



# Chordae Tendineae Approximation Technique for Severe Tricuspid Regurgitation with Severe Leaflet Tethering Using a Totally Endoscopic Beating-Heart Strategy: A Case Report

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Untreated severe tricuspid regurgitation (TR) is associated with poor outcomes. Functional TR occurs secondary to dilatation of the annulus and tethering of the leaflets. Ring annuloplasty alone can correct most cases, but is insufficient in cases of severe annular dilatation due to severe leaflet tethering. In such cases, a tricuspid edge-to-edge technique may be an option. However, stitching of the leaflet tips alone is likely to result in tearing of the leaflets. Approximation of the durable chordae tendineae is considered helpful for this problem. Herein, we present the case of a 39-year-old man who had undergone open-heart surgery for acute type A aortic dissection 13 months earlier. A right mini-thoracotomy approach with a beating-heart strategy was used, which did not require unnecessary pericardial adhesiolysis and dissection. This technique had the advantage of reducing the operation time and the risk of bleeding. To summarize, we present a case of tricuspid valve repair in a high-risk patient with severe leaflet tethering that was successfully managed using these methods.

**Keywords:** Tricuspid valve insufficiency, Edge-to-edge repair, Minimally invasive cardiac surgery, On-pump beating cardiac surgery, Case report

## Case report

A 39-year-old man diagnosed with severe tricuspid regurgitation (TR) and dyspnea was admitted to Asan Medical Center. He had undergone ascending aorta and total arch replacement, valve-sparing aortic root reimplantation, and coronary artery bypass grafting (CABG) for acute type A aortic dissection with coronary malperfusion 13 months earlier. Echocardiography revealed severe TR secondary to severe annular dilatation and leaflet tethering. The right ventricular contractility was decreased with an ischemic insult to the right coronary artery territory. Computed tomography revealed a patent previous CABG graft crossing the mediastinum and thick peri-aortic tissue growth, suggesting severe pericardial adhesion (Fig. 1). To avoid damaging the heart and injuring the CABG graft, we performed on-pump beating tricuspid valve repair via a totally endoscopic right mini-thoracotomy approach using a 3-dimensional endoscope system (IMAGE1 S 3D Full-HD Video Endo-

scope System; Karl Storz SE & Co. KG, Tuttlingen, Germany).

Under general anesthesia with double-lumen intubation, cardiopulmonary bypass (CPB) was established by cannulating the right internal jugular vein and femoral vessels as described previously [1]. A 4-cm mini-thoracotomy (working port) and a separate 10-mm trocar incision was made. Under CPB support, the right atrium (RA) and its attached pericardium were opened together without adhesiotomy. The superior vena cava (SVC) was occluded using a small sponge at the SVC-RA junction, and the inferior vena cava was opened using vacuum-assisted venous drainage.

Annular dilatation and leaflet tethering were severe, so the saline test was useless. Thus, ring annuloplasty was performed first and the leaflet function was rechecked. Annuloplasty was performed in a usual manner using a 32-mm MC3 ring (Edwards Lifescience, Irvine, CA, USA) with titanium fasteners. Even after ring annuloplasty, the anterior leaflet tethering was so severe that it looked like the leaflet would tear with the usual edge-to-edge method.



Therefore, after grasping the anterior and posterior chordae, they were tied together using a Gore-Tex CV-4 suture (W.L. Gore & Associates Inc., Flagstaff, AZ, USA) (Fig. 2, Supplementary Video 1). The chordae approximation was made in a shape like a flower bouquet. The saline test showed residual leakage from the prolapsed posterior leaflet, so clover (edge-to-edge) repair was added.

Postoperative echocardiography showed mild TR (grade 1), and on color Doppler ultrasonography, there was no

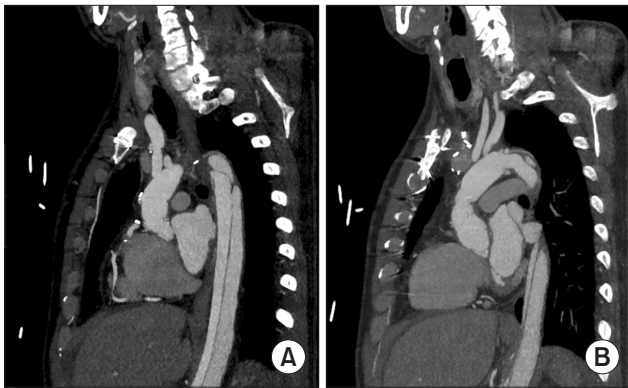
significant stenotic component, with a diastolic peak and mean pressure gradient of 11 mm Hg and 5 mm Hg, respectively. The patient's postoperative course was uncomplicated, and he was discharged on postoperative day 5.

We obtained informed consent form from the patient for publication of his clinical details in a case report.

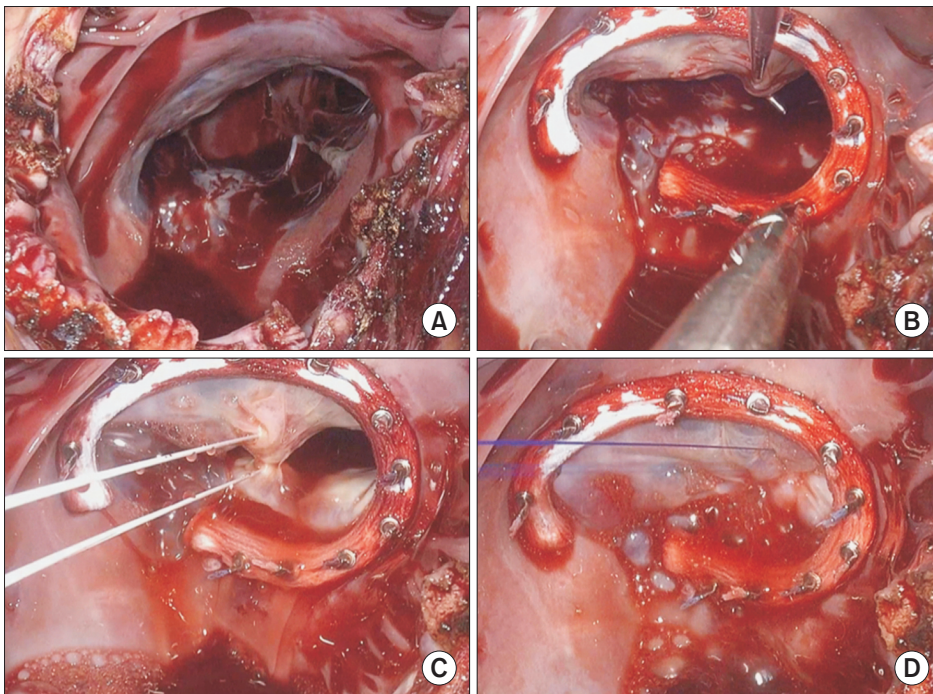
## Discussion

The most common type of tricuspid valve pathology is functional TR, which occurs secondary to dilatation of the tricuspid annulus and tethering of the leaflets caused by right ventricular enlargement. Untreated severe TR is associated with poor outcomes and a high mortality rate. Likewise, tricuspid valve surgery is associated with a poor prognosis. For these reasons, TR is usually treated medically first, and surgery is performed at a later stage after the deterioration of right ventricular function.

As annuloplasty alone is insufficient for the complex lesions in severe TR, valve replacement is frequently needed. However, according to observational data, right ventricular failure and ensuing hemodynamic compromise were common after tricuspid valve replacement [2]. Therefore, instead of valve replacement, repair of the leaflet prolapse has been recommended because of more favorable clinical outcomes. As another technique, edge-to-edge leaflet repair is a method of stitching the free edges of the leaflets,



**Fig. 1.** (A, B) Computed tomography revealed a patent previous coronary artery bypass graft crossing the mediastinum and thick peri-aortic tissue growth suggesting severe pericardial adhesion. An informed consent form for publication of the image was obtained from the patient.



**Fig. 2.** The anterior and septal chordae tendineae are grasped together to approximate the leaflets using a Gore-Tex suture to reduce the computation gap. An informed consent form for publication of the image was obtained from the patient.

thereby achieving leaflet coaptation in the presence of tethering. This technique is chosen for degenerative disease with leaflet tethering or prolapse or when there is residual TR after annuloplasty [3]. It can be performed easily, even on a beating heart without an aortic cross-clamp. This technique permits manipulation of only the leaflets, without distorting the right ventricle geometry and performing annuloplasty. For these reasons, a previous study showed that the edge-to-edge leaflet repair technique had favorable outcomes for TR [4].

However, if leaflet tethering is severe, the edge-to-edge method of stitching the leaflet tips alone is highly likely to result in tearing of the leaflets because of tension. In this case, the method of approximation of the durable chordae tendineae with the clover technique has been thought to help reduce the risk of tear.

Several transcatheter devices are currently used to repair the tricuspid valve. These spiral-shaped devices are used to grasp and approximate the chordae tendineae to form a “bouquet” shape. The concept of these devices is similar to that of the chordae approximation technique, but these devices do not affect the valve leaflets or annulus [5].

In this case, the patient was at high risk for redo surgery. Previous reports indicated that the minimally invasive, beating-heart technique was better in redo tricuspid valve operations [6]. With this strategy, there is no need for aortic cross-clamping, thereby avoiding the need for peri-aortic dissection for cannulation, and it can be performed without touching the CABG graft. In addition, the beating-heart technique helps reduce ischemic reperfusion injury and protects the myocardium. In this case, there was no need for adhesiolysis because right atriotomy including the pericardium was performed. Moreover, the bleeding risk is minimized, and any bleeding that does occur can be controlled quickly because the right atriotomy site is the only possible source of bleeding.

In conclusion, minimally invasive, totally endoscopic, beating-heart tricuspid valve repair with a combination of the edge-to-edge repair and chordae tendineae approximation techniques can be performed easily and quickly for high-risk patients with TR and severe leaflet tethering.

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## Conflict of interest

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## Supplementary materials

Supplementary materials can be found via <https://doi.org/10.5090/jcs.22.077>. **Supplementary Video 1.** Totally endoscopic chordae tendineae approximation on the beating-heart.

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