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CASE REPORT

INTERMEDIATE

CLINICAL CASE SERIES: PCR TRICUSPID

A Stepwise Approach for Transcatheter Edge-to-Edge Repair in Very Advanced Tricuspid Regurgitation

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ABSTRACT

Transcatheter edge-to-edge repair (TEER) is the most widely used approach for tricuspid regurgitation in patients with prohibitive surgical risk. However, TEER might not be feasible in advanced tricuspid regurgitation. In such cases, a stepwise approach with initial annuloplasty and subsequent TEER can be a worthwhile alternative, which is reported in this series. (**Level of Difficulty: Intermediate.**) (J Am Coll Cardiol Case Rep 2023;16:101874) © 2023 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

CASE 1

An 82-year-old woman with history of permanent atrial fibrillation and arterial hypertension presented to our clinic with progressive dyspnea on exertion (NYHA functional class III). She had no clinical signs of congestion on a stable dose of diuretic agents (torsemide 10 mg). Transthoracic echocardiography (TTE) showed a "torrential" tricuspid regurgitation (TR) (VC biplane 14 mm, effective regurgitant orifice area [EROA] proximal isovelocity surface area 1.3 cm^2, regurgitant volume [RVol] 95 mL) with a large coaptation gap with good systolic left and right ventricular function, moderate aortic regurgitation, and no other relevant abnormalities.

LEARNING OBJECTIVES

- To understand the role of thorough echocardiographic assessment for tailoring treatment options in TR.
- To highlight the possibility of a stepwise approach for the treatment of advanced TR.

Right heart catheterization showed isolated postcapillary pulmonal hypertension (mean pulmonary artery pressure 23 mm Hg, pulmonary capillary wedge pressure 18 mm Hg, and pulmonary vascular resistance 1.5 WU), most likely caused by heart failure with preserved ejection fraction secondary to hypertensive heart disease.

Transesophageal echocardiography confirmed torrential functional TR (grade 5 of 5) with a large gap of 8 mm and a restrictive septal leaflet unfavorable for tricuspid transcatheter edge-to-edge repair (TEER) (**Figure 1A**, Video 1).

Because the patient was at high surgical risk (TRI-SCORE 4 of 12, 8%), our heart team decided to go for a stepwise approach with an initial percutaneous annuloplasty with the Cardioband system (Edwards Lifesciences) and the option of subsequent TEER

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ABBREVIATIONS AND ACRONYMS

EROA = effective regurgitant orifice area

LVEF = left ventricular ejection fraction

MR = mitral regurgitation

RVol = regurgitant volume

TEER = transcatheter edge-to-edge repair

TR = tricuspid regurgitation

TTE = transthoracic echocardiography

VC = vena contracta

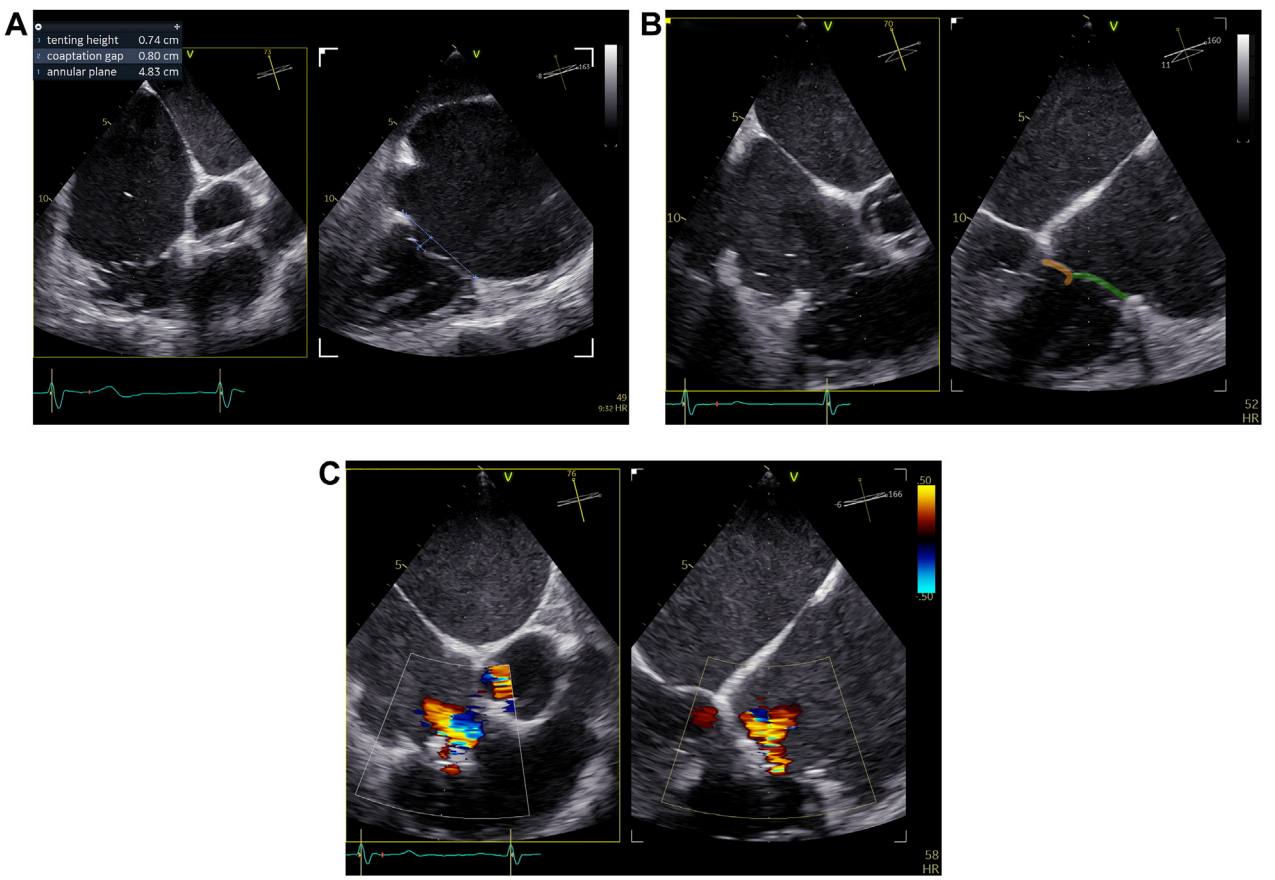
(Supplemental Figure 1, Video 2). A reduction in TR was achieved from torrential (5 of 5) to severe (3 of 5) (Video 3) and the big gap was almost closed (**Figure 1B**, Supplemental Figure 2).

We evaluated the patient after 5 months. Although she reported better exercise tolerance, she remained symptomatic with onset of leg edema so that the dose of diuretic agents had to be increased. Follow-up TTE revealed severe residual TR (vena contracta [VC] biplane 13 mm, EROA 0.4 cm^2, RVol 53 mL). Therefore, we decided to proceed with the TEER procedure using the Pascal Ace device (Edwards Lifesciences) and a classical 3-orifice technique (Video 4) with the insertion of 2 Pascal devices: one anteroseptally (8- to 2-o'clock orientation on transgastric view) and the other posteroseptally (9- to 3-o'clock orientation on transgastric view). TR was reduced to a mild degree (**Figure 1C**, Video 5) with a residual gradient across the tricuspid valve of 3 mm Hg after the combined procedure. At the 12-month follow-up, the patient was doing well with improved symptoms and a stable result on TTE.

CASE 2

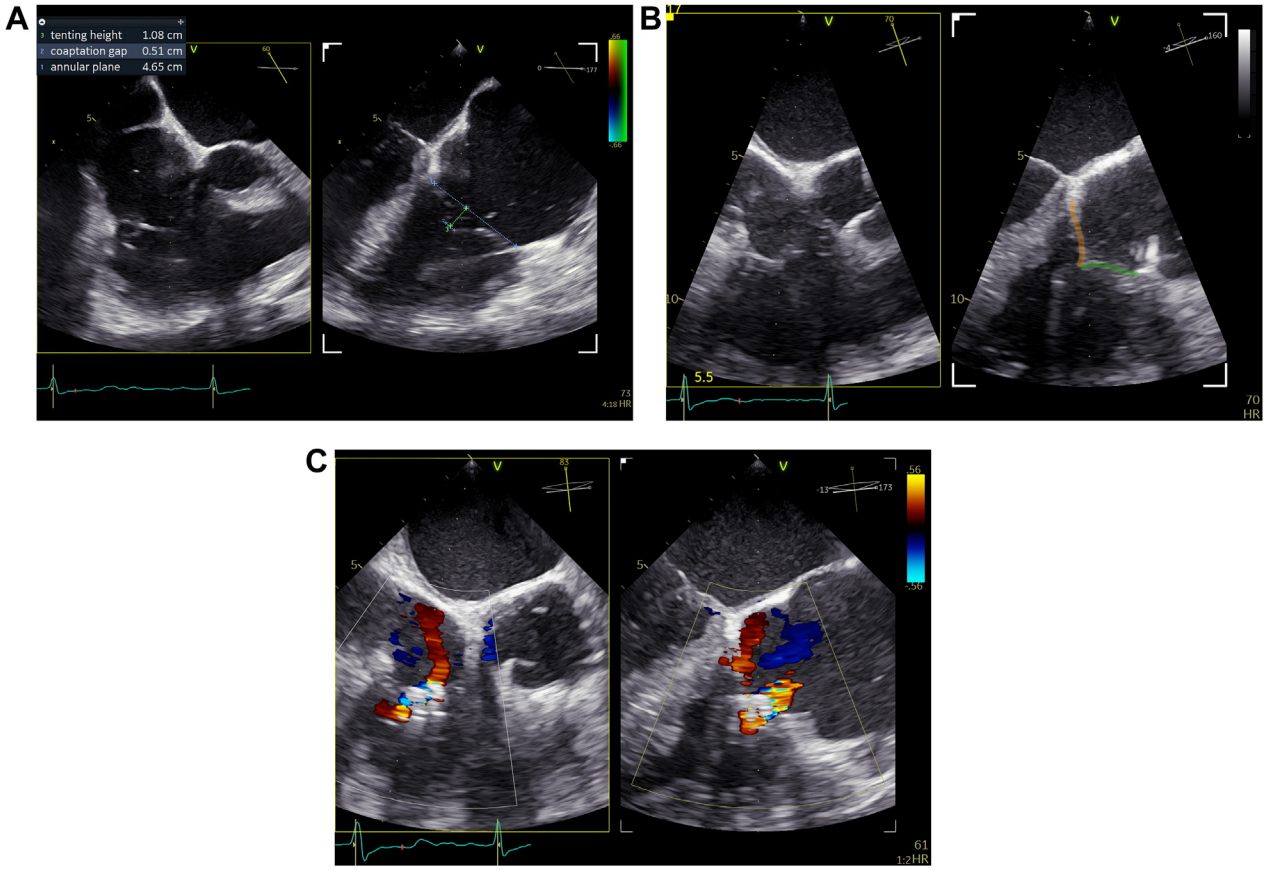
An 81-year-old man presented to our hospital 2 years ago with increasing peripheral edema and worsening dyspnea (NYHA functional class III). He had a history of coronary artery disease treated with coronary artery bypass graft 22 years ago, permanent atrial fibrillation with direct oral anticoagulation, and

FIGURE 1 Periprocedural Images of Case 1



(A) Initial transesophageal echocardiography (TEE) showing a coaptation gap with a restriction of the septal leaflet and mild tenting. **(B)** Postprocedural TEE (annuloplasty) showing a reduction of gap with a restrictive septal leaflet. **(C)** TEE after transcatheter edge-to-edge repair showing a good result, with only mild residual tricuspid regurgitation.

FIGURE 2 **Periprocedural Images of Case 2**



(A) Initial transesophageal echocardiography: biplane view showing a coaptation gap and moderate leaflet tenting. **(B)** Transesophageal echocardiography showing good gap reduction after annuloplasty (septal **[orange]** and lateral **[green]** leaflets). **(C)** Follow-up TTE showing only mild TR.

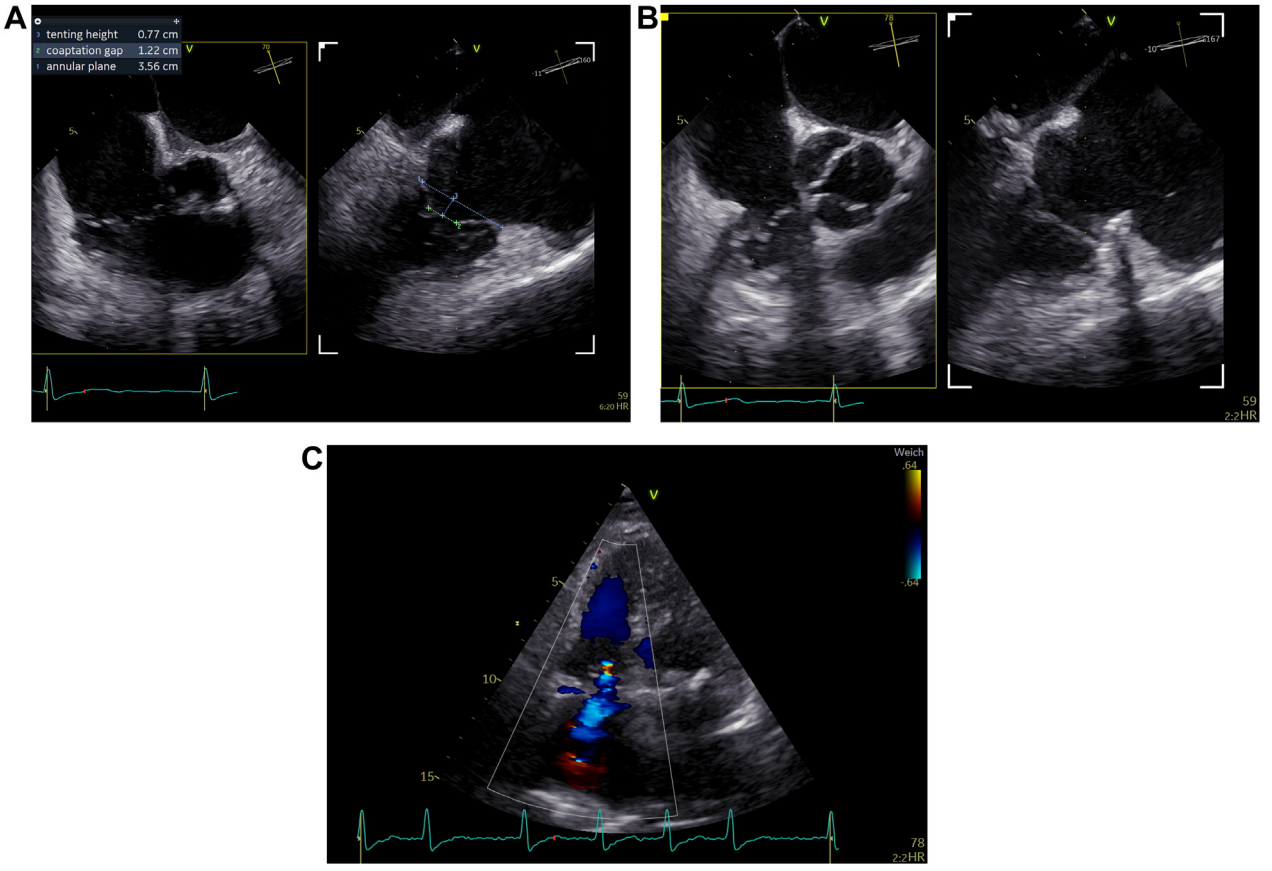
chronic kidney disease (grade 3b; glomerular filtration rate ~34 mL/min).

TTE showed a mildly reduced left ventricular ejection fraction (LVEF) (50%), moderate secondary mitral regurgitation (MR), and massive functional TR. Transesophageal echocardiography was performed after treatment with intravenous loop diuretic agents with decongestion and subsequent weight loss of 4 kg. This showed only moderate MR but still a massive TR (grade 4 of 5, VC biplane 17 mm, EROA 0.7 cm^2, RVol 67 mL) with a septolaterally measured coaptation gap of 5 mm (**Figure 2A**, Video 6).

Coronary angiography showed stable disease with intact bypass vessels. Right heart catheterization showed isolated postcapillary pulmonary hypertension caused by slightly reduced LVEF, moderate MR, and atrial fibrillation. After discussion in the heart team, a decision for interventional treatment was recommended based on the prohibitive surgical risk (Society of Thoracic Surgeons 8%; TRI-SCORE 8 of 12, 48%). Because of the borderline coaptation gap with tethering of the septal leaflet, we decided against TEER. However, despite tethering of the septal leaflet, there was no excessive tenting of the entire valve, thus we decided to perform a percutaneous annuloplasty. The procedure was performed after 3 months, and the severity of TR decreased from grade 4 to grade 1 (**Figure 2B**, Video 7).

Unfortunately, TR relapsed over time, probably because of the persistent tethering of the septal leaflet, and the patient was readmitted with cardiac decompensation 3 months later. TTE showed severe TR (grade 3 of 5). After decongestion and optimization of diuretic therapy, follow-up showed persistent severe TR (grade 3 of 5, VC biplane 9 mm, EROA 0.5 cm^2, RVol 50 mL) (Video 8, Supplemental Figure 3).

FIGURE 3 Periprocedural Images of Case 3



(A) Initial transesophageal echocardiography: biplane view showing a big coaptation gap and a moderate tenting. **(B)** Transesophageal echocardiography biplane view showing improved coaptation of the tricuspid valve.**(C)** Follow-up transthoracic echocardiography showing only mild tricuspid regurgitation.

In addition, the patient had persistent dyspnea (NYHA functional class III). Therefore, we decided to treat this TR with TEER. Two devices were placed in a central position posteroseptally (Supplemental Figure 4) with a significant reduction of TR to grade 1 (**Figure 2C**, Video 9).

At the 14-month follow-up, the patient was doing well with only mild dyspnea (NYHA functional class II). TTE showed only a mild residual TR with no relevant stenosis (mean trans-tricuspid pressure gradient 2.5 mm Hg).

CASE 3

An 84-year-old woman with a history of isolated mitral valve replacement 1 year previously caused by severe primary MR presented with worsening dyspnea (NYHA functional class III) and leg edema. TTE showed preserved LVEF (55%) with a good function of the biological mitral valve prosthesis (mean pressure gradient of 3 mm Hg) with no MR. However, torrential (5 of 5) TR (Video 10) was evidenced (VC biplane 21 mm, EROA 1.4 cm^2, RVol 86 mL) with a large coaptation gap of 12 mm and moderate tenting (**Figure 3A**). Preoperative TTE performed 1 year previously had shown only moderate TR with a tricuspid valve annulus diameter of 39 mm. Right heart catheterization showed isolated postcapillary pulmonary hypertension caused by valvular heart disease.

The patient had a EuroSCORE (European System for Cardiac Operative Risk Evaluation) II of 11% and the TRI-SCORE was 4 of 12, 8%. In addition, because of the large gap, we decided against TEER. We performed a percutaneous tricuspid annuloplasty with an initial reduction from grade 5 to grade 3 (Video 11) and good gap reduction (**Figure 3B**). At the 1-month

follow-up, there was only moderate TR (grade 2 of 5) (Supplemental Figure 5), and after 1 year TR had improved to mild (grade 1 of 5) (**Figure 3C**, Video 12) with marked reductions in right ventricular diameters. Clinically, she had improved to NYHA functional class I and was doing well.

EXPERT TIPS

In cases of advanced TR, a stepwise approach of transcatheter or surgical annuloplasty followed by TEER can extend the spectrum of patients able to access transcatheter tricuspid therapy. Annuloplasty could be performed as the first step, and close follow-up should determine whether subsequent TEER is required and feasible. Even when the anatomy is suboptimal for annuloplasty, the leaflet approximation provided by annuloplasty facilitates TEER, thereby providing more reliable results in advanced cases than TEER alone.

DISCUSSION

This case series highlights several issues that are relevant for the treatment of patients with advanced TR. In patients with extensive annular dilation and large coaptation gaps that are not amenable to TEER, tricuspid annuloplasty represents a valuable treatment option and may provide durable TR reduction as a stand-alone therapy, only if there is mild to moderate leaflet tenting.[1] As endorsed in the state-of-the-art paper on transcatheter tricuspid interventions,[1] severe tenting was defined as a tenting height of >1.0 cm, measured from the leaflet tips to the annular plane performed at mid-systole. Surgical experience has shown that the degree of valve tenting correlated not only with TR severity and right ventricular dilatation, but also with persistent or recurrent TR after surgical repair.[2] As such, an annuloplasty repair is less likely to treat this particular pathophysiology and additional techniques, such as leaflet augmentation or even valve replacement, should be considered.[3] The same concept applies for transcatheter treatments: in patients with advanced tricuspid disease and more than moderate leaflet tenting, annuloplasty alone would not be sufficient. However, a staged approach of annuloplasty with consequent TEER could prove to be a valuable option. It is also important to note that additional factors, such as concomitant mitral and aortic disease, pulmonary pressure, atrial fibrillation, and, most importantly, right ventricular size and function, play an important role in determining the most appropriate treatment strategy and the success or failure of initial treatment with annuloplasty. Therefore, comprehensive assessment that takes all these factors into account is essential for good treatment decision making.

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APPENDIX For supplemental figures and videos, please see the online version of this paper.