Endovascular Repair of a Traumatic Thoracic Aortic Injury Resulting in Late Aortic Dilatation

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Abstract

Keywords

- ▶ traumatic thoracic aortic injury
- ▶ curved nitinol stent-graft
- ▶ homemade stent-graft
- ▶ complication

We present an unusual complication following endovascular repair of traumatic thoracic aortic injury using a homemade stent-graft. Although an initial technical success was apparently obtained, the aorta showed remarkable dilatation without shortening or migration of the stent skeleton in late follow-up period. The possible cause of the dilatation was considered to be the expansion and gathering of the crimped, loosely attached, graft fabric in addition to the incomplete exclusion due to the insufficient landing zone and the limited radial force. Thus, the specific feature of stent-graft, considered to provide an advantage to treatment, has adversely affected the native aorta.

Recently, thoracic endovascular aneurysm repair (TEVAR) of several aortic conditions, including blunt traumatic aortic injury, has rapidly become an accepted alternative to open surgical repair. Several studies have consistently reported a survival advantage with endovascular repair as well as a reduction in major perioperative morbidity, including paraplegia.^{1,2} With the increase in TEVAR, the complication profile, mainly including endoleak, has gradually become clear. Above all, several device-specific complications have also been reported, such as device collapses in traumatic aortic injuries in the steeper and smaller aorta, predominantly in younger people.^{3,4}

In this report, we present an unusual late complication of endovascular repair using a homemade stent-graft, whose specific feature adversely affected the native aorta.

Case Report

A 52-year-old woman met with a traffic accident and was referred to our hospital for the repair of a traumatic thoracic aortic injury. Computed tomography (CT) images revealed aortic disruption at the level of the ligamentum arteriosum, together with mediastinal hematoma (▶Fig. 1a), bilateral

hemopneumothorax, multiple fractures of the sternal bone, right clavicle, and bilateral ribs, ventral hernia due to disruption of the rectus abdominis muscle and mesenterium, and an intestinal injury involving hemorrhagic ascites. The patient was not a candidate for surgical aortic repair because of her concomitant systemic injuries; thus, endovascular repair was considered. After obtaining written informed consent, we performed endovascular repair with a curved Matsui-Kitamura (MK) stent-graft, which was formerly used as homemade stent-graft in several institutions prior to the approval of a commercially available device.^{5–7} The MK stent-graft is constructed from a self-expanding stent comprising a braided single nitinol wire and a seamless, cylindrical woven graft made of polyester fabric. The graft has crimp, and is only sewn at its ends with 5–0 interrupted polypropylene sutures (▶Fig. 2). Its detailed structure has been described previously.⁵

The materials and procedures used were approved by the Medical Ethics Committee of Kanazawa University. The stent-graft was deployed across the damaged segment in an operating room. The left subclavian artery was intentionally occluded without a bypass operation to obtain an appropriate landing zone. The deployed MK stent-graft was 28 mm in

Fig. 1 A 52-year-old woman suffered a traffic accident. (a) Contrast-enhanced CT image showing an aortic disruption at the level of the ligamentum arteriosum (arrowhead), together with a mediastinal hematoma and bilateral hemothorax (arrows). (b) Contrast-enhanced CT image 1 week after stent-grafting showing neither endoleak nor aortic dilatation (arrowheads). (c) Contrast-enhanced CT image 24 months after stent-grafting showing the markedly dilated aorta (arrowheads). (d) Contrast-enhanced CT (oblique-sagittal multiplanar reformatted image) image 24 months after stent-grafting showing the markedly dilated aorta (arrows). The stent-graft without shortening or migration appears intact, an incomplete exclusion of the aneurysm is suspected.

diameter and 106 mm in length, and these dimensions were chosen by measuring the aortic diameter in the landing zone (23 mm) and with the graft oversized by 20%.⁵ The initial placement was apparently successful on aortogram. No complications, such as endoleaks, migration, or access vessels injuries, were identified, and no neurologic complications were noted. Subsequently, the disrupted rectus abdominis muscle and mesenterium as well as the intestinal injury were surgically repaired.

CT images obtained 1 week after the procedure revealed neither endoleak nor aortic dilatation (→Fig. 1b). CT images obtained 1 month, 3 months, 6 months, and 12 months after the procedure also demonstrated no change in the diameter of the aorta and migration. After that, the patient was followed-up every 6 months using CT images, and the aorta gradually dilated. CT images obtained 24 months after the procedure revealed the dilatation of the aorta measuring ~35 mm of maximum diameter. The stent-graft without shortening or migration appeared intact, and the incomplete exclusion of the aneurysm was suspected (→Fig. 1c, d). Originally, a subsequent bridging operation was planned;

however, she rejected the operation and has been followed up without treatment until the present day. The diameter of the aorta has remained stable during the last 22 months.

Discussion

With the widespread use of TEVAR, several kinds of commercially available devices as well as homemade devices, which were used prior to the approval of the commercial devices, have been developed and improved. Each device has unique features, and has both advantages and disadvantages depending on the structure characteristics.⁸ For example, in the commercial device, the Gore TAG (WL Gore & Assoc, Flagstaff, AZ) is tractable and low profile, it cannot be partially deployed and repositioned. As a result, blowback by the arterial pulsation is a significant concern. The stiff longitudinal spine of the Talent device (Medtronic; World Medical Manufacturing Corp., Sunrise, FL) can be disadvantageous in the severely angulated neck.⁸ In addition to device-specific issues, the physical condition of the patient, patient's specific anatomic matters, and the aortic conditions such as aneurysm,

Fig. 2 The Matsui-Kitamura stent-graft is composed of a nitinol stent and polyester fabric. The stent skeleton is composed of a braided single nitinol wire. The graft has crimp, and is only sewn at its ends with 5–0 interrupted polypropylene sutures.

dissection, infection, and trauma are also related to the technical success and complications of TEVAR. For example, the device collapse in traumatic aortic injuries was found to be related to both the steeper and smaller aorta in a majority of younger patients and device-specific structure.^{3,4}

For traumatic aortic injuries, we had formerly used MK stent-grafts, and have had favorable outcomes.^{5–7} The characteristics of the MK stent-graft including its flexibility, shape memory, and small delivery system gave it some advantages for the treatment of traumatic aortic injuries.⁶ The distinctive feature of MK stent-graft, which is also related to the present complication, is that the braided structure of stent skeleton and the possible extended crimp of graft fabric which is only attached at its ends. The braided structure and the characteristic graft fabric can be suited to the aortic wall without damaging, in which it can be extended along the long axis of the aorta. However, the present case resulted in remarkable aortic dilatation in late follow-up period. One of the causes was the incomplete exclusion due to the insufficient landing zone and the limited radial force associated with the braided structure, since the shortening or migration was not identified and stent-graft appeared intact. The another possible cause was presumed to be the fact that the graft had crimp, and was loosely attached to the stent endoskeleton only at the

proximal and distal ends. The gathered crimps of the graft could have put pressure on the damaged aortic wall and bulged out under continuous aortic blood flow resulting in aortic dilatation.

Aortic dilatation after endovascular repair was also reported earlier in aneurysm or traumatic aortic injuries^{9,10}; however, the dilatation was very slight, and showed completely different characteristics from the present case. Nevertheless, the speculated causes, namely, a continual overdilation and an expansible force by stent skeleton, interference with the recovery of the damaged aortic wall by the occlusion of vasa vasorum by the covered portion, and potential friability of the damaged aortic wall,⁹ might possibly be related to the dilatation of the present case.

In conclusion, we report an unusual late complication of endovascular repair using MK stent-graft, whose structural advantages negatively affected the aorta.

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