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Custom Made Fenestrated Stent Graft Collapse after Thoracic Endovascular Aortic Repair: A Case Report

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Abstract

We present a case of stent graft collapse after performing thoracic endovascular aortic repair with a custom-made fenestrated stent graft. The patient was a 70-year-old woman with an asymptomatic aneurysm of the distal aortic arch, and thoracic endovascular aortic repair was performed. The patient showed a blood pressure difference between the left arm and the right arm on postoperative day (POD) 17 prompting the performance of a chest computed tomography scan which revealed stent graft collapse. She then underwent staged debranching of thoracic endovascular aortic repair. Stent graft collapse is a rare but well-described complication of thoracic endovascular repair. Therefore, patients who undergo such a procedure should be carefully monitored for signs and symptoms, which suggest the possibility of stent collapse.

Keywords

Thoracic Endovascular Aortic Repair, Collapse, Custom Made Fenestrated Stent Graft, Bird-Beak Deformity

1. Introduction

An increasing number of elderly patients are undergoing stent graft (SG) interpolation treatments for the management of thoracic aortic aneurysms. A number of complications have been reported [1] and cases of stent graft collapse [2] [3] [4] [5] [6] have been identified with a high risk of complications and death. The main cause was endograft oversizing. A mismatch between the endograft and the aortic diameter may lead to incomplete deployment and infolding of the endograft. However, the endograft was oversized in about one-third of all cases.

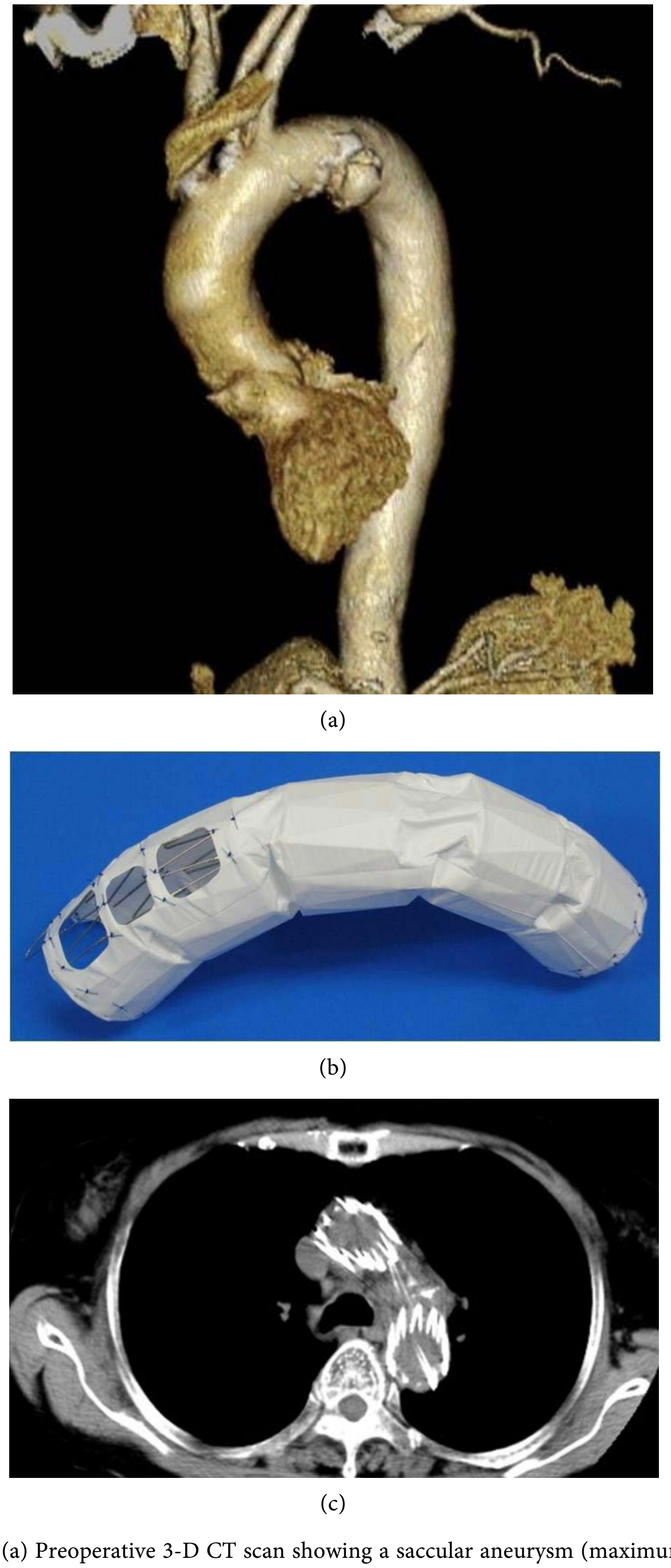
The aortic anatomy, which consists of a small radius to the curve of the aortic arch, may be crucial as well in the development of endograft collapse. Proximal fixation of thoracic endograft to oversize and increase aortic arch angulation was investigated. Oversizing of endografts negatively affects device-wall apposition. SG collapse, which is probably one of the most serious sequelae, can lead to acute aortic occlusion and multiorgan failure due to malperfusion [4]. To improve the long-term prognosis of TEVAR patients, better insight into the causes, timing, and optimal management of endograft collapse after TEVAR is necessary [1]. In this patient, we performed TEVAR of a saccular aneurysm (maximum diameter, 38 mm) in the small curvature of the distal aortic arch by using a custom-made fenestrated SG. After the operation, the SG collapsed because it did not adequately attach at the center of the lesser curvature of the aorta. Herein, we report our findings and those of other studies.

2. Case Report

A 70-year-old Japanese woman with a history of asthma, emphysema, hypertension and obesity was admitted to our hospital, and she was diagnosed as having an asymptomatic aneurysm of the distal aortic arch. Routine chest computed tomography (CT) revealed a saccular aneurysm (maximum diameter, 38 mm) in the small curvature of the distal aortic arch, and the diameter of the aorta was about 27 mm proximally and about 28 mm distally (**Figure 1(a)**). We used a custom-made fenestrated SG with a built-in Z stent and 3 holes for the branches of the aortic arch (**Figure 1(b)**). The SG traversed the entire aortic arch.

Operation 1: The operation was performed under general anesthesia on June 8, 2011, and the left femoral artery was cannulated. Contrast material was injected through the ascending aorta, thereby guiding and ensuring the correct placement of the 30-mm custom-made fenestrated SG, which was deployed by using the pull-through method. During the operation, a bird-beak configuration, which is the radiological detection of a wedge-shaped gap between the undersurface of the SG and the aortic wall, was observed in the SG at the lesser curvature of the ascending aorta. However, no leakage was observed; thus, touch-up ballooning was not performed.

Postoperative course: Just after TEVAR, the patient was alert and had no symptoms. A three-dimensional (3-D) CT performed on POD 3 did not show migration of the SG, leakage, or any other specific problems. The patient was followed up for another week. A brain CT was performed on POD 11 because the patient experienced deterioration in limb activity, but no abnormal finding was obtained from the CT study (**Figure 1(c)**). Since the patient's symptoms improved thereafter and no abnormal laboratory findings were observed, we decided to follow up. However, the patient showed a blood pressure difference of about 50 - 60 mm Hg between the left and right arms. Therefore, 3-D CT was performed again on POD 17 and revealed poor apposition of the endograft to the arch, which had migrated proximally (**Figure 2(a)**). The collapse of the SG and occlusion of the arch branches occurred simultaneously, followed by the



(a)

(b)

(c)

Figure 1. (a) Preoperative 3-D CT scan showing a saccular aneurysm (maximum diameter, 38 mm) in the distal aortic arch. The length of the proximal landing zone is shorter (about 5 mm). (b) The custom-made fenestrated SG with a built-in Z stent and 3 holes for the branches of the aortic arch without the use of snorkels. (c) Postoperative CT scan obtained on POD 3, showing no migration of the SG, leakage, or any other problem.

(a)

(b)

(c)

Figure 2. (a) The SG was pushed toward the greater curvature of the aortic arch and occluded the left common carotid and subclavian arteries. (b) An aorto-bi-axillary bypass (Y graft 16 × 8 mm: Hemashield®) was performed on POD 21. (c) Imaging studies for visualization of the debranching graft that confirmed that the deployed SG was retained at its appropriate position.

appearance of a cerebral symptom in the form of severe dizziness. Therefore, a debranching bypass operation was performed to maintain the blood flow in the occluded parts. The patient was scheduled to undergo a staged operation. To this end, an ascending aorto-bi-axillary bypass (Y graft, 16 × 8 mm; Hemashield®) was performed on POD 21. Moderate stenosis and plaque on the common carotid artery were observed, and we did not want to perform extensive operative manipulation.

Operation 2: Under general anesthesia, the right and left subclavian arteries were exposed, median sternotomy was performed, and the heart was exposed. A tunnel passing through the pleura was created, extending from the mediastinal space to the axillary artery. The end-to-side anastomosis was performed to connect the 8-mm artificial blood vessel (VXT vascular graft; ADVANTA™) to the axillary arteries through the tunnel. Next, end-to-side anastomosis was performed to connect the Y-graft of the artificial blood vessel (Hemashield®) to the ascending aorta. Furthermore, both the limbs of the Y-graft were connected to the artificial blood vessels connected to the left and right axillary arteries via end-to-end anastomosis to enable blood flow from the ascending aorta to both the axillary arteries (**Figure 2(b)**). The origin of the left subclavian artery was ligated after a bypass operation.

Operation 3: A repeated TEVAR was performed under general anesthesia 3 days after the operation, and a TAG device (GORE®) was inserted via a right femoral incision. As the previous procedure resulted in distortion of the custom-made fenestrated SG, a 28 mm TAG was inserted this time in the descending aorta and another 31 mm TAG was inserted in the ascending aorta-aortic arch. The second SG was deployed into the collapsed SG, which was pressed against the aortic arch wall. After the SG was reinforced by using touch-up ballooning, imaging studies for visualization of the debranching graft were performed; these studies confirmed that the deployed SG was retained at its appropriate position. A new CT angiography was performed before discharge, which showed a regular graft diameter, normal renal perfusion, and no signs of any endoleaks (**Figure 2(c)**).

The patient's consciousness and limb activity improved drastically. Her overall condition was good, and she was discharged from the hospital on POD 35.

3. Discussion

Generally, an aortic aneurysm with a 38 mm diameter is not indicated for operation. The present case of the aneurysm was not large but was of the saccular type, which has been known to have a tendency to become enlarged over time. Hence, in the present case, TEVAR was performed because of the possibility of enlargement and in accordance with the patient's hope.

Anatomic complexities at the aortic arch are the most important reasons for early and late SG treatment failure. Some studies that reported the use of custom-made SGs also reported migration of the SG during early follow-up [7]. An incidence of collapse is reported in around 1.4% - 2.7% [6] [8] of TEVAR operation cases.

In this case, SG migration developed between PODs 3 and 17. Postoperatively, the patient should have undergone more strict follow-up and examinations according to the patient's condition. SG migration should be considered as an indicator of an abnormality when the SG is deployed in the aortic arch, and diagnostic imaging should be performed regularly.

The following are the causes of SG migration and its mechanisms: problems in 1) manipulation techniques; 2) stent placement site; and 3) the stent itself.

1) In this case, stent graft collapse after TEVAR seems to be related to poor apposition of the stent grafts in an angulated aortic arch and/or excessive stent graft oversizing. Anatomical characteristics and stents' mechanical factors play a role in stent graft collapse, and we should have considered the patient's condition more strictly. In planning a treatment strategy, assessment of aortic arch anatomy and appropriate choice of the device may prevent such a complication.

2) When the SG is deployed in a steep site such as the aortic arch, care is necessary to isolate the site. When the SG shows a bird-beak configuration, migration could develop owing to excessive force applied to the SG. In this case, a bird-beak configuration was confirmed after TEVAR. Whether the deployed SG is misplaced or whether a different route should be chosen should be determined.

3) Regarding the stent itself, it's being custom-made seems problematic. It is advantage to insert in the vessel wall a custom-made stent made according to the shape of the blood vessel. Although manufacturers of SGs should perform a durability test, some custom-made SGs available in the market might not have undergone a durability test and are thus prone to migration owing to their weak structure.

Recently, a flexible device designed to conform to the configuration of the aortic arch such as Relay NBS plus [9] (Bolton Medical, Sunrise, FL, USA) has been developed and is being used in Europe. This device is comprised of self-expanding sinusoidal nitinol stents, and the proximal end of this SG is an open bare stent [10]. Therefore, SGs should be matched to the shape of the blood vessel by using a new device for adaptation to different situations.

4. Conclusion

Some symptoms that develop after SG placement are indicative of collapse. Therefore, if the patient presents with any of these symptoms, whether SG collapse has occurred should be determined. If examination reveals SG collapse, a suitable correction method should be decided on the basis of the image findings. Therefore, patients undergoing such procedures should be closely monitored for signs and symptoms that may indicate one possible stent-graft collapse.

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The contents of this article reflect the personal opinion of the author and may not represent the official perspective of the affiliated organization.

Conflicts of Interest

The authors certify that there is no conflict of interest with any financial/ research/academic organization, with regards to the content/research work discussed in the manuscript.

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