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Coronary: Short Report

Use of the In Situ Right Internal Thoracic Artery as an Alternative Single-Inflow Source

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ABSTRACT

BACKGROUND This study was conducted to evaluate whether the in situ right internal thoracic artery (RITA) can be an effective alternative to the left internal thoracic artery (LITA) as a single-inflow source in coronary artery bypass grafting (CABG).

METHODS Between 2006 and 2018, 73 patients underwent CABG with the composite grafting based on the in situ RITA as a single-inflow source (the RITA group). Angiographic patency and clinical outcomes were evaluated. These were compared with results after CABG using the composite grafting based on the in situ LITA (the LITA group) by 1:1 propensity score matching.

RESULTS Forty-three pairs were extracted by 1:1 propensity score matching. There were no significant intergroup differences in overall patency rates between the RITA and LITA groups at 1 year (92.2% [95/103] and 92.5% [111/120], respectively; $P = .90$) and 5 years (87.3% [48/55] and 90.4% [85/94], respectively; $P = .58$). There were no significant differences in the cumulative incidences of reintervention and major adverse cardiac events between the 2 groups (hazard ratio, 2.0 [95% CI, 0.33-11.97] and 1.50 [0.41-5.45], respectively).

CONCLUSIONS Five-year graft patency and long-term clinical outcomes after CABG using the composite grafting based on the in situ RITA were not significantly different from those after CABG using the LITA.

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Use of the in situ left internal thoracic artery (LITA), especially as a graft to the left anterior descending coronary artery (LAD), has been recommended in coronary artery bypass grafting (CABG), mainly because of its long-term patency.[1-4] However, there might be clinical situations in which it is impossible to use the in situ LITA, such as the presence of an ipsilateral arteriovenous fistula because of the issue of "coronary steal."[5,6] Other situations include subclavian artery stenosis and trauma to the proximal LITA during harvesting. The right internal thoracic artery (RITA) has the same physiologic characteristics as the LITA, which is a potential advantage of the RITA.[7] However, data are limited as to whether the RITA could be a single-inflow source in CABG. This study was therefore conducted to evaluate whether composite grafting based on the in situ RITA could be an effective alternative to composite grafting based on the in situ LITA.

IN SHORT

- Coronary artery bypass grafting with a composite grafting strategy based on the in situ right internal thoracic artery might be an effective alternative when the in situ left internal thoracic artery is unavailable.
- Five-year graft patency and long-term clinical outcomes after coronary artery bypass grafting did not differ between patients in the in situ right and left internal thoracic artery groups.

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PATIENTS AND METHODS

This study was conducted as a single-center retrospective study. The study protocol was approved by the institutional review board, and written informed consent was waived. Of a total of 1863 patients who underwent isolated primary CABG between 2006 and 2018, there were 73 patients who underwent CABG with the composite grafting strategy based on the in situ RITA as a single-inflow source (Supplemental Table 1).

SURGICAL TECHNIQUES AND GRAFTING STRATEGIES. Our CABG preference was anaortic off-pump CABG using a Y or I composite graft based on the in situ LITA.[5] Composite grafting based on the in situ RITA was used when the LITA was not appropriate as an inflow source based on the preoperative findings in most of the patients. In addition, intraoperative decision was made when the LITA was injured during harvest (n = 9 [12.3%]) or had too small caliber (n = 7 [9.6%]; Supplemental Table 2). When composite grafting based on the in situ RITA was performed, the RITA was used to revascularize the LAD if the RITA was long enough to reach the LAD. Other coronary vessels were revascularized with the second grafts as I or Y composite grafts, as appropriate (Supplemental Table 3).

All arterial conduits including both LITA and RITA and right gastroepiploic artery were harvested with skeletonization. The saphenous vein was harvested by the "no-touch" technique.[8]

EVALUATION OF ANGIOGRAPHIC GRAFT PATENCY. Early (1 [1-2] days), 1-year (12.4 [11.8-13.1] months), and 5-year (61.0 [60.3-62.9] months) graft angiograms were obtained as a routine postoperative evaluation protocol in 97.3% (n = 71), 79.5% (n = 58), and 42.5% (n = 31) of the study patients by conventional angiography or multidetector computed tomography angiography.

EVALUATION OF CLINICAL OUTCOMES. Early mortality was defined as any death within 30 days after surgery or during the same hospitalization. Long-term clinical outcomes included all-cause mortality and major adverse cardiac event (MACE), defined as the composite of cardiac death, acute myocardial infarction (AMI), and reintervention (by percutaneous coronary intervention or redo CABG). The median follow-up duration was 59.5 (25.1-98.5) months.

STATISTICAL ANALYSIS. Statistical analyses were performed with SAS software (version 9.4; SAS Institute). Categorical variables were reported as numbers and proportions. Continuous variables were presented as mean ± SD and median with interquartile range for normally and nonnormally distributed variables, respectively.

During the study period, 1629 patients underwent off-pump CABG with use of the in situ LITA as a single-inflow source. To compare the results of CABG in the study patients with those using composite grafting based on the in situ LITA, 1:1 propensity score matching was performed with these patients. Twenty-one preoperative and intraoperative variables shown in Supplemental Table 1 were used for propensity score matching. With the caliper matching method, pairs of patients were matched by the nearest neighborhood method (greedy matching) within a caliper width of 0.1 in propensity scores, with a ratio of 1:1. The balance of covariates between groups was evaluated with standardized mean differences ($\leq$0.1 indicates a negligible difference between groups). To compare categorical and continuous variables between the matched groups, the McNemar test and paired Student *t*-test were used. The graft patency rates were compared between the 2 groups established through propensity score matching using generalized estimating equations.

Overall survival was estimated by the Kaplan-Meier method, and a weighted Cox proportional hazards model was used to compare overall survival between the propensity score–matched groups. Cumulative incidence curves were estimated considering noncardiac death and all-cause death as competing events for the analysis of reintervention and MACE, respectively. A weighted Fine and Gray subdistribution hazards model was used to compare cumulative incidence between the groups. A *P* value of $<$.05 was considered statistically significant.

RESULTS

EARLY AND LONG-TERM CLINICAL OUTCOMES. Early mortality rates were 2.7% (n = 2). The early postoperative outcomes are shown in Supplemental Table 4. All-cause mortality occurred in 46 patients. The 5- and 10-year survival rates were 55.7% and 32.2%, respectively. MACE occurred in 12 patients, including cardiac death, AMI, and reintervention in 4, 2, and 9 patients, respectively. The cumulative incidence rates of reintervention at 5 and 10 years were 8.6% and 13.5%, respectively. The cumulative incidence rates of MACE at 5 and 10 years were 12.3% and 15.7%, respectively (Figure 1).

EARLY, 1-YEAR, AND 5-YEAR POSTOPERATIVE ANGIOGRAPHIC PATENCY. The overall early, 1-year, and 5-year graft patency rates were 98.1% (212/216 distal anastomoses), 94.4% (168/178), and 90.5% (86/95), respectively. The corresponding graft patency rates of the in situ RITA grafts were 100% (14/14), 91.7% (11/12), and 80% (4/5), respectively. Those of composite conduits decreased from 98% (198/202) in the early

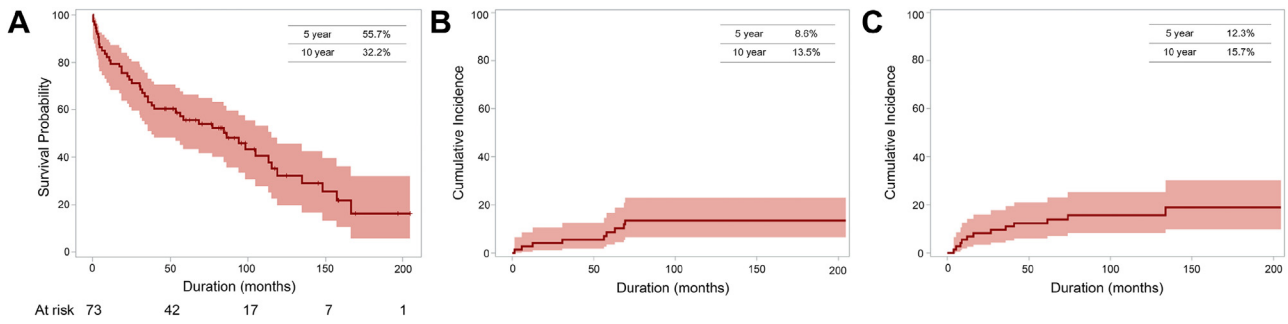

FIGURE 1 (A) Overall survival, (B) cumulative incidence of reintervention, and (C) cumulative incidence of major adverse cardiac events in the 73 study patients.

postoperative period to 94.4% (143/162) at 1 year and 91.1% (82/90) at 5 years.

CLINICAL OUTCOMES IN THE PROPENSITY SCORE–MATCHED GROUPS. Forth-three pairs were extracted after 1:1 propensity score matching (Supplemental Table 5). There were no significant differences in early clinical outcomes (Table 1).

All-cause mortality occurred in 25 patients in the RITA group and 15 patients in the LITA group. The weighted Cox proportional hazards model showed that overall survival was significantly lower in the RITA group than in the LITA group (hazard ratio, 2.29; 95% CI, 1.16-4.49). MACE occurred in 3 patients in each group, including cardiac death, AMI, and reintervention in 1, 0, and 2 patients, respectively, in the RITA group, and 2, 0, and 1 patients, respectively, in the LITA group. There were no significant differences in the cumulative incidences of reintervention and MACE between the 2 groups (2.0 [0.33-11.97] and 1.50 [0.41-5.45], respectively; Figure 2).

TABLE 1 Comparison of Early Clinical Outcomes in the Propensity Score–Matched RITA and LITA Groups

Variables	Propensity Score–Matched Patients		
	RITA Group (n = 43)	LITA Group (n = 43)	*P* Value
Operative mortality	2 (4.7)	0	.50
Postoperative complications			
Atrial fibrillation	14 (32.6)	14 (32.6)	…
Respiratory complication	2 (4.7)	2 (4.7)	…
Acute renal failure	4 (9.3)	2 (4.7)	.68
Perioperative myocardial infarction	1 (2.3)	2 (4.7)	…
Bleeding reoperation	1 (2.3)	1 (2.3)	…
Low cardiac output syndrome	1 (2.3)	3 (7)	.62
Stroke	0	0	…
Mediastinitis	0	0	…

Data are presented as number (percentage). LITA, left internal thoracic artery; RITA, right internal thoracic artery.

ANGIOGRAPHIC RESULTS IN THE PROPENSITY SCORE–MATCHED GROUPS. The overall patency rates at the early postoperative period were lower in the RITA group than in the LITA group (96.9% [125/129 distal anastomoses] and 100% [134/134], respectively; $P < .001$). However, there were no significant intergroup differences in the overall patency at 1 year (92.2% [95/103] and 92.5% [111/120], respectively; $P = .90$) and 5 years (87.3% [48/55] and 90.4% [85/94], respectively; $P = .58$). The patency rates of the in situ internal thoracic artery and composite grafts were also not significantly different between the 2 groups (Table 2).

COMMENT

This study demonstrated that CABG performed with composite grafting based on the in situ RITA might be an effective alternative to CABG based on the in situ LITA in terms of early and long-term clinical outcomes and graft patency rates at 1 year and 5 years.

Bypass grafting of the LITA to the LAD has been considered the standard treatment strategy for coronary artery revascularization because of its proven long-term patency and resultant favorable clinical outcomes.[1] However, there are several conditions in which the LITA is not available for use as a bypass conduit demonstrated in the study patients. In these circumstances, alternative grafting strategies, such as in situ RITA and aortocoronary saphenous vein, are needed to revascularize the LAD as well as other target vessels.[9] Because the RITA has the same physiologic characteristics as the LITA, it might also have the same advantages as a bypass conduit.[7-9] In addition, it can be used as an in situ conduit like the LITA, which allows anaortic CABG. However, no study

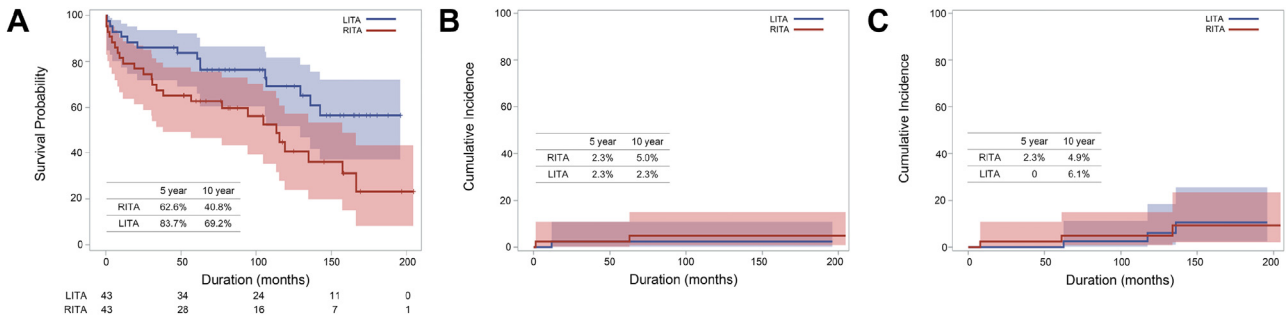

FIGURE 2 Comparisons of (A) overall survival, (B) cumulative incidence of reintervention, and (C) cumulative incidence of major adverse cardiac events in the propensity score–matched right internal thoracic artery (RITA) and left internal thoracic artery (LITA) groups.

has evaluated the safety and efficacy of CABG using the in situ RITA as a single blood source in multivessel coronary artery grafting.

As demonstrated in this study, this grafting strategy is rare in daily clinical practice, and only 73 of 1700 patients underwent CABG with this strategy during the study period. Because of the differences in characteristics between the study patients and the control group patients, propensity score matching was conducted. The study results showed that clinical outcomes, such as the cumulative incidences of reintervention and MACE, and the graft patency rates up to 5 years were not significantly different between the 2 groups. Although the overall survival rate was significantly lower in the RITA group than in the LITA group, this difference might have been due to the imbalance in demographic data even though propensity score matching was performed.

LIMITATIONS. This study has several limitations that should be noted. First, this was a retrospective observational study at a single institution. Second, whereas

TABLE 2 Comparison of the Early, 1-Year, and 5-Year Graft Patency Rates in the Propensity Score–Matched RITA and LITA Groups

Variables	RITA Group	LITA Group	
Early patency rates	**(n = 41)**	**(n = 43)**	***P* Value**
Overall	96.9 (125/129)	100 (134/134)	<.001
In situ ITA	100 (10/10)	100 (32/32)	…
Composite conduits used	96.6 (115/119)	100 (102/102)	<.001
Contralateral ITA	100 (10/10)	100 (10/10)	…
RGEA	100 (28/28)	100 (19/19)	…
Saphenous vein	95.1 (77/81)	100 (73/73)	.06
1-year patency rates	**(n =32)**	**(n = 39)**	
Overall	92.2 (95/103)	92.5 (111/120)	.90
In situ ITA	100 (8/8)	96.7 (29/30)	.93
Composite conduits used	91.6 (87/95)	91.1 (82/90)	.93
Contralateral ITA	90 (9/10)	71.4 (5/7)	.51
RGEA	100 (26/26)	89.5 (17/19)	.13
Saphenous vein	88.1 (52/59)	93.8 (60/64)	.25
5-year patency rates	**(n = 17)**	**(n = 31)**	
Overall	87.3 (48/55)	90.4 (85/94)	.58
In situ ITA	100 (4/4)	100 (24/24)	…
Composite conduits used	86.3 (44/51)	87.1 (61/70)	.90
Contralateral ITA	100 (3/3)	71.4 (5/7)	.46
RGEA	94.1 (16/17)	84.6 (11/13)	.44
Saphenous vein	80.7 (25/31)	90 (45/50)	.19

Values are reported as % (n/N). ITA, internal thoracic artery; LITA, left internal thoracic artery; RGEA, right gastroepiploic artery; RITA, right internal thoracic artery.

propensity score matching was used, only 43 matched pairs were extracted, corresponding to a relatively small number of patients. Finally, follow-up coronary angiography was not performed in all patients.

CONCLUSION. A composite grafting strategy based on the in situ RITA might be an effective alternative to CABG based on the in situ LITA in terms of long-term clinical outcomes and MACE and graft patency rates at 1 year and 5 years.

The Supplemental Tables can be viewed in the online version of this article [https://doi.org/10.1016/j.atssr.2023.04.001] on http://www.annalsthoracicsurgery.org.

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DISCLOSURES

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