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ORIGINAL ARTICLE

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An evaluation of the long-term patency of the aortocoronary bypass graft anastomosed to a vascular prosthesis

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Key question

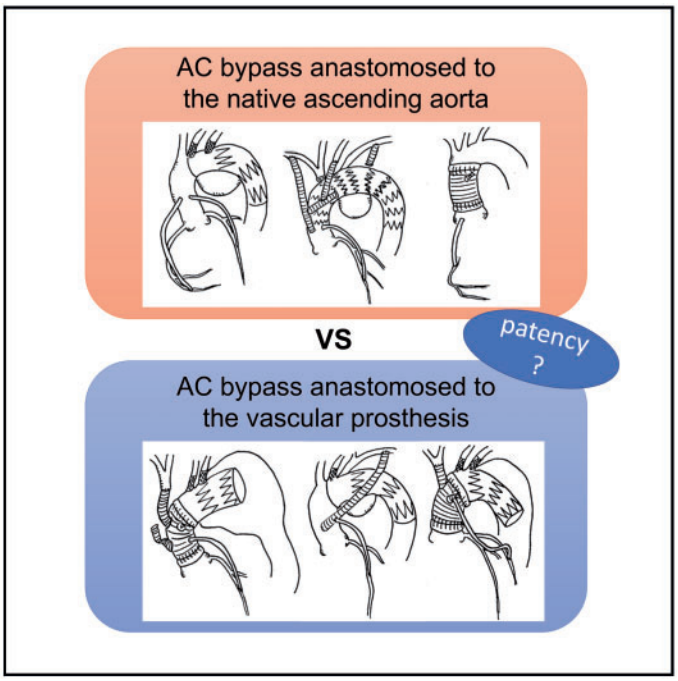
What is the long-term patency of the aortocoronary bypass graft anastomosed to a vascular prosthesis?

Key finding(s)

The patency of the grafts anastomosed to the vascular prosthesis was significantly worse than that of the native aorta.

Take-home message

In concomitant coronary artery bypass grafting and thoracic aortic surgery, aortocoronary bypass on vascular prosthesis should be avoided.



Abstract

OBJECTIVES: Although concomitant surgery for coronary artery disease (CAD) and thoracic aortic aneurysm is performed often, the long-term patency of the coronary artery bypass grafting (CABG) anastomosed to a vascular prosthesis has not been fully investigated. Here, we explored the long-term patency of the graft in comparison with the proximal anastomosis site on the native ascending aorta or vascular prosthesis.

METHODS: A total of 84 patients with concomitant CABG who underwent surgery for thoracic aortic aneurysm at 3 Osaka Cardiovascular Research Group institutes were retrospectively investigated for this study. The patency of 109 aortocoronary bypasses using saphenous vein grafts was evaluated with computed tomography angiography or coronary angiography, comparing the grafts anastomosed on the vascular prosthesis (group P, $n = 75$) to those anastomosed on the native ascending aorta (group N, $n = 34$).

RESULTS: During 45.9 ± 39.7 months follow-up, significantly worse patency of the grafts in group P was revealed when compared with those in group N (100% vs 77.6% in 12 months, 100% vs 52.7% in 36 months and 100% vs 31.6% in 57 months, log rank $P < 0.001$). The poor patency of the grafts was confirmed in each target lesions (left anterior descending artery: $P = 0.050$, right coronary artery: $P = 0.045$, left circumflex artery: $P = 0.051$) and regardless of the severities of the target coronary vessels (severe stenosis: $P = 0.013$, mild-to-moderate stenosis: $P = 0.029$). Furthermore, an analysis of graft occlusion risk factors using the univariate Cox proportional hazards model revealed that the proximal anastomosis site on the vascular prosthesis was the sole risk factor for graft occlusion ($P < 0.001$).

CONCLUSIONS: In the simultaneous surgery for CAD and thoracic aortic aneurysm, CABG design from vascular prosthesis to coronary artery should be avoided if possible, although further studies are warranted.

Keywords: Coronary artery bypass grafting • Coronary artery disease • Thoracic aortic aneurysm • Concomitant surgery

ABBREVIATIONS

AC	Aortocoronary
CABG	Coronary artery bypass grafting
CAD	Coronary artery disease
COPD	Chronic obstructive pulmonary disease
CPB	Cardiopulmonary bypass
CT	Computed tomography
CTA	Computed tomography angiography
SVG	Saphenous vein graft
TAA	Thoracic aortic aneurysm
TAR	Total arch replacement

INTRODUCTION

Coronary artery disease (CAD) is often detected during preoperative examinations for the treatment of thoracic aortic aneurysm (TAA), and in such cases, coronary artery bypass grafting (CABG) should be performed simultaneously in addition to providing TAA treatment. Previous studies have reported the incidence of the concomitant operation for CAD and TAA to be 15–30% of all surgeries for TAA [1]. The prognosis of the patients with simultaneous CABG and total arch replacement (TAR) has been considered worse than patients with isolated TAR [2, 3], although more recent studies have reported almost equivalent outcome for the patients with CABG and TAR attributable to the recent treatment improvements [4, 5].

Since internal thoracic artery is not suitable when the aneurysm involves cervical branches, saphenous vein graft (SVG) is frequently used in simultaneous surgery for CABG and TAA; however, the patency of SVG anastomosed to the vascular prosthesis has not been fully studied. Although previous papers reported a favourable patency of the grafts [1], the follow-up period was only limited to early phase, and little is known about the long-term patency of the grafts.

Here, we explored the mid- and long-term patency of an SVG anastomosed to a vascular prosthesis and found the cumulative patency rate to be worse when compared to the SVG anastomosed to the native ascending aorta.

PATIENTS AND METHODS

Patients

The data of 106 adult patients who underwent simultaneous surgery for CAD and TAA at the Department of Cardiovascular Surgery at Osaka University Hospital, Osaka National Hospital, and Fukui Cardiovascular Centre between January 2002 and December 2016 were retrieved from the Osaka Cardiovascular Research Group (OSCAR) database (approved by the institutional ethics committee of Osaka University Hospital). Among the 106 patients, 11 patients without postoperative coronary artery graft evaluation with diagnostic imaging and 11 patients without aortocoronary bypass (AC bypass) using SVG were excluded; finally, we retrospectively evaluated 84 patients from 3 institutes (Fig. 1).

CABG from the native ascending aorta or the vascular prosthesis after the graft replacement of the ascending aorta to the coronary artery was defined as AC bypass. Based on the proximal anastomosis site, the patients were classified into 2 groups: (i) group N—patients whose proximal anastomoses were on the native ascending aorta ($n = 25$, 34 bypasses) and (ii) group P—patients with proximal anastomoses on the vascular prosthesis ($n = 59$, 75 bypasses) (Fig. 1). Sequential bypasses (23 bypasses) were also included in the AC bypass, although only the first anastomosis sites were evaluated.

Operative procedures

Operative procedures for TAA were dependent on individual surgeons. Generally, Bentall procedure was performed to treat TAA on Valsalva sinus, with simultaneous graft replacement of the ascending aorta or aortic arch if required. For the treatment of an ascending aortic aneurysm or type A aortic dissection, graft replacement of the ascending aorta was the first choice. For an aortic arch aneurysm, conventional TAR was selected initially. Since we changed our strategy from open surgery with deep hypothermic circulatory arrest to endovascular repair using aortic stent grafting, to make operations less invasive, thoracic endovascular aneurysm repair with or without reconstruction of the cervical branch vessels was also selected afterwards. Collagen-impregnated Dacron prostheses such as Hemashield (Maquet, Rastatt, Germany, $n = 38$), Gelweave (Vascutek, Inchinnan, UK, $n = 3$) and J-Graft (Japan Lifeline, Tokyo, Japan, $n = 14$), or Triplex (Termo, Tokyo, Japan, $n = 4$), which is a woven nylon and ePTFE graft sealed with non-biodegradable coating material, were used for the graft replacement in group P. All surgeries were performed with cardiopulmonary bypass (CPB). Concerning CABG, target vessels were decided based on the preoperative coronary computed tomography angiography (CTA) or coronary artery angiography results for the patients with elective surgery, and complete revascularization was usually achieved with individual or sequential bypasses. For the patients with emergent surgery such as acute aortic dissection who had not been examined CAD preoperatively, the target vessels of CABG were decided based on the preoperative colour-enhanced computed tomography (CT) and intraoperative findings. The impaired coronary artery orifice was ligated and SVG was anastomosed to the distal branch

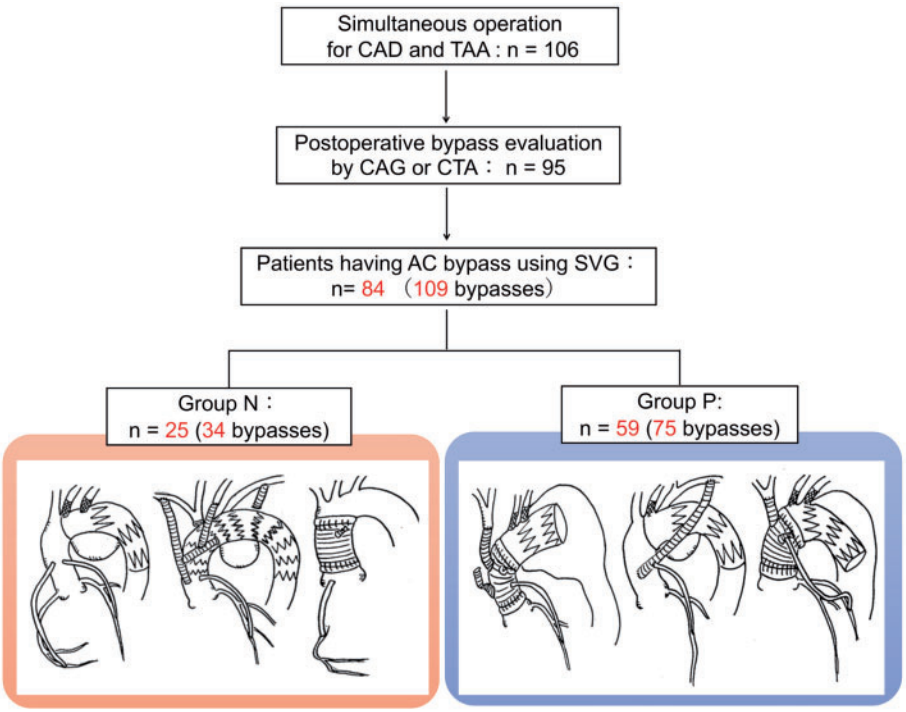


Figure 1: The schema of the patients enrolled in this study. Among 106 patients who underwent concomitant coronary artery bypass grafting and surgery for TAA, 84 patients with AC bypass, using SVG, who were examined CAG or CTA postoperatively were enrolled in this study. The patients were divided into 2 groups according the proximal site of the AC bypass: patients whose proximal anastomosis sites were on the native aorta were classified into group N (n = 25, 34 bypasses) and patients whose proximal anastomosis sites were on the vascular prosthesis were classified into group P (n = 59, 75 bypasses). AC: aortocoronary; CAD: coronary artery disease; CAG: coronary angiography; CTA: computed tomography angiography; SVG: saphenous vein graft; TAA: thoracic aortic aneurysm.

of coronary artery. Native ascending aorta was selected for the inflow of AC bypass wherever possible, and the proximal anastomosis was made on the vascular prosthesis only if there was not enough space for proximal anastomosis of AC bypass on the native ascending aorta. All SVGs were harvested under direct vision. The distal anastomosis of CABG was mainly performed during central cooling under CPB support. Distal and proximal anastomoses were performed using 7–0 Prolene and 6–0 Prolene sutures (Ethicon, Somerville, NJ, USA), respectively. Postoperatively, aspirin was prescribed for all patients.

Clinical data collection

Patients' data were collected from the Japan Adult Cardiovascular Surgery Database and medical records of each hospital, including the following: age, sex, body mass index, preoperative comorbidities such as diabetes mellitus, hypertension, dyslipidaemia, smoking, haemodialysis, chronic obstructive pulmonary disease (COPD), history of cerebral infarction or peripheral artery disease, preoperative unstable angina/myocardial infarction, estimated left ventricular ejection fraction on echocardiography, operative procedure, emergency operation, redo surgery, operative time, CPB time, aortic cross-clamp time, postoperative mechanical support such as intra-aortic balloon pump or extracorporeal membrane oxygenation and postoperative complications.

Follow-up

The median follow-up period was 45.9 ± 39.7 months, and the follow-up rate was 92.9%. The outcomes of the patients with major cardiac or cerebrovascular events, defined as the composite of death, myocardial infarction, cerebral infarction or coronary artery revascularization, were extracted from the medical records.

Evaluation of graft patency

CABG grafts were routinely examined by CTA before discharge. For outpatients, grafts were evaluated by colour-enhanced CT with regular TAA assessment if the patient's kidney function was normal. When patients complained of chest pain, CTA was added if needed, and coronary angiography was performed if the coronary event due to graft occlusion was strongly suspected.

Statistical analysis

Continuous variables are reported as mean ± standard deviation, and categorical variables are reported as frequencies. Categorical variables were compared using Fisher's exact test, and continuous variables were compared using Student's t-test or Wilcoxon signed-rank test, based on the distribution of data. Cumulative graft patency was compared using the log rank test.

Univariate Cox proportional hazards model was applied for the risk factor analysis, and the risks were reported as hazard ratios with 95% confidence intervals. As for COPD and graft anastomosed to native aorta (group N), we only assessed P-values since the number of incidences was 0. Multiple testing using Bonferroni method was performed for adjusting P-values. Two-sided P-values <0.05 were considered statistically significant. All statistical analyses were performed using JMP 13.0 (SAS Institute, Cary, NC, USA) and Prism 8 (GraphPad Software, San Diego, CA, USA).

RESULTS

Patient characteristics and operations

The characteristics of the 84 patients enrolled in this study are summarized in Table 1. The average age of the patients was 72 years (range 45–88 years), and 81.0% of them were male patients.

All patients were divided into groups N ($n = 25$) and P ($n = 59$) based on the proximal anastomosis site of AC bypass (Fig. 1). Between these 2 groups, the proportion of the diabetes patients was significantly higher in group N (44.0% vs 13.6%, $P = 0.004$); however, the other characteristics did not show any significant differences.

The aetiology, location of the aneurysm and operative procedures for TAA are described in Table 2. True aneurysm due to atherosclerosis accounted for 67.9% of all aneurysms in the patients, and the main locus was the aortic arch (51.2%). Dissecting aortic aneurysm was 27.4%, and the combination of true TAA and dissecting aortic aneurysm was 4.8%, in which

Table 1: Basic characteristics of the patients divided into groups N and P according to the proximal site of AC bypass

	Total ($n = 84$)	Group N ($n = 25$)	Group P ($n = 59$)	*P*-value
Age (years), mean ± SD	72.0 ± 8.0	71.1 ± 8.9	72.3 ± 7.7	0.56
Male gender, *n* (%)	68 (81.0)	23 (92.0)	45 (76.3)	0.13
Obesity (BMI ≥ 25), *n* (%)	25 (29.8)	8 (32.0)	17 (28.8)	0.8
Diabetes, *n* (%)	19 (22.6)	11 (44.0)	8 (13.6)	0.004*
Hypertension, *n* (%)	65 (77.4)	20 (80.0)	45 (76.3)	0.78
Dyslipidaemia, *n* (%)	31 (36.9)	7 (28.0)	24 (40.7)	0.33
Smoking, *n* (%)	46 (54.8)	17 (68.0)	29 (49.2)	0.15
Preoperative dialysis, *n* (%)	1 (1.2)	1 (4.0)	0 (0)	0.30
COPD, *n* (%)	3 (3.6)	1 (4.0)	2 (3.4)	1.00
History of cerebral infarction, *n* (%)	18 (21.4)	3 (12.0)	15 (25.4)	0.25
PAD, *n* (%)	36 (42.9)	12 (48.0)	24 (40.7)	0.63
UA or MI, *n* (%)	16 (18.8)	3 (11.5)	13 (22.0)	0.37
Low LVEF (≤35%), *n* (%)	2 (2.5)	0 (0.0)	2 (3.6)	1.00
Postoperative dialysis, *n* (%)	10 (11.9)	2 (8.0)	8 (13.6)	0.72

AC: aortocoronary; BMI: body mass index; COPD: chronic obstructive pulmonary disease; LVEF: left ventricular ejection fraction; MI: myocardial infarction; PAD: peripheral artery disease; SD: standard deviation; UA: unstable angina.

Table 2: Details of the TAA and surgery

	Total ($n = 84$)	Group N ($n = 25$)	Group P ($n = 59$)	*P*-value
Types of aneurysm, *n* (%)				
True aneurysm	57 (67.9)	22 (88.0)	35 (59.3)	0.011*
Dissection	23 (27.4)	1 (4.0)	22 (37.3)	0.001*
Combined	4 (4.8)	2 (8.0)	2 (3.4)	0.58
Sites of true TAA (partially overlapped), *n* (%)				
Valsalva	4 (4.8)	3 (12)	1 (1.7)	0.077
Ascending aorta	15 (17.9)	1 (4.0)	14 (23.7)	0.033*
Aortic arch	43 (51.2)	20 (80.0)	23 (39.0)	<0.001*
Descending aorta	1 (1.2)	0 (0)	1 (1.7)	1.00
Types of DAA, *n* (%)				
Acute type A dissection	10 (11.9)	0 (0)	10 (17.0)	0.029*
Chronic type A dissection	3 (3.6)	0 (0)	3 (5.1)	0.55
Chronic type B dissection	14 (16.7)	3 (12.0)	11 (18.6)	0.54
Operative procedures (partially overlapped), *n* (%)				
Aortic root replacement	7 (8.3)	3 (12.0)	4 (6.8)	0.42
Graft replacement of ascending aorta	31 (36.9)	1 (4.0)	30 (50.9)	0.063
TAR/PAR	45 (53.6)	18 (72.0)	27 (45.8)	0.033*
Debranching TEVAR	17 (20.2)	3 (12.0)	14 (23.7)	0.37
Concomitant procedures, *n* (%)				
AVR	2 (2.4)	0 (0.0)	2 (3.4)	1.00
MVR + TAP	1 (1.2)	1 (4.0)	0 (0.0)	0.30
Operative duration (min), mean ± SD	502 ± 153	483 ± 123	510 ± 165	0.41
CPB time (min), mean ± SD	223 ± 88	189 ± 92	237 ± 84	0.034*
ACC time (min), mean ± SD	119 ± 58	123 ± 76	117 ± 49	0.74
Mechanical support, *n* (%)	8 (9.5)	2 (8.0)	6 (10.2)	1.00

ACC: aortic cross-clamp; AVR: aortic valve replacement; CPB: cardiopulmonary bypass; DAA: dissecting aortic aneurysm; MVR: mitral valve replacement; PAR: partial arch replacement; SD: standard deviation; TAA: thoracic aortic aneurysm; TAP: tricuspid annuloplasty; TAR: total arch replacement; TEVAR: thoracic endovascular arch repair.

Table 3: Details of the coronary artery bypass grafting

	Total (n = 109), n (%)	Group N (n = 34), n (%)	Group P (n = 75), n (%)	P-value
Individual	86 (78.9)	27 (79.4)	59 (78.7)	1.00
Sequential	23 (21.1)	7 (20.6)	16 (21.3)	1.00
Target vessels				
LAD	45 (41.3)	9 (26.5)	36 (48.0)	0.038*
LCX	29 (26.6)	10 (29.4)	19 (25.3)	0.65
RCA	35 (32.1)	15 (44.1)	20 (26.7)	0.080
Mild-to-moderate stenosis (<90%)	31 (28.4)	8 (23.5)	23 (30.7)	0.63

LAD: left anterior descending artery; LCX: left circumflex artery; RCA: right coronary artery.

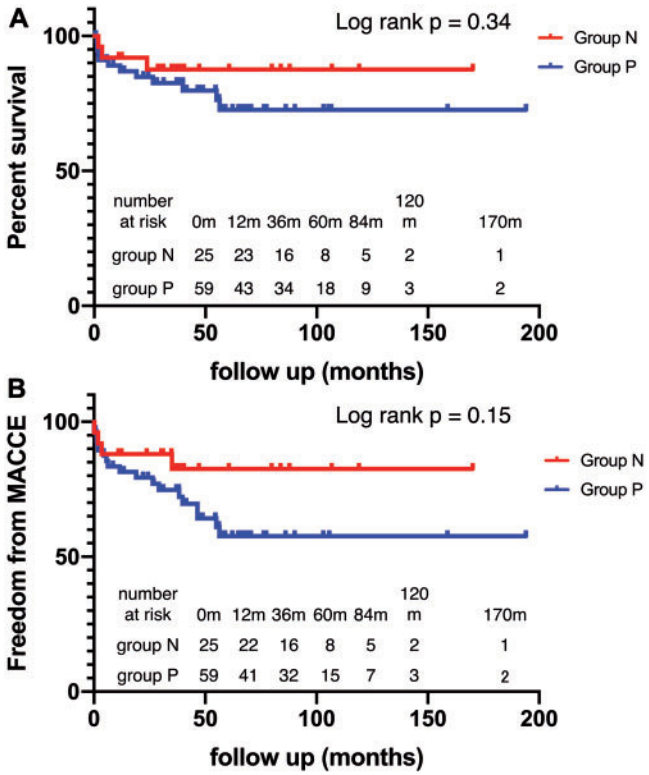


Figure 2: Overall survival and freedom from MACCE of the patients. (**A**) Overall survival rate was almost equivalent in groups N and P (P = 0.34). (**B**) Freedom from MACCE analysis demonstrated no significant difference in groups N and P (P = 0.15). MACCE: major cardiac or cerebrovascular event.

acute type A dissection, chronic type A dissection and chronic type B dissection were 11.9%, 3.6% and 16.7%, respectively. Patients with aneurysms involving the ascending aorta were more prevalent in group P compared to group N (23.7% vs 4.0%, P = 0.033). The proportion of the patients with acute type A dissection was also higher in group P compared to group N (17.0% vs 0%, P = 0.029). According to these results, the patients with graft replacement of ascending aorta were more prevalent in group P compared to group N without significant difference (50.9% vs 4.0%, P = 0.063). Conversely, the number of the patients with true TAA in the aortic arch was higher in group N compared

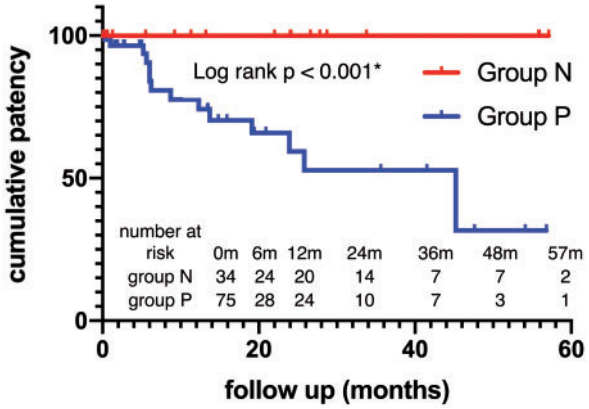


Figure 3: Cumulative patency of the coronary artery bypass grafts anastomosed to the native aorta versus vascular prosthesis. Cumulative patency of the grafts was compared, which revealed the worse patency of the grafts anastomosed to the vascular prosthesis (group P) than the grafts anastomosed to the native ascending aorta (group N) (log rank *P < 0.001).

to group P (80.0% vs 39.0%, P < 0.01), which leads to the higher proportion of the patients in group N who underwent TAR/partial arch replacement compared to those in group P (72.0% vs 45.8%, P = 0.033)

The details of CABG are summarized in Table 3. A total of 109 AC bypasses, including 86 individual bypasses and 23 sequential bypasses containing 2 anastomoses in each sequential bypass, were performed in these 84 patients. There was no preference of either the individual or sequential bypass between these 2 groups (P = 1.00). Target lesions of the AC bypasses were almost equally distributed among the left anterior descending artery (41.3%), the left circumflex artery (26.6%) and the right coronary artery (32.1%), although the proportion of the AC bypasses to left anterior descending artery was higher in group P compared to group N (48.0% vs 26.5%, P = 0.038).

Operation time, CPB time and aortic cross-clamp time were 502 ± 153, 223 ± 88 and 119 ± 58 min, respectively. There was no significant difference of operation and aortic cross-clamp times between these 2 groups, whereas CPB time was significantly longer in group P than in group N (237 ± 84 vs 189 ± 92 min, P = 0.034, Table 2).

Outcomes and major cardiac or cerebrovascular events

The mean duration of intensive care unit and hospital stay was 9 days (range 0–104 days) and 45 days (range 9–367 days), respectively. Ten (11.9%) patients required re-exploration for bleeding. In-hospital mortality was seen in 8 (9.5%) patients, including 2 (8%) cases in group N and 6 (10.2%) in group P (P = 1.00). There was no significant difference in the long-term survival rate between the groups (P = 0.34, Fig. 2A). During follow-up, 23 patients had a major cardiac or cerebrovascular event, including 10 postoperative strokes. Freedom form major cardiac or cerebrovascular event rates was slightly higher in group N compared to group P without any significant difference (P = 0.15, Fig. 2B). Coronary events occurred in 4 patients in group P, and they required percutaneous coronary intervention.

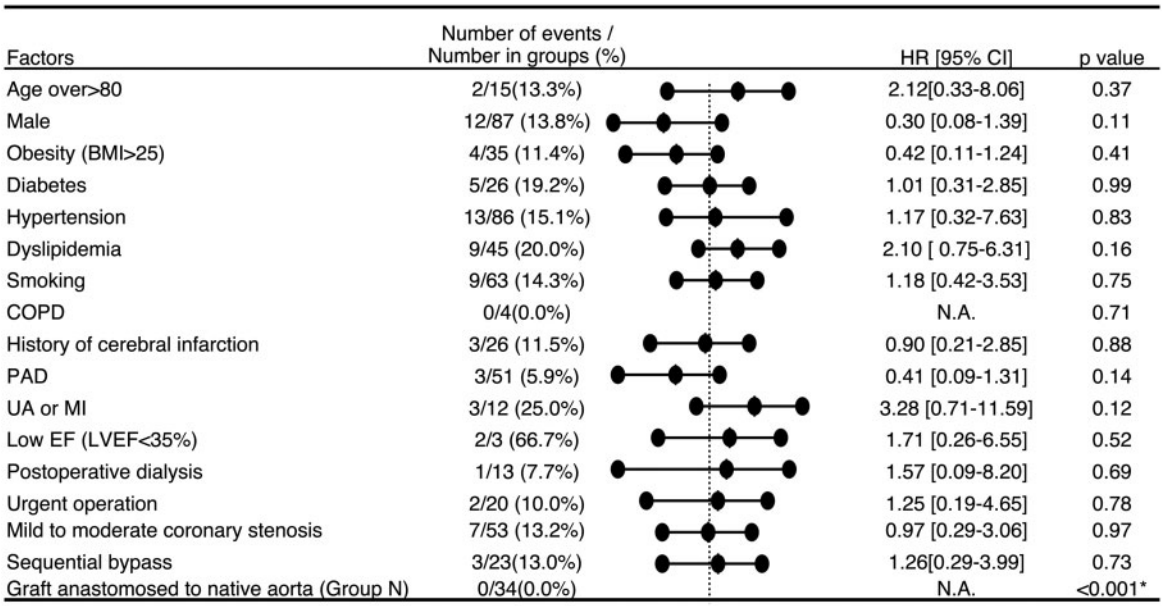


Figure 4: Risk factor analysis of the coronary artery bypass graft occlusion. Risk factor analysis by univariate Cox proportional hazards model was performed with some possible factors of graft occlusion including the proximal anastomosis site of aortocoronary bypass. Among the factors, HRs of COPD and graft anastomosed to native aorta (group N) could not be assessed due to complete separation. The proximal anastomosis site was identified as the sole risk factor among these factors (*P < 0.001). BMI: body mass index; CI: confidence interval; COPD: chronic obstructive pulmonary disease; HR: hazard ratio; LVEF: left ventricular ejection fraction; MI: myocardial infarction; N.A.: not assessed; PAD: peripheral artery disease; UA: unstable angina.

The patency of the saphenous vein grafts

The patency of each AC bypass graft was examined by coronary angiography or CTA, and total 258 CTA and 10 coronary angiography examinations were performed during the follow-up period. Early graft occlusion was seen in 2 patients in group P (1.83%). Cumulative graft patency was compared using the log rank test, which demonstrated significantly lower patency in group P compared to group N (P < 0.001, Fig. 3). The patency of the grafts was 77.6% vs 100% in 12 months, 52.7% vs 100% in 36 months and 31.6% vs 100% in 57 months. Individual bypasses in group P also demonstrated significantly worse cumulative patency compared to those in group N (P = 0.002, Supplementary Material, Fig. S1a). The patency of the sequential bypasses in group P also demonstrated the same trend as the individual bypasses, although there was no significant difference (P = 0.095, Supplementary Material, Fig. S1b). The patency of the graft was not different depending on the material of the vascular prosthesis (data not shown).

Graft patency by target vessels

For further analysis, cumulative graft patency was compared with respect to each target vessel, which revealed worse patency of the grafts in each target lesion for group P, although the patency of the grafts anastomosed to left circumflex artery did not reach significant difference (left anterior descending artery: P = 0.050, right coronary artery: P = 0.045, left circumflex artery: P = 0.051, Supplementary Material, Fig. S2). Furthermore, the cumulative graft patency was compared regarding the degree of stenosis, which demonstrated significantly worse patency in group P regardless of the severity of the stenosis in the target vessels (severe stenosis: P = 0.013, mild-to-moderate stenosis: P = 0.029, Supplementary Material, Fig. S3).

Aortocoronary bypass graft anastomosed to vascular prosthesis was the independent risk for graft occlusion

Risk factor analyses using Cox proportional hazards analysis was performed to clarify the disadvantage of the grafts anastomosed to vascular prosthesis. Sixteen SVGs were occluded within 4 years. Some factors such as old age, sex, obesity, diabetes, hypertension, dyslipidaemia, smoking, COPD, history of cerebral infarction, peripheral artery disease, preoperative unstable angina/myocardial infarction, low cardiac function (left ventricular ejection fraction ≤ 35%), postoperative dialysis and urgent operation, in addition to the degree of stenosis on the target vessels and the proximal anastomosis site of AC bypass were analysed using univariate Cox regression model, which revealed that the proximal anastomosis site was the only risk factor for graft occlusion even after the multiple testing using the Bonferroni correction, although the hazard ratio could not be calculated due to the complete separation (P < 0.001, Fig. 4).

DISCUSSION

Here, we investigated the patency of the AC bypass grafts in patients with simultaneous CABG and thoracic vascular surgery and reported significantly worse patency of the grafts anastomosed to a vascular prosthesis (group P) compared to the grafts anastomosed to the native ascending aorta (group N) regardless of the severity of the lesion in the target vessels. In group P, the proximal anastomosis site on the vascular prosthesis did not affect the patency. Moreover, univariate Cox regression analysis revealed that the proximal site of the AC bypass on the vascular prosthesis was the sole independent risk factor of graft occlusion instead of other known risk factors [6–8].

Simultaneous operation for CAD and TAA was often performed; however, there has been no consensus regarding the graft design, especially the proximal anastomosis site of the AC bypass. Only 2 previous studies have been reported regarding the patency of an SVG anastomosed to a vascular prosthesis. Consistent with our results, Kara *et al.* [9] reported the poor SVG cumulative patency of an SVG anastomosed to the aortic Dacron graft, 45.9% at 3.7 ± 1.9 years, by investigating 48 patients with 61 bypasses. Furthermore, they reported that the occluded grafts were mainly anastomosed to the right coronary artery, although there was no significant difference. On the contrary, Sako *et al.* [10] followed up 24 patients with 33 AC bypasses and reported good patency of the SVG, with 90.9% patent at 4.9 ± 2.8 years. The reason for this discrepancy is unclear, and the limited number of patients in both reports warranted further analysis.

The cause of the CABG graft occlusion is multifactorial [11]. Early graft failure is attributed to technical problems of the surgery and resulting thrombosis, while late graft failures are mainly caused by the progression of atherosclerosis on the graft or intimal hyperplasia at the anastomosis site [12, 13]. In our study, the cumulative patency of the grafts was almost equivalent until 6 months in both P and N groups; however, the patency reduced gradually and demonstrated significant differences after 1 year. Therefore, some mechanisms that raised the intimal hyperplasia at the proximal anastomosis site on the vascular prosthesis might have existed.

Some factors including disturbed local haemodynamics, endothelial injury, platelet activation, inflammation and compliance mismatch between the graft and target vessel are considered to induce intimal hyperplasia [11, 13, 14]. Immune reaction to the vascular prosthesis might have also played a role in the occurrence of the graft occlusion. Nevertheless, considering the diverse cumulative patency between groups P and N observed in this study, it should be better to avoid using a vascular prosthesis as the inflow of the AC bypass. To use the internal thoracic artery for the inflow would be a suitable alternative, if the native aorta is not available.

This study has several limitations as follows: (i) it is a retrospective study, with a multicentre design, (ii) the number of the patients enrolled this study was limited (especially the patients in group N), (iii) the operative procedures or the timing of the postoperative examinations was dependent on individual surgeons or institutes, (iv) patients with kidney dysfunction could not be examined with the colour-enhanced CT regularly and (v) the medical database lacked some data.

In conclusion, AC bypass grafts anastomosed to the vascular prosthesis demonstrated a lower cumulative patency compared to those anastomosed to the native ascending aorta in patients with concomitant surgery for CAD and TAA, regardless of the target lesion or severity of stenosis. This finding may be helpful in determining the optimal bypass design of the CABG, while further studies are warranted to confirm this finding and to know the detailed mechanism.

SUPPLEMENTARY MATERIAL

Supplementary material is available at *EJCTS* online.

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Conflict of interest: none declared.

Author contributions

Ai Kawamura: Conceptualization; Data curation; Formal analysis; Investigation; Project administration; Writing—original draft; Writing—review & editing. **Daisuke Yoshioka:** Conceptualization; Data curation; Formal analysis; Writing—original draft; Writing—review & editing. **Koichi Toda:** Conceptualization; Supervision. **Ryoto Sakaniwa:** Formal analysis; Methodology; Writing—original draft. **Shigeru Miyagawa:** Data curation. **Yasushi Yoshikawa:** Data curation. **Hiroki Hata:** Data curation. **Kazuo Shimamura:** Data curation. **Keiwa Kin:** Data curation. **Satoshi Kainuma:** Data curation. **Takuji Kawamura:** Conceptualization; Data curation. **Kenta Masada:** Data curation. **Masayuki Sakaki:** Data curation. **Osamu Monta:** Data curation. **Toru Kuratani:** Conceptualization; Supervision. **Yoshiki Sawa:** Conceptualization; Supervision.

Reviewer information

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