

Gap-filler method for mechanical aortic valve closure with ventricular assist device implantation



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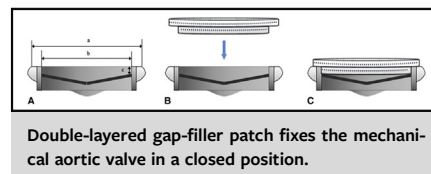
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Double-layered gap-filler patch fixes the mechanical aortic valve in a closed position.

CENTRAL MESSAGE

We developed a novel method using a layered polytetrafluoroethylene felt patch that fixes the mechanical aortic valve in a closed position by filling the gap between the orifice ring and leaflet.

▶ Video clip is available online.

Implantation of a continuous-flow type left ventricular assist device (VAD) can cause a reduced or absent aortic valve opening, resulting in an underlying risk of thrombus formation in the aortic root or valve itself.¹ Especially for patients who have undergone mechanical aortic valve replacement, replacement with a bioprosthetic valve or closed mechanical valve must be performed at the time of VAD surgery.^{1,2} Mechanical aortic valve closure has recently shown a tendency to be chosen in this setting and several closing techniques have been reported³⁻⁵; however, an ideal procedure has yet to be established.

PATIENT HISTORY

A 49-year-old man developed acute type A aortic dissection involving the left coronary artery 2 years before the

VAD implantation. Bentall procedure with a mechanical aortic valve, as well as total arch replacement with an open stent graft, was performed, followed by the additional coronary artery bypass grafting using a saphenous vein graft for the left anterior descending artery because of the malperfusion of the left main trunk. The patient was discharged once. However, severe heart failure remained due to ischemic cardiomyopathy, so our team decided to perform LVAD implantation as a bridge to heart transplantation.

SURGICAL TECHNIQUE

A 23-mm St Jude Medical Regent valve had been implanted in an aortic position in the patient. Our team chose mechanical valve closure rather than replacement with a

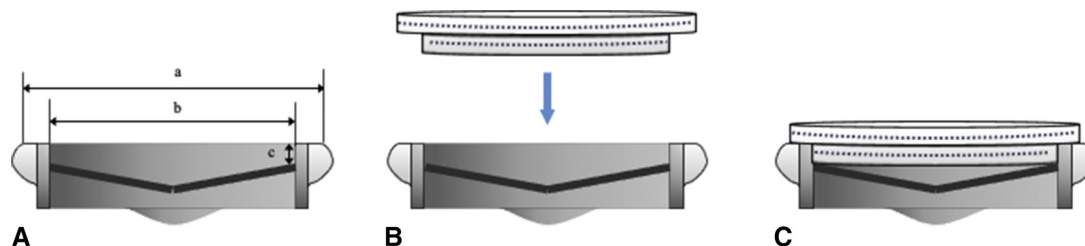


FIGURE 1. Schematic representation of gap-filler method for mechanical bileaflet valve closure. A, Key diameter measurements of St Jude Medical Regent valve. a, Tissue annulus diameter. b, Valve orifice inner diameter. c, Diameter of gap in closed position between orifice ring and edge of leaflet. B, Placement of double-layered polytetrafluoroethylene felt circular patch. C, Gap filled with patch.

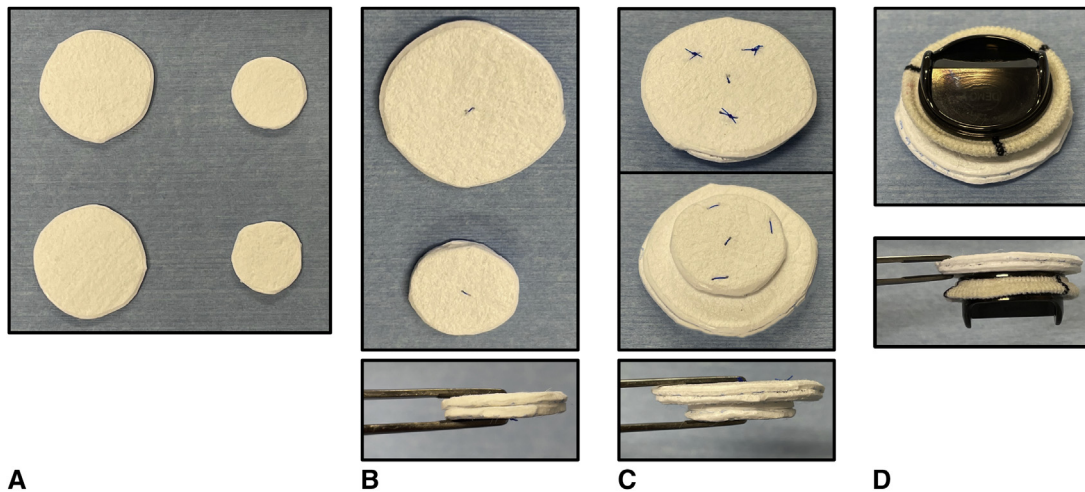
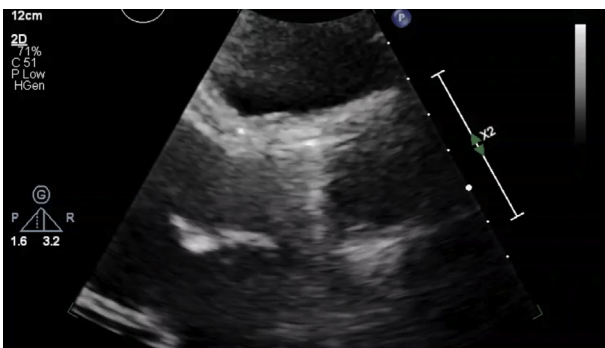


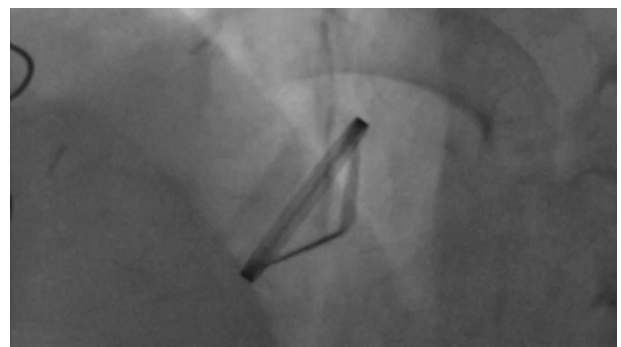
FIGURE 2. A, Four polytetrafluoroethylene circular felt patches, 2 large (diameter, 26 mm) and 2 small (diameter, 22 mm), were fashioned. Determination of the size of the large patch was based on the size of the implanted prosthesis graft. B, Patches of the same size were sutured together with a 4–0 Prolene stitch. C, The smaller patches were then sutured to the larger patches using 3 4–0 Prolene stitches. D, The resultant gap-filler patch was inserted into the inner orifice area of the valve.

bioprosthetic valve. Analysis and measurements of a mock St Jude Medical valve of the same size in the closed position were performed, which resulted in a gap 3 mm in depth between the orifice ring and edge of the leaflet (Figure 1, A). Furthermore, we determined that the valve could be fixed in a closed position with something used to fill the gap (Figure 1, B and C). During the surgery, a sterilized low porosity polytetrafluoroethylene felt patch (thickness, 1.85 mm) (C.R. Bard) was cut into 4 circles with 2 different sizes, 2 circles larger than the outer diameter of the orifice ring and 2 circles the same size as the inner diameter. Using those, a double-layered structure felt gap-filler patch was constructed (Figure 2). Following aortic crossclamping, a transverse incision of the ascending aortic prosthetic graft was made. Three interrupted horizontal sutures were then

placed using 4–0 Prolene on the inner side of the implanted Gelweave Valsalva graft (26 mm) (Terumo Vascutek) just above the valve. The sutures were brought to the outer circular patch, which was seated with tie sutures and used to fill the gap of the mechanical valve. After aortotomy closure and declamping, a HeartWare VAD (Medtronic) was subsequently implanted in a standard fashion. Outflow graft of the HeartWare VAD was anastomosed to the ascending graft material. Postoperative antiplatelet and anticoagulation (prothrombin time, 2.0-2.5) therapy were performed as usual. Follow-up echocardiography (Video 1) and fluoroscopy (Video 2) demonstrated that the mechanical aortic valve remained in a closed position without thrombus for more than 2 years, and no thromboembolic events were found either, clinically.



VIDEO 1. Transthoracic echocardiogram (parasternal long-axis view) obtained at two years after the operation showing that the mechanical aortic valve remained in closed position and no evidence of thrombus. Video available at: [https://www.jtcvs.org/article/S2666-2507\(22\)00102-X/fulltext](https://www.jtcvs.org/article/S2666-2507(22)00102-X/fulltext).



VIDEO 2. Fluoroscopy image obtained at 2 years after the operation showing that the mechanical aortic valve remained in a closed position with the felt patch. Video available at: [https://www.jtcvs.org/article/S2666-2507\(22\)00102-X/fulltext](https://www.jtcvs.org/article/S2666-2507(22)00102-X/fulltext).

DISCUSSION

The major advantages of the present method include a pre-cutttable patch, simple stitching for fixation, and a no-touch technique performed underside of the implanted valve. As for the first advantage, creation of an adequate gap-filler patch can be easily performed during the operation because the implanted aortic prosthesis size is known preoperatively. An undersized, lower circular patch cut to the exact size can contribute to reliable closure of the valve because it becomes seated in the gap in the closed position between the orifice ring and edge of the leaflet. Regarding fixation of the closing material, there is a large difference in terms of number of stitches. Our method required only 3 stitches in the seat of the felt patch, resulting in a simple and quick closure and decreased procedure time. Third, all procedures associated with this method can be completed on the aortic side of the implanted mechanical valve. The effectiveness of a sandwich plug technique using felt has been previously reported,⁵ although it might be a high-risk maneuver because there is a possibility that the material could accidentally fall into the left ventricle.

This method also has some limitations because potential long-term outcomes, including such complications as dislocation and thrombus formation caused by the patch, have

not been elucidated. Additionally, its feasibility may depend on the structural design of the mechanical valve.

CONCLUSIONS

A newly developed gap-filler method for mechanical aortic valve closure in patients with VAD implantation was found to be safe and effective for more than 2 years after the operation. Although further clinical follow-up examinations are needed, this structural design-based technique may become a new surgical option for mechanical aortic valve closure in VAD implantation cases.

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