CASE REPORT

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Hemolytic anemia due to a felt strip used in the early stage of acute aortic dissection surgery

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ABSTRACT

Hemolytic anemia is a rare complication after aortic surgery. We herein report an early postoperative case of hemolytic anemia caused by an internal felt strip. A 57-year-old man underwent emergency partial aortic arch replacement for acute type A aortic dissection. The proximal stump was reinforced using internal and external polytetrafluoroethylene felt strips. The patient subsequently developed profound mechanical hemolytic anemia two weeks after the operation. Computed tomography did not reveal any narrowing of the anastomosis or kinking of the graft. However, transesophageal echocardiography confirmed that the internal felt strip had become inverted by the blood flow. Reoperation was performed to redo the proximal anastomosis, while also removing the internal felt strip. Hemolysis diminished soon after the reoperation. We encountered a case of acute aortic dissection that required reoperation because of hemolytic anemia caused by internal felt strip inversion. Further measures are required to prevent hemolysis with felt strips.

Keywords: felt strip, aortic dissection, hemolytic anemia

Abbreviations:
CT: computed tomography
LDH: lactate dehydrogenase
TEE: transesophageal echocardiography

INTRODUCTION

The outcomes of surgery for acute aortic dissection have improved over the years. Various reinforcement techniques have been reported to overcome the fragility of the dissected aorta.[1] In our hospital, we have been performing aortic reinforcement of the dissected aorta using felt strips at the intimal and adventitial sides for acute aortic dissection surgery (sandwich method).

We herein report an early postoperative case of hemolytic anemia caused by an internal felt strip.

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CASE REPORT

A 57-year-old man with a diagnosis of type A acute aortic dissection was transported to our hospital for emergency surgery. Contrast-enhanced computed tomography (CT) revealed aortic dissection from the aortic root to the right common iliac artery. The right brachiocephalic artery was dissected.

Median sternotomy was performed under general anesthesia. Cardiopulmonary bypass was established by femoral artery and ascending aortic cannulation, bicaval venous drainage, and left ventricular venting. Under circulatory arrest with moderate hypothermia, the ascending aorta was resected and antegrade cerebral perfusion was established for cerebral protection. Intraoperative findings showed an intimal tear at the orifice of the right brachiocephalic artery; therefore, partial arch replacement with a right brachiocephalic arterial reconstruction was performed. On the distal side of the aorta, a 12-mm-wide polytetrafluoroethylene felt strip (Matsuda Medical Industries, Tokyo, Japan) was used inside the intima and outside the adventitia, and the felt strips were fixed using four 4-0 polypropylene mattress sutures. After fixation, 3-0 polypropylene end-to-end distal anastomosis of an artificial graft (Triplex Advanced 24 mm, 1 branch; Terumo Corporation, Tokyo, Japan) was performed using the turnup method.[2]

The proximal side of the ascending aorta was trimmed to 2 cm distal to the sinotubular junction. The false lumen of the proximal aorta was injected with biological glue, and a felt strip was fixed with four 4-0 polypropylene mattress sutures using the same method as the distal side. We further reinforced additional continuous over-and-over sutures with 4-0 polypropylene sutures in the proximal aorta. The proximal anastomosis was performed with 3-0 polypropylene continuous sutures. Finally, the right brachiocephalic artery was reconstructed. Cardiopulmonary bypass was weaned, and emergent surgery was completed. Six units of red blood cell transfusion were required intraoperatively.

Immediately after surgery, the patient's subsequent course was considered to be good without hemolytic findings. However, on postoperative day 7, the serum lactate dehydrogenase (LDH) level rose to 1275 U/L on a blood examination. On postoperative day 14, the serum LDH level increased further to 2148 U/L, and the patient required red blood cell transfusion due to anemia. The examination of LDH isozyme showed elevated LDH1 and LDH2 levels, suggesting hemolysis. Detailed blood examination data from approximately two weeks postoperatively are shown in Table. Prior to surgery, there was no history of blood transfusions. Six units of red blood cells were transfused during the first surgery.

A postoperative contrast-enhanced CT scan confirmed that there was no kinking of the graft or stenosis of the anastomosis. More specifically, a CT scan did not clearly reveal either inversion or protrusion of the felt strip at the anastomotic site (Fig. 1). However, transesophageal echocardiography (TEE) demonstrated that the internal felt strip at the proximal anastomosis had been pushed back by the blood flow (Fig. 2). The findings therefore confirmed that the inversion of the internal felt strip had occurred. For the TEE, the pressure gradient was not measured; however, the image was not considered to have a large pressure gradient. Therefore, the patient underwent reoperation 31 days after the previous emergent surgery.

Table Blood examination data

Laboratory parameter	Results	Unit	Normal range	Date of test
Red blood cells	1.97 $\times 10^6$	/μL	3.3–8.6	POD 14
Hemoglobin	5.7	g/dL	13.7–16.8	POD 14
Hematocrit	18.2	%	40.7–50.1	POD 14
Mean corpuscular volume	92.4	fL	83.6–98.2	POD 14
Mean corpuscular hemoglobin	28.9	pg	27.5–33.2	POD 14
Mean corpuscular hemoglobin concentration	31.3	g/dL	31.7–35.3	POD 14
Reticulocytes	9.8	%		POD 14
White blood cells	22.2 $\times 10^3$	/μL	3.3–8.6	POD 14
Platelets	893 $\times 10^3$	/μL	158–348	POD 14
Serum iron	57	μg/dL	40–188	POD 14
Ferritin	1229.5	ng/mL	18.6–261	POD 14
Vitamin B12	328	pg/mL	233–914	POD 14
Folic acid	5.9	ng/mL	3.6–12.9	POD 14
Unsaturated iron binding capacity	266	μg/dL	140–330	POD 14
Total bilirubin	2.9	mg/dL	0.4–1.5	POD 15
Direct bilirubin	1.3	mg/dL	0.0–0.4	POD 15
Direct Combs test	(–)		(–)	POD 16
Indirect Combs test	(–)		(–)	POD 16
LDH	1947	U/L	124–222	POD 16
Isozyme LDH 1	36.7	%	20.0–31.0	POD 16
Isozyme LDH 2	35.9	%	28.8–37.0	POD 16
Isozyme LDH 3	17.2	%	21.5–27.6	POD 16
Isozyme LDH 4	4.3	%	6.3–12.4	POD 16
Isozyme LDH 5	5.9	%	5.4–13.2	POD 16
Haptoglobin	10>	mg/dL	19–170	POD 16

LDH: lactate dehydrogenase
POD: days after the first operation

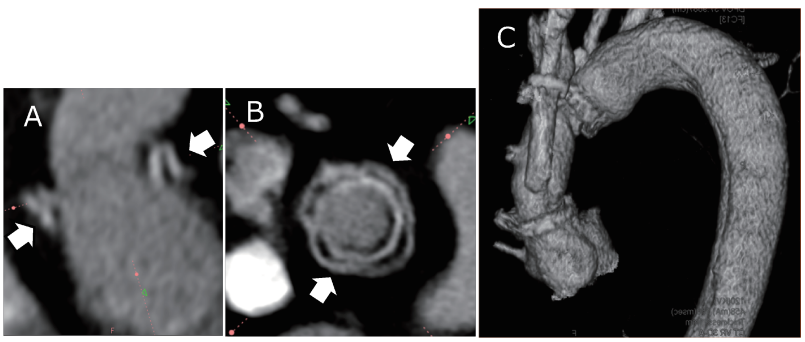

Fig. 1 Computed tomography findings after the first surgery
Fig. 1A: Felt strips at the proximal anastomosis in the long axis section (white arrows)
Fig. 1B: Felt strips at the proximal anastomosis in the horizontal section (white arrows)
Fig. 1C: Three-dimensional computed tomography

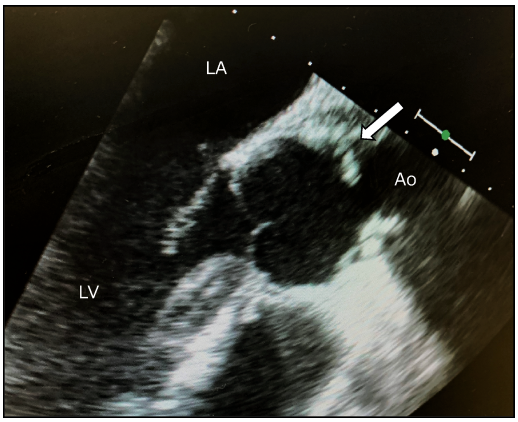

Fig. 2 Internal felt strip pushed back by blood flow (white arrow) on transesophageal echocardiography
LA: left atrium
LV: left ventricle
Ao: ascending aorta

After redo median sternotomy, cardiopulmonary bypass was established using artificial graft cannulation and right atrial venous drainage. The artificial graft was clamped, and cardioplegia was induced using an aortic root vent. The proximal anastomosis was disconnected and found to be intact, with the internal felt strip showing no deformities. There was a slight loosening of the 4-0 polypropylene over-and-over suture used to reinforce the anastomosis, and the anastomosis was easily inverted by light traction. The felt strip on the intimal side was removed, and proximal re-anastomosis was performed directly using an artificial graft from the previous surgery (Fig. 3). Twelve units of red blood cells were transfused during the reoperation.

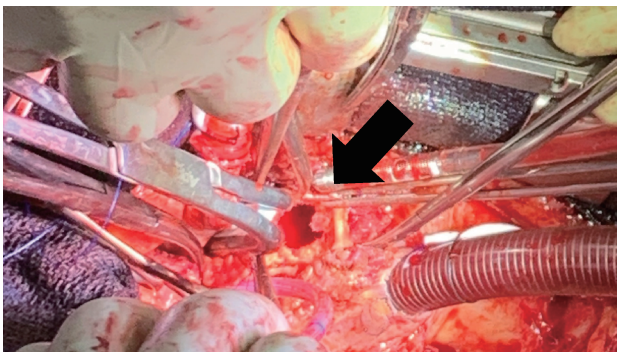

Fig. 3 Intraoperative photography of proximal anastomosis site at the second operation (black arrow)

Hemolysis diminished soon after the reoperation. After that, there was no further progression of anemia, the serum LDH level normalized, and the patient was discharged 47 days after the initial surgery. A graph of the trends in the blood examination data over a short period between the first operation and discharge is shown in Fig. 4.

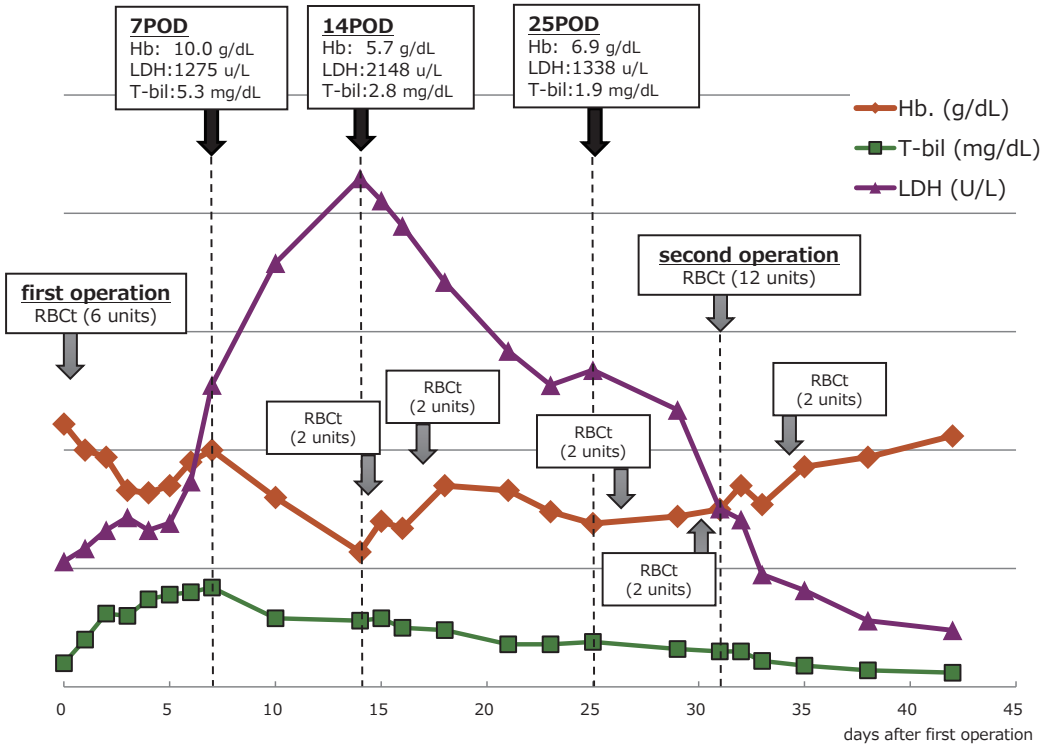

Fig. 4 A graphical schematic illustration showing the trends in blood examination data and red blood cell transfusions between first emergency surgery and discharge
POD: postoperative days from the first operation
Hb: hemoglobin
LDH: lactate dehydrogenase
T-bil: total bilirubin
RBCt: red blood cell transfusions

DISCUSSION

Hemolytic anemia after aortic surgery has been reported to have several causes (eg, stenosis at the anastomosis site and artificial graft kinking).[3-5] Felt strip-induced hemolysis has also been reported, especially at the aortic proximal anastomosis. Some case reports of hemolytic anemia due to medial felt deformation have been previously reported, but most of them seem to be cases in which reoperation was performed months or years after surgery.[6-9] The medial felt was hardened and fixed with an inverted shape in these previous reports. Cases such as the present one, which required reoperation for hemolysis about one month after surgery, are rare. Despite the obvious TEE findings of medial felt inversion in the present case, intraoperative findings showed that the medial felt strip was not inverted and appeared normal in the absence of blood flow in the situation of cardiac arrest. Since only approximately one month had passed since the initial surgery, the remaining flexibility and mobility of the felt strip was thought to be the cause of inversion only in the situation of aortic blood flow.

Prior to experiencing this case, we tried to avoid using small-diameter artificial grafts to prevent stenosis at the anastomosis site and were alert to kinking of the artificial graft. Proximal

aortic reinforcement using the felt sandwich technique was performed for not only fixation of four mattress sutures but also additional continuous over-and-over sutures to prevent the intimal felt strip from turning over due to blood flow. Nevertheless, the present case suggests that we need to be more creative in our aortic reinforcement and anastomosis procedures.

Two important factors must be considered in the reinforcement of the dissected aorta: first, as mentioned above, the felt strip should be firmly fixed to prevent inversion by the blood flow, and second, too many sutures at the reinforcement may cause cutting of the dissected intima, which may lead to the creation of a new intimal tear. Based on the present findings, we propose two points of caution with regard to the formation of proximal reinforcement.

First, aortic reinforcement with continuous over-and-over sutures should be threaded widely, close to the edge of the intimal felt strip. In addition, we used a 12-mm-wide felt strip made of polytetrafluoroethylene; however, the material and size of the felt strip should be reconsidered. The sandwich method using felt strips is a standard method for reinforcing the dissected aorta. Polytetrafluoroethylene is widely applied as a material in the sandwich method because of its low longitudinal degradation and low tissue reactivity. Some innovations have been made in the fabrication of the material in the plasticity and strength of the felt strips. However, since hemolytic anemia caused by felt strips is rare, it is difficult to conclude their superiority at the present time.

Second, we should endeavor to eliminate loosening of the continuous suture by adding ligation in the middle of the continuous sutures. After the experience, we modified the proximal side reinforcement as follows: the first fixation method of the proximal aorta using four mattress sutures was the same as before. Second, the threads used in the four mattress stitches were used directly in a continuous over-and-over suture, and threads were added between the mattress sutures. We believe that this modification will reduce the occurrence of thread loosening compared with simple continuous sutures with a single thread. The development of hemolytic anemia due to an intimal felt strip is a rare complication. The effectiveness of our improvements in this case must be evaluated over a longer period.

Furthermore, in the present case, contrast-enhanced CT and transthoracic echocardiography could not confirm the cause of the hemolysis. Alkhouli[10] and de Castro[3] have described in detail the examination and treatment of hemolysis after cardiac surgery. However, a few case reports have described the diagnosis of hemolytic anemia of aortic origin. Although the blood examination in the present case was sufficient to confirm the presence of hemolytic anemia, definitive imaging is essential for mechanical hemolysis of the graft. Although we did not measure the flow velocity at the stenosis caused by the felt strips, the increased velocity and turbulence of blood flow resulted in the mechanical destruction of the red blood cells. Hemolysis due to the felt strip cannot be completely ruled out, even if there is no obvious evidence of turbulent blood flow on CT or transthoracic echocardiography. Additional examinations, such as TEE or 4-dementinal flow magnetic resonance imaging may be useful.[11] Because the diagnosis was confirmed by TEE in the present case, no additional examinations were performed; however, these examinations could have been an option if a definitive diagnosis of the causative disease of hemolytic anemia could not be made.

In conclusion, we encountered a case of acute aortic dissection that required reoperation because of hemolytic anemia caused by internal felt strip inversion. Further measures are required to prevent hemolysis with felt strips.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

FINANCIAL DISCLOSURE

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