

Repeated Transcatheter Edge-to-Edge Repair Procedure of the Tricuspid Valve in a Patient with Mitral Valve Replacement

Mitral Kapak Replasmanlı Bir Hastada Triküspit Kapağın Tekrarlanan Transkateter Uçtan Uca Onarım Prosedürü

ABSTRACT

Tricuspid regurgitation (TR) is associated with poor prognosis and increased morbidity, especially in patients with high surgical risk and limited treatment options. We present the case of a 70-year-old male with a history of mitral valve replacement and prior transcatheter edge-to-edge repair (TV-TEER), who underwent a successful redo TV-TEER due to torrential TR. Post-procedural evaluation revealed a significant reduction in TR severity and clinical improvement. Unfortunately, the patient succumbed to infectious complications and sepsis in the third week of follow-up. Due to the limited data on redo TV-TEER interventions, this case adds to the existing literature and suggests that redo TV-TEER may be a viable alternative to surgery in selected patients.

Keywords: Redo procedure, transcatheter edge-to-edge repair, tricuspid regurgitation

ÖZET

Triküspit yetmezliği (TR), kötü prognoz ve artmış morbidite ile ilişkili olup, yüksek cerrahi riske sahip hastalarda tedavi seçenekleri sınırlıdır. Bu olguda, mitral kapak replasmanı ve önceki TV-TEER öyküsü olan 70 yaşında erkek hastada, şiddetli TR nedeniyle redo triküspit kapak transkateter uç uca onarım başarıyla uygulanmış, işlem sonrası TR şiddeti azalmış ve klinik iyileşme sağlanmıştır. Ancak üçüncü haftada gelişen enfeksiyöz komplikasyonlar ve sepsis nedeniyle hasta kaybedilmiştir. Redo TV-TEER işlemlerine dair sınırlı veri bulunması bu olguyu literatürde özgün kılmakta olup, uygun hastalarda bu yöntem cerrahiye alternatif bir seçenek olarak değerlendirilebilir.

Anahtar Kelimeler: Redo işlem, transkateter uçtan uca onarım, triküspit yetersizliği

Tricuspid regurgitation (TR) is a common condition, with prevalence increasing with age.¹ Functional TR is the most frequent type, typically occurring in patients with left-sided valvular disease, pulmonary arterial hypertension, or atrial fibrillation, in which annular dilation may develop independently.¹

TR is associated with poor prognosis, with increased mortality and heart failure-related hospitalization. Surgical intervention is rarely performed in this population due to high comorbidity-related risk.¹ Despite advances in surgical techniques, valve repair, including annuloplasty for isolated TR, has not demonstrated a mortality benefit.² Interest in transcatheter approaches has grown for this high-risk group with controversial surgical outcomes. One such innovation, designed for severe TR management, is the TriClip system (Abbott, Chicago, IL, USA).³ Recent studies indicate that transcatheter valve repair may surpass conventional methods.⁴ Tricuspid valve transcatheter edge-to-edge repair (TV-TEER) reduces recurrent hospitalizations and improves quality of life in severe TR.⁵ Advances in technology and access have increased both surgical and transcatheter interventions. Moreover, redo procedures are now considered when necessary.⁶

In our case, we highlight the feasibility and potential benefit of redo TV-TEER in a patient with prior mitral valve replacement and prior TV-TEER. Major studies on this topic excluded patients with previous tricuspid interventions, rendering our case particularly unique.⁷

CASE REPORT OLGU SUNUMU

Mücahit Tan¹ 

Yüksel Kaya¹ 

Zeynettin Kaya² 

İsmail Ateş³ 

¹Department of Cardiology, Yüzüncü Yıl University Faculty of Medicine, Van, Türkiye
²Department of Cardiology, Antalya ASV Life Hospital, Antalya, Türkiye
³Department of Nursing, Bahçeşehir University, Faculty of Health Sciences, Istanbul, Türkiye

Corresponding author:

Mücahit Tan
✉ dr.mucahit.tan@gmail.com

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Case Report

A 70-year-old male presented to our clinic with dyspnea, lower extremity edema, and abdominal distension. He had been hospitalized three times in the past six months. Twenty-five years earlier, he had undergone mitral valve replacement for primary valvular pathology. Three years earlier, he underwent transcatheter tricuspid valve edge-to-edge repair for severe secondary tricuspid regurgitation. One XTW clip had been previously implanted between the septal and posterior leaflets, and another between the septal and anterior leaflets. Tricuspid regurgitation decreased from massive to moderate severity. During the three-year follow-up period, his symptoms regressed and he remained hospitalization-free until the last six months. Congestion was managed with diuretics. In addition to known valvular heart disease, the patient had a history of atrial fibrillation (AF) and chronic obstructive pulmonary disease (COPD).

On admission, vital signs were stable. Physical examination revealed marked ascites and grade +3 pretibial edema in both legs. The patient's functional status was classified as New York Heart Association (NYHA) class IV. Electrocardiography demonstrated AF with a ventricular rate of 113 bpm. Transthoracic echocardiography demonstrated a left ventricular ejection fraction (LVEF) of 45%, a normofunctional mechanical mitral valve (gradient 10/5 mmHg), torrential TR, pulmonary artery systolic pressure (PASP) of 65 mmHg, right ventricular ejection fraction (RVEF) of 35%, tricuspid annular plane systolic excursion (TAPSE) of 2 cm, and right ventricular systolic tissue Doppler wave (Sm) of 10 cm/s.

The patient's medications included warfarin 5 mg once daily, sacubitril/valsartan 24/26 mg twice daily, carvedilol 6.25 mg twice daily, spironolactone 25 mg once daily, dapagliflozin 10 mg once daily, furosemide 40 mg three times daily, and inhaled ipratropium bromide plus levalbuterol 20/50 mcg. Blood tests revealed elevated creatinine, low hemoglobin levels, and raised acute phase reactants. International normalized ratio (INR) and liver function tests were within normal limits (Table 1).

The patient was admitted to the intensive care unit, where heart failure therapy was optimized and intravenous furosemide infusion initiated. Paracentesis and pleurocentesis were performed for third-space fluid management, and empirical antibiotic therapy was started per infectious disease team recommendations. Paracentesis fluid was transudative. TR progression over three years was attributed to annular dilatation secondary to chronic right ventricular volume overload from longstanding AF, along with progression of COPD and renal dysfunction. The patient had high surgical risk (European System for Cardiac Operative Risk Evaluation [EuroSCORE]: 49.48%). The Tricuspid Regurgitation Impact (TRI) score, used to estimate mortality risk after tricuspid valve surgery, was 9, indicating a 65% surgical mortality risk.

After transesophageal echocardiography (TEE) evaluation and in light of recurrent, prolonged hospitalizations despite high-dose diuretics, redo TV-TEER was performed for torrential TR (Figure 1). Two XTW clips were sequentially deployed between the septal-posterior and septal-anterior leaflets (Figure 2). Post-procedural echocardiography demonstrated a significant reduction in TR from torrential to severe. Vital signs remained

ABBREVIATIONS

AF	Atrial fibrillation
CABG	Coronary artery bypass grafting
COPD	Chronic obstructive pulmonary disease
INR	International normalized ratio
KCCQ-OS	Kansas City Cardiomyopathy Questionnaire-Overall Summary
LVEF	Left ventricular ejection fraction
NYHA	New York Heart Association
PASP	Pulmonary artery systolic pressure
RV	Right ventricular
RVEF	Right ventricular ejection fraction
STS	the Society of Thoracic Surgeons
TAPSE	Tricuspid annular plane systolic excursion
TEE	Transesophageal echocardiography
TR	Tricuspid regurgitation
TRI	Tricuspid Regurgitation Impact
TTVR	Transcatheter tricuspid valve replacement
TV-TEER	Tricuspid valve transcatheter edge-to-edge repair

stable. Over three weeks of follow-up, clinical improvement was observed, with decreased creatinine levels (Table 1). Congestion regressed, and the need for diuretics decreased to intravenous furosemide 20 mg twice daily.

In the second week, an increase in acute phase reactants and clinical deterioration prompted repeated blood cultures, which were positive for *Klebsiella pneumoniae*. The respiratory panel detected Coronavirus HKU1. The patient was treated with vancomycin, meropenem, polymyxin, and caspofungin. In the third week, liver function worsened and thrombocytopenia developed; hematology consultation attributed this to infection-related thrombocytopenia. The patient's condition deteriorated further, with impaired oral intake and hemodynamic instability. Despite inotropic support and appropriate antibiotic therapy, he developed cardiac arrest and was declared deceased after resuscitation attempts failed.

Discussion

Tricuspid regurgitation is a common condition historically managed with diuretics or surgery and is associated with poor prognosis.¹ Repeat surgery for symptomatic TR in patients with prior coronary artery bypass grafting (CABG) or mitral valve surgery carries high risk.² Dreyfus et al.⁸ reported that isolated tricuspid valve surgery was associated with high mortality rates. Standard risk scores, including the Society of Thoracic Surgeons (STS) and EuroSCORE/EuroSCORE II, are not designed for TV surgery, emphasizing the need for dedicated models. Dreyfus et al.⁹ introduced the TRI-SCORE, comprising eight variables, with ≥ 6 indicating high surgical risk. Accurate TRI-SCORE assessment is essential for outcome optimization in TV surgery patients; in our case, scoring models indicated high risk.

The safety and efficacy of the TriClip procedure have been demonstrated in several studies. The TRILUMINATE trial (Tricuspid Regurgitation Repair with Transcatheter Edge-to-Edge Valve Repair Study) was a prospective, single-arm study involving 85 patients from 21 centers in the US and Europe.⁷ Patients with severe pulmonary hypertension, LVEF < 20%, or prior TV procedures

Table 1. Laboratory findings at baseline and during follow-up

Parameter	Day 0	Week 1	Week 2	Week 3
WBC (10 ³ /μL)	8.23	8.56	7.56	14.99
Hemoglobin (g/dL)	8.3	9.8	9.4	9.7
Platelets (10 ³ /μL)	251	138	109	16
INR	3.65	2.9	3.19	3.05
Creatinine (mg/dL)	1.64	1.1	1.33	1.17
Sodium (mmol/L)	140	139	134	150
Potassium (mmol/L)	5.5	3.3	4.0	4.8
ALT (U/L)	15	15	10	1073
AST (U/L)	48	34	35	4000
Albumin (g/L)	19.8	24.5	23.3	22.3
Iron (mg/dL)	34	—	—	—
Total iron binding capacity (mg/dL)	80	—	—	—
Total bilirubin (mg/dL)	0.66	1.24	1.13	8.6
Direct bilirubin (mg/dL)	0.34	0.46	0.52	5.45
CRP (mg/L)	90	52	101	105
hs-Troponin	Negative	—	—	—
Microbiology	Blood culture: negative Respiratory panel: negative	—	Blood culture: <i>Klebsiella pneumoniae</i> Respiratory panel: Coronavirus HKU1	—

WBC, White blood cell; ALT, Alanine aminotransferase; AST, Aspartate aminotransferase; CRP, C-reactive protein.

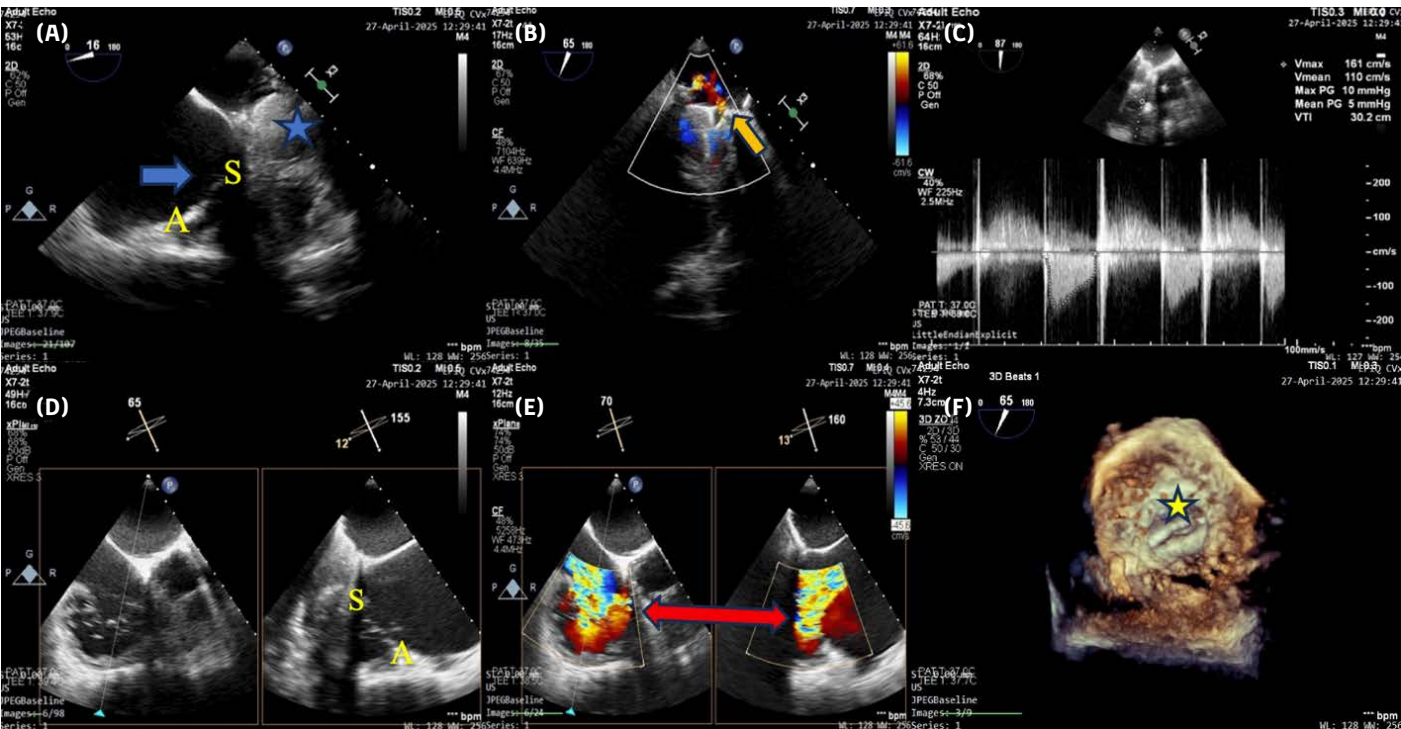


Figure 1. Pre-procedural transesophageal echocardiographic (TEE) images: (A) Mid-esophageal four-chamber view at 16° showing the mechanical mitral valve replacement (MVR) (blue star) and tricuspid valve leaflets (blue arrow; A: anterior leaflet, S: septal leaflet); (B) Mild paravalvular leak observed on MVR assessment (orange arrow); (C) MVR gradient measurement with a maximum/mean peak gradient of 10/5 mmHg; (D) X-plane view in the mid-esophageal right ventricular inflow-outflow window showing anterior (A), posterior, and septal (S) leaflets of the tricuspid valve; (E) Color Doppler imaging in the right ventricular inflow-outflow view demonstrating torrential tricuspid regurgitation (double-headed red arrow), with a vena contracta (VC) ≥ 21 mm; (F) 3D TEE view of the MVR (yellow star).

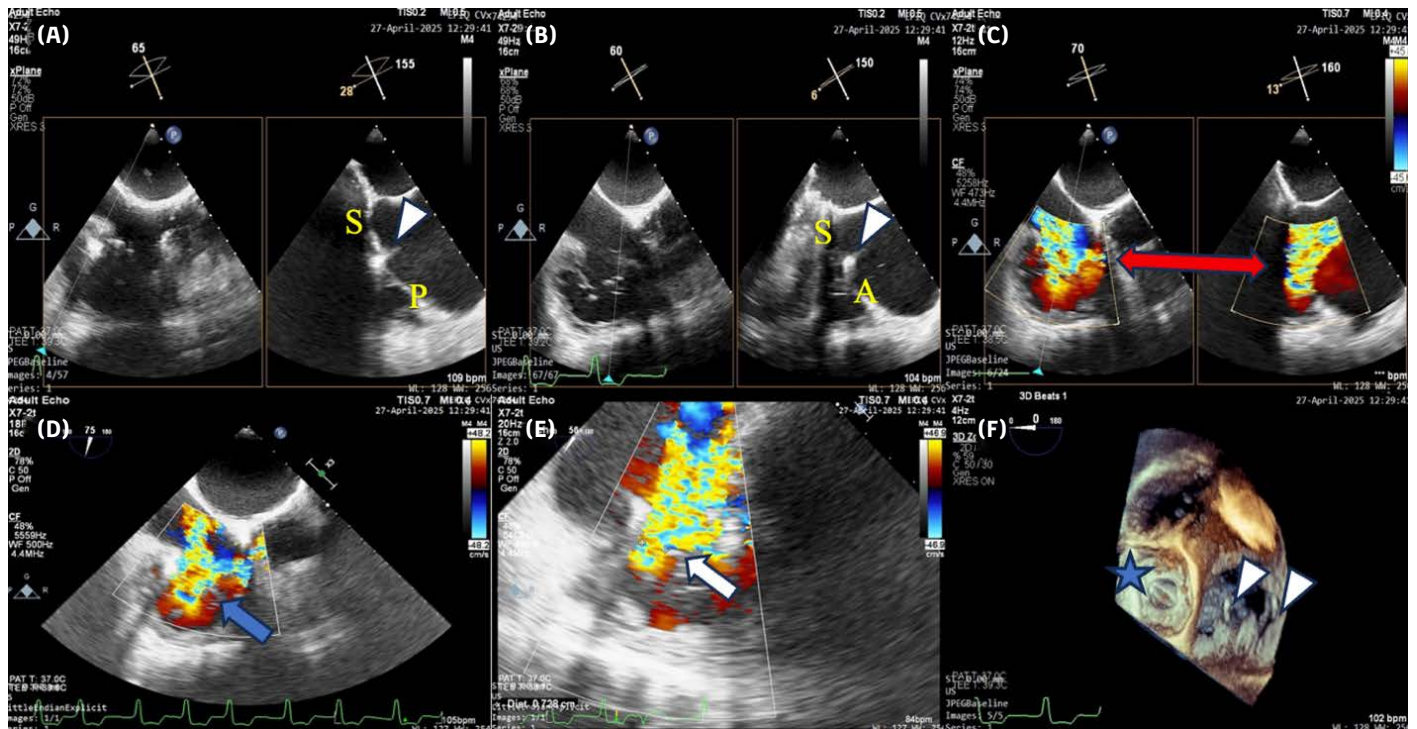


Figure 2. Intraprocedural and post-procedural transesophageal echocardiography (TEE) images: (A) X-plane view in the mid-esophageal right ventricular inflow-outflow window showing successful grasping of the septal (S) and posterior (P) leaflets of the tricuspid valve with a clip (white arrowhead); (B) X-plane view demonstrating grasping of the septal (S) and anterior (A) leaflets with a clip (white arrowhead); (C) Pre-procedural color Doppler imaging in the same view showing torrential tricuspid regurgitation (red arrow), with a vena contracta (VC) $\geq$ 21 mm; (D) Post-deployment of the first clip between the posterior and septal leaflets, a reduction in the regurgitant jet is observed (blue arrow, VC: 11 mm); (E) Following placement of a second clip between the prior clip and the septal-posterior leaflets, a further decrease in vena contracta is evident on color Doppler (white arrow, VC: 7 mm); (F) 3D TEE image showing the mechanical mitral valve replacement (MVR) (blue star) and implanted clips (white arrowheads).

were excluded. Of these patients, 75% were NYHA class III-IV, and 33% had a history of cardiac surgery. Procedural success (clip implantation) was 100%. At 30 days, 86.6% of patients showed $\geq$ 1-grade TR reduction. Echocardiographic assessments showed improved regurgitant volume, annular diameter, mean gradient, and cardiac output. Furthermore, 80% of patients were NYHA class I-II at 30 days. No deaths, myocardial infarctions, or strokes were reported, and no cases required conversion to open surgery. At two years, 85.4% of patients maintained at least a one-grade reduction in TR, and hospitalizations decreased by 49%. Quality-of-life improvements, measured by the Kansas City Cardiomyopathy Questionnaire-Overall Summary (KCCQ-OS), were sustained over this period.⁷

Another important study by Polat et al.¹⁰ evaluated 42 patients with symptomatic secondary TR (57.1% massive, 42.9% torrential, mean age 70.7 ± 14.0 years, 73.8% female). Exclusions included rheumatic valve disease, coaptation defect $\geq$ 10 mm, severe right ventricular (RV) dilation/dysfunction, PASP $>$ 65 mmHg, pulmonary vascular resistance $>$ 4 WU, or lead-induced TR. All patients were high surgical risk (EuroSCORE II, TRI-SCORE). The TriClip system was used in 69% of patients and MitraClip in 31%. Post-procedural TR severity was mild-moderate in 88.1% of patients, and only 11.9% had persistent severe TR. Within the first month, functional status improved (four patients remained in NYHA class III, while 28 improved to class II and eight to class I), with no significant change in hospital readmission rates.¹⁰

The need for a contemporary grading system to allow for a more objective and treatment-guiding assessment of TR has led to the introduction of a new classification that expands the severity scale to include the categories "massive" and "torrential." According to this scheme, TR is classified as mild, moderate, severe, massive, or torrential.¹¹

Although transcatheter edge-to-edge repair is a promising technique, it presents certain challenges, including the potential need for repeat procedures. Residual or recurrent TR is observed in approximately 14% of patients within the first month following all types of tricuspid annuloplasty. In annuloplasty using the De Vega technique, significant late worsening of TR has been reported in up to 30% of patients, likely due to gradual re-dilatation of the annulus.¹² In a case report published by Afzal et al.,¹³ successful transcatheter edge-to-edge repair was performed in a patient with a history of surgical tricuspid annuloplasty, resulting in a reduction of massive TR to mild. In our case, a history of prior surgical intervention on the tricuspid valve did not constitute a barrier to performing TEER. Although the authors expressed concerns regarding the potential development of tricuspid stenosis, no post-procedural stenosis was observed. Consistent with the literature, the recurrence of torrential TR within three years after the initial TV-TEER in our patient was attributable to re-dilatation of the annulus. Furthermore, the feasibility of TV-TEER following annuloplasty in our case was encouraging.

Toggweiler et al.¹⁴ reported the use of transcatheter tricuspid valve replacement (TTVR) with the EVOQUE valve in cases of severe TR following initially unsuccessful TV-TEER. In these cases, TR recurred after a transient improvement. Similarly, Ozdemir et al.¹⁵ described TTVR in a patient with recurrent severe TR following prior TV-TEER. In our case, consistent with the literature, tricuspid regurgitation recurred, highlighting the need for alternative treatment strategies in the absence of a standardized approach. Our experience supports the consideration of redo TV-TEER, in addition to TTVR, as a viable therapeutic option in such complex scenarios.

Before considering redo TEER in patients with prior tricuspid annuloplasty or TV-TEER, several important factors should be taken into account. First, the underlying mechanism of recurrent tricuspid regurgitation must be understood, and the likelihood of successfully treating the regurgitation should be evaluated. In patients who previously underwent suture-based annuloplasty, annular re-dilatation, leaflet tethering, or suture loosening can often be effectively addressed with TV-TEER, whereas a tissue tear near the annuloplasty ring or ring dehiscence may be difficult or even impossible to treat percutaneously. The potential for worsening tricuspid stenosis following device deployment in a repeat TEER procedure should also be considered. Therefore, assessment of the transvalvular tricuspid valve gradient before and during the procedure is mandatory.¹³

According to the current literature, redo TV-TEER is feasible in patients with RVEF > 30%, coaptation gap < 7–8 mm, and no severe leaflet tethering, provided annular dilation is not excessive, though comprehensive clinical and imaging evaluation is needed.^{10,13} Our patient presented with both a history of prior valve interventions and impaired right ventricular function (RVEF 35%, unexpectedly preserved TAPSE 2 cm, RV Sm 10 cm/s), in addition to pulmonary hypertension (PASP 65 mmHg), thus meeting exclusion criteria in most existing studies. This highlights the encouraging nature of the case and underscores the difficulty of defining clear procedural boundaries in light of current evidence.

TRILUMINATE's long-term results demonstrated sustained TR reduction in 85.4% of patients and a 49% reduction in hospitalizations over two years, highlighting the durability of the TriClip approach. Among the 84 patients followed, four (5%) died, with only one death considered possibly device-related.⁷ In Polat et al.'s study,¹⁰ 3 of 42 patients (7.1%) died—2 from heart failure and one from acute renal failure. In our case, TR reduction and improved cardiac output were maintained during the three-week follow-up period. Consistent with the literature, mortality in our case was unrelated to the procedure.

In our case, the TriClip system was used in a patient with NYHA class IV symptoms and torrential functional TR who had a high surgical risk profile. The patient also had atrial fibrillation and chronic kidney disease. Procedural success, defined as clip implantation and at least a one-grade TR reduction, was achieved without the need for emergency surgery. Notably, renal function improved significantly until the development of septic shock in the second week. Unlike the TRILUMINATE population, our patient had reduced LVEF, potentially increasing procedural risk and mortality.

Our case contributes to the growing body of evidence supporting TEER for tricuspid repair. The exclusion of patients with prior TV interventions from key studies further underscores the significance of this report. Although interest in TV-TEER has increased in recent years, the available studies remain limited in number, and key aspects such as procedural indications, predictors of procedural success, and anatomical eligibility criteria have not yet been standardized. There is a clear need for larger-scale studies in this field. Our case is particularly valuable in demonstrating procedural success in the context of the existing echocardiographic parameters. It offers valuable insights into the feasibility, safety, and outcomes of redo TV-TEER in high-risk patients with previous valve interventions.

Conclusion

In conclusion, this case contributes to the expanding body of evidence supporting TV-TEER as a feasible and effective alternative to conventional surgery, particularly in patients with limited treatment options and high surgical risks due to prior valve interventions. TV-TEER should therefore be considered a viable treatment option in carefully selected high-risk patients who are not suitable candidates for repeat surgery.

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

Informed Consent: Patient consent was obtained and is available upon request.

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