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Journal Article

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Publication date:
2022-04

Permanent link:
https://doi.org/https://doi.org/10.3929/ethz-b-000530924

Originally published in:
Journal of Cardiac Surgery 37(4), https://doi.org/10.1111/jocs.16276

Received: 22 October 2021 | Accepted: 16 December 2021

DOI: 10.1111/jocs.16276

HOW DO I DO IT

JOURNAL OF CARDIAC SURGERY WILEY

Right atriotomy closure with modified ventricular assist device ring

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Abstract

Background: Severe tricuspid regurgitation is a known risk factor for right ventricular failure (RVF) after left ventricular assist device (LVAD) implantation and is often treated with concomitant tricuspid valve repair (TVR). The right atriotomy needed for exposure of the tricuspid valve may complicate early implantation of a durable right ventricular assist device, which may be needed if RVF persists.

Materials & Methods: A 53-year-old male patient on Impella and extracorporeal life support was scheduled for LVAD implantation with concomitant TVR.

Results: We performed a technique for closure of the right atrium after TVR with a modified ventricular assist device ring to facilitate right ventricular support implantation if needed.

KEYWORDS
perfusion

Right ventricular failure (RVF) is a major complication after left ventricular assist device (LVAD) implantation. Although several risk scores for postoperative RVF exist, the clinical assessment and treatment remains challenging. More than 60% of patients with RVF after LVAD implantation can be weaned from a temporary right ventricular assist device (RVAD).[1] As severe tricuspid regurgitation (TR) is among the known risk factors for RVF, concomitant tricuspid valve repair (TVR) is often indicated to prevent RVF.[2,3] A right atriotomy as is required for surgical TVR can complicate implantation of a durable RVAD soon after LVAD implantation. Here we describe a technique for LVAD implantation with concomitant TVR that facilitates permanent RVAD implantation should it become necessary for persistent RVF. Approval by our institutional ethics committee (Charité - Universitätsmedizin Berlin EA2/016/20) was obtained before publication.

A 53-year-old male patient with ischemic cardiomyopathy and prior bypass surgery was on Impella 5.5 (Abiomed Inc.) and extracorporeal life support (ECLS). Despite full Impella 5.5 support, ECLS weaning failed because of severe TR and RVF. The patient was scheduled for permanent LVAD implantation with concomitant TVR. In addition, preparations for temporary RVAD were made, as the patient did develop a significant increase in bilirubin and creatinine levels despite ECLS support, but had no lower leg discoloration.[4]

Before surgery, the outlet cannula ring (HeartWare; Medtronic) modification for future RVAD implantation was performed as previously described, using five pieces of PTFE felt (Bard) and two pieces of bovine pericardial patch (St. Jude Medical; Figure 1A). Only the felt pieces were punched with the standard apex knife to create a hole in the middle (Figure 1B). The first felt piece was then glued to the

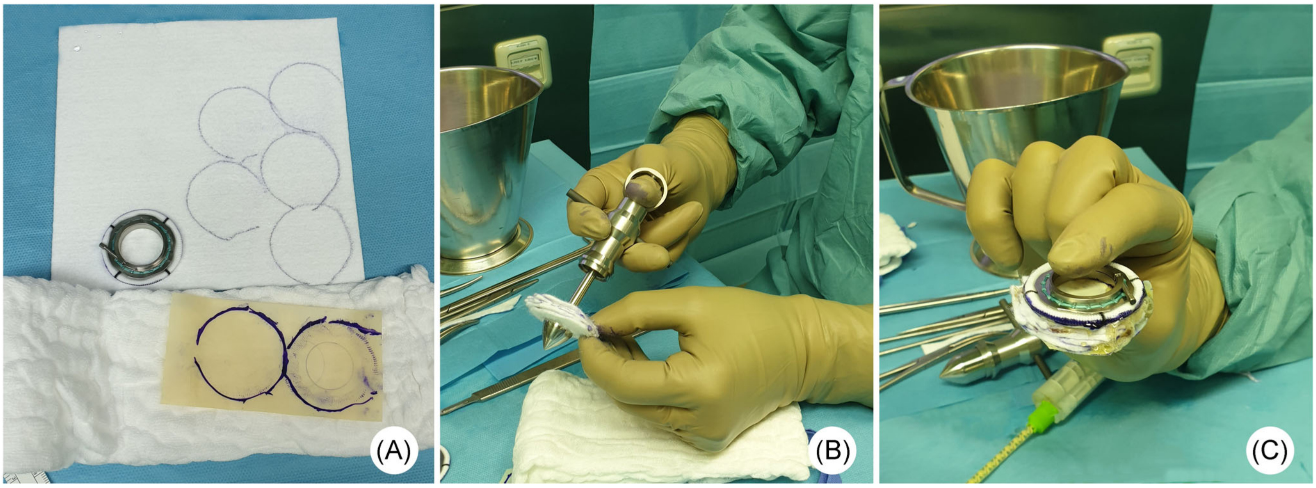

FIGURE 1 Teflon and pericardial patch marked in the dimension of a ventricular assist device (VAD) fixation ring (A), creation of a hole in the middle of the Teflon pieces with a standard apex knife (B) and the final modified VAD ring (C)

pericardial patch using surgical glue (BioGlue; Cryolife). The other parts were fixed on top of each other in the same way. The second pericardial patch was used for the last layer. In a final step, the LVAD ring was attached on top of the stack (Figure 1C).

Once the ring augmentation was finished, the ECLS cannulas in the femoral vessels were used for connecting the patient to cardiopulmonary bypass (CPB). After median sternotomy and additional cannulation of the superior vena cava, the Impella device was removed and the optimal site for potential cannula placement was identified using transesophageal echocardiography. Right atriotomy was subsequently carried out at the determined location and a double orifice valve technique was used for TVR.[5] To close the right atriotomy, 12 Prolene 3-0 sutures with pledgets were placed around the atrial defect to fix the ring as previously described (Figure 2). After all sutures were knotted, surgical glue was applied to support hemostasis (Figure 3). The LVAD was then implanted in a standard fashion.[6] As the CPB flow was reduced and the heart was allowed to fill, the TV and the right ventricular function were examined. Despite a competent TVR, weaning from CBP failed due to severely impaired right ventricular function. For temporary RVAD implantation, a 10-mm vascular graft (Getinge) was anastomosed to the pulmonary artery in an end-to-side fashion and then externalized through the skin. After the 19-Fr cannula (Maquet; Getinge) was inserted into the graft and connected to the CentriMag pump (Abbott), the venous ECLS cannula was used for drainage (Figure 4 and Video S1). Finally, weaning from CPB was successful with a blood flow of around 5 L/min on both devices. After surgery, the patient developed pneumogenic sepsis with subsequent multiorgan failure and died.

Many studies have reported several risk factors for RVF, including INTERMACS level 1, preoperative need for ECLS, prior heart surgery, or severe TR.[3,7] We were well aware that our patient exhibited all these risk factors and therefore attempted to increase the chances for sufficient right ventricular function by opting for beating-heart tricuspid valve annuloplasty. Since promising temporary RVAD weaning rates in combination with better short- and long-term survival rates for single LVAD compared to permanent biventricular assist devices had been reported, we opted for temporary RVAD implantation, as CPB weaning failed.[1,7,8] Nevertheless, we took precautions for an expected, prolonged RVF with the necessity to implant a permanent RVAD in a few weeks and used the modified LVAD ring. Unfortunately, there is no permanent ventricular assist device available in the market that is specially tailored for right ventricular support. Therefore, ring augmentation with felt patches is

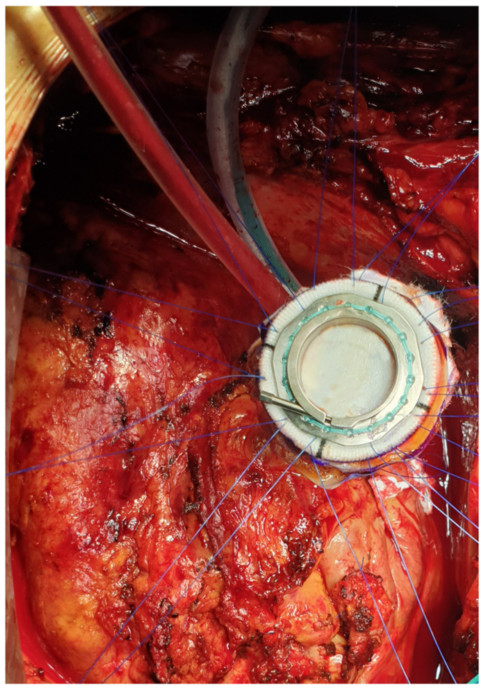

FIGURE 2 Fixation of the modified ring with interrupted sutures going through all layers

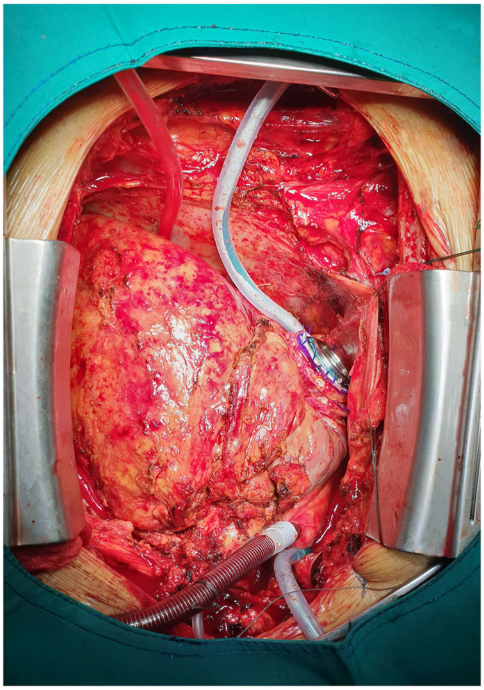

FIGURE 3 Right atriotomy closure with modified ventricular assist device ring

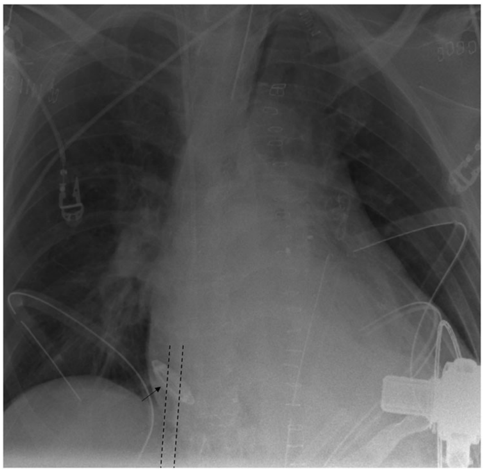

FIGURE 4 Postoperative chest X-ray (the dotted lines mark the right ventricular assist device drainage cannula and the arrow points at the modified ventricular assist device ring)

required to reduce the intraluminal cannula length and thereby the risk of suction events.[9,10] Although we implanted the fixation ring from the HeartWare HVAD, it would have been suitable to also implant a HeartMate 3 (Abbott) as previously described.[11]

In conclusion, TVR with the sealing of the right atriotomy using a modified apical LVAD ring can establish safe cessation of bleeding and may prevent unnecessary surgical trauma for RVAD.

ACKNOWLEDGEMENT

Open Access funding enabled and organized by Projekt DEAL.

CONFLICT OF INTERESTS

Volkmar Falk receives institutional support from Abbott and Medtronic. Evgenij Potapov is a proctor and speaker for Abbott, Medtronic, and Abiomed. Christoph Starck declares payment to his institution related to his activity as speaker and consultant for Abiomed and Medtronic. Other authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Evgenij Potapov conceived and planned the surgical approach. Jaime-Jürgen Eulert-Grehn and Pia Lanmüller contributed to patient selection and follow-up. Pia Lanmüller took the lead in writing the manuscript. Volkmar Falk, Christoph Starck, and Evgenij Potapov supervised the project. All authors performed a critical revision of the article and were involved in the final version of the manuscript.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

How to cite this article: Lanmüller P, Eulert-Grehn J-J, Starck C, Falk V, Potapov E. Right atriotomy closure with modified ventricular assist device ring. *J Card Surg*. 2022;37: 1114-1117. doi:10.1111/jocs.16276