—Report on Experiments and Clinical Cases—

Surgical Endovascular Stent Grafting for a Ruptured Penetrating Atherosclerotic Ulcer of the Aortic Arch

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Abstract

Penetrating atherosclerotic ulcer (PAU) is defined as an atherosclerotic lesion in which an ulceration occurs in the diseased aortic intima leading to disruption of the internal elastic lamina. It may cause a pseudoaneurysm formation or transmural aortic rupture. We describe a patient in whom a ruptured PAU in the distal aortic arch was treated successfully by a surgical endovascular stent graft. Through a median sternotomy and under deep hypothermic circulatory arrest, the aorta was transected between the left common carotid and subclavian arteries. A dacron prosthetic graft with self-expanding original Z type stents attached inside of the distal half was inserted through the aortotomy to exclude the PAU. By performing the procedure through a median sternotomy, we could eliminate dissection around the ruptured aortic wall. The stented graft was secured safely in the thoracic aorta to exclude the ruptured ulceration located distal to the left subclavian artery. PAU should be recognized widely as a distinct cardiovascular surgical problem which may lead to intramural hematoma with or without dissection or rupture. (J Nippon Med Sch 2002; 69: 49–52)

Key words: penetrating atherosclerotic ulcer, endovascular stent graft

Introduction

Stanson et al. first described penetrating atherosclerotic ulcer (PAU) as a distinct pathologic entity in 1986 in which ulceration penetrated the internal elastic lamina into the media and was associated with a variable amount of hematoma within the aortic wall[1]. Such ulcers may lead to pseudoaneurysmal formation or localized dissection. Although the natural course of PAU remains ill-defined, the affected intima of the aortic wall may be disrupted, leading to rupture.

We describe a patient in whom a ruptured penetrating atherosclerotic ulcer of the distal aortic arch was treated by surgical endovascular stent grafting under deep hypothermic circulatory arrest. This procedure enabled us to exclude the ruptured lesion safely with minimal dissecting around the aortic arch.

Case

A 69-year-old female patient with a history of hypertension and diabetes mellitus was admitted to the intensive care unit of our hospital because of severe back pain and hemoptysis lasting for a couple of days. On admission, her hemodynamic status was

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stable with a systemic blood pressure of 128/84 mm Hg. Auscultatory examination was negative. Laboratory findings were within the normal range, except for slight anemia (serum hemoglobin level of 10.4 g/dL) and an increase in the serum CRP level to 6.3 mg/dL. A chest roentogenogram and contrast enhanced computed tomography (CT) showed an abnormal shadow just adjacent to the aortic arch (**Fig. 1**). No false lumen or intimal flap was observed in the CT. An aortic angiogram performed after admission revealed a small pouch, 2 cm in diameter, on the outside of the aortic arch (**Fig. 2**). After further scrutiny for a differential diagnosis of the lesion around the aortic arch, a PAU which had ruptured into the lung was considered to be most probable, while the possibility of an invasive neoplastic lesion remained.

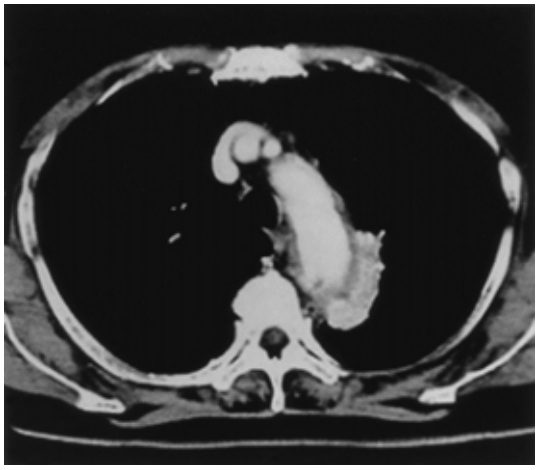

Fig. 1 An enhanced CT scan shows a contrast-enhanced mass around the aortic arch. There is no evidence of an intimal flap or false lumen.

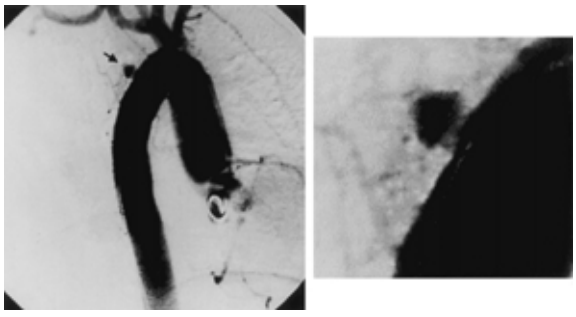

Fig. 2 Preoperative aortic angiogram showing a small pouch, 2 cm in diameter, on the outside of the distal aortic arch.

We decided to perform a surgical stent graft insertion through a median sternotomy. It seemed to us that this approach would allow us to explore the pulmonary lesion as well as to avoid possible risks of dissection around the aortic arch through the left thoracotomy.

The use of the stent graft was approved by the local ethics committee and informed consent was obtained from the patient.

Since there was firm adhesion between the left upper lung and the distal aortic arch, a limited dissection was carried out down to the level of the origin of the left subclavian artery to expose the proximal aortc arch. No tumorous mass was identified in the left upper lobe of the lung.

Cardiopulmonary bypass was initiated with cannulae in the ascending aorta and the right atrium for arterial return and venous drainage. The bilateral axillary arteries were also cannulated for cerebral perfusion. The patient was cooled down to an esophageal temperature of 22 degrees, and the systemic circulation was stopped.

The proximal aortic arch was transected between the left common carotid artery and the left subclavian artery. The subclavian artery was ligated and divided. Selective cerebral perfusion was maintained by perfusing the bilateral axillary arteries and the left carotid artery during the circulatory arrest. A well-demarcated, ulcerated pouch filled with thrombi was found on the medial side of the aorta, 5 cm distal to the subclavian artery. A 26-mm woven Dacron prosthetic graft (Hemashield, Boston Scientific, Boston, USA) with double self-expanding original Z type stents attached to the inside of the distal half was introduced in the aortic lumen (**Fig. 3**). The distal end of the graft was fixed by the stents in the descending thoracic aorta, 6 cm distal to the ulceration. The proximal end of the graft was fixed to the edge of the distal aorta circumferencially with a 4-0 monofilament suture. The transected aorta was approximated again to restore its continuity. The left subclavian artery was reconstructed with a 10-mm Dacron prosthetic graft anastomosed to the ascending aorta. Total circulatory arrest time and total cardiopulmonary bypass time were 48 minutes and 142 minutes, respectively.

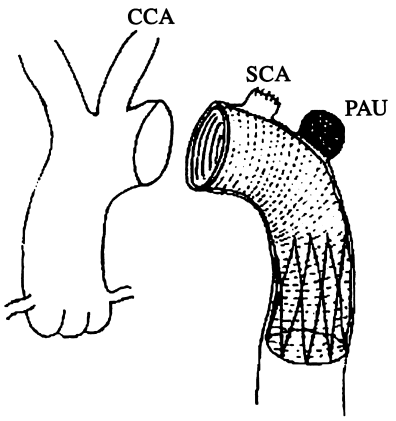

Fig. 3 Operative procedure. For details, see text. CCA: Left common carotid artery; SCA: Left subclavian artery; PAU: Penetrating atherosclerotic ulcer.

Fig. 4 An aortic angiogram, taken 2 months after surgery, shows the exclusion of theulcer.

She recovered uneventfully and was discharged 3 weeks postoperatively.

A postoperative aortic angiogram confirmed the disappearance of outpouching in the aortic arch (**Fig. 4**).

Discussion

Intimal defects resulting from atherosclerotic ulcers occur in patients with advanced atherosclerosis. Stanson et al. reported atheromatous ulcerations in the descending thoracic aorta that had penetrated the internal elastic lamina and resulted in the formation of hematomas in the media[1]. Although the natural history of PAU remains unclear, the intima of the affected aortic wall may distort, leading to pseudoaneurysmal formation, localized dissection, embolization or rupture.

PAU has been found by means of CT, magnetic resonance imaging (MRI) and aortography, to be a distinct clinical entity, consisting of contrast-filled outpouchings of the aorta in the absence of an intimal flap or false lumen. These findings represent distinctly different characteristics from those of classic aortic dissections[2].

The natural history of PAU is still controversial. Some studies suggest that conservative observation should be considered first because of the low incidence of dissection or rupture[3,4], whereas others advocate early surgical intervention for the treatment of PAU[2,5~7]. Since all the above reports were of retrospective studies and the number of cases in each study was rather small, there may have been a certain bias in patient groups in these studies.

Reports on the treatment of PAU by transluminal endovascular stent grafting have been accumulating[8,9]. This seems to be a promising alternative to classical surgery as it could reduce postoperative morbidity and mortality, especially in elderly patients in poor condition. In the present case, transfemoral endovascular stent grafting might have been another option. However, as the CT scan showed the aortic arch was extensively involved in the ruptured PAU close by the left subclavian artery, the proximal stent of a graft would have endangered the origin of the artery. Therefore, we employed an open endovascular stent grafting through a median sternotomy. By adopting this approach, we could exclude ulceration successfully using an endovascular stent graft without further dissection around the distal aortic arch.

This "open" or "surgical" stent graft placement has recently been applied in the treatment for distal aortic arch aneurysm or aortic dissection[10,11]. With minimal dissection of the aortic arch, the aorta is transected between the left carotid and subclavian arteries under a hypothermic circulatory arrest. After the stented graft is placed in the descending thoracic aorta, the transected aorta is approximated again with the proximal end of the stented graft

sewn inside the aorta. The procedure can eliminate the distal anastomosis between the graft and the aorta that is the most crucial maneuver in conventional surgery, thus making the circulatory arrest time significantly shorter and reducing the risk of bleeding. As the proximal end of the graft is fixed firmly on the aortic wall, there is no concern about endoleakage.

The number of reported cases with PAU that require surgical or non-surgical intervention is increasing. In patients suffering from severe, intractable pain in the chest or back without any evidence of aortic dissection, a PAU should be on the list of differential diagnoses. Once the presence of a PAU is diagnosed, regular close follow-ups will be necessary.

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