Hybrid One-Stage Repair Using a Sutureless Telescopied Stent Graft Fixation for Ruptured Multiple Thoracic Aortic Aneurysms

Keiji Kamohara, MD, PhD, Atsuhisa Tanaka, MD, Manabu Itoh, MD, Hiroyuki Morokuma, MD, Kojiro Furukawa, MD, PhD, and Shigeki Morita, MD, PhD

We report the case of a 58-year-old man who underwent emergency one-stage hybrid repair for multiple thoracic aortic aneurysms involving giant arch and ruptured descending aortic aneurysms. Retrograde thoracic endovascular aortic repair for the ruptured descending aortic aneurysm was first performed to stabilize the hemodynamics. Then, a total arch replacement with an open stent graft, which was inserted into the previous stent graft of the descending aorta in a sutureless telescopied fashion, was performed without any technical problems. This procedure may be one useful therapeutic option for multiple thoracic aortic aneurysms, especially for emergency cases requiring one-stage repair.

Keywords: multiple thoracic aortic aneurysms, hybrid one-stage repair, stent graft

Introduction

Surgical treatment of multiple thoracic aortic aneurysms (TAAs) remains technically challenging. Approaches such as two-stage repair using an “elephant trunk” prosthesis,1) median sternotomy with left thoracotomy,2) and clamshell incision3) have been applied to cope with extensive or multiple TAAs. However, these methods have high surgical invasiveness, and there is high interval morbidity and mortality in the two-stage repair.2–4) Since the introduction of thoracic endovascular aneurysm repair (TEVAR), two-stage repair using TEVAR in the second stage has been aggressively performed in our institution.

In this context, we experienced an emergency case of multiple TAAs with giant arch and ruptured descending aortic aneurysms. To minimize the surgical invasiveness, we adopted hybrid one-stage repair consisting of retrograde TEVAR for coverage of the ruptured descending aneurysm as a first step, open stent grafting for connecting with previous stent graft in the descending aorta in a sutureless telescopied fashion, and conventional arch replacement using a four-branched graft.

Case Report

A 58-year-old man was referred to our institution with a diagnosis of ruptured descending aortic aneurysm. On admission, he had persistent chest pain with a heart rate of 110 bpm and blood pressure of 78/42 mmHg. A computed tomography (CT) scan revealed an 80 mm diameter saccular aneurysm of the descending aorta with a large amount of hematoma that caused severe compression of the esophagus (Fig. 1A). In addition, a CT scan also showed a 75 mm diameter fusiform aneurysm of the aortic arch (Fig. 1B). The descending aorta between the arch aneurysm and ruptured descending aneurysm was preserved with a maximal diameter and length of 26 mm and 18 mm, respectively (Fig. 1C).
One-stage complete repair in an emergency setting was required due to ruptured descending aneurysm and giant arch aneurysm. Standard open repair of the multiple TAAs was thought to be a high risk for this patient, who was in vital shock. Therefore, hybrid one-stage repair using TEVAR, open stent grafting, and conventional arch replacement was selected. The ruptured descending aneurysm was initially treated by transfemoral TEVAR under general anesthesia and spinal cord monitoring using motor evoked potentials (MEPs). A 30 mm to 14 cm Zenith TX2 stent graft (Cook Inc., Bloomington, Indiana, USA) was deployed with an adequate distal landing zone above the celiac axis. The 26-mm diameter and 18-mm long preserved aortic portion just distal to the arch aneurysm was used as a temporary proximal landing zone. After covering the rupture site using TEVAR, the vital signs became stable and improved to the normal range. During TEVAR, no ischemic changes occurred in MEPs.

A standard median sternotomy was then performed under stable hemodynamics. Cardiopulmonary bypass was established with arterial cannulation in the ascending aorta and two-stage venous cannulation in the right atrium, and core cooling was started. At a core temperature of 25°C, circulation was arrested with selective cerebral perfusion. The aortic arch was opened and transected between the left common carotid artery and left subclavian artery. At this point, the proximal end of the previously placed TX2 stent graft was clearly discerned through the open distal aortic stump. After closing the orifice of the left subclavian artery, a handmade open stent\(^5\) constructed with polyester graft fabric (34 mm in diameter, 20 cm in length; Japan Lifeline, Tokyo, Japan) and one piece of a self-expanding Gianturco Z stent (Cook Inc., Bloomington, Indiana, USA) at the distal site were used to connect with the TX2 stent graft. During placement of the handmade open stent, the proximal end of the TX2 stent graft was securely grasped with forceps to prevent migration of the TX2 stent graft, and the open stent was inserted into the TX2 stent graft with a sufficient overlap of more than 10 cm in a sutureless telescoped fashion. After the distal anastomosis of a 4-branched graft (Japan Lifeline, Tokyo, Japan) (Fig. 2), reconstruction of branch arteries and proximal anastomosis were performed. MEPs monitoring at the end of the operation revealed no ischemic changes.

The postoperative course was uncomplicated with no endoleak on postoperative CT scans. However, the CT scans showed severe compression of the mid-portion of the esophagus by the residual descending aneurysm and hematoma, which may cause late aortoesophageal fistula (AEF). Currently, about 8 months postoperatively, no
endoleak has occurred with a trend of reduction of esophageal compression by the residual descending aneurysm on CT scans (Fig. 3A and 3B).

Discussion

Treatment of extensive or multiple TAAs involving the aortic arch and the descending aorta still represents a challenge for the surgeon. Since the introduction of the elephant trunk technique, a two-stage operation has become the conventional form of repair for extensive or multiple TAAs. However, this technique involves two major surgical procedures, with one performed through a median sternotomy and the second through a lateral thoracotomy. Therefore, this approach does not eliminate mortality and morbidity due to rupture during the interval between the two stages and increases the cumulative risk. One-stage open repair using a clamshell incision or median sternotomy with left thoracotomy can avoid interval mortality and morbidity, but the excessive invasiveness causes a high incidence of major complications.

Hybrid repair that includes conventional arch replacement with open stent grafting has been reported, and this eliminates the need for left thoracotomy and enables completion of the procedure in one stage according to the distal end of the TAA. In our institution, this one-stage repair approach has been aggressively adopted. When the distal end of the descending aneurysm is not completely sealed using open stent grafting, retrograde TEVAR is added as a second-stage procedure to cover the distal end of the descending aneurysm, which completes the entire treatment under steady hemodynamics or even with arterial pressure augmentation. Therefore, this two-stage hybrid repair may be a less invasive treatment with a lower incidence of major complications such as spinal cord injury and respiratory failure.

One problem with this two-stage strategy is the potential for interim rupture of a residual aneurysm between the two stages because the first stage operation, open arch repair, requires a relatively long time until recovery. However, if hybrid repair is planned in one stage for avoidance of interim rupture, the antegrade or retrograde TEVAR following open arch repair is potentially performed under unstable hemodynamics with a bleeding tendency after the discontinuation of cardiopulmonary bypass, which may cause spinal cord ischemia. Given these concerns, one option is to perform retrograde TEVAR for the descending aneurysm as the first stage, which provides for a quicker recovery, and then perform open arch repair with an open stent for the remaining proximal aneurysm as the second stage.

The advantages of this reverse hybrid repair are: (1) minimization of the risk of interim rupture, (2) reduction of major complications such as spinal cord injury and respiratory failure because of the feasibility of completion of TEVAR and open arch repair under steady hemodynamics without thoracotomy, and (3) achievement of sutureless connection and fixation of the open stent into the previously placed stent graft without the need for dissection around the distal side of the arch aneurysm, resulting in elimination of the risk of significant bleeding and injury of phrenic and/or recurrent nerves. Among elective cases, depending on the size and extent of aneurysms, reverse hybrid repair allows for the completion of the entire treatment in two consecutive days, as the shortest form of two-stage hybrid repair or even one-stage repair. In addition, as performed in the emergency case described in this report, this reverse hybrid repair also provides rapid coverage of the rupture site and consequent hemodynamic stabilization, which is advantageous for perioperative spinal cord protection.

In this case, we selected reverse one-stage hybrid repair from the perspectives of life saving and prevention of spinal injury and respiratory failure. However, this carried a risk of development of AEF after TEVAR, which is avoided by conventional one-stage open repair. AEF after TEVAR is a rare complication, but it is fatal due to massive hemorrhage and severe infection. Therefore, postoperative follow-up to detect both endoleak and AEF is essential.
Conclusion

For patients with multiple TAAs, the reverse hybrid procedure using a sutureless telescopied fixation is one useful therapeutic option, especially for emergency cases requiring one-stage repair. In addition, since this procedure does not require a relatively long period between the two stages, it can be selected as a two-stage technique in elective cases.

Disclosure Statement

None of the authors have a conflict of interest.

References