Case report

Thoracic aneurysm rupture due to graft perforation after endovascular stent-grafting via median sternotomy

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Abstract

We performed emergency repeat surgery for aneurismal rupture due to graft perforation with mechanical stress of the Z stent in a kinking graft after frozen elephant trunk procedure. Graft kinking occurred due to cranial migration of the Z stent. It is important to prevent stent dislodgement in order to achieve long-term durability and reliability in the frozen elephant trunk procedure.

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1. Introduction

Endovascular stent-grafting (EVG) of a thoracic aneurysm via the aortic arch has been performed in Japan for many years. There have been no reports of aneurysm rupture due to graft injury after EVG via median sternotomy. We report here, a case of distal arch aneurysm rupture due to graft perforation by mechanical stress of the Z stents on the kinking graft.

2. Case history

A 70-year-old man was transferred to our emergency room for sudden chest pain. He had undergone distal aortic arch aneurysm repair with EVG via median sternotomy (frozen elephant trunk) 5 years previously. A stent-graft was manufactured with an ultra-thin wall woven Dacron graft (Ubekosan, Ube, Japan) and 50 mm-length of double-linked Z stent on its distal edge. The patient had complications with the graft kinking according to shrinking of the aneurysm 1 year after surgery. There had been no symptoms or signs of endoleakage. His emergent chest CT scan revealed left hemothorax and graft kinking with cranial dislodgment of the Z stent, but no obvious endoleakage or bleeding points in the 5 cm large distal arch aneurysm (Fig. 1). An emergency operation was performed following a diagnosis of aneurysm rupture probably due to type III endoleakage.

Left thoracotomy was applied via the fourth intercostal space. A large amount of hemotoma was present and the lung had a firm adhesion to the aneurysm. Partial cardiopulmonary bypass was established by femoral vein drainage and descending thoracic aorta return. The descending aorta was transected on the distal site of the aneurysm after clamping of the distal aorta and occluding of the stent graft by a Fogarty occlusion balloon (Edwards Lifescience Corp., Irvine, CA). The stent graft was pulled down and the Z stent alone was removed; the graft was re-sutured to the proximal site of the transected aorta with a 4-0 polypropylene running suture. The descending aorta was then interposed with a short segment of 22 mm of Hemashield graft (Boston Scientific, Natick, MA). Heparin action was reversed, but there was large amount of bleeding from parietal pleura near the aortic arch. Epiaortic echography revealed a suspected perforation of the graft, but type I endoleakage was not ruled out. Partial cardiopulmonary bypass was re-established and the aneurysm was opened under hypothermic low flow perfusion at a nasopharyngeal temperature of 25 °C. Two bleeding points were found on two small protrusions on the graft, which would have been pressed by the Z stent edge (Fig. 2). We speculate that mechanical stress of the edge of the Z stent caused the graft perforation. The rest of the graft was intact, so that the bleeding points alone were repaired, using pledgeted 4-0 propylene sutures. The aneurysm was then closed and hemostasis was achieved. The patient was discharged and returned home without any complications or problems on the 21st postoperative day. His postoperative chest CT revealed no endoleakage or graft kinking (Fig. 1).
3. Comment

There are several reports of endoleakage and rupture following catheter-based EVG [1,2]. At the 1st, 5th and 8th year after endovascular repair of descending aortic aneurysm, Demers et al. reported that freedom from endoleakage ran at $78\pm4$, $64\pm5$ and $50\pm9\%$, respectively, and freedom from aortic rupture was $98\pm2$, $91\pm3$ and $80\pm8\%$ [2]. They noted the relatively high incidence of late rupture of patients with endoleakage alone. Very few reports of graft injury exist. Seno et al. reported that type III endoleakage can be caused by a graft injury at the time of stent grafting [1].

The incidence of endoleakage or rupture after frozen elephant trunk procedure is not well known. We have experienced 5 cases, complicated with rupture or endoleakage in the late phase, out of a total of 24 patients. One was a chronic type B dissection; impending rupture was revealed due to false lumen infection 1 year after the operation. Two cases required repeat surgery via left thoracotomy due to endoleakage by cranial dislodgement of the stent at 3 or 4 years after surgery. One died due to aneurismal rupture with type I endoleakage 5 years after surgery. The most recent of these cases was the present case [3,4]. In our series, the free rate of EVG-related events was 61.2% at 5 years after surgery.

We applied an ultra-thin wall woven Dacron graft and a double-linked Z stent on its distal edge. We used 20% oversized stent grafts of the distal aortic neck to get enough radial force, and more than 5 cm of landing zone to achieve adequate endoseal and prevent stent graft migration. However, blood flow causes a curve along the arch in the stent graft. The center of the stent graft was retracted, and graft kinking may occur. The Z stent migrated cranially, consistent with graft kinking, causing type III endoleakage. We applied anchoring sutures to fix the stent graft to the aortic wall, and there have been no EVG related late complications in 13 recent cases.

In the present case, the aneurismal rupture was caused by perforation of the graft due to mechanical stress at the edge of the Z stent. The material of the graft is also important in achieving long durability. The integrity of vascular prostheses is verified prior to clinical application. The burst strength has been measured in the laboratory for grafts, but the relevance of the results in real situations of EVG is not clear. However, the graft used for stent grafting must be thin, for loading in a delivery sheath. We have used an ultra-thin wall woven Dacron graft (Ubekosan, Ube, Japan), which is proving to have adequate mechanical strength even for graft replacement and is commonly used in custom made endovascular stent grafts in Japan.

We have found aneurismal rupture due to graft perforation with mechanical stress of Z stents in a kinking graft after EVG via median sternotomy. Most late complications following this procedure are related to cranial dislodgement of the Z stent. Preventing stent dislodgement is vital in achieving long-term durability and reliability in the frozen elephant trunk procedure.

Fig. 1. Preoperative CT scan showed graft kinking and no endoleak (left). Postoperative CT scan showed neither graft kinking nor endoleak (right).

Fig. 2. Bleeding from the graft.
References


