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CASE REPORTS

Valve-Preserving Repair of Traumatic Tricuspid Regurgitation Using the Clover Technique: A Case Report

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ABSTRACT

Introduction: Traumatic tricuspid regurgitation (TR) is a rare complication of blunt chest trauma, often characterized by a long latent period before clinical presentation.
We report the case of a 38-year-old male presenting with severe TR 12 years after a motor vehicle accident. Intraoperative findings revealed a unique longitudinal fissure of the anterior leaflet extending from the annulus to the apex and anterior papillary muscle rupture.
We performed a complex reconstruction by incorporating the anterior papillary muscle into the leaflet, followed by the "Clover technique" to ensure central coaptation.
This hybrid approach allowed for a successful valve-preserving repair, restoring competence in a severely remodeled right ventricle.
Conclusion; Our case mirrors the complex pathology seen in the most difficult scenarios of the Alfieri series, where multiple lesions and RV deterioration preclude classic techniques. By incorporating the papillary muscle into the leaflet, we bridged a massive structural defect that would have otherwise necessitated valve replacement. The subsequent Clover repair provided a functional solution that neutralized the tethering of the posterior and septal leaflets.
Keywords: Tricuspid valve; valve repair; Clover technique; traumatic tricuspid regurgitation; cardiac surgery.

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INTRODUCTION

Tricuspid regurgitation resulting from blunt chest trauma is frequently underdiagnosed due to subtle initial manifestations. Diagnosis often occurs years later when the patient presents with symptoms of right-sided heart failure and its real prevalence is probably underestimated. (1)

The majority of patients described have been treated with valve replacement but, more recently, repair of the native valve is emerging as the treatment of choice. While anatomical reconstructive methods (chordal transposition or papillary reinsertion) are traditional, they often fail in chronic cases due to massive right ventricular (RV) dilatation. (2)

We present a case where a novel functional approach, the Clover technique, was successfully utilized to manage a complex valve defect.

CASE PRESENTATION

A 38-year-old male presented with a 3-month history of progressive dyspnea and palpitations. His medical history was notable for a severe motor vehicle accident 12 years prior. ECG demonstrated a completely right bundle branch block (RBBB) and right axis deviation. Echocardiography revealed severe tricuspid regurgitation with flail leaflets and a pulmonary artery systolic pressure (PASP) of 45 mmHg.

Intraoperatively, through a median sternotomy and right atriotomy, we identified an extensive longitudinal fissure of the anterior leaflet, extending the entire length from the annulus to the free edge (apex) and rupture of anterior papillary muscle.

This was accompanied by chordal rupture and restricted motion of the posterior and septal leaflets due to RV dilatation.

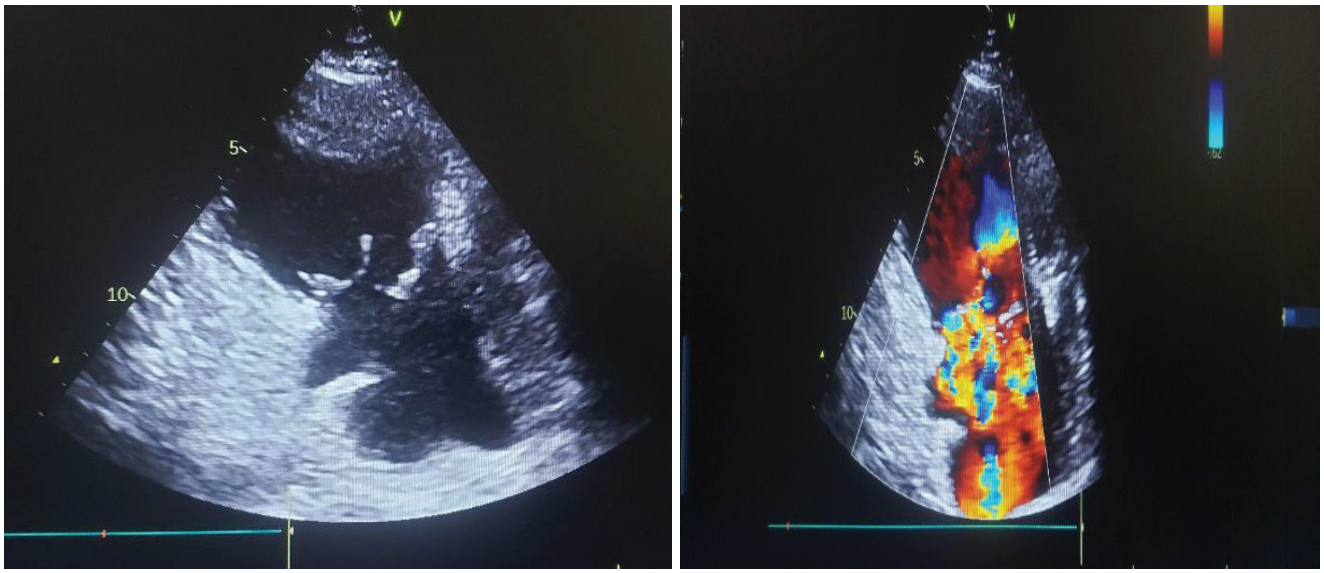

Figure 1. Pre-operative Echocardiographic Assessment.

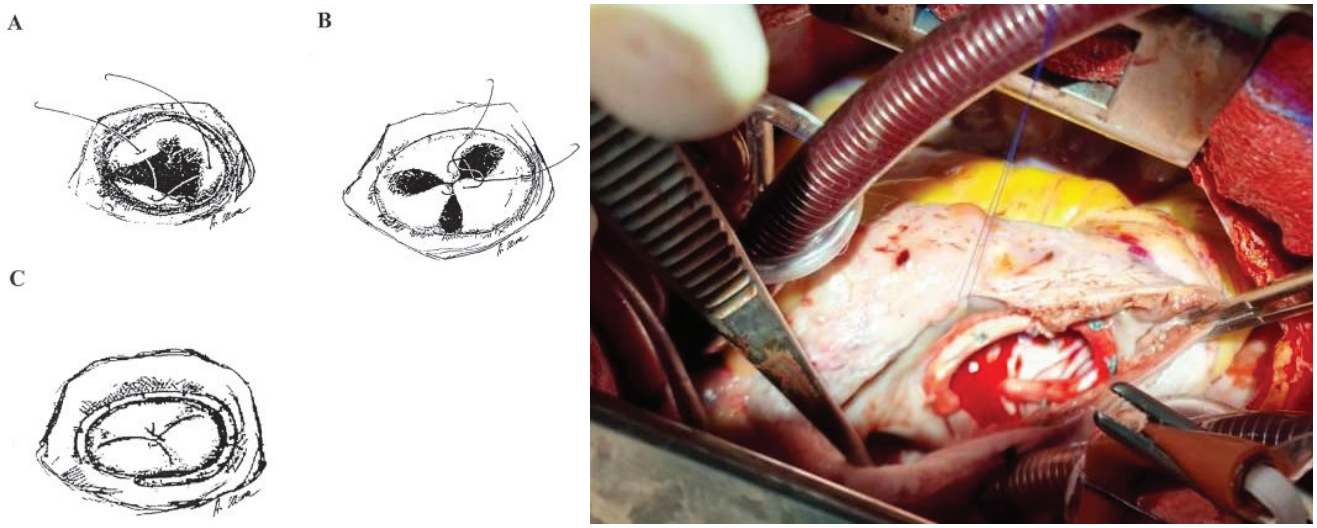

Figure 2. Schematic View of the Clover Technique and Final Intraoperative Result

The repair was performed by first reconstructing the anterior leaflet; the anterior papillary muscle was incorporated directly into the leaflet body using a continuous suture.

Following this, the Clover technique was applied by stitching together the middle points of the free edges of the reconstructed anterior, septal, and posterior leaflets. An Edwards annuloplasty ring (No. 32) was implanted to stabilize the repair.

Postoperative echocardiographic evaluation demonstrated trivial residual regurgitation, a low mean transvalvular gradient of 1.2–1.4 mmHg, and an estimated pulmonary systolic arterial pressure (PSAP) of 35 mmHg.

The postoperative course was uneventful, with no major complications observed. Clinically, the patient remained asymptomatic and was classified as New York Heart Association (NYHA) functional class I. The patient was discharged in good clinical condition on diuretic therapy and oral anticoagulation.

Figure 3. Post-operative Hemodynamic Evaluation: mean postoperative transvalvular gradient was low 1.2 mmHg.

DISCUSSION

Traumatic tricuspid regurgitation is an uncommon but clinically significant consequence of blunt chest trauma and remains one of the most frequently underdiagnosed valvular lesions. Symptoms may develop gradually over several years after the initial injury, leading to delayed diagnosis and progressive right ventricular remodeling. Chronic severe regurgitation results in right ventricular volume overload, annular dilatation, leaflet tethering, and eventual right-sided heart failure, factors that significantly increase the complexity of surgical management. (2)

The underlying mechanism of injury is generally related to a sudden rise in right ventricular pressure during chest compression while the tricuspid valve is closed.

This may produce a wide spectrum of anatomical lesions, including rupture of the chordae tendineae, papillary muscle avulsion, leaflet prolapse, and leaflet tears. Chordal rupture has been reported as the most common lesion, followed by papillary muscle rupture and leaflet injury.

In chronic cases, secondary annular enlargement and right ventricular dysfunction further aggravate valvular incompetence. (3)

Surgical intervention is indicated in symptomatic patients or in those with progressive right ventricular dilatation and dysfunction. Over the last decades, surgical management has progressively shifted toward valve repair instead of valve replacement, particularly in younger patients.

Repair preserves the native valve apparatus and right ventricular geometry while avoiding prosthesis-related complications, including thrombosis, structural valve degeneration, infective endocarditis, and the need for lifelong anticoagulation. (4)

These considerations are especially important in the tricuspid position, where prosthetic valve outcomes remain suboptimal compared with left-sided valve replacement.

Despite these advantages, repair of traumatic tricuspid lesions remains technically challenging because the lesions are often complex and multifactorial. Conventional reconstructive techniques include artificial chordal implantation, papillary muscle reimplantation, commissuroplasty, leaflet resection, and annuloplasty. However, chronic right ventricular remodeling and leaflet tethering may compromise the effectiveness and durability of anatomical reconstruction. (2,4)

Several published series have highlighted the limitations of conventional repair techniques in traumatic tricuspid insufficiency. Richard et al. (5) described nine patients with traumatic tricuspid regurgitation, predominantly caused by anterior papillary muscle rupture, in whom valve repair was feasible in only one patient, whereas the remaining patients ultimately required valve replacement.

Similarly, Holper et al. (6) reported five patients undergoing surgery for traumatic tricuspid insufficiency after a mean interval of more than 13 years from trauma to surgery. Although primary valve reconstruction was initially attempted in several patients, durable repair was achieved in only one case, and most patients eventually underwent prosthetic valve replacement because of persistent regurgitation.

Comparable findings were reported in the Mayo Clinic experience (7), where 13 patients with traumatic tricuspid insufficiency underwent surgical treatment. Valve repair was considered feasible in only 38% of cases, while the majority required valve replacement. These studies underline the technical difficulty of conventional anatomical repair, particularly in longstanding lesions associated with severe annular dilatation and right

ventricular enlargement.

In the present case, repair was preferred over replacement because of the patient's young age and the potential benefits of preserving native valve function. The clover technique was chosen as a functional repair strategy to improve leaflet coaptation despite the complexity of the lesion and the presence of annular dilatation.

Unlike purely anatomical reconstruction, this approach focuses on restoring valvular competence through central leaflet approximation, thereby reducing the impact of leaflet tethering and distorted subvalvular anatomy.

The immediate postoperative result was satisfactory, with postoperative echocardiography demonstrating trivial residual regurgitation, a low mean transvalvular gradient of 1.2–1.4 mmHg, and no evidence of significant functional stenosis. Clinically, the patient had an uneventful postoperative recovery and remained asymptomatic in NYHA functional class I.

Although long-term follow-up data remain limited because of the rarity of traumatic tricuspid regurgitation, current evidence suggests that reparative strategies should be preferred whenever technically feasible. Functional techniques such as the clover repair may provide favorable outcomes in complex traumatic lesions, particularly in patients with chronic right ventricular remodeling where conventional anatomical repair may be insufficient. Larger studies and longer follow-up are necessary to better define the durability and long-term performance of these reconstructive approaches.

CONCLUSION

As noted in the preliminary experience of Alfieri et al. (1), the frequency of this disease is likely underestimated. Our case mirrors the complex pathology seen in the most difficult scenarios of the Alfieri series, where multiple lesions and RV deterioration preclude classic techniques.

By incorporating the papillary muscle into the leaflet, we bridged a massive structural defect that would have otherwise necessitated valve replacement.

The subsequent Clover repair provided a functional solution that neutralized the tethering of the posterior and septal leaflets. For young, active patients, this valve-preserving approach is superior as it avoids the 20-30% complication rate associated with tricuspid prostheses and eliminates the need for long-term anticoagulation.

It allows surgeons to restore valve competence in the presence of severe RV remodeling, offering a durable alternative to valve replacement.

Editorial Statements

Ethics Approval and Consent to Participate

This study involved the analysis of data from human participants. The research protocol was reviewed and approved by the Institutional Ethics Committee and was conducted in accordance with institutional regulations, the principles of the Declaration of Helsinki, and internationally accepted standards for biomedical research ethics.

Data Availability Statement

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Author Contributions (CRediT): Conceptualization & Methodology: FM; Data Curation, Investigation and Writing – Original Draft: KK, ML: Formal Analysis: AV: Writing – Review & Editing: KK: Supervision: FM. All authors have read and approved the final version of the manuscript.

Artificial Intelligence (AI) Statement

The authors used a generative artificial intelligence tool solely for language editing and grammar improvement. All scientific content, data analysis, interpretation, and conclusions were independently developed, verified, and approved by the authors.

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