2002, transcatheter aortic valve implantation has evolved into a widely accepted treatment and is now considered the preferred therapeutic option for patients with severe aortic stenosis who are at high surgical risk. Over time, the rate of procedure-related complications has markedly declined, largely due to increasing operator experience, more precise valve sizing using computed tomography, major advances in valve technology, and the development of lower-profile delivery systems.<sup>14</sup>

This case highlights the multifactorial nature of post-TAVI regurgitation, in which PVL, HALT, and HAM may coexist. Comprehensive multimodal imaging was crucial in identifying the mechanism of dysfunction and guiding management. When anticoagulation therapy and BPD proved ineffective, redo TAVI achieved durable valve competence and complete resolution of symptoms. An individualized, imaging-guided approach remains essential for optimizing outcomes in patients with complex post-TAVI complications.

With the growing number of TAVI procedures performed in recent years, clinical practice has increasingly shifted toward the management of procedure-related complications. Accurate identification and appropriate treatment of conditions such as HALT, PVL, and THV thrombosis are particularly important, given the current lack of robust evidence-based management guidelines. In this context, case reports such as ours may contribute valuable clinical experience and incremental evidence to help inform and refine future management strategies.

### Clinical Implications

Persistent symptoms after TAVI warrant systematic reassessment using multimodal imaging to distinguish PVL, TVL, and leaflet dysfunction. HALT and HAM may not always resolve with anticoagulation therapy, highlighting the importance of individualized treatment strategies. Redo TAVI represents

a feasible and effective solution for refractory post-TAVI regurgitation, particularly when guided by comprehensive imaging. Future research should focus on refining post-TAVI imaging protocols, defining optimal antithrombotic strategies, and evaluating the long-term outcomes of redo TAVI procedures.

**Ethics Committee Approval:** This is a single case report, and therefore ethics committee approval was not required in accordance with institutional policies.

**Informed Consent:** Written informed consent was obtained from the patient for publication of this case report and any accompanying images. The patient was informed that all identifying information would be anonymized.

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