

Anaortic Off-pump Coronary Artery Bypass Grafting in Patients with Takayasu's Arteritis

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Background: Coronary involvement in Takayasu's arteritis is a rare but fatal disease. The aim of this study was to evaluate the early and mid-term results of Takayasu's arteritis patients who underwent coronary artery bypass grafting (CABG). **Materials and Methods:** Of 2,280 patients who underwent isolated CABG from January 1998 to June 2012, Takayasu's arteritis was identified in 5 patients. There were 3 female patients, and the mean age was 58±9 years. Takayasu's arteritis was diagnosed during preoperative evaluation for coronary artery disease in 4 patients, and the initial manifestation was angina pectoris in 4 patients. All of the patients underwent anaortic off-pump CABG (OPCAB) using the *in situ* left or right internal thoracic arteries (ITA); 3 patients had severe stenosis of the proximal left subclavian artery and the *in situ* right ITA was used instead. Medical treatment for inflammatory arteritis during the perioperative and follow-up period was performed if indicated. Early, 1-year, and 5-year angiographic results and clinical outcomes were analyzed. **Results:** There was no surgical mortality, and all of the patients were discharged without complications on postoperative 8±2 days. Early postoperative (postoperative 2±1 days) angiography demonstrated a graft patency of 100% (12 of 12 distal anastomoses). One-year (13±3 months) angiography was performed in 4 patients, and all of the grafts were patent (100%, 9 of 9 distal anastomoses). **Conclusion:** By performing anaortic OPCAB in patients with Takayasu's arteritis, we were able to avoid complications associated with manipulating an atherosclerotic and severely calcified ascending aorta. The early and mid-term graft patency of OPCAB in Takayasu's arteritis was maintained when concomitant with medical treatment.

Key words: 1. Takayasu's arteritis
2. Coronary artery bypass surgery
3. Off-pump

INTRODUCTION

Takayasu's arteritis (TA) is a vasculitis of the large vessels affecting the aorta and its major branches. The incidence of coronary artery involvement complicating TA has been reported as approximately 10% in patients with a clinical diagnosis of TA [1]. The clinical manifestation of coronary in-

volvement in patients with TA could be lethal because occlusion of the ostia and proximal segment of the coronary arteries is found frequently [1,2]. Of several therapeutic options for coronary artery disease in TA, surgical revascularization is very often recommended [1,3,4]. Previous studies have reported results of coronary artery bypass grafting (CABG) using an aortocoronary bypass technique [3-7]. However, there

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Table 1. Preoperative computed tomographic angiography findings

Findings	No. of patients
Severe calcification of ascending aorta	5
Diffuse wall thickening of thoracoabdominal aorta	5
Total occlusion or severe stenosis of left subclavian artery	3
Severe stenosis of left common carotid artery	2
Severe stenosis of right common carotid artery	1
Severe stenosis of both internal carotid arteries	2

have been only a few studies demonstrating the results of anaortic off-pump CABG (OPCAB) using an *in situ* arterial graft in this population. The aim of this study was to evaluate early and mid-term angiographic results of anaortic OPCAB using *in situ* arterial grafts in patients with TA.

METHODS

1) Patients

Of 2,280 patients who underwent isolated CABG from January 1998 to June 2012, 5 patients (0.2%) had a history of TA. Four patients were diagnosed with TA while they were under evaluation for coronary artery disease, and 1 patient had been diagnosed with TA before diagnosis of coronary artery disease. Preoperative computed tomographic (CT) angiography showed severe atherosclerosis of the thoracic and abdominal aorta and severe stenosis of multiple large arteries in all of the patients (Table 1). The diagnosis of TA was established by the American College of Rheumatology 1990 criteria for the classification of TA (at least 3 of the following criteria: age \leq 40 years at disease onset, claudication of the extremities, decreased brachial artery pressure, blood pressure difference $>$ 10 mmHg between the arms, bruit over the subclavian arteries or aorta, and abnormal arteriographic results) [8]. There were 3 female (60%) and 2 male (40%) patients, and their mean age was 58 ± 9 years (range, 44 to 65 years). Four patients (80%) had angina as an initial manifestation, and one patient was incidentally diagnosed as having severe coronary artery disease during a diagnostic work-up for underlying renal cell carcinoma. Preoperative coronary angiography revealed that the ostium or proximal part of the

Table 2. Preoperative coronary artery angiography findings

Significant lesion	No. of patients
Left main coronary artery	3
Ostium of right coronary artery	3
Ostium of LAD or LCx	3
Distal LAD and LCx	3
Distal right coronary artery	2
Diagonal branch	1

LAD, left anterior descending coronary artery; LCx, left circumflex coronary artery.

coronary arteries, such as the right coronary artery (RCA), left coronary artery, and left main coronary artery, were involved in most cases; lesions of the distal coronary artery system were relatively rare (Table 2).

2) Operative strategies

OPCAB was performed as previously described [9]. Our surgical strategies during the study period were as follows: (1) performing off-pump revascularization while avoiding aortic manipulation; (2) complete revascularization if possible, using a composite graft anastomosed to the available *in situ* internal thoracic arteries (ITA). Aortocoronary bypass was not considered in patients with TA because of severe calcification and thickening of the aortic wall, which was identified in preoperative CT angiography and intra-operative examination. An *in situ* left ITA was used for revascularization in 2 patients who had a preserved left subclavian artery. In the other 3 patients, an *in situ* left ITA was not used because the patients showed severe stenosis of the proximal left subclavian artery; an *in situ* right ITA was used instead. The grafts created for composite grafting were the right gastroepiploic artery (n=3), saphenous vein (n=2), and left ITA (n=1). The numbers of anastomoses were 1 in 1 patient, 2 in 1 patient, and 3 in 3 patients (mean number of distal anastomoses per patient= 2.4 ± 0.9).

The patients received an initial dose of 1.5 mg/kg of heparin and periodically received supplemental doses to maintain an activated clotting time of greater than 300 seconds. The distal anastomosis was constructed using a continuous technique with 8-0 polypropylene sutures.

All of the patients took aspirin (200 mg/day) until the day

of surgery and resumed it as soon as possible after surgery, usually 1 day postoperatively. Ticlopidine hydrochloride (200 mg/day) was used simultaneously with aspirin for 2 months during the early postoperative period. Antilipid therapy was initiated postoperatively if the patient had a high blood low-density lipoprotein cholesterol level (>100 mg/day). Perioperative anti-inflammatory therapy was considered by rheumatologists in patients in the active stage of TA. One patient was in the active stage of TA preoperatively, and he underwent steroid therapy for 3 months before undergoing OPCAB. All of the patients underwent steroid therapy after the surgery to control the activity of the TA. Two patients showed aggravated clinical symptoms of vascular insufficiency and elevation of the erythrocyte sedimentation rate and C-reactive protein levels during follow-up after the surgery; azathioprine was thus added to the steroid therapy.

3) Evaluation of clinical outcomes

The patients underwent regular postoperative follow-up with a cardiac surgeon and rheumatologist through the outpatient clinic. Operative mortality was defined as death within 30 days, including death after hospital discharge. Cardiac death was defined as a death related to cardiac events, including sudden death during follow-up. Major adverse cardiovascular or cerebral events included acute myocardial infarction, coronary reintervention, death from any cause, and cerebrovascular event.

4) Angiographic evaluation of patency

Patients underwent early, 1-year, and 5-year follow-up coronary angiograms regardless of angina symptoms for evaluation of the anastomotic sites and patency of the grafts. All of the patients underwent early postoperative (2.0 ± 1.0 days) angiograms. One-year (13 ± 3 months) angiography was performed in 4 patients who were followed up for 1 year or more, and 5-year (63 ± 3 months) angiography was performed in 3 of the 4 patients who were followed up for 5 years or more.

RESULTS

The patients' characteristics and clinical data are described

in Table 3.

1) Early and mid-term clinical outcomes

There was no operative mortality or postoperative morbidities. The patients were discharged on postoperative 8 ± 2 days (range, 6 to 10 days). One patient underwent coronary reintervention 5 years after the surgery because of occlusion of the right ITA graft anastomosed to the RCA of a moderately stenosed lesion. The other 4 patients had no major adverse cardiovascular or cerebrovascular events during follow-up. One late sudden death occurred about 3 years after the surgery.

2) Early, 1-year and 5-year angiographic results

The early postoperative angiography demonstrated a patency rate of 100% (12 of 12 distal anastomoses). One-year follow-up angiography demonstrated a patency rate of 100% (9 of 9 distal anastomoses). Five-year follow-up angiography was performed in 3 patients and the patency rate was 83% (5 of 6 distal anastomoses). Occlusion of a right ITA graft anastomosed to the RCA of a moderately stenosed lesion occurred in 1 patient. The patient underwent percutaneous coronary intervention at postoperative 67 months.

DISCUSSION

The present study demonstrated two major findings. First, anaortic off-pump revascularization using available *in situ* arterial grafts may avoid operative morbidity in patients with TA. Second, early and mid-term results of angiographic graft patency and clinical outcomes showed satisfactory results when followed up with a rheumatologist for control of the inflammatory disease.

TA is a chronic inflammatory disease of medium and large arteries, and mainly involves the aorta and its major branches, especially their orifices [2]. It predominantly affects young females (almost 90%) with an onset between 10 and 50 years, and a high prevalence is reported in Japan, Southeast Asia, India, and Mexico [1]. Cardiac manifestations of TA are the consequences of the various features related to TA: hypertension, aortic regurgitation, coronary artery and pulmonary artery involvement, and direct involvement of the

Table 3. Summary of characteristics of five cases

Characteristic	Case 1	Case 2	Case 3	Case 4	Case 5
Age/gender	44/Female	62/Female	65/Female	66/Male	53/Male
Presentation	Unstable angina	Unstable angina	Unstable angina	Unstable angina	None
Coronary angiography	Ostial stenosis of RCA Occlusion of left SCA	Ostial occlusion of RCA Stenosis of LMCA Stenosis of mid LAD Stenosis of proximal LCx Occlusion of left SCA	Stenosis of LMCA Stenosis of mid LAD Stenosis of mid RCA Stenosis of left SCA	Total occlusion of LAD Stenosis of proximal LCx Stenosis of distal RCA	Stenosis in LMCA Stenosis of D1 branch Stenosis of mid-LAD Stenosis of distal LCx Tight stenosis of left SCA
Surgical procedure	<i>In situ</i> right ITA to RCA	Free RGEA graft to <i>in situ</i> right ITA graft as an I graft, free RSV graft to <i>in situ</i> right ITA graft as Y graft; RGEA to LAD and D, SV to OM	Free RGEA graft to <i>in situ</i> left ITA graft as a U graft, remnant RGEA graft to <i>in situ</i> right ITA graft as an I graft; <i>in situ</i> left ITA to LAD, RGEA to OM, right ITA-RGEA to RCA	SV to <i>in situ</i> left ITA as a Y graft; <i>in situ</i> left ITA graft to LAD, SVG to R and distal OM	Free RGEA to <i>in situ</i> right ITA as a I graft and free left ITA to free RGEA; RGEA to LAD, RGEA-left ITA to OM3
Angiography					
Early postoperative	Patent	All patent	All patent	All patent	All patent
1-Year	Patent	All patent	All patent	Not done	All patent
5-Year	Right ITA graft occlusion-PCI to RCA	Follow-up loss	All patent	Not done	All patent

RCA, right coronary artery; LMCA, left main coronary artery; LAD, left anterior descending coronary artery; SCA, subclavian artery; LCx, left circumflex coronary artery; D, diagonal; ITA, internal thoracic artery; RGEA, right gastroepiploic artery; RSV, reversed saphenous vein; SVG, saphenous venous graft; R, Ramus; OM, obtuse marginal; SV, saphenous vein; PCI, percutaneous coronary intervention.

myocardium. Coronary involvement occurs in approximately 10% of TA patients, and causes symptoms by myocardial ischemia and congestive heart failure [1].

Of the therapeutic options available for coronary artery disease, percutaneous coronary intervention may be performed in TA; however, it has been reported in very limited cases, and the results have not been satisfactory [10]. The presence of chronic inflammation and calcification of the aorta and its branches associated with severe coronary artery disease also pose difficulties for surgeons choosing the optimal surgical option. The inflammatory process usually involves the entire aortic wall, resulting in thickening of the intima, degeneration of the elastic tissue, and proliferation of the connective tissue in the medial layer, which leads to aortic wall thickening and loss of elasticity [11]. Preoperative evaluation of inflammatory activity is mandatory in TA patients. If the TA is in the active stage of inflammation, treatment for coronary artery disease should be delayed and anti-inflammatory treatment for TA must come first for a better outcome [12].

However, in patients with unstable angina or myocardial infarction, treatment for coronary artery disease is usually required without delay because of the potentially fatal outcome [12].

The incidence of cerebrovascular accident becomes higher when manipulating the aorta with heavy calcification. A recent meta-analysis demonstrated that avoiding aortic manipulation during CABG decreased the rate of perioperative stroke [13]. For myocardial revascularization, a saphenous vein graft has commonly been used with a method of direct anastomosis to the ascending aorta because the subclavian arteries, from which the ITA originate, are commonly affected vessels in TA [3-5,7]. In addition, ITAs have rarely been used for *in situ* grafting because the arterial grafts can be influenced by the underlying TA itself and graft occlusion may occur later. However, failure of saphenous vein grafts occurs frequently, mainly at the proximal anastomosis site, due to intimal thickening of the aorta. The long-term graft patency of the saphenous vein graft in TA was limited to 60% at 4 years after

surgery [14]. In the present study, all 5 patients had severe calcification, atherosclerosis, and thickening of the aortic wall diagnosed by preoperative CT angiography and intra-operative examination. In these patients, aortic cannulation and partial clamp application for direct graft anastomosis may cause critical results such as cerebrovascular accident or aortic wall disruption. We avoided manipulating the thickened and calcified ascending aorta by performing anaortic OPCAB, and there were no complications such as cerebrovascular event or other embolic events. Available *in situ* arterial grafts were used for coronary revascularization instead of aortocoronary bypass. *In situ* arterial grafts such as ITA or right gastroepiploic artery were used if there was no significant stenosis or occlusion at the inflow arteries; the inflow artery of the graft was confirmed to be patent in preoperative coronary angiography and CT angiography. In the present study, 1-year follow-up angiography showed graft patency of 100% in four patients, and 5-year follow-up angiography showed graft patency of 83%. The outcome of intervention or bypass surgery in TA is significantly influenced by the activity of arteritis [15]. Control of disease activity in TA is one of the most important factors for maintaining long-term graft patency [11]. In the present study, 3 patients (60%) were further treated with anti-inflammatory medications during follow-up at the rheumatology outpatient clinic.

There are limitations to the present study that must be recognized. First, our study included only a small number of patients. Second, more follow-up is needed on these patients to evaluate long-term graft patency and clinical outcomes.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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