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Endovascular Stent Graft Repair of Thoracic Aortic Aneurysms

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Purpose

Although there have been ramarkable improvements in the surgical repair of aneurysms of the thoracic aorta, the operative mortality is still remains in unsatisfactory degree mainly due to procedural difficulties as well as complicated circulatory adjunct. Therefore, endovascular surgery is expected to enable successful treatment as a minimally invasive alternative procedure for aneurysms of the thoracic aorta(1).

Since 1995, endovascular stent grafting (ESG) was applied for the aortic aneurysms in the Department of Surgery II, following approval of the Ethics Committee of Tokyo Medical University. The initial clinical results of ESG particularly performed on the aneurysms of the thoracic aorta is reported.

Patients

Fron 1995 to 1997, endovascular stent-graft exclusion of the aneurysm was performed in 55 patients. There were 35 patients with thoracic aortic aneurysms including 4 traumatic and 6 inflammatory. The mean age of this group is 74 years old. The aneurysm was located at the arch, distal to the arch, or in the proximal descending or descending aorta below the level of Th8. There were 20 patients with aortic dissection. The mean age was 64 years old. Nine were type B dissection with an enlarged false lumen (double barrel formation). A localized false lumen (ulcer-like projection, ULP) was observed in 11 patients. The location of the false lumen was in the proximal descending aorta in 4 patients, in the middle descending in 4 and in the distal descending in 3 patients (Table 1).

Method

The stent graft device was constructed of a self-expandable stainless steel Gianturco Z stent (GZV, Cook Inc., Denmark)(2) covered with seamless tube graft of ultrathin-wall woven polyester fabric 0.1 mm in thickness (Intravascular Inc., USA). A 400 cm long guide wire was introduced through the

Table 1 Patients treated by endovascular stent grafting (1995～1997)

Thoracic aortic aneurysm	35 (74 ± 12 yrs.)
aortic arch	1
distal aortic arch	2
proximal descending aorta	17 (trauma: 4)
descending aorta	15 (inflammation: 6)
Aortic dissetion	20 (64 ± 12 yrs.)
type B dissection	9
localized false lumen (ULP)	11
Total	55

brachial artery, across the aortic arch and inserted downstream to the femoral artery. The guide wire was kept under continuous strain by traction at both ends of brachial and femoral access in order to overcome any possible tortousity of the aorto-femoral route when advancing the catheter sheath (tug of wire technique). Stent graft was deployed by pushing out of the sheath which introduced through the femoral artery by the tug of wire technique. Indications for the ESG procedure is aneurysm or intimal tear of the aortic dissection located at least 15 mm below the left sabclavian artery branching for stent graft deployment. Diameter of the stent graft is decided to be 20% greater than the proximal and distal aorta measured by CT scan.

Prior to expansion of the stent graft in the aorta, mean arterial prassure was decreased to approximately 80 mmHg through deep anesthesia and nifedipine administration, in order to prevent migration of the stent graft.

Result

Complete aneurysm exclusion was obtained in 17 patients with aneurysm of the proximal descending aorta, and 13 patients with that of the middle or distal descending thoracic aorta. Major endoleak was detected in 3 patients, due to misplacement or insufficient deployment of the stent graft in the proximal neck of the aneurysm located in the aortic arch or distal aortic arch. Damage to delivery sheath was encountered in the early period of this series. One patient died from multiple organ failure resulting from sudden hypotension caused by retroperitoneal bleeding from a sheath-related iliac artery transection. Distal micro embolism (splenic infarction) was observed in one patient. Arterial wall fixation of the femoral artery was performed in 2 patients. There were no paraplegia nor graft infection after the operation. The initial success rate was 86%, and the operative mortality rate was 6% (Table 2).

Stent graft migration was observed in 2 patients during the follow-up period. Stent graft was again deployed slightly forward to and connect with the previous stent graft in a patient. In the other one, surgical fixation of the stent graft was performed. Under circulatory arrest followed by systemic deep hypothermia induced by the extra corporeal circulation, the aortic arch was cut open, and the migrated stent graft was pulled out at the proximal edge and fixed it with incised wall of the aorta. Surgical lung resection was performed on a patient with uncontrollable hemoptysis. Total aortic arch replacement surgery using a synthetic vascular graft was performed in a patient with major endoleak observed at the distal aortic arch.

As for type B aortic dissection, the intimal tear located below the left subclavian artery branching was successfully closed by stent grafting in 7 patients. However, endoleak remained in 2 patients. The false lumen of the thoracic aorta was entirely thrombosed immediately after neutralization of heparin if re-entry was located below the celiac artery branching. However, residual retrograde blood flow from the re-entry remainde in these 2 patients. Incomplete exclusion of the false lumen was observed in 2

Table 2 Results of endovascular stent grafting of thoracic aortic aneurysm

Thoracic aortic aneurysm of		
aortic arch	endoleak:	1
distal aoritc arch	endoleak:	2
proximal descending aorta	exclusion:	17
descending aorta	exclusion:	13
	damage to sheath:	1
	iliac artery transection:	1

Initial success rate: 86% (30/35)
Mortality rate: 6% (2/35)

Table 3 Results of endovascular stent grafting of aortic dissection

Type B dissection with intimal tear in the proximal descending aorta	closure (entry):	7
	endoleak:	2
Localized false lumen (ULP) in proximal descending aorta	exclusion:	4
middle descending aorta	exclusion:	4
distal descending aorta	exclusion:	3

Success rate: 90% (18/20), Mortality rate: 0%

patients. Minor leakage remained at the anastomotic site of the synthetic graft which was used in previous open surgery. Localized false lumen and ULP were excluded in all patients. The overall initial success rate was 90%, and there was no operative mortality (Table 3).

Discussion

Spinal cord ischemia is one of the most serious complications in patient with aneurysm located below the middle or distal descending thoracic aorta. In these cases, evoked spimal cord potential (ESCP) monitoring(3) was performed according to the direct spinal cord stimulation method under temporary exclusion of the aneurysm by our novel retrievable covered stent device, in order to detect spinal cord ischemia caused by interruption of the critical intercostal arteries nearby the aneurysm. Consequently, there was no paraplegia occurred in this series.

Endoleak at the proximal neck was observed in 2 of 6 patients treated with stent grafts until March 1996. Stent graft migration was observed a year after the operation in 1 patient. Endoleak or migration was induced mainly due to not only technical failure but insufficient preoperative measurement of the aneurysm configuration. In the 7th patient, a sheath was extremely bented when it pass through the tortuous aorto-iliac route and broken by the tip of stent at the time of delivery. After improvement of the delivery sheath by employing much more elastic material and changing the guide wire method into the tug of wire technique July 1996, there was remarkable increase in number of candidates, and also success rate of procedure was improved. However, a serious unexpected complication was experienced in our latest patient. In this case, pull off injury of the common iliac artery was induced when the delivery sheath was withdrawn after successful deployment of stent graft. Bleeding was not anticipated until the blood pressure suddenly dropped without any feeling of sheath friction. There was neither tortuousity of the ilio-femoral artery, nor diameter mismatch between the delivery sheath and the artery. This seems to have been unavoidable technical failure.

It will only be when the risk of complications associated with arterial injury, acute thrombosis, neurological deficit and graft migration is reduced to negligible proportions that endovascular stent graft treatment can truly be recognized as a valid catheter-besed minimally invasive surgical strategy for thoracic aortic aneurysms. The minimally invasive alternative technique is expected not only to enable successful treatment on high risk patients but also to confer benefits on all aneurysm patients by relieving them from the risk of surgery, reducing the need for intensive care and long hospital stays, and thereby decreasing overall costs.

Further investigation is necessary to clarify graft durability, aneurysmal neck enlargement or the fate of the excluded aneurysm sac for long follow-up periods.

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