

# Multidisciplinary heart team approach with laser lead extraction and transcatheter tricuspid valve-in-valve replacement



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## Introduction

Patients who undergo tricuspid valve replacement (TVR) are often complex and have multivalvular disease. These patients often require pacemaker placement owing to postoperative heart block. Over time, bioprosthetic valves degenerate, warranting replacement. Off-label use of a transcatheter valve to replace a degenerated bioprosthetic valve in the tricuspid position has been reported previously in patients who are at high risk for surgical reintervention. We report a complex case of a pacemaker-dependent patient with severe tricuspid regurgitation in a degenerated bovine TVR complicated by pacemaker lead impediment.

## Case report

The patient is a 67-year-old man with a history of permanent atrial fibrillation as well as mitral and tricuspid rheumatic valvular disease. He underwent concomitant mechanical mitral valve replacement (#31, St. Jude) and bioprosthetic TVR (#33, Carpentier-Edwards) 20 years ago. His postoperative course at the time was complicated by complete heart block requiring placement of a single-chamber permanent pacemaker (Medtronic, Minneapolis, MN). He presented to the emergency department with worsening shortness of breath and progressive peripheral edema. His physical exam was significant for jugular venous distension, a holosystolic murmur at the left lower sternal border, and bilateral 3+ pitting peripheral edema. Initial laboratory tests revealed an international normalized ratio level of 8.9, a creatinine of 1.65, and a pro-BNP of 955. A transthoracic echocardiogram was performed and revealed severe regurgitation of the bioprosthetic tricuspid valve, a severely dilated right atrium, and a moderately dilated right ventricle (RV). Left ventricular

## KEY TEACHING POINTS

- Management of severe tricuspid regurgitation in the presence of a degenerative bioprosthetic valve and pacing lead impediment is complex and requires a multidisciplinary heart team approach.
- The use of novel transcatheter tricuspid valve-in-valve replacement in patients with a degenerated bioprosthetic valve at high risk for reoperation should be considered.
- Transvenous lead extraction can be performed safely, even with 20-year-old leads, in experienced centers in preparation for transcatheter tricuspid valve-in-valve replacement to avoid trapping of the lead.

function was normal with an ejection fraction of 55%–60%, and the mechanical mitral valve had normal function. Subsequently, a transesophageal echocardiogram (TEE) was performed. It showed severe tricuspid valve regurgitation with a degenerated bioprosthetic valve and septal leaflet impingement by the ventricular pacing lead (Figures 1 and 2). TEE again revealed normal function of the mechanical mitral valve. Right heart catheterization revealed an elevated right atrial pressure of 26 mm Hg, pulmonary artery pressure of 55/22 mm Hg with a mean of 34 mm Hg, and normal cardiac output and index.

Cardiothoracic surgery was consulted to evaluate the patient for a reoperative TVR. Given the previous surgery and his current condition, the patient's surgical risk was deemed to be high. A multidisciplinary heart team recommended RV lead extraction followed by percutaneous transcatheter TVR.

The patient was brought to the hybrid operating room after improvement in his volume status and correction of his

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international normalized ratio. He underwent placement of a left ventricular epicardial lead by cardiothoracic surgery via a small left thoracotomy. The lead was tunneled to the existing pacemaker pocket in the left anterior chest wall. The epicardial lead was connected to a new pulse generator (Medtronic, Minneapolis, MN). Next, the right common femoral vein was accessed using ultrasound guidance and a 12F peel-away sheath was inserted. A super-stiff guidewire was advanced to the right internal jugular vein for placement of a superior vena cava rescue balloon if needed during lead extraction. The RV lead (Medtronic 5023) was disconnected from the old pulse generator and prepped for extraction. An EZ locking stylet (Philips, Cambridge, MA) was placed down the lumen of the RV lead. A 14F laser sheath (Philips) was prepped and used to extract the RV lead without any complications (Figure 3). Intraoperative TEE revealed persistent severe tricuspid regurgitation after extraction.

Next, the right femoral venous sheath was exchanged for an Agilis sheath (Abbott, Abbot Park, IL). The Agilis sheath was used to direct the soft exchange wire through the bioprosthetic tricuspid valve and into the RV. A pigtail catheter was inserted over the soft exchange-length wire and directed to the RV apex, then exchanged for an Amplatz Super Stiff wire. The sheath was upsized to a 26F Gore Dry-Seal (Gore Medical, Flagstaff, AZ). A Sapien 3 Ultra valve (Edwards, Irvine, CA) was prepped and inserted over the Amplatz wire and successfully positioned in the existing bioprosthetic tricuspid valve. Prior to deployment of the valve, rapid pacing was performed at a heart rate of 150 beats per minute, via the permanent pacemaker, to stabilize the valve in the proper position. The valve than was deployed slowly under TEE and fluoroscopy guidance in the intended position (Supplemental Figures S1 and S2). TEE revealed optimal positioning and no intravalvular or paravalvular regurgitation. At the conclusion of the procedure the sheath was removed, and a mattress suture was applied along with 10 minutes of manual compression to achieve hemostasis.

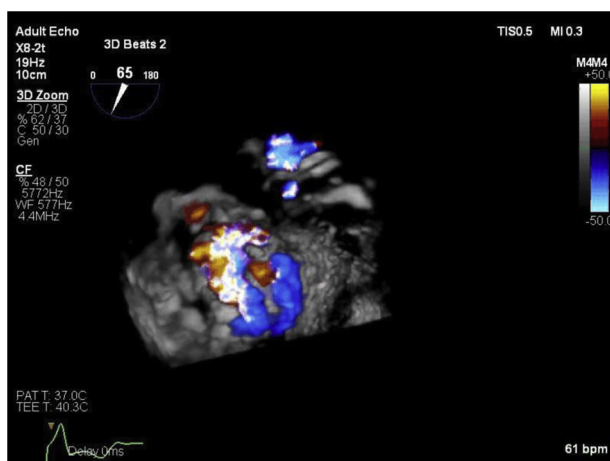
He was subsequently seen 1 month later in clinic. His follow-up echocardiogram showed trace tricuspid regurgitation. The patient was successfully weaned off diuretics without further episodes of heart failure in the following 6 months.

## Discussion

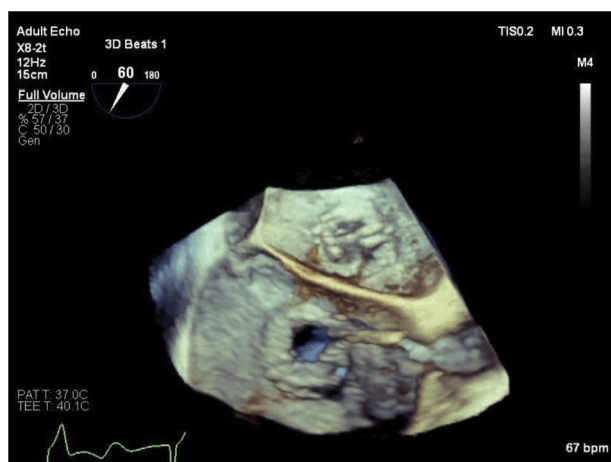
Historically, the anatomic features of a degenerative tricuspid valve have been considered unsuitable for repair, with surgical valve replacement being the treatment of choice when intervention is indicated. Bioprosthetic valves are preferred over mechanical valves in the tricuspid position for many reasons, including the requirement for high-level systemic anticoagulation and elevated risk for thrombosis of mechanical valves.<sup>1</sup> The deterioration rate of a bioprosthetic valve is estimated at 1.7% per year,<sup>2</sup> with 10%–22% of bioprosthetic valves requiring reoperation at 9 years.<sup>3</sup> The perioperative mortality of redo tricuspid valve surgery is reported at 13%–27%.<sup>4</sup> In addition, 5.8% of patients develop heart block and require placement of a pacemaker following TVR.<sup>5</sup> Preoperative active endocarditis, preexisting left bundle branch block, same-time multiple valve intervention, pulmonary hypertension, and reoperation are considered risk factors for developing postoperative heart block.<sup>6</sup>

Over the past 50 years, multiple studies have shown an association between device lead presence and tricuspid regurgitation, with a reported range of 7%–45% of patients developing tricuspid regurgitation following lead implantation.<sup>7,8</sup> Risk factors for development of tricuspid regurgitation post lead placement include leaflet perforation, leaflet impingement, lead adherence, and lead entanglement in the valve apparatus.<sup>9</sup> Some experts have advocated for usage of the prolapsing technique during lead implantation to decrease risk of trauma and damage to the tricuspid apparatus, resulting in less tricuspid regurgitation,<sup>10</sup> though data for its use and prevention of tricuspid regurgitation is lacking. The development of lead-related severe tricuspid regurgitation is associated with about 40%–75% mortality when left untreated.<sup>11,12</sup>

The management of lead-related tricuspid regurgitation depends on the severity of tricuspid regurgitation, the extent of lead-related valvular damage, the degree of annular dilatation, the presence of RV heart failure, and the degree of RV dysfunction. Distinguishing lead-related tricuspid regurgitation from secondary functional tricuspid regurgitation is challenging and often impossible, complicating management and outcomes. Conservative management with diuretics is considered the mainstay of therapy, though data regarding long-term outcomes are lacking. To date, no guideline support exists for lead extraction in lead-related severe tricuspid regurgitation. Lead extraction is considered an important intervention when operative risk is low, and the mechanism of tricuspid regurgitation is thought to be related to the lead, especially given the high rate of mortality in patients that are left untreated. However, lead extraction can further



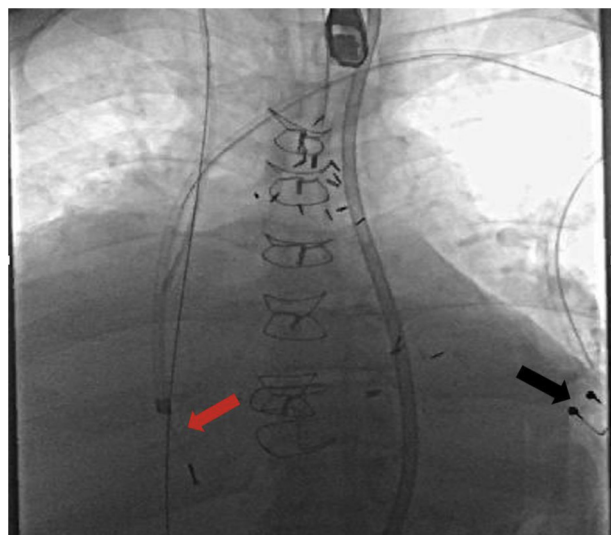
**Figure 1** Transesophageal echocardiogram showing severe bioprosthetic tricuspid valve regurgitation.



**Figure 2** Transesophageal echocardiogram 3-dimensional image showing the right ventricular pacemaker lead laying against the septal leaflet.

damage the tricuspid valve and lead to worsening tricuspid regurgitation. The timing and indication for surgical intervention remains open to debate.

Transcatheter tricuspid valve-in-valve replacement has been shown to be feasible in different age groups and a variety of valve sizes. Perioperative and 30-day mortality is reported at 3%,<sup>13</sup> with excellent valve durability at 15.9 months. In our patient, valve degeneration was complicated by pacemaker lead placement and pacemaker dependence. Minimally invasive epicardial lead placement, coupled with transvenous lead extraction, allowed for successful tricuspid valve-in-valve replacement. Though jailing of the current lead could be considered with valve-in-valve replacement, alleviating the need for extraction, the risk of chronic lead infection, valve infection, and inability to extract in the future



**Figure 3** Fluoroscopy image showing the epicardial left ventricular lead (black arrow) and the laser sheath with the removed right ventricular lead (red arrow).

would not be ideal in a nonsurgical patient. Finally, the placement of a leadless pacemaker instead of an epicardial system was considered in this pacemaker-dependent patient with permanent atrial fibrillation. However, given concerns of dislodging the leadless pacemaker by the interventional cardiology team, the decision was made to proceed with an epicardial system. Since, we have successfully placed leadless pacemakers in similar cases without leadless pacemaker dislodgment. The use of a leadless pacemaker is more ideal as compared to the use of an epicardial system, given the limited longevity of epicardial leads and the need for thoracotomy for lead placement.

## Conclusion

Tricuspid valve disease is difficult to manage, especially after valve replacement and concurrent lead presence. Bioprosthetic valve failure in this population is challenging and requires a multidisciplinary heart team approach. Transvenous lead extraction can be performed safely, even with 20-year-old leads, in experienced centers. The off-label use of transcatheter valve replacement of a bioprosthetic valve in the tricuspid position is considered safe and feasible, with excellent mid-term results based on current registry data. Proper patient selection, careful preplanning with multimodality imaging, and a multidisciplinary heart team approach including cardiac surgery, electrophysiology, and structural cardiology are of paramount importance to achieve a favorable outcome in a patient with a complex clinical scenario.

## Appendix

### Supplementary data

Supplementary data associated with this article can be found in the online version at <https://doi.org/10.1016/j.hrcr.2021.11.013>.

## References

- Liu P, Qiao WH, Sun FQ, et al. Should a mechanical or biological prosthesis be used for a tricuspid valve replacement? A meta-analysis. *J Card Surg* 2016; 31:294–302.
- Rizzoli G, Vendramin I, Nesseris G, et al. Biological or mechanical prostheses in tricuspid position? A meta-analysis of intra-institutional results. *Ann Thorac Surg* 2004;77:1607–1614.
- Guenther T, Noebauer C, Mazzitelli D, et al. Tricuspid valve surgery: a thirty-year assessment of early and late outcome. *Eur J Cardiothorac Surg* 2008;34:402–409. discussion 409.
- Jaganathan R, Armstrong S, Al-Alao B, Tirone D. The risk and outcomes of reoperative tricuspid valve surgery. *Ann Thorac Surg* 2013;95:P119–P124.
- Herrmann FEM, Graf H, Wellmann P, Sadoni S, Hagl C, Juchem G. Atrioventricular block after tricuspid valve surgery. *Int Heart J* 2021;62:57–64.
- Herrmann FEM, Graf H, Wellmann P, Sadoni S, Hagl C, Juchem G. Etiology of tricuspid valve disease is a predictor of bradyarrhythmia after tricuspid valve surgery. *J Cardiovasc Electrophysiol* 2019;30:1108–1116.
- Nath J, Foster E, Heidenreich PA. Impact of tricuspid regurgitation on long-term survival. *J Am Coll Cardiol* 2004;43:405–409.
- Al-Bawardy R, Krishnaswamy A, Bhargava M, et al. Tricuspid regurgitation in patients with pacemakers and implantable cardiac defibrillators: a comprehensive review. *Clinical Cardiol* 2013;36:249–254.
- Addetia K, Harb SC, Hahn RT, Kapadia S, Lang RM. Cardiac implantable electronic device lead-induced tricuspid regurgitation. *JACC Cardiovasc Imaging* 2019;12:622–636.

10. Rajappan K. Permanent pacemaker implantation technique: part II. *Heart* 2009; 95:334–342.
11. Delling FN, Hassan ZK, Piatkowski G, et al. Tricuspid regurgitation and mortality in patients with transvenous permanent pacemaker leads. *Am J Cardiol* 2016; 117:988–992.
12. Hoke U, Auger D, Thijssen J, et al. Significant lead-induced tricuspid regurgitation is associated with poor prognosis at long-term follow-up. *Heart* 2014;100:960–968.
13. McElhinney, Cabalka A, Aboulhosn A, et al. Transcatheter tricuspid valve-in-valve implantation for the treatment of dysfunctional surgical bioprosthetic valves, an international, multicenter registry study. *Circulation* 2016;133:1582–1593.