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Extra-Anatomic Ascending Aorta to Abdominal Aorta Bypass in Takayasu Arteritis Patients with Mid-Aortic Syndrome

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Background: We evaluated the operative outcomes of an extra-anatomic bypass from the ascending aorta to the abdominal aorta in patients with type II or III Takayasu arteritis (TA) with mid-aortic syndrome. **Methods:** From 1988 to 2014, 8 patients with type II (n=2) or III (n=6) TA underwent an ascending aorta to abdominal aorta bypass. The mean patient age was 43.5±12.2 years and the mean peak pressure gradient between the upper and lower extremities was 54.8±39.0 mm Hg. The median follow-up duration was 54.4 months (range, 17.8 to 177.4 months). **Results:** There were no cases of operative mortality. The mean peak pressure gradient significantly decreased to −2.4±32.3 mm Hg (p=0.017 compared to the preoperative value). Late death occurred in 2 patients. The symptoms of upper extremity hypertension and claudication improved in all patients. The bypass grafts were patent at 47.1±58.9 months in 7 patients who underwent follow-up imaging studies. **Conclusion:** An extra-anatomic ascending aorta to abdominal aorta bypass could be an effective treatment option for severe aortic steno-occlusive disease in patients with type II or III TA, with favorable early and long-term outcomes.

Key words: 1. Extra-anatomic bypass
2. Takayasu arteritis
3. Mid-aortic syndrome

Introduction

Takayasu arteritis (TA) is a rare, nonspecific, systemic inflammatory arteriopathy that causes various types of steno-occlusion or aneurysmal dilatation involving the aorta, its branches, and pulmonary artery [1]. In patients with Ueno type II or III TA, narrowing of the thoracoabdominal aorta, which is known as mid-aortic syndrome, results in upper extremity hypertension and claudication that may require surgical correction. The standard anatomic repair consists of resection and anastomosis or the replacement of a diseased segment [2]. Even though extensive aortic replacement is theoretically possible, complex vascular problems may call for extra-anatomic bypass grafts, especially in cases where long segments are narrowed or if multiple consecutive areas of stenosis are present [3]. The aim of this study was to evaluate early and long-term outcomes after an extra-anatomic bypass from the ascending to abdominal aorta in TA patients with mid-aortic syndrome.

Methods

1) Patient characteristics

From January 1998 to December 2014, 8 patients

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(2 males and 6 females) underwent an ascending aorta to abdominal aorta bypass for TA at Seoul National University Hospital. Two patients had Ueno type II TA and 6 patients had Ueno type III TA. The mean age at operation was 43.5±12.2 years. The most common symptoms were upper extremity hypertension (n=4, 50%) and claudication (n=4, 50%) (Table 1).

Seven patients had a preoperative computed tomography (CT) scan (Fig. 1A) and 1 patient underwent aortography to evaluate the aorta and arch vessels, and transthoracic echocardiography was performed in all patients within 3 months before surgery. The mean diameters of the ascending and narrowed abdominal aorta were 35.6±4.7 mm and 11.3±1.5 mm, respectively (Table 1). The mean peak pressure gradient (PG) between the upper and lower extremities was 54.8±39.0 mm Hg. The left ventricular mass index was 164.2±65.8 g/m^2.

2) Operative strategy

All operations were performed via median sternotomy and split midline laparotomy. After opening the pericardium, proximal anastomosis was done to the anterolateral aspect of the mid-ascending aorta in an end-to-side fashion. Seven patients underwent proximal anastomosis with a side-biting clamp without cardiopulmonary bypass. In the other patient, however, cardiopulmonary bypass and total circulatory arrest were required due to a severely calcified ascending aorta. After the completion of proximal anastomosis, the graft was passed down through the right pleural cavity and anterolateral border of the right-side diaphragm to the peritoneal cavity. The graft was then brought into the retroperitoneal cavity, anteriorly to the liver and posteriorly to the

Table 1. Preoperative characteristics of the study patients (n=8)

Characteristic	Value
Age (yr)	43.5±12.2
Male:female	2:6
Ueno type (II:III)	2:6
Smoking	0
Diabetes mellitus	2 (25.0)
Hypertension	5 (62.5)
History of stroke	1 (12.5)
Overweight (body mass index >25 kg/m^2)	1 (12.5)
Coronary artery disease	3 (37.5)
Chronic renal failure	1 (12.5)
Symptom	5 (62.5)
Claudication	4 (50.0)
Hypertension on upper extremity	4 (50.0)
Headache	2 (25.0)
Peak systolic blood pressure (mm Hg)	
Upper extremity	148.6±41.2
Lower extremity	93.9±20.4
Peak pressure gradient	54.8±39.0
Left ventricle ejection fraction (%)	58.0±10.1
Left ventricle mass index (g/m^2)	164.2±65.8
Operative data	
Diameter of ascending aorta (mm)	35.6±4.7
Diameter of narrowed aorta (mm)	11.3±1.5
Graft size (mm)	13.3±2.4
Cardiopulmonary bypass use	1 (12.5)
Operation time (min)	326.9±54.2

Values are presented as mean±standard deviation or number (%).

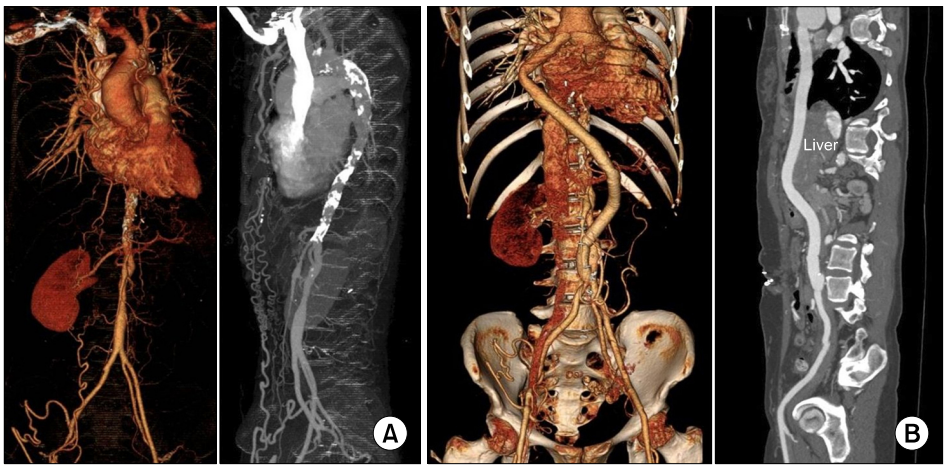

Fig. 1. (A) Preoperative computed tomography angiography. It shows diffuse calcification and narrowing of the descending thoracic and abdominal aorta. (B) Postoperative computed tomography angiography.

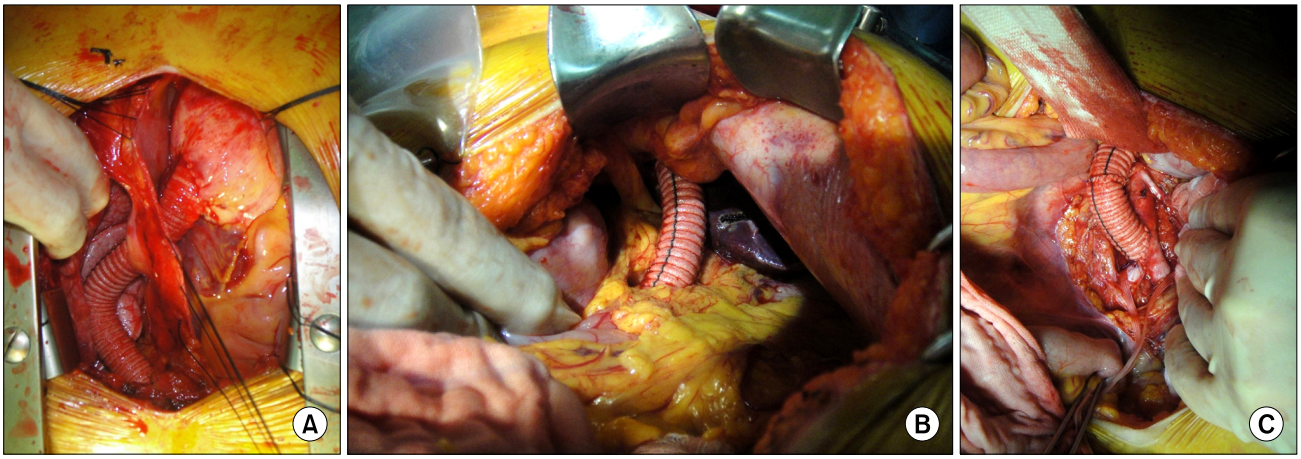

Fig. 2. (A) Operative photographs of the ascending aorta-to-infrarenal abdominal aorta bypass. The graft was anastomosed proximally to the ascending aorta and passed down through right pleural cavity and diaphragm via median sternotomy. (B) Then the graft was made to take ante-hepatic, retro-gastric course and brought into retroperitoneal cavity. (C) The distal anastomosis was performed to infrarenal abdominal aorta, just above the iliac bifurcation.

stomach, and was anastomosed to the infrarenal abdominal aorta, just above the iliac bifurcation under cross-clamps at the proximal and distal parts of the anastomosis site (Fig. 2). Commercially available vascular grafts were used with graft sizes ranging from 12 to 18 mm. The distal anastomosis site was wrapped with omentum and the posterior parietal peritoneum was closed to prevent an aorto-intestinal fistula and pseudoaneurysmal changes.

3) Evaluation of early and long-term clinical outcomes

Patients underwent regular postoperative follow-up in our outpatient clinic at 3- to 4-month intervals. The clinical follow-up period for this study ended on March 31, 2016. Follow-up was complete in all patients, with a median follow-up duration of 54.4 months (range, 17.8 to 177.4 months). The peak systolic PG between the upper extremity and lower extremity (upper extremity systolic pressure minus lower extremity systolic pressure) was checked before discharge in all patients. An early postoperative graft evaluation (within 2 months after surgery) was performed in 6 patients using CT (Fig. 1B), and a follow-up CT scan was carried out in 7 patients at 39.6 months (range, 0.4 to 170.9 months) after surgery. Final follow-up echocardiography was done in 6 patients at 45.8 months (range, 0.8 to 155.4 months) after surgery.

4) Statistical analysis

Statistical analyses were performed using IBM SPSS ver. 22.0 (IBM Corp., Armonk, NY, USA). Values were presented as mean±standard deviation, median with ranges, or proportions. The Wilcoxon signed-rank test was used to compare the changes in the peak PG and the left ventricular mass index. Survival analysis was performed using the Kaplan-Meier method. All p-values <0.05 were considered to indicate statistical significance.

Results

1) Early results

There were no cases of early mortality. The postoperative complications included respiratory complications (n=1) and a wound problem (n=1) (Table 2). The intensive care unit stay and hospital stay were 1.92 days (range, 1 to 27.2 days) and 12 days (range, 6 to 74 days), respectively. The peak systolic PG between the upper and lower extremities decreased significantly immediately after surgery, from 54.8±39.0 mm Hg to −2.4±32.3 mm Hg (p=0.017).

2) Follow-up results

Late death occurred in 2 patients. One patient died suddenly without any notable cause 7 months after surgery and the other patient died from multiple myeloma 8 months after the operation. The actuarial survival rates at 5 and 10 years were 75% and 75%,

Table 2. Early clinical outcomes of the study patients(n=8)

Variable	Value
In-hospital mortality	0
Hospital stay (day)	13 (6–74)
Intensive care unit stay (day)	1.9 (1–27.2)
Ventilator support (hr)	20 (3–556)
Peak systolic blood pressure (mm Hg)	
Upper extremity	125.3±22.6
Lower extremity	127.6±27.1
Peak pressure gradient	−2.4±32.3
Left ventricle mass index (g/m^2)	111.9±35.0
Complications	
Respiratory complication	1 (12.5)
Wound problem	1 (12.5)
Bleeding reoperation	0

Values are presented as number (%), median with ranges, or mean± standard deviation.

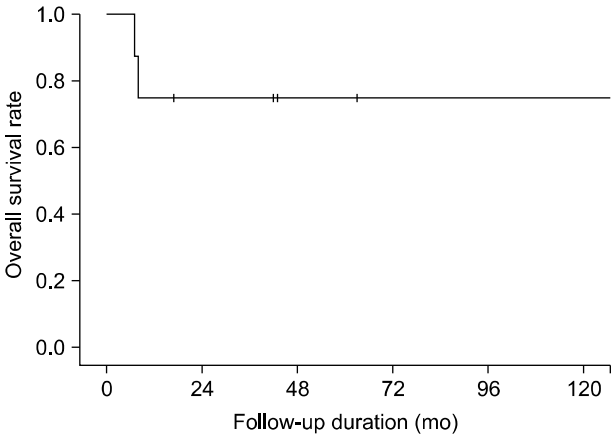

Fig. 3. Kaplan-Meier overall survival estimates.

respectively (Fig. 3). Symptoms of upper extremity hypertension, claudication, and headache improved in all patients. The bypass grafts were patent at 47.1± 58.9 months in the 7 patients who underwent follow-up imaging studies. No patients suffered from vascular complications such as graft infection, graft-intestinal fistula, or pseudoaneurysmal changes up to 5.2±5.2 years after surgery. The left ventricular mass index decreased after surgery from 164.2±65.8 g/m^2 to 111.9±35.0 g/m^2, but this change was not statistically significant (p=0.116).

Discussion

This study demonstrated that an extra-anatomic bypass from the ascending to infrarenal abdominal aorta might be a safe and effective treatment option for TA patients with mid-aortic syndrome.

TA is a nonspecific form of large-vessel vasculitis first described in 1908 by Mikito Takayasu, a Japanese ophthalmologist. The disease predominantly involves large vessels, and causes steno-occlusive lesions or aneurysmal changes in the aorta, its primary branches, and the pulmonary artery. It is classified into 3 types according to the extent of the disease; type III TA is the most common and characterized by a combination of type I, which presents as occlusive lesions of the major branches of the aortic arch, and type II, which affects the thoracoabdominal aorta and its branches [4]. Usually, medical treatment with corticosteroids is used as an initial management strategy to alleviate systemic inflammatory processes. In cases of steroid resistance or relapse after cessation of the steroids, immunosuppressive agents such as methotrexate, cyclophosphamide, or azathioprine are tried [5]. Although endovascular treatments, such as percutaneous transluminal angioplasty, have become attractive for steno-occlusive aortic lesions resulting from TA [6], restenosis in the treated lesions still remains a common complication [7]. The anatomic correction of aortic disease comprises resection and anastomosis or the replacement of diseased segments. Even though extensive aortic replacement may be possible with advances in cardiovascular surgery, complex vascular problems may call for extra-anatomic bypass grafts.

The concept of utilizing the ascending aorta as an inflow source for such bypass grafts was described by Shumacker Jr et al. [8] in 1968 in a patient with a mycotic aneurysm of the thoracic aorta following coarctation repair. Several case reports have described extra-anatomic aortic bypass surgery between the ascending aorta and the infra-renal abdominal aorta, including our previous study [9-11]. The basic concepts of the procedure performed in this study are similar to those cases. In the current study, surgery was mainly required due to upper extremity hypertension caused by descending thoracic and abdominal aortic stenosis. We performed extra-anatomic bypass grafts because the lesions were regarded as too extensive for standard treatment. When performing a distal anastomosis, great care is needed to ensure that the distal anastomotic site is well covered

with the posterior parietal peritoneum, and the distal part of the graft should be wrapped with omentum. Doing so may be helpful for preventing potentially fatal complications, such as aorto-intestinal fistula and pseudoaneurysmal changes of the anastomosis site [12]. Although the number of patients was small, no patients suffered from complications related to the bypass graft up to 5.2±5.2 years after surgery.

There are several limitations to the present study that must be recognized. First, this is a retrospective observational study conducted at a single institution. Second, the number of enrolled patients was too small to generalize long-term outcomes, such as long-term survival. However, to the best of our knowledge, this is the largest case series reporting the results of extra-anatomic bypass using the ascending aorta.

In conclusion, an extra-anatomic ascending aorta to abdominal aorta bypass may be an effective treatment option for severe aortic steno-occlusive disease in patients with type II or III TA, with favorable early and long-term outcomes.

Conflict of interest

No potential conflicts of interest relevant to this article are reported.

Acknowledgments

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References

1. Giordano JM. *Surgical treatment of Takayasu's arteritis.* Int J Cardiol 2000;75 Suppl 1:S123-8.
2. Heinemann MK, Ziemer G, Wahlers T, Kohler A, Borst HG. *Extraanatomic thoracic aortic bypass grafts: indications, techniques, and results.* Eur J Cardiothorac Surg 1997;11: 169-75.
3. Blaisdell FW, De Mattei GA, Gauder PJ. *Extraperitoneal thoracic aorta to femoral bypass graft as replacement for an infected aortic bifurcation prosthesis.* Am J Surg 1961; 102:583-5.
4. Ueno A, Awane Y, Wakabayashi A, Shimizu K. *Successfully operated obliterative brachiocephalic arteritis (Takayasu) associated with the elongated coarctation.* Jpn Heart J 1967;8:538-44.
5. Ogino H, Matsuda H, Minatoya K, et al. *Overview of late outcome of medical and surgical treatment for Takayasu arteritis.* Circulation 2008;118:2738-47.
6. Bali HK, Bhargava M, Jain AK, Sharma BK. *De novo stenting of descending thoracic aorta in Takayasu arteritis: intermediate-term follow-up results.* J Invasive Cardiol 2000; 12:612-7.
7. Saxena A, Kothari SS, Sharma S, Juneja R, Srivastava S. *Percutaneous transluminal angioplasty of the aorta in children with nonspecific aortoarteritis: acute and follow-up results with special emphasis on left ventricular function.* Catheter Cardiovasc Interv 2000;49:419-24.
8. Shumacker Jr HB, Nahrwold DL, King H, Waldhausen JA. *Coarctation of the aorta.* Curr Probl Surg 1968;5:1-61, 63-4.
9. Matsuno Y, Mori Y, Umeda Y, Imaizumi M, Takiya H. *A successful case of ascending aorta: abdominal aorta bypass for middle aortic syndrome.* Vasc Endovascular Surg 2009;43:96-9.
10. Yun JK, Kim JB. *Extra-anatomic aortic bypass for the management of mid-aortic syndrome caused by Takayasu arteritis.* Korean J Thorac Cardiovasc Surg 2015;48:70-3.
11. *Ahn H, Hwang HY. Ascending aorta-abdominal aorta bypass for Takayasu's arteritis.* Asian Cardiovasc Thorac Ann 2003;11:357-8.
12. Gelfand ET, Callaghan JC, Sterns LP. *Extended aortic bypass.* J Thorac Cardiovasc Surg 1980;79:381-7.