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ORIGINAL ARTICLE
Surgery

Off-Pump Bilateral Skeletonized Internal Thoracic Artery Grafting in Octogenarians

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Background: We compared postoperative outcomes in octogenarians who underwent off-pump isolated coronary artery bypass grafting for multivessel disease using either skeletonized bilateral or single internal thoracic artery (ITA).

Methods and Results: Among 1,532 patients who underwent isolated coronary artery bypass grafting between 2002 and 2021, 173 octogenarians were analyzed retrospectively. After inverse probability of treatment weighting, we found no statistically significant difference regarding patients' preoperative characteristics. No patient experienced deep sternal wound infection. More patients in the single than bilateral ITA group died within 30 days after surgery (5.0% vs. 0%, respectively; P=0.003). The mean follow-up duration was 4.2 years. At 5 years, the freedom from overall death following bilateral versus single ITA grafting was 78.2% and 53.7%, respectively (log-rank test, P=0.003), and freedom from major adverse cardiac and cerebrovascular events (MACCE) was 67.9% and 44.8% respectively (log-rank test, P=0.002). In multivariable Cox models, bilateral ITA grafting was significantly associated with a lower risk of overall death (hazard ratio [HR] 0.555; 95% confidence interval [CI] 0.342–0.903; P=0.018) and MACCE (HR 0.586; 95% CI 0.376–0.913; P=0.018).

Conclusions: Compared with single ITA grafting, off-pump skeletonized bilateral ITA grafting is associated with lower rates of overall death and MACCE in octogenarians undergoing CABG and does not increase the risk of deep sternal wound infection.

Key Words: Coronary artery bypass grafting; Deep sternal wound infection; Octogenarian

With increasing life expectancy, the number of elderly people continues to grow. For example, the US healthcare system will care for an estimated 32.5 million octogenarians by 2050,[1] and more than 40% of these people are likely to have coronary artery disease.[2] In octogenarians, coronary artery bypass grafting (CABG) has been reported to be associated with lower rates of cardiac death, myocardial infarction (MI), and need for target vessel revascularization than percutaneous coronary intervention.[3] Therefore, CABG remains an important option, even in octogenarians.

Bilateral internal thoracic artery (BITA) grafting has been reported to provide better long-term outcomes than single internal thoracic artery (SITA) grafting in several diseases.[4–7] However, little is known about BITA grafting for octogenarians with limited life expectancy. The aim of the present study was to compare postoperative outcomes in octogenarians undergoing off-pump isolated CABG using skeletonized BITA or SITA for multivessel coronary disease.

Methods

All patients had previously provided informed consent for their medical records to be used for research purposes. This study was approved by the Ethics Committee of Shiga University of Medical Science (Registration no. R2021-071; approval date August 5, 2021). The procedures in this study were performed in accordance with the Declaration of Helsinki.

Between January 2002 and December 2021, 1,532 patients underwent isolated CABG at the Department of Surgery, Shiga University of Medical Science. Among these, there were 185 consecutive octogenarian patients. Patients who underwent grafting without using the internal thoracic artery (ITA; n=3) were excluded, as was 1 patient who preoperatively had emergency percutaneous cardiopulmonary bypass support at another hospital during cardiopulmonary resuscitation for cardiac arrest caused by acute MI and another 8 patients whose coronary anatomy presented only one target vessel in the left coronary artery system. Thus, 173 patients were included in the study. The postoperative outcomes of these patients were analyzed retrospectively after adjusting for patients' background information, using weighted logistic regression analysis and inverse probability of treatment weighting (IPTW).

Outcome Measures and Definitions

The primary outcome measure was overall mortality. The

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secondary outcome was the incidence of major adverse cardiac and cerebrovascular events (MACCE), defined as a composite of all-cause death, non-fatal MI, non-fatal heart failure, non-fatal stroke, and the need for repeat revascularization. Non-fatal MI, non-fatal heart failure, and non-fatal stroke were defined as new admissions with a diagnosis of these disease during the follow-up period that did not result in death.

Postoperative stroke was defined as newly developed symptoms of central nervous system paralysis ≥72 h before discharge. Postoperative MI was defined according to the standard definition[8] as an elevation of cardiac troponin >10-fold the 99th percentile upper reference limit in patients with normal baseline values with at least one of the following elements: new pathological Q waves, imaging evidence of new loss of viable myocardium or new regional wall motion abnormality in a pattern consistent with an ischemic etiology, angiographic graft occlusion, or native coronary artery occlusion. Deep sternal wound infection (DSWI) was defined as any chest wound infection involving the sternum or mediastinal tissues during the follow-up period.

Patients attend an outpatient follow-up once a year after CABG. Data for all pre-, intra-, and postoperative variables were obtained from the database or directly from individual electronic medical records at the Department of Surgery, Shiga University of Medical Science. Information on late follow-up was collected from hospital records or primary care doctors. In case the information was still inadequate, further details were sought from relatives by telephone.

Surgical Treatment and Graft Arrangement

The off-pump technique was used in all patients. Details of surgical techniques, including graft harvest and graft arrangement, have been published previously.[4] The left anterior descending (LAD) artery was always revascularized using in situ grafting of the ITA. A second ITA and/or saphenous vein, as either a sequential or individual graft, was grafted to the circumflex and/or diagonal branches. The inferior wall was revascularized using the saphenous vein, in situ gastroepiploic artery (GEA), or both. Use of the GEA required stenosis of >90% in the target vessels. In most patients who underwent BITA grafting, the in situ right ITA was tunneled through a right-sided pericardial incision and routed anterior to the aorta across the midline for grafting to the LAD, and the in situ left ITA was used for the circumflex branches, diagonal branches, or both. Radial artery grafts and endoscopic vein harvest were not used in any of these cases.

When the ITA was injured at its proximal portion, or when the right ITA was too short for grafting to the LAD artery, we constructed a composite graft. The free ITA was anastomosed to the other ITA in an end-to-side manner in BITA group, whereas in SITA group the free ITA was anastomosed to the saphenous vein graft or GEA in an end-to-side manner. We routinely performed computed tomography scans and epiaortic ultrasound to assess the severity and location of ascending aortic atherosclerosis to prevent complications related to manipulating the ascending aorta. When the surgeon judged that partial clamping of the ascending aorta carried a risk of embolism, a proximal anastomotic device (Novare Enclose; Novare Surgical Systems, Cupertino, CA, USA) was used.

BITA grafting was preferred for revascularization of the left coronary territory whenever anatomically possible, even if the patient had poor blood sugar control before surgery, and in emergency operations. We measured blood pressure non-invasively in both upper arms preoperatively. The measurement was performed at rest in the supine position in both upper arms simultaneously. When there was a difference of ≥20 mmHg between blood pressure measurements, we did not use the ITA on the side with the lower pressure.

Statistical Analysis

Continuous variables are presented as the mean±SD or median and interquartile range (IQR), whereas categorical variables are presented as percentages. Comparisons of clinical characteristics between the 2 groups were performed using the unpaired t-test for normally distributed variables, the Mann-Whitney U test for skewed variables, and Pearson's χ^2 test for categorical variables. Probabilities of survival were estimated using the Kaplan-Meier method, in which patients still alive were censored at the date of their last follow-up; the log-rank test was used for comparisons. Univariable and multivariable logistic regression analyses were performed to identify independent predictors of 30-day mortality. Univariable and multivariable Cox proportional hazards regression analyses were performed to analyze overall deaths and MACCE. Variables reaching P<0.050 in the univariable analysis or those that were considered clinically important were entered into the multivariable model. All statistical testing was 2-sided, and results were considered statistically significant at P<0.050.

Patients' baseline characteristics were adjusted using weighted logistic regression and IPTW to reduce any effect of selection bias and potential confounding factors. Weights for patients receiving BITA grafting were the inverse of propensity scores, and weights for patients receiving SITA grafting were the inverse of 1 – the propensity score. The following 20 adjustment variables were used to derive the propensity score: age, sex, body mass index, hypertension, diabetes, dyslipidemia, smoking history, previous cerebrovascular accident, history of percutaneous coronary intervention, peripheral artery disease, 3-vessel disease, left main trunk disease, HbA1c, estimated glomerular filtration rate (eGFR) <30 mL/min/1.73 m^2, preoperative hemodialysis, redo surgery, emergency operation, acute MI, left ventricular ejection fraction, and intra-aortic balloon pumping. The model was well calibrated (Hosmer-Lemeshow test, P=0.097), with reasonable discrimination (C-statistic, 0.720). Absolute standardized mean differences were calculated to compare the balance in baseline characteristics between the BITA and SITA groups in the unweighted and weighted cohorts. An absolute standardized mean difference of >0.100 was considered a meaningful imbalance.[9]

All statistical analyses were performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA) and SAS version 9.4 (SAS Institute, Cary, NC, USA).

Results

Right ITAs were too short to revascularize the LAD artery in 7 patients in the BITA group, so composite grafts were constructed in these patients. There was a difference of ≥20 mmHg in blood pressure measurements between the upper arms preoperatively in 1 patient in the SITA group, so that patient underwent SITA grafting using the right ITA. The mean age of the study population was 82.8±2.7 years, and 116 (67.1%) were male. Before adjustment, a

Table 1. Preoperative Patient Characteristics

	Unweighted				Weighted			
	BITA (n=69)	SITA (n=104)	P value	ASMD	BITA (SoW=174.04)	SITA (SoW=173.44)	P value	ASMD
Age (years)	82.6±2.6	83.0±2.7	0.315	0.151	82.8±2.7	82.8±2.7	0.895	0.015
Male sex	50 (72.5)	66 (63.5)	0.213	0.194	117.94 (68.8)	115.57 (66.6)	0.667	0.047
BMI (kg/m²)	22.6±2.9	22.0±3.1	0.204	0.200	22.2±2.9	22.3±3.3	0.657	0.032
Hypertension	51 (73.9)	77 (74.0)	0.985	0.002	129.52 (74.4)	127.39 (73.4)	0.837	0.023
Diabetes	33 (47.8)	42 (40.4)	0.336	0.149	63.51 (36.5)	70.41 (40.6)	0.433	0.084
Dyslipidemia	23 (33.3)	45 (43.3)	0.188	0.207	69.88 (40.2)	67.31 (38.8)	0.799	0.029
Smoking history	39 (56.5)	45 (43.3)	0.089	0.266	92.54 (53.2)	85.89 (49.5)	0.497	0.074
Previous CVD	7 (10.1)	14 (13.5)	0.516	0.106	20.65 (11.9)	20.11 (11.6)	0.938	0.009
Previous PCI	17 (24.6)	20 (19.2)	0.399	0.131	36.66 (21.1)	38.54 (22.2)	0.794	0.027
PAD	3 (4.3)	7 (6.7)	0.514	0.105	14.61 (8.4)	10.61 (6.1)	0.415	0.089
Three-vessel disease	56 (81.2)	82 (78.8)	0.713	0.060	134.29 (77.2)	139.67 (80.5)	0.430	0.081
LMT disease	35 (50.7)	50 (48.1)	0.735	0.052	78.91 (45.3)	87.11 (50.2)	0.364	0.098
HbA1c (%)	6.2±1.0	6.0±0.8	0.158	0.221	6.0±0.9	6.1±0.8	0.676	0.047
eGFR <30 mL/min/1.73 m²	13 (18.8)	20 (19.2)	0.949	0.010	27.56 (15.8)	30.33 (17.5)	0.681	0.046
Hemodialysis	7 (10.1)	6 (5.8)	0.313	0.159	11.59 (6.7)	11.28 (6.5)	0.953	0.008
Redo surgery	0 (0)	1 (1.0)	0.417	0.142	0 (0)	1.0 (0.6)	0.319	0.108
Emergency operation	23 (33.3)	54 (51.9)	0.015	0.383	75.47 (43.4)	75.55 (43.6)	0.971	0.004
Acute MI	22 (31.9)	45 (43.3)	0.129	0.237	77.22 (44.4)	68.79 (39.7)	0.376	0.095
LVEF (%)	53.9±10.9	49.2±13.5	0.013	0.383	50.9±11.4	51.2±13.5	0.810	0.024
IABP	9 (13.0)	31 (29.8)	0.006	0.419	44.66 (25.7)	39.59 (22.8)	0.539	0.068
STS score (%)	3.4 [2.2–7.1]	6.1 [2.8–17.1]	0.005	0.437	3.9 [2.4–12.5]	3.4 [2.1–13.2]	0.930	0.009
EuroSCORE II (%)	2.9 [1.7–6.9]	4.5 [2.2–16.8]	0.008	0.407	4.2 [2.5–15.0]	3.6 [2.0–11.3]	0.282	0.109

Unless indicated otherwise, data are given as the mean ± SD, median [interquartile range], or n (%). ASMD, absolute standardized mean difference; BITA, bilateral internal thoracic artery; BMI, body mass index; CVD, cerebrovascular disease; eGFR, estimated glomerular filtration rate; EuroSCORE, European System for Cardiac Operative Risk Evaluation; IABP, intra-aortic balloon pumping; LMT, left main trunk; LVEF, left ventricular ejection fraction; MI, myocardial infarction; PAD, peripheral artery disease; PCI percutaneous coronary intervention; SITA, single internal thoracic artery; SoW, sum of weights; STS, Society of Thoracic Surgeons.

Table 2. Operative and Postoperative Data

	Unweighted			Weighted		
	BITA (n=69)	SITA (n=104)	P value	BITA (SoW=174.04)	SITA (SoW=173.44)	P value
Operative data						
Operation time (m)	233±51	219±61	0.114	231±52	219±58	0.035
Proximal anastomosis to aorta	10 (14.5)	90 (86.5)	<0.001	27.80 (16.0)	147.12 (84.8)	<0.001
Partial clamp	7 (10.1)	74 (71.2)	<0.001	21.09 (12.1)	118.00 (68.0)	<0.001
Anastomotic device	3 (4.3)	16 (15.4)	0.012	6.71 (3.9)	29.12 (16.8)	<0.001
No. distal anastomoses	3.3±0.8	3.3±0.8	0.645	3.1±0.9	3.3±0.8	0.085
No. grafts	2.8±0.4	2.1±0.3	<0.001	2.7±0.5	2.1±0.3	<0.001
Sequential grafting	31 (44.9)	90 (86.5)	<0.001	77.86 (44.7)	145.65 (84.0)	<0.001
GEA use	42 (60.9)	29 (27.9)	<0.001	91.62 (52.6)	52.36 (30.2)	<0.001
SVG use	11 (15.9)	92 (88.5)	<0.001	30.02 (17.2)	150.08 (86.5)	<0.001
Postoperative data						
Myocardial infarction	0 (0)	0 (0)	–	0 (0)	0 (0)	–
DSWI	0 (0)	0 (0)	–	0 (0)	0 (0)	–
Stroke	0 (0)	1 (1.0)	0.417	0 (0)	1.52 (0.9)	0.219
ICU stay >48 h	9 (13.0)	24 (23.1)	0.087	44.56 (25.6)	35.66 (20.6)	0.266
Ventilation >48 h	5 (7.2)	15 (14.4)	0.127	20.47 (11.8)	22.70 (13.1)	0.709
30-day mortality	0 (0)	6 (5.8)	0.014	0 (0)	8.66 (5.0)	0.003

Unless indicated otherwise, data are given as the mean ± SD or n (%). DSWI, deep sternal wound infection; GEA, gastroepiploic artery; ICU, intensive care unit; LAD, left anterior descending artery; SVG, saphenous vein graft. Other abbreviations as in Table 1.

Table 3. Causes of Overall Death

	Unweighted			Weighted		
	BITA (n=69)	SITA (n=104)	P value	BITA (SoW=174.04)	SITA (SoW=173.44)	P value
All-cause death	25 (36.2)	51 (49.0)	0.095	49.73 (28.6)	90.65 (52.3)	<0.001
Cardiac death	3 (4.3)	14 (13.5)	0.030	7.20 (4.1)	23.29 (13.4)	0.002
Myocardial infarction	0 (0)	4 (3.8)	0.045	0 (0)	5.73 (3.3)	0.016
Heart failure	3 (4.3)	10 (9.6)	0.169	7.20 (4.1)	17.56 (10.1)	0.030
Lethal arrhythmia	0 (0)	0 (0)	–	0 (0)	0 (0)	–
Non-cardiac death	22 (31.9)	37 (35.6)	0.618	42.53 (24.4)	67.36 (38.8)	0.004
Pneumonia	4 (5.8)	8 (7.7)	0.633	7.24 (4.2)	14.03 (8.1)	0.128
Stroke	2 (2.9)	1 (1.0)	0.342	3.36 (1.9)	1.89 (1.1)	0.522
Sepsis	2 (2.9)	8 (4.8)	0.535	3.17 (1.8)	8.60 (5.0)	0.107
Cancer	4 (5.8)	7 (6.7)	0.807	7.88 (4.5)	16.57 (9.6)	0.068
Others	10 (14.5)	16 (15.4)	0.873	20.88 (12.0)	26.27 (15.1)	0.393

Unless indicated otherwise, data are given as n (%). Abbreviations as in Table 1.

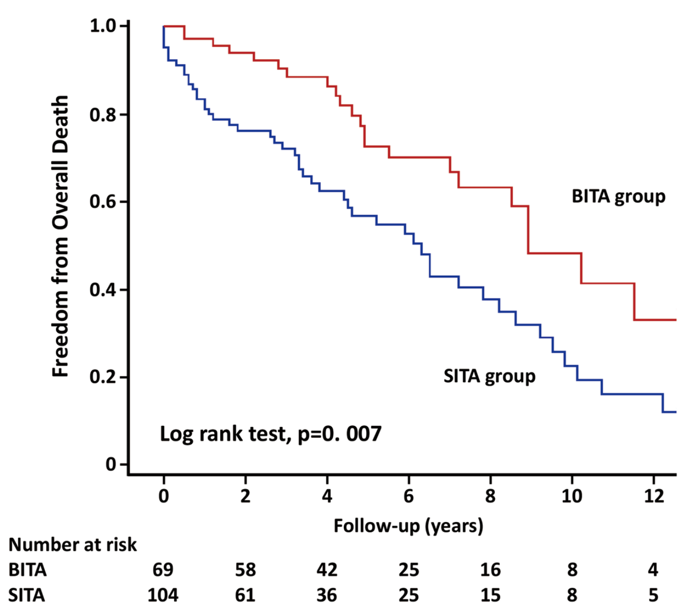

Figure 1. Freedom from overall death in the unweighted cohort. BITA, bilateral internal thoracic artery; SITA, single internal thoracic artery.

greater number of patients in the SITA than BITA group underwent emergency operation (51.9% vs. 33.3%, respectively; P=0.015) or had preoperative intra-aortic balloon pumping (29.8% vs. 13.0%, respectively; P=0.006; **Table 1**). The left ventricular ejection fraction was lower in the SITA than BITA group (49.2±13.5% vs. 53.9±10.9%, respectively; P=0.013). After adjustment using IPTW, the 2 groups were well balanced.

Early Outcomes

Operative and postoperative outcomes are presented in **Table 2**. Operation times were longer in the BITA than SITA group (231±52 vs. 219±58 min, respectively; P=0.035). There was no significant difference in the number of distal anastomoses between the 2 groups (P=0.085), but the number of grafts was greater in the BITA than SITA group (2.7±0.5 vs. 2.1±0.3, respectively; P<0.001). The BITA group also had higher rates of GEA use (52.6% vs. 30.2%; P<0.001) and lower rates of proximal anastomosis to the ascending aorta (16.0% vs. 84.8%; P<0.001), sequential grafting (44.7% vs. 84.0%; P<0.001), and saphenous vein graft use (17.2% vs. 86.5%; P<0.001). No patient in either group experienced DSWI. There was a higher rate of 30-day mortality in the SITA than BITA group (5.0% vs. 0%, respectively; P=0.003).

Preoperative data in **Table 1** and operative data in **Table 2** were included in logistic regression analyses to investigate predictors of 30-day mortality. Univariable logistic regression analyses showed that left ventricular ejection fraction was the only predictor (odds ratio 0.895; 95% confidence interval [CI] 0.835–0.961; P=0.002), so multivariable analyses were not performed.

Mid-Term Outcomes

Follow-up was completed in 97.1% of patients (168/173), and the mean follow-up duration was 4.2±3.7 years (maximum 16.9 years). All-cause death data, which include patients

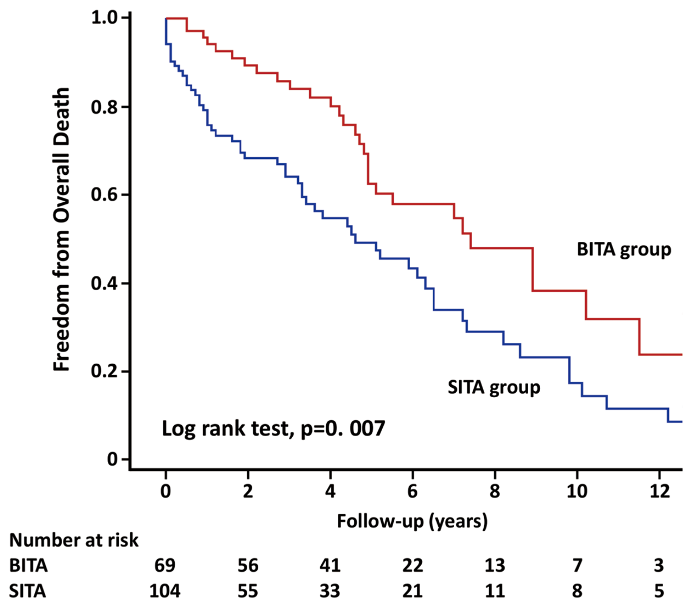

Figure 2. Freedom from major adverse cardiac and cerebrovascular events (MACCE) in the unweighted cohort. BITA, bilateral internal thoracic artery; SITA, single internal thoracic artery.

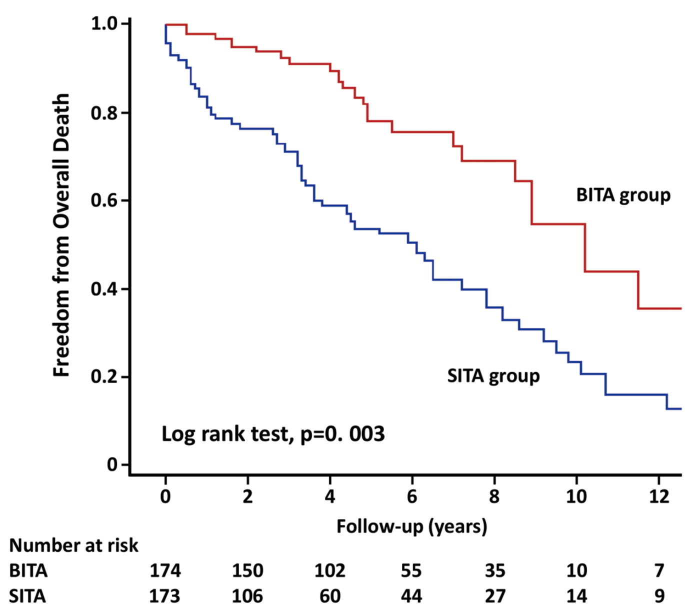

Figure 3. Freedom from overall death in the weighted cohort. BITA, bilateral internal thoracic artery; SITA, single internal thoracic artery.

who died within 30 days, are presented in **Table 3**. In the unweighted cohort, in the BITA group compared with the SITA group the 5-year estimated rates of freedom from overall death were 72.6% vs. 56.7%, respectively (**Figure 1**), and those of MACCE were 62.6% vs. 49.3%, respectively (**Figure 2**); the curves presented significant differences in overall death (P=0.007) and MACCE (P=0.007). In the weighted cohort, in the BITA group compared with the SITA group, the adjusted 5-year estimated rates of freedom from overall death were 78.2% vs. 53.7%, respectively (**Figure 3**), and those of MACCE were 67.9% vs. 44.8%, respectively (**Figure 4**); curves presented significant differences in overall death (P=0.003) and MACCE (P=0.002).

Multivariable Cox proportional hazards analysis showed that the independent predictors of overall death were age (hazard ratio [HR] 1.205; 95% CI 1.027–1.231; P=0.011), eGFR <30 mL/min/1.73 m^2 (HR 1.797; 95% CI 1.013–3.188; P=0.045), and BITA use (HR 0.555; 95% CI 0.342–0.903; P=0.018; **Table 4**). The independent predictors of MACCE were age (HR 1.099; 95% CI 1.012–1.194; P=0.025) and BITA use (HR 0.586; 95% CI 0.376–0.913; P=0.018).

Discussion

A major finding of the present study was that the overall survival rate was significantly higher in the BITA than SITA

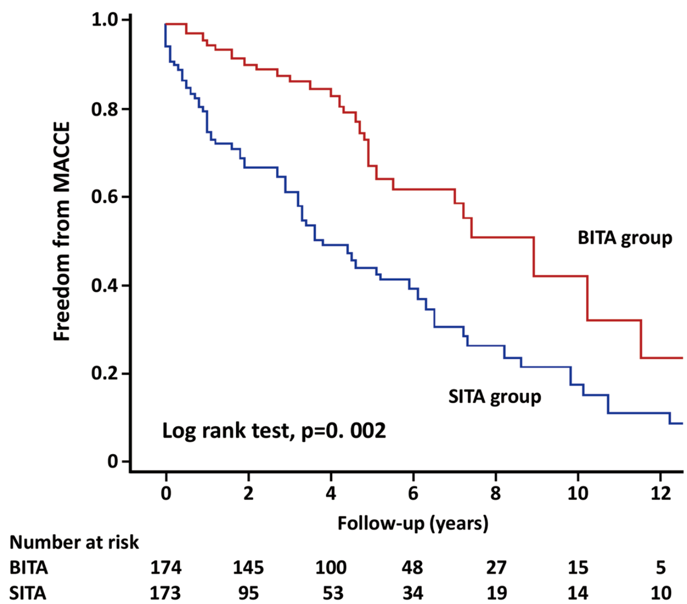

Figure 4. Freedom from major adverse cardiac and cerebrovascular events (MACCE) in the weighted cohort. BITA, bilateral internal thoracic artery; SITA, single internal thoracic artery.

Table 4. Multivariable Cox Proportional Hazards Model for the Predictors of Overall Death and MACCE

Predictor	HR	95% CI	P value
Overall death			
Age	1.125	1.027–1.231	0.011
eGFR <30 mL/min/1.73 m²	1.797	1.013–3.188	0.045
LVEF	0.983	0.964–1.002	0.084
BITA use	0.555	0.342–0.903	0.018
MACCE			
Age	1.099	1.012–1.194	0.025
eGFR <30 mL/min/1.73 m²	1.636	0.964–2.774	0.068
LVEF	0.985	0.968–1.003	0.109
BITA use	0.586	0.376–0.913	0.018

CI confidence interval; HR hazard ratio; MACCE, major adverse cardiac and cerebrovascular events. Other abbreviations as in Table 1.

group; BITA grafting was significantly associated with a lower risk for overall death after adjustment for potential confounders. It was of note that BITA grafting showed survival benefit even in octogenarians with short life expectancy. Pevni et al investigated outcomes in 190 propensity score-matched octogenarians undergoing BITA or SITA grafting and showed equal long-term survival for BITA and SITA grafting in octogenarians.[10] Gatti et al investigated outcomes in octogenarians undergoing CABG using BITA grafting in 135 patients and SITA grafting in 95 patients and showed no significant differences in late outcomes.[11] However, these studies included on-pump surgery in 61.8% (235/380) and 85.2% (196/230) of patients. Older patients often present with multiple comorbidities and unique physiology in the respiratory, cardiovascular, and metabolic systems.[12,13] In addition, aging has been reported to be associated with vascular calcification, impairing tissue perfusion, and determining end-organ damage.[14] Therefore, the use of cardiopulmonary bypass for such frail patients may have affected postoperative outcomes more than usual in these previous studies. Conversely, our study included off-pump surgery only, so we were able to examine the effect of BITA grafting precisely in octogenarians. We believe that off-pump BITA grafting provides better survival benefit in octogenarians than SITA grafting.

In the Department of Surgery, Shiga University of Medical Science, we perform BITA grafting whenever anatomically possible, even in emergency operations. However, before adjustment using IPTW, more patients in the SITA than BITA group underwent emergency operation (51.9% vs. 33.3%, respectively; P=0.015). We may have tended to perform SITA grafting for octogenarians with short life expectancy in such cases. We adjusted patients' baseline characteristics using weighted logistic regression and IPTW, but selection bias and potential confounding factors cannot be completely excluded. Thus, our results should be interpreted with caution. In fact, 6 patients in the SITA group died within 30 days after surgery, 5 of whom underwent emergency operations (**Table 2**).

Another major finding of this study was that the rate of freedom from MACCE was significantly higher in the BITA than SITA group. Gaudino et al reported the results of a large individual participant data meta-analysis of CABG trials including 10,479 men and 2,714 women that assessed whether there are sex differences in the outcomes after CABG; in that analysis, in subgroup analysis, multiple arterial grafts (MAG) were associated with a smaller risk of MACCE than were single arterial grafts (SAG) in men.[15] After that study, Tam et al compared the clinical outcomes of MAG vs. SAG in 10,915 women undergoing CABG for multivessel disease and found that MAG was associated with a smaller risk of MACCE than was SAG.[16] The mean ages of those cohorts were 67.0 years and 68.1 years. In the present study, BITA grafting was associated with a lower rate of MACCE in older patients with mean age of 82.8 years. Our results indicate that BITA grafting should be considered for octogenarians with limited life expectancy requiring CABG.

The World Health Organization reported that average life expectancy at birth in the year 2019 was 84.3 years in Japan and 78.5 years in the US,[17] and Japanese life expectancy is still among the longest in the world. Patients in the present study were all Japanese, so the long life expectancy of these patients may have resulted in significant differences in mid-term outcomes, even in the present study for octogenarians.

The BITA group used more GEA and less saphenous vein than SITA group (**Table 2**). When the right coronary artery system needed revascularization, the BITA group needed at least one graft in addition to BITA, because the BITA were anastomosed to the left coronary artery system. We aggressively used GEA as a third conduit in the BITA group when the posterior descending artery had >90% stenosis. Conversely, the GEA was used less in the SITA group because a saphenous vein was often used as a sequential graft to revascularize both the circumflex branches and the posterior descending artery. Previous reports showed the survival benefits of GEA grafting to the right coronary artery area.[18,19] Therefore, the higher rate of GEA grafting in the BITA group may have affected mid-term outcomes.

BITA grafting has been reported to be associated with an increased the risk of postoperative DSWI.[20,21] In addition, octogenarians are more prone to sternal dehiscence because of the prevalence of diabetes, osteoporosis of the sternum, and peripheral vascular and lung diseases.[10] In the present study, no patient experienced postoperative DSWI (**Table 2**). Using the skeletonization technique when harvesting the ITA reduces wound infection rates compared with pedicled harvesting.[20,21] In the present study, all patients underwent CABG using the skeletonization technique, and our results may suggest that skeletonization should be used to reduce sternal infection after CABG, even in octogenarians.

Study Limitations

This study had several limitations. First, the study had a retrospective design with intrinsic selection bias. Despite statistical adjustments with IPTW, unmeasured confounders may have affected the postoperative outcomes. Second, all studied subjects were Japanese patients at a single center, which may limit generalizability. Finally, the lack of available coronary angiography data prevented evaluation of whether the survival benefit of BITA grafting is related to graft patency.

Conclusions

Off-pump skeletonized BITA grafting is associated with lower rates of overall death and MACCE than SITA grafting in octogenarians undergoing CABG without increasing the risk of DSWI.

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Disclosures

The authors have no conflicts of interest to declare.

IRB Information

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