Late post-pump blood flow obstruction in a novel left ventricular assist device: The unusual case of a twisted outflow graft

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Angiogram showing sandglass-like outflow stenosis with double contour of the graft wall.

▶ Video clip is available online.

Central Message

We describe a case of diagnosis and treatment of late outflow graft torsion manifesting more than 2 years after the initial surgery in a patient supported with the HeartMate 3 (Thoratec Corp, Pleasanton, Calif) left ventricular assist device.

See Editorial Commentaries pages e37 and e39.

One of the life-threatening complications in patients treated with a left ventricular assist device is obstruction of the blood flow through the pump.^{1,2} When an obstruction

FIGURE 1. CT scan showing sandglass-like outflow graft stenosis (arrow) before stent implantation.

occurs, recognition of the type of obstruction and appropriate treatment are important for outcome.

CASE REPORT

A 72-year-old patient with dilative cardiomyopathy (Intermacs level 3) received implantation of the HeartMate 3 (Thoratec Corp, Pleasanton, Calif) through a median sternotomy using cardiopulmonary bypass with visual control of the position of the outflow graft and the bend relief. After a complication-free period of 2 years and 1 month, the patient was admitted with symptoms of heart failure and an abrupt decrease of pump flow to 2.6 to 3 L/min at 5700 rpm pump speed over several days. The internal trend-line parameter of “rotor noise,” which describes vibrations of the impeller, simultaneously increased by 30%. The left ventricle was enlarged to up to 7 cm with opening of the aortic valve. Computed tomography (CT) scanning revealed severe stenosis of the outflow graft at the end of the bend relief (Figure 1). The next day, angiography was performed with a reduced pump speed of 4000 rpm to reduce dilution of the contrast (Figure 2 and Video 1), and a 14/35 stent was implanted using the Sentinel system

FIGURE 2. Angiogram showing sandglass-like outflow graft stenosis (yellow arrow) with double contour of the graft wall.

(Claret Medical, Inc, Santa Rosa, Calif)³ for carotid protection, under the assumption of outflow graft thrombosis but no improvement in the pump flow was achieved. The procedure was being performed in a hybrid operating room and under intubation. The patient was then turned slightly to the right side, and a left anterior thoracotomy was performed in the sixth intercostal space under the assumption of graft torsion. The tissue around the pump and the outflow graft was dissected; the bend relief, which was correctly connected, was longitudinally opened at its plastic part and a circular transection was made close to its metal part with the snap mechanism. The outflow graft was found to be distorted (**Figure 3, A**) counterclockwise looking from the pump in the direction of flow. Rotation without loosening of the nut of approximately 80° to 110° (**Figure 3, B**) normalized the graft alignment, and pump flow increased to 5.5 L/min. Before the wound was closed, the outflow graft was

VIDEO 1. The catheter was introduced retrogradely from the ascending aorta and passed behind the twisting. The pump speed was slowed down to 4000 rpm, resulting in a pump flow of less than 3 L/min, and contrast medium was injected. The angiogram shows sandglass-like outflow graft stenosis with double contour of the graft wall. Video available at: [http://www.jtcvsonline.org/article/S0022-5223\(17\)31779-8/fulltext](http://www.jtcvsonline.org/article/S0022-5223(17)31779-8/fulltext).

protected by wrapping with a 5-cm-long piece of a 20-mm ring reinforced polytetrafluoroethylene (Gore-Tex, WL Gore & Associates Inc, Flagstaff, Ariz) graft. The patient was discharged home 1 week later.

DISCUSSION

In the present case, the torsion of the outflow graft was diagnosed more than 2 years after surgery. Retrospectively, it is not possible to define the time point of the torsion.

FIGURE 3. A, Intraoperative view of the twisted graft after opening of the kinking protector. B, The same view after rotation of the graft into the correct position.

Speaking against intraoperative twisting are the 2-year event-free period with pump flow of over 5 L/min and the rapid onset of the symptoms and flow decrease. However, the fairly tightly screwed nut, as ascertained during the revision, would have made gradual rotation of the graft after surgery unlikely, but not impossible, because the graft alignment was corrected without loosening the nut. What remains unclear is whether there could have been gradual rotation that might have occurred because of flow characteristics (abrupt changes in the pump speed 30 times per minute) or cardiac pulsation, that over time might have caused rotation of the graft, even though the nut was tightly secured.

It may also be speculated that the twist could have been produced during implantation but have been spread over the whole length of the graft, thus not causing significant stenosis. Over time, fibrin deposits between the bend relief and the outflow graft may have led to concentration of the twisting at one point, with the onset of clinically evident stenosis.

The CT scan did not differentiate between thrombotic mass and twisting, whereas in retrospect the sandglass-like form of the stenosis on CT scan and the angiogram showing the typical double contour of the twisted graft wall during the stenting might have led to the appropriate diagnosis. Unfortunately, the late onset of the symptoms led to a false interpretation of the findings. Only the lack of effect and the motion of the stenosis toward the pump prompted the correct diagnosis and appropriate treatment: surgical revision of the graft position.

To avoid the complication, we recommend paying close attention to the intraoperative positioning of the outflow graft before attaching the bend relief after the aortic anastomosis and apical connection have been completed. It would be helpful if the company would add two radiopaque lines

along the graft to aid diagnosis and make changes to avoid any rotation of the graft after the nut has been secured.

After the proper diagnosis of twisting was established and thrombus inside the graft was ruled out, the surgeon assumed that graft rotation would not cause systemic embolization and carried less risk for bleeding than full re sternotomy and the use of cardiopulmonary bypass for outflow graft replacement.

Meanwhile, very similar complications, with the same direction of graft rotation, have been diagnosed at our institution and treated as described above in 2 more patients 20 and 11 months, respectively, after HeartMate 3 implantation.

CONCLUSIONS

The CT scan should be used as a screening tool to detect pre- or postpump obstruction,⁴ and the angiogram should be used to verify the diagnosis. The sandglass form of the stenosis and the double contour of the graft wall at the narrow point, as seen in the angiogram, diagnosed the graft twisting. In this case, surgical revision is the only solution.

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