Minimally invasive coronary artery bypass grafting using the skeletonized right gastroepiploic artery

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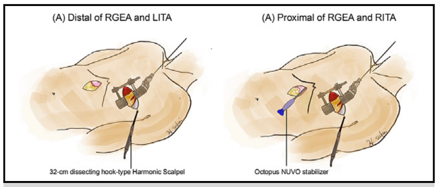
ABSTRACT

Objective: To evaluate the clinical outcomes of right gastroepiploic artery use in minimally invasive coronary artery bypass grafting.

Methods: A total of 428 patients who underwent minimally invasive coronary artery bypass grafting from February 2012 to February 2024 were included into this retrospective cohort study. The selection criteria for right gastroepiploic artery use included satisfactory artery size and length, significant stenosis (99% to 100%) of the right coronary artery, and unsuitable ascending aorta for partial clamping.

Results: The study cohort comprised 70 men and 8 women, with an average age of 63.6 ± 10.5 years. The right gastroepiploic artery was used in 18.2% (78 out of 428) of cases, without the aorta being touched in all these cases. Total arterial revascularization was achieved in 93.6% of cases and complete revascularization was achieved in 98.7%. Notable postoperative outcomes included zero in-hospital mortality, an incidence of new-onset atrial fibrillation of 9.0%, and a median intensive care unit stay of 2 days. Surgical site infections occurred in 7.5% of patients.

Conclusions: The use of the right gastroepiploic artery in minimally invasive coronary artery bypass grafting is a viable option for achieving total arterial revascularization without touching the ascending aorta, enhancing the rate of optimal clinical outcomes. (JTCVS Techniques 2024;28:82-90)



It is possible to save time by devising a procedure for RGEA and BITA harvesting.

CENTRAL MESSAGE

In off-pump MICS CABG, the right gastroepiploic artery can be an important third arterial graft to achieve complete revascularization without touching the ascending aorta.

PERSPECTIVE

The right gastroepiploic artery may be an important option in minimally invasive coronary artery bypass grafting, enabling further optimization of the procedure to improve patient outcomes.

▶ Video clip is available online.

In coronary artery bypass grafting (CABG), the right gastroepiploic artery (RGEA) is an effective third arterial graft in cases where the posterior descending artery has significant stenosis.[1,2] In CABG, the RGEA is used particularly in Japan. RGEA use was first reported by Suma and colleagues in 1987.[3] The Japanese Association for Coronary Artery Surgery stated in their 2020 annual report that the RGEA was used in 3% of single CABG procedures. As a branch of the celiac artery, the RGEA is easily influenced by competitive flow and is prone to spasms. Consequently, the bilateral internal thoracic arteries (BITAs) remain the primary graft choice. However, as long as it is used appropriately, the utility of the RGEA is high, especially in minimally invasive CABG (MICS CABG). Its value as an arterial graft is particularly notable in achieving complete revascularization without manipulating the aorta or maintaining long-term patency.

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Abbreviations and Acronyms

- BITA = bilateral internal thoracic artery
- CABG = coronary artery bypass grafting
- CT = computed tomography
- LITA = left internal thoracic artery
- MICS = minimally invasive cardiac surgery
- NTSVG = no-touch saphenous vein graft
- PDA = posterior descending artery
- RA = radial artery
- RGEA = right gastroepiploic artery
- RITA = right internal thoracic artery

In MICS CABG, achieving total arterial revascularization without touching the ascending aorta is ideal. Although our institution primarily uses the BITA, we aim to achieve these goals using the RGEA. In this study, we analyzed the methods used in cases of MICS CABS and their clinical outcomes, including those of cases in which the RGEA was used.

METHODS

Study Design and Patient Selection

This was a retrospective cohort study. The medical records of 436 patients who underwent MICS CABG by 3 surgeons between February 2012 and February 2024 were assessed. Nine patients with confirmed nosocomial infections caused by coronavirus disease or vancomycin-resistant enterococci were excluded because their length of hospital stay and tracheal intubation time were particularly long and their clinical course was different from that of most of the patients in whom the GEA was used for MICS CABG. Of the remaining 428 patients, 78 patients in whom the RGEA was used were examined (Figure E1).

This study was approved by the institutional review board of Tokyo Bay Medical Center (July 26, 2024; No. 957). The requirement for patient consent was waived because this was a retrospective study. Data on preoperative patient demographic characteristics, intraoperative variables, and postoperative outcomes were collected retrospectively.

Surgical Procedures

Before surgery, the quality and length of the RGEA were assessed using enhanced 3-dimensional computed tomography (CT) to evaluate its suitability as a graft (Figure E2). Under general anesthesia, patients were intubated using a double-lumen tube to facilitate 1-lung ventilation. Patients were placed in the right semidecubitus position inclined at an angle of approximately 30°, allowing isolated ventilation of the right lung. For the MICS CABG procedure, the surgical area was expanded according to the technique described by Kikuchi and colleagues.[4] An 8-cm left thoracotomy was performed at the fifth intercostal space below the left nipple. A ThoraTrak retractor (Medtronic) was used to access the thoracic cavity, which was maneuvered cranially and leftward with the assistance of an additional crane retractor.[5]

Harvesting Grafts

The left internal thoracic arteries (LITAs) and right internal thoracic arteries (RITAs) were harvested using a 32-cm dissecting hook-type Harmonic scalpel (Ethicon Endo-Surgery Inc), at the same time as the RGEA.

Typically, the RGEA was harvested concurrently with the BITAs. A 6-cm skin incision was made along the midline of the abdomen from the xiphoid process to expose the stomach. The RGEA was identified and harvested using a scissor-shaped Harmonic scalpel. The distal end of the RGEA was harvested. While the distal end of the RGEA was dissected, the LITA was harvested from the right fifth intercostal space ahead of the RITA (Figure E3, *A*). First, several spots around the RGEA were taped using vessel tapes. The anterior layer of the greater omentum in front of the RGEA was peeled off with a scissor-shaped harmonic scalpel (Figure 1, *A*). Next, with the RGEA in traction with the vessel tape, the remaining anterior layer of the greater omentum was similarly detached. At this time, the small artery from the RGEA to the stomach and the satellite vein were also dissected (Figure 1, *B*).

The Octopus Nuvo stabilizer (Medtronic) was inserted through the same layer to facilitate RITA harvesting. After the Octopus Nuvo was placed via a small abdominal incision, the proximal end of the RGEA was dissected (Figure E3, *B*). After carefully detaching the RGEA, heparin was injected and the distal end of the RGEA was cut off. The diaphragm was incised in an *L*-shaped manner and the harvested RGEA was transferred from the abdominal cavity into the pericardium (Figure 2). The RGEA was then anastomosed to the target vessel of the right coronary artery using 8-0 polypropylene according to previously reported methods[4] (Video 1).

Statistical Analysis

Statistical analyses were performed using IBM SPSS statistics version 29.0.1.0 for Windows (IBM-SPSS Inc). Descriptive statistics, including means, percentages, and medians for all relevant variables, were calculated to provide an overview of the demographic and clinical characteristics and postoperative outcomes of the patients. This approach allowed us to effectively evaluate the clinical influence of RGEA in our cohort.

RESULTS

Patient Characteristics

This study evaluated 78 patients who underwent MICS CABG using the RGEA. The patient characteristics are presented in Table 1. This cohort had an average age of 63.6 ± 10.5 years, with a sex distribution of 70 men and 8 women. The average patient height was 171.2 ± 40.9 cm, and the average weight was 72.4 ± 14.8 kg; the mean body surface area was 1.79 ± 0.19 m^2.

Cardiac characteristics included stable angina in 68 (87.2%) patients, unstable angina in 10 (12.8%), and acute myocardial infarction in 2 (2.6%). The average ejection fraction was 54.2 ± 12.4%, with a left ventricular end-diastolic diameter of 49.0 ± 6.57 mm and an end-systolic diameter of 35.1 ± 7.51 mm. The coronary artery disease profile showed that 61 (78.2%) patients had a 3-vessel disease, 16 (20.5%) had a 2-vessel disease, and 1 (1.28%) had a single-vessel disease. Diabetes mellitus was present in 56 patients (71.8%) with an average glycated hemoglobin level of 7.07 ± 1.46. Sixty patients (76.9%) had hypertension and 39 (50%) had a history of smoking. Other significant medical conditions included chronic renal insufficiency in 27 patients (34.6%), chronic pulmonary disease in 3 (3.8%), and hemodialysis in 17 (21.8%). Forty-four patients (56.4%) had a prior myocardial infarction, 26 (33.3%) had undergone a prior percutaneous coronary intervention, and 9 (11.5%) had an older brain infarction.

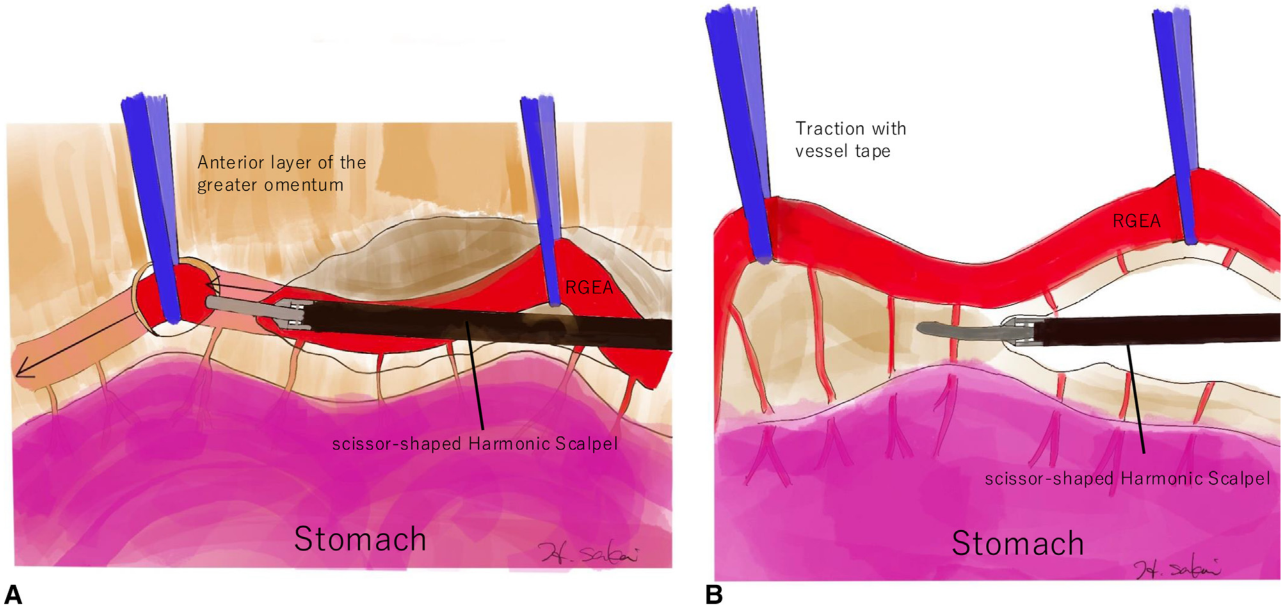


FIGURE 1. A, Several spots around the RGEA were taped using vessel tapes. The anterior layer of the greater omentum in front of RGEA was peeled off with a scissor-shaped harmonic scalpel. B, The RGEA in traction with the vessel tape, the small artery from the RGEA to the stomach and the satellite vein were also dissected.

Indications and Exclusion Criteria for Using the RGEA

The RGEA was used in patients who satisfied the following 3 conditions: satisfactory size of the RGEA on preoperative CT, right coronary artery stenosis of 99% to 100%, and unsuitable ascending aorta for partial clamping. We often avoid using the RGEA in patients with a history of previous abdominal surgery or in patients who are severely obese and have thick abdominal walls because the approach used to access the RGEA can be difficult. Furthermore, the RGEA is not used as a bypass graft in patients with stenosis or strong calcification of the celiac artery because blood flow in the RGEA may be limited.

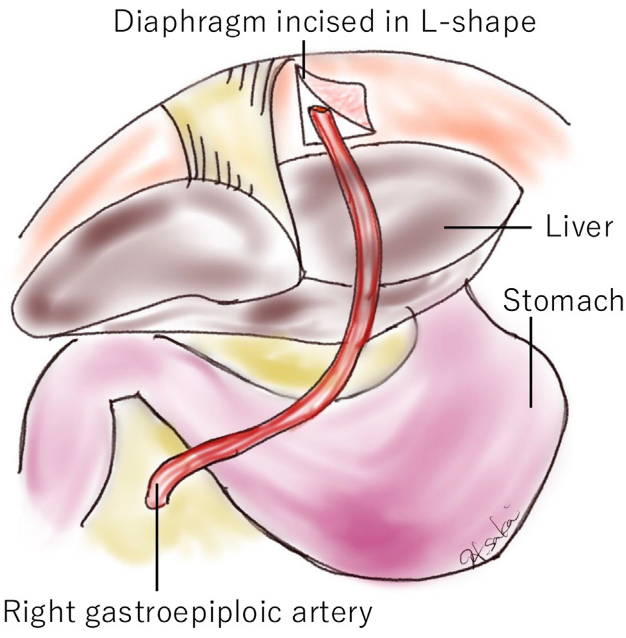
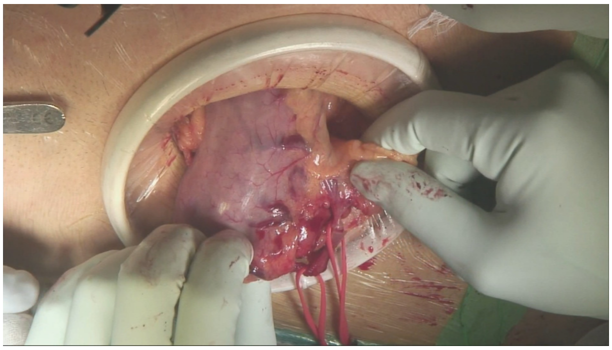


FIGURE 2. Right gastroepiploic artery arrangements.

Operative Characteristics

The operative characteristics are shown in Table 2. Of the 428 patients who underwent MICS CABG, the RGEA was used in 18.2% (78) of the patients. The procedures were completed without cardiopulmonary bypass in 75 (96.2%) patients; 3 patients underwent cardiopulmonary bypass for hemodynamic stabilization. The number of grafts per patient varied: a single graft was used in 1 (1.28%) patient, 2 were used in 17 (21.8%) patients, 3 were used in 42 (53.8%) patients, and 4 were used in 18 patients (23.1%).

The BITA was used in 56 (71.8%) patients. Sequential bypass with in situ RGEA was performed in 10 (12.8%) patients. The average number of distal anastomoses was 3.21 ± 1.0/patient. The aorta was not touched in all patients (100%). This approach, along with strategies to minimize aortic manipulation, was adopted to reduce the risk of potential complications. Total arterial revascularization was achieved in 73 out of 78 (93.6%) patients and complete revascularization was achieved in 77 out of 78 (98.7%). No conversion to sternotomy was performed.



VIDEO 1. The procedure begins with simultaneous incisions on the skin below the xiphoid and at the left fifth intercostal space (0:00). The LITA and the distal RGEA harvests are initiated concurrently. A wound protector (size S) is inserted into the incision for RGEA harvesting (0:08). The stomach is slightly lifted to identify and tape the distal end of the RGEA (0:15). The anterior layer of the greater omentum is cut using a scissors-shaped Harmonic scalpel (Ethicon Endo-Surgery Inc) (0:20). This tool is also used to sever branches of the RGEA and the associated satellite vein (0:31). The stomach is then retracted to the right, allowing further dissection of the peripheral RGEA using the same technique (0:34). After the distal RGEA is dissected, a hole is made to pass a retractor used for the RITA harvest, guiding it from the abdominal side into the mediastinum (0:46). Concurrently with the RITA harvest, the proximal RGEA is dissected similarly to the distal portion (1:00). Once both the RITA harvest and proximal RGEA harvest are complete, the retractor is removed. Following heparin injection, the distal RGEA is ligated and cut (1:15). Papaverine hydrochloride is applied to the harvested RGEA, and hemostasis of its branches is verified (1:30). An L-shaped incision is made in the diaphragm with an electrocautery knife (Figure 2), taking care to prevent thermal damage to the heart (1:37). The RGEA is passed from the peritoneal side into the pericardial cavity (1:52), with view from the pericardial cavity side (1:59). Finally, the RGEA is anastomosed to the PDA (2:07). Video available at: https://www.jtcvs.org/article/S2666-2507(24)00425-5/fulltext.

TABLE 1. Preoperative patient characteristics

Characteristic	Result
Age (y)	63.6 ± 10.5
Male/female	70/8
Height (cm)	171.2 ± 40.9
Weight (kg)	72.4 ± 14.8
BSA (m^2)	1.79 ± 0.19
Stable angina	68 (87.2)
Unstable angina	10 (12.8)
Acute MI	2 (2.6)
Ejection fraction (%)	54.2 ± 12.4
LVDd (mm)	49.0 ± 6.57
LVDs (mm)	35.1 ± 7.51
1-vessel disease	1 (1.28)
2-vessel disease	16 (20.5)
3-vessel disease	61 (78.2)
Left main trunk disease	13 (16.7)
Diabetes mellitus	56 (71.8)
HbA1c	7.07 ± 1.46
Hypertension	60 (76.9)
Smoking history	39 (50)
Chronic pulmonary disease	3 (3.8)
Chronic renal insufficiency	27 (34.6)
Hemodialysis	17 (21.8)
Old brain infarction	9 (11.5)
Prior myocardial infarction	44 (56.4)
Prior PCI	26 (33.3)

Values are presented as n (%) or mean ± SD. *BSA*, Body surface area; *MI*, myocardial infarction; *LVDd*, left ventricular diameter at end-diastole; *LVDs*, left ventricular diameter at end-systole; *HbA1c*, glycated hemoglobin; *PCI*, percutaneous coronary intervention.

Distribution of Conduits and Target Vessels

The distributions of the conduits and target vessels are shown in Tables 3 and 4. In the 78 patients in whom the RGEA was used for MICS CABG, the distribution of conduits with the RGEA as the inflow source varied significantly among patients. A single inflow exclusively using the RGEA occurred in only 1 (1.28%) patient, whereas a combination of a RGEA with 1 additional inflow was used in 20 (25.6%) patients; the RGEA and 2 other inflows were used in majority of the procedures (57 patients [73.1%]) (Table 3).

The RGEA was used exclusively for the RCA with 69 grafts (63 individuals and 6 composites). The RGEA was not utilized in any other coronary arteries. The LITA was used predominantly for the left anterior descending artery (50 grafts; 47 individuals and 4 composites) and the circumflex artery (27 grafts; 22 individuals and 5 composites). The RITA was also used for the left anterior descending and circumflex arteries in 29 (28 individuals and 1 composite) and 21 grafts (2 individuals and 19 composites), respectively (Table 4).

Postoperative Outcomes

The postoperative outcomes are summarized in Table 5. The postoperative phase following MICS CABG showed exceptional safety records with no in-hospital mortality. The RGEA graft showed patency in all cases during postoperative evaluation. No deep sternal wound infections were observed. New-onset arterial fibrillation occurred in 9.0% of patients; pleural effusion was observed in 26 (32.5%) patients, and pleural drainage using chest puncture was required in 13 (16.7%) patients.

The average stay in the intensive care unit was notably short, with a median of 2 days and a range of 2 to 4 days. Other significant but less frequent complications included stroke in 3 patients (3.8%) who had a cerebral infarction on the third or fourth postoperative day, suspected to be

TABLE 2. Operative characteristics

Characteristic	Result
Use of GEA among all MICS CABG cases	78 (18.2)
No. of grafts	
1	1 (1.28)
2	17 (21.8)
3	42 (53.8)
4	18 (23.1)
Use of BITA	56 (71.8)
Sequential bypass with in-situ GEA	10 (12.8)
Average distal anastomosis	3.21 ± 1.0
Aortic no-touch technique	78 (100)
Total arterial revascularization	73 (93.6)
Complete revascularization	77 (98.7)
Use of cardiopulmonary bypass	3 (3.8)
Conversion to sternotomy	0 (0)
Procedure time (min)	366 (283-477)

Values are presented as n (%) or median (interquartile range). *GEA*, Gastroepiploic artery; *MICS*, minimally invasive cardiac surgery; *CABG*, coronary artery bypass grafting; *BITA*, bilateral internal thoracic artery.

due to accidental plaque rupture. Perioperative blood transfusions were administered to 14 (17.9%) patients. One patient developed acute renal failure during the perioperative period from end-stage renal dysfunction; this patient required temporary hemodialysis but was weaned off of it by the time they were discharged. Surgical site infections were reported in 5 (7.5%) patients, the RGEA harvesting site in 2 (2.6%) patients, and the saphenous vein graft harvesting site in 2 (2.6%) patients.

Patency evaluation is mainly performed with coronary contrast-enhanced CT during the same admission. Coronary contrast-enhanced CT can confirm the patency of the RGEA graft without problems. Cardiologists often perform angiography of the RGEA, which is the easiest procedure. In the postoperative evaluation, all RGEAs were patent.

Perioperative Medical Management

To prevent postoperative spasms of the grafts, we routinely administer continuous intravenous diltiazem hydrochloride (0.5-1.0 μg/kg/minute) and continuous intravenous nicorandil (0.5-1.0 μg/kg/minute) beginning postoperatively as soon as the blood pressure is normal. When oral feeding is resumed, the continuous intravenous diltiazem hydrochloride and nicorandil are switched to oral drugs (diltiazem hydrochloride 100-200 mg/day, nicorandil 15 mg/day). If an arterial graft is used, the patient receives aspirin (100 mg/day) and clopidogrel sulfate (75 mg/day) for the first 6 months postoperatively, and then aspirin (100 mg/day) alone for the rest of their life. Pregabalin is administered from 2 days before surgery to 4 weeks postoperatively to prevent pain. This protocol was followed for the patients in this study.

TABLE 3. Distribution of number of inflows (N = 81)

No. of inflows	Result
1 (only GEA)	1 (1.28)
2	20 (25.6)
3	57 (73.1)

Values are presented as n (%). *GEA*, Gastroepiploic artery.

DISCUSSION

MICS has gained increasing attention in recent years for procedures involving the coronary arteries, valvular diseases, mechanical circulatory support, and arrhythmias, and demand has risen because many good outcomes have been reported.[6,7] Reports have demonstrated the feasibility of complete revascularization using an approach involving a small incision through a left small thoracotomy. In patients with comorbid coronary artery disease, MICS and conventional CABG have comparable revascularization performances.[8] Additionally, MICS CABG can effectively reduce, if not prevent, poor clinical outcomes and complications such as poor incision healing, sternal infection, and prolonged length of hospital stay for patients with diabetes.[9] However, MICS CABG still presents challenges. It is difficult to anastomose the graft to the ascending aorta safely and securely, and harvesting the BITA through the small left thoracotomy without injuring it is challenging. Grafting techniques involving the ascending aorta have been reported[10] along with methods for skeletonized BITA harvesting from the same incision,[5] improving the feasibility of complete revascularization using MICS CABG.

An additional issue is obtaining a third inflow. This study showed that the RGEA can be used as an important inflow to the RCA territory instead of the ascending aorta being used for proximal anastomosis. If preoperative CT scans do not show atherosclerosis of the ascending aorta, proximal anastomosis of the aorta can be performed without hesitation.[11] However, with the recent increase in cases of severe atherosclerosis of the ascending aorta, performing the anaortic technique while not clamping the ascending aorta as much as possible is preferable to prevent stroke.[12-14] Using the RGEA for graft inflow to the posterior descending artery (PDA) region may enhance the potential for complete revascularization without touching the aorta.

The excellent outcomes of using the RGEA for CABG were first reported by Pym and colleagues[15] and Suma and colleagues.[3] Although the RGEA is prone to spasms, harvesting it using a harmonic scalpel for skeletonization has been shown to result in a good early patency rate.[16] In off-pump CABG using the BITA, the use of the RGEA

TABLE 4. Distribution of conduits and target vessels

Target coronary area	Inflow		
	GEA: Individual/composite	LITA: Individual/composite	RITA: Individual/composite
RCA	69 (63/6)	0 (0/0)	0 (0/0)
LAD	0 (0/0)	50 (47/3)	29 (28/1)
Circumflex	0 (0/0)	27 (22/5)	21 (2/19)
Total	69 (63/6)	77 (69/8)	50 (30/20)

Values are presented as total number (number of individual/number of composite). *GEA*, Gastroepiploic artery; *LITA*, left internal thoracic artery; *RITA*, right internal thoracic artery; *RCA*, right coronary artery; *LAD*, left anterior descending artery.

has superior survival rates and cardiovascular event prevention compared with saphenous vein graft.[17] From an anatomical perspective, the RGEA is considered the most suitable arterial graft for PDA.[18] However, in patients who require dialysis or who are older adults, the RGEA is often calcified, making it unsuitable for use.[19] In patients who are extremely obese, harvesting the RGEA can be challenging, and it is therefore not recommended.[18] Patients with diabetes may develop mediastinitis, requiring omentoplasty. Because using the RGEA as a graft can hinder omentoplasty, it is preferable not to use the RGEA as a graft in patients with diabetes.

Owing to its susceptibility to atherosclerotic lesions, careful consideration is necessary when using the RGEA. Our practice is to avoid using the RGEA in situ unless the stenosis in the right coronary artery region is severe. Moderate stenosis in the target vessel can increase the risk of graft occlusion as blood might preferentially flow to the abdominal organs rather than the coronary artery; additionally, when an RGEA is anastomosed in situ to a coronary artery with moderate stenosis, it can lead to a competitive flow pattern.[1] As a result of this, we actively use the RGEA in young patients in whom the right coronary artery is either 99% stenosed or has a chronic total occlusion, allowing for total arterial revascularization.

The arterial graft diameter is crucial because the use of distal small sections is inappropriate. To aim for in situ total arterial revascularization, larger parts of the arterial grafts should be used; if the distal part of the ITA is small, the RGEA or radial artery may be used as a free graft to create a composite graft. The fundamental graft design varies between the BITA and no-touch saphenous vein graft (NTSVG), in situ RGEA, or free radial artery (RA), depending on the case. When planning the graft design, at least 2 inflows should be secured (ideally 1 inflow per area). The RA, which can be needed for future dialysis access, was not used in the patient undergoing hemodialysis in this cohort; the typical configurations were the BITA and NTSVG. Because the NTSVG can be harvested endoscopically,[20] it is used as the third graft if the quality of the RGEA is poor. Consequently, younger patients not undergoing dialysis often have graft designs for the BITA, RGEA, BITA, and RA. The fundamental policy is to connect the RGEA to the PDA.

Regarding the harvesting techniques, the RITA was harvested before the LITA when harvesting the BITA using MICS CABG.[5] During RITA harvesting, the Octopus Nuvo stabilizer is used to press the right lung dorsally to obtain the surgical field for RITA harvesting. However, this procedure requires the insertion of the Octopus Nuvo from the epigastrium to the mediastinum when harvesting the RITA, which causes uncomfortable harvesting of the RGEA. Alternatively, if the RGEA is harvested first, followed by the RITA and LITA, more time is required. If the RGEA needs to be harvested, its distal end should be harvested while simultaneously harvesting the LITA. Once the distal end of the RGEA has been harvested, the Octopus Nuvo can be inserted through the epigastric incision into the mediastinum to harvest the RITA. Even with the Octopus Nuvo in place, the proximal part of the RGEA can be harvested, saving operative time.

TABLE 5. Postoperative outcomes

Outcome	Result
In-hospital mortality	0 (0)
Stroke	3 (3.8)
Reoperation for bleeding	1 (1.28)
Perioperative transfusion	14 (17.9)
Respiratory insufficiency	1 (1.28)
Re-intubation	1 (1.28)
New-onset aterial fibrillation	7 (9.0)
New-onset renal failure	1 (1.28)
Pleural effusion	26 (33.3)
Surgical site infection	5 (6.4)
At GEA harvesting	2 (2.6)
At SVG harvesting	2 (2.6)
Unknown site of SSI	1 (1.28)
ICU stay (d)	2 (2-4)
Median days of hospitalization (d)	12 (9-17)

Values are presented as n (%) or median (interquartile range). *GEA*, Gastroepiploic artery; *SVG*, saphenous vein graft; *SSI*, surgical site infection; *ICU*, intensive care unit.

Overall, we found that the RGEA was an extremely useful graft for MICS CABG. In our strategy, when performing sequential anastomosis, the target with the tightest stenosis is the final anastomosis to prevent graft occlusion; anastomoses on the less-stenosed branches should be minimized to prevent competitive flow. When the RGEA passes through the diaphragm, it is crucial to prevent narrowing at the diaphragmatic penetration site. In MICS CABG, there is a high possibility of incomplete incision in the diaphragm because the field of view is limited; it is essential to make an *L*-shaped incision on the left side of the diaphragm to prevent narrowing of the RGEA, although this process must be performed carefully to avoid liver damage. The attention to detail during RGEA manipulation and graft design maximizes the patency of bypass grafts in MICS CABG, and careful surgical planning and execution are important to minimize intraoperative complications.

This study has some limitations. Because this was a retrospective study involving a small number of patients treated consecutively by 3 surgeons, selection bias may have persisted throughout the study. Further studies with more comprehensive clinical data are needed.

CONCLUSIONS

The use of the RGEA during MICS CABG increased the possibility of achieving total arterial revascularization in an aortic fashion. Overall, the utilization of the RGEA could become an important option in MICS CABG grafting strategies, enabling further optimization of the procedure to improve patient outcomes.

Conflict of Interest Statement

The authors reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling or reviewing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

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Key Words: right gastroepiploic artery, minimally invasive, coronary artery bypass grafting, off-pump CABG, total arterial revascularization

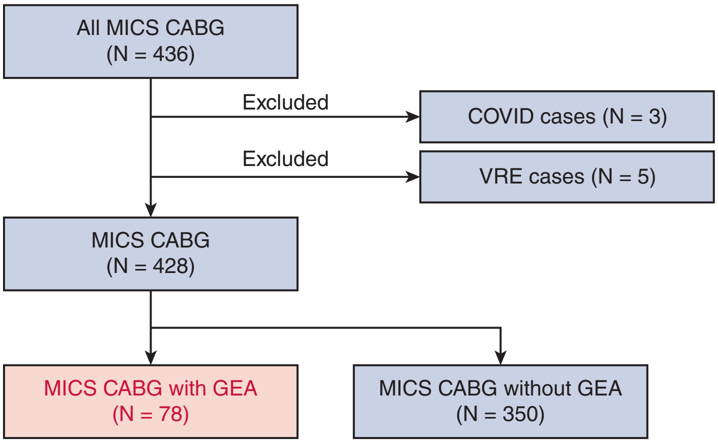

FIGURE E1. Patient selection. *MICS CABG*, Minimally invasive coronary artery bypass grafting; *VRE*, vancomycin-resistant enterococci; *GEA*, gastroepiploic artery.

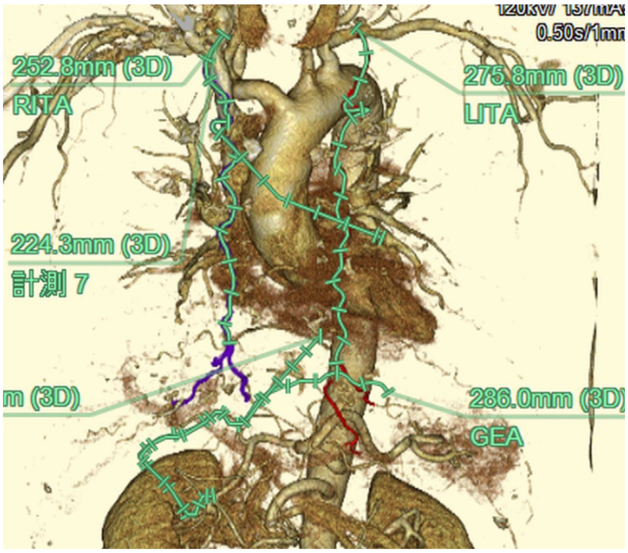

FIGURE E2. Preoperative 3-dimensional computed tomography scan to evaluate graft suitability. *RITA*, Right internal thoracic artery; *LITA*, left internal thoracic artery; *GEA*, gastroepiploic artery.

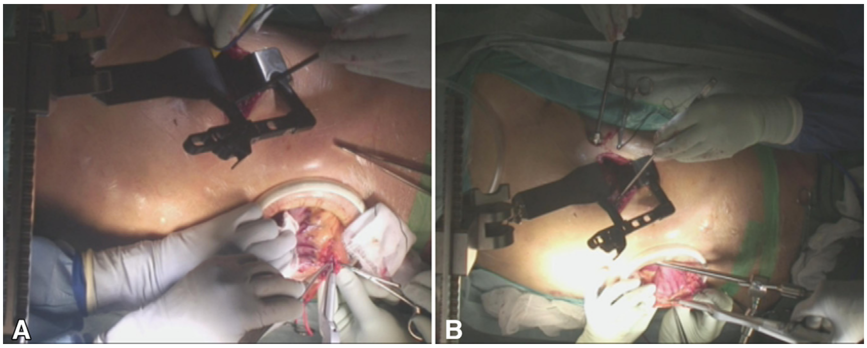

FIGURE E3. A, Surgical field of the simultaneous distal end of right gastroepiploic artery (*RGEA*) and left internal thoracic artery (*LITA*) harvesting. B, Surgical field of the simultaneous proximal end of RGEA and right internal thoracic artery harvesting using the Octopus Nuvo (Medtronic) tissue stabilizer.