How to do it

Implantation of an endovascular covered stent-graft for distal aortic arch aneurysm via midsternotomy under pigtail catheter guidance

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Abstract

We implanted an endovascular covered stent-graft for distal aortic arch aneurysm involving the left subclavian artery in 12 cases. A stent-graft was delivered just below the aneurysm via aortotomy with direct vision using a 12 F delivery sheath under guidance of a pigtail catheter placed via the groin artery. The proximal anastomosis of the stent-graft was performed with inclusion technique, and the aortotomy was then closed with it. This technique reduces operative damage by eliminating distal anastomosis and should reduce operative mortality and morbidity. © 1999 Elsevier Science B.V. All rights reserved.

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1. Introduction

Approach and exposure of the distal aortic arch just below left subclavian artery is difficult due to its location, and surgery for distal arch aneurysm has carried the risk of high morbidity and mortality. Implantation of an endovascular covered stent-graft via midsternotomy is one of methods to reduce operative damage by eliminating distal anastomosis. This technique has been previously described by Kato and colleagues [1]. We have applied an endovascular covered stent-graft for distal aortic arch aneurysm involving left subclavian artery to 12 cases since January 1997. We made some modifications to improve the original techniques based on our case experiences.

2. Methods

2.1. Patient material

All patients were assigned to this study under informed consent. We usually implant an endovascular stent-graft to relatively high-risk patients. There were 12 such patients from January 1997 until September 1998, 11 of whom were true aneurysms and one a chronic type B dissection. They were just half of the surgical cases of distal aortic arch aneurysm encountered in this period. All but one patient had preoperative complications as follows: brain infarction in 4, myocardial infarction and angina pectoris in 2, left side pleural adhesion in 2, advanced age (82 years) in 1, severe obesity in 1, and bilateral carotid artery stenosis in 1. Combined procedures were total aortic arch replacement in 1 case, and aortocoronary bypass grafting in 2. The average operation time was 364 min and retrograde cerebral perfusion (RCP) time was 42 min. Cardiopulmonary bypass time averaged 211 min. All patients awoke within 12 h after the operation. Nine patients were extubated within 24 h. In half of the cases, no blood transfusion was used. There was no mortality, but cerebral infarction and paraplegia were complications in 1 case. The average follow-up period was 17 ± 5, ranging from 8 to 28, months. Eleven patients were followed up for more than 1 year. There was no evidence of endovascular leakage, and all 12 aneurysms were thrombosed completely on an enhanced chest computed tomography scan before discharge and 6 months thereafter (Fig. 1).

2.2. Preparation for endovascular covered stent-graft

The endovascular covered stent-graft procedure has been approved by the Nagoya University Ethical Committee. A stainless self-expanding double-linked 8-bend Z stent is
made ourselves for each case. Its diameter is 40% larger
tan that of the descending aorta. The endovascular covered
stent-graft is assembled in the operation room. The Z stent is
inserted into an ultrathin woven Dacron graft (Ubekosan,
Ube, Japan), with a diameter approximately 20% larger than
that of the descending aorta. They are sutured together at
each end of the eight bends. Then the woven Dacron graft is
flipped over and the Z stent is inserted into a 12 F delivery
sheath (Greenfield vena cava filter, Boston Science Corp.,
MA, USA) with an extra-hard guide-wire (Amplatz super-
stiff guidewire, Boston Science Corp.) in its center. The
woven Dacron graft is then flipped back to the normal posi-
tion.

2.3. Operative procedure

The patient is placed in the supine position, and the pigtail
catheter is inserted via the groin artery and placed at the
distal aortic arch (Fig. 2). A mid sternotomy is performed
and a cardiopulmonary bypass is applied with bicaval,
ascending aortic cannulations and left ventricular venting.
The patient is cooled down to 20°C of the nasopharyngeal
temperature, RCP is started, and the heart is arrested with
retrograde cardioplegia without aortic clamping. The ante-
rior wall of an aortic arch is opened transversely. Then the
inside of the aneurysm is inspected, and the pigtail catheter
is grasped. The length of the aneurysm is measured by the
marker on the pigtail catheter, which is then inserted into an
endovascular covered stent-graft using the guide-wire inside
it. Then the endovascular covered stent-graft is inserted into
the descending aorta via aortotomy by guiding the pigtail
catheter (Fig. 1). The Z stent is released and the 12 F deliv-
ery sheath is removed using a solid Teflon rod just below the
aneurysm. The graft is trimmed according to the shape of
the proximal anastomosis site. Proximal anastomosis on the
posterior wall is performed with an inclusion technique, and
the aortotomy is then closed by fixing the anterior wall of
the graft. Deairing of the aorta is performed by venting the
ascending aortic cannulae, and antegrade perfusion is resumed.

3. Discussion

We used a knitted Dacron graft (Gelsheal, Vascutek,
Scotland, UK) with polytetrafluoroethylene (PTFE) covered
stent-graft without pigtail catheter guidance in the first 6
cases. At that time, we experienced some difficulty in insert-
ing the graft into the descending aorta. There was also some
concern about releasing debris from the aneurysmal throm-
bus. A bulky graft would also interfere with inspection of

Fig. 1. Enhanced chest CT findings before and after implantation of an
endovascular covered stent-graft. (A) Enhanced chest CT before operation.
(B) Enhanced chest CT 1 month after operation.

Fig. 2. A pigtail catheter is inserted via the groin artery and is placed at the
distal aortic arch. The pigtail catheter is inserted into an endovascular
covered stent-graft using the guidewire placed inside. Then the endovas-
cular covered stent-graft is inserted into the descending aorta under pigtail
catheter guidance.
the aneurysm and make it difficult to decide the place for Z stent release. There actually was a case complicated with a minor cerebral infarction. Following these experiences, we applied an ultrathin woven Dacron graft under pigtail catheter guidance. When an endovascular covered stent-graft is implanted for a distal aortic arch aneurysm, the key points are how to guide the stent-graft into the descending aorta, and how to decide the place for the stent to be delivered. Forcible insertion of a stent-graft may cause an intimal tear, so as to cause an aortic dissection, and blind insertion may misplace it into the false lumen in patients with a dissecting aneurysm. Smooth and harmless insertion of a stent-graft and correct delivery are possible under pigtail guidance even in a patient with a dissecting aneurysm. A self-expanding Z stent should be delivered into the descending aorta just below the aneurysm. Deep insertion of a stent-graft interrupts blood flow of more intercostal arteries and increases the risk of paraparesis or paraplegia. Conversely, its insufficient insertion may lead to eventual dislocation. An ultrathin woven Dacron graft does not obstruct direct inspection, so the self-expanding Z stent can be delivered to exactly the right place. We believe that the implantation of an ultrathin woven Dacron graft-made stent-graft under pigtail catheter guidance should reduce the chance of arterial injury and spinal cord injury and may improve surgical outcome.

References