Complete revascularization in coronary artery bypass grafting with coronary artery endarterectomy: updated findings from Vietnam

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ABSTRACT

We examined the technique and early outcomes of coronary artery bypass graft surgery (CABG) with endarterectomy. In 2023, the single-center database identified 24 severe coronary disease patients undergoing CABG with coronary artery endarterectomy. The patients were in a selected cohort with a minimum of three grafts for the three main vessels. Patients' mean age was 63.8 years. The mean number of grafts was 4.3. A coronary endarterectomy (CE) was performed on the right coronary artery in 45.8% of patients, the left anterior descending artery in 29.1%, the circumflex artery in 16.6%, and the diagonal artery in 29.1%. Aortic cross-clamp took 147.2 minutes, perfusion 180.9 minutes, mechanical ventilation 18.9 hours, and intensive care unit stay 4.8 days. Our in-hospital mortality rate was 8.3% with no technical complications. To achieve complete revascularization in patients with extensive coronary artery disease, CE should be considered an acceptable adjunct to CABG.

Introduction

Coronary artery bypass graft surgery (CABG) is a conventional open-heart surgery for the treatment of stenotic atherosclerotic coronary artery disease (CAD). To achieve complete revascularization in patients with severely stenotic coronary arteries, many authors in the world reported on the combination of coronary endarterectomy (CE) and CABG. However, this issue is still controversial due to the complexity and risks of the operation.[1,2] In Vietnam, until now, no authors have discussed this technique. Preliminary evidence regarding CABG with concomitant CE in patients with severe coronary disease from a developing country' clinical experience is a very important contribution to such scanty problems. Hence, we ought to evaluate the early outcomes after CABG with concomitant CE, while simultaneously describing the technique and investigating the indications.

Materials and Methods

Patient records at the Cardiovascular Center, E Hospital (Hanoi, Vietnam) were queried for 24 patients with severe CAD who underwent CABG surgery with at least 3 grafts into the three main coronary arteries and concomitant CE within the year 2023. The patients were operated on according to the classical surgical method with extracorporeal circulation, and aortic cross-clamp on the arrested heart. These operations were performed by the same group of surgeons. Herein, we carried out a retrospective medical record review for all patients. All study parameters before, during, and after the operation were included on the basis of clinical judgment and the medical record availability in our hospital.

Continuous variables were expressed as the mean (standard deviation) or median (25^{th} and 75^{th} percentiles). Categorical variables were expressed as numbers (%). Statistical analyses were performed using SPSS software, version 22.0 (IBM, Armonk, NY, USA).

Results

Preoperative main clinical parameters of the patients are shown in Table 1. Among twenty-four patients, the mean age was 63.8 (±7.5, range 52-81) years and the body mass index was 22.7 (±2.79, range 17.6-27.5) kg/m^2. Twenty (83.3%) of the patients were men. Comorbidities included hypertension (70.1%), diabetes mellitus (25.0%), smoking (45.8%), and renal failure (8.3%). Prior myocardial infarction was presented in three (12.5%) patients, prior percutaneous intervention (PCI) in four (16.7%) patients, and cerebrovascular accident in three (12.5%) patients. The mean Euroscore II was 5.1 (±3.6, range 0-14). Six (25.0%) patients were classified as NYHA III & IV.

Intraoperative patients' characteristics are shown in Table 2. The right coronary artery was the most common (11; 45.8%), while the distribution of other main coronary arteries with CE were the left anterior descending artery (LAD) (7; 29.1%), circumflex artery (4; 16.6%), and diagonal (7; 29.1%). Nearly half of CE was performed in the right coronary artery (11; 45.8%), 29.1% was performed in LAD (7; 29.1%), and 16.6% was in the circumflex artery. Seven (29.1%) cases required an endarterectomy followed by a diagonal artery. The mean number of grafts was 4.3. The mean cardiopulmonary bypass (CPB) time and cross-clamp time were 180.9 minutes and 147.2 minutes, respectively.

There were two in-hospital mortality (8.3%). Mechanical ventilation time, intensive care unit (ICU) length of stay, and hospital length of stay among in-hospital mortality patient group and in-hospital survival patient group are presented in Table 3.

Table 4 presents postoperative complications. Reoperation due to uncontrolled bleeding happened in a case (4.1%), renal failure leading to peritoneal dialysis in two patients (8.3), local infection in two patients (8.3%), pneumonia in three patients (12.5%) and sternitis in a case (4.1%).

Table 1. Preoperative patient characteristics.

Preoperative patient characteristics	Patients (N=24)
Age (years)	
Mean ± standard deviation – year	63.8±7.5
Range-year	52-81
BMI	
Mean ± standard deviation – kg/m2	22.7±2.79
Range-kg/m2	17.6-27.5
Gender (%)	
Male	20 (83.3)
Female	4 (16.7)
Hypertension (%)	17 (70.1)
Diabetes mellitus (%)	6 (25.0)
Smoking (%)	11 (45.8)
Renal failure (%)	2 (8.3)
Prior MI (%)	3 (12.5)
Prior PCI (%)	4 (16.7)
CVA (%)	3 (12.5)
Risk classification according to the EuroSCORE (%)	
0-2	5 (20.8)
3-5	10 (41.7)
≥6	9 (37.5)
Euroscore II	
Mean ± standard deviation	5.1±3.6
Range	0-14
NYHA functional class (%)	
1-2	18 (75.0)
3-4	6 (25.0)
CCS class (%)	
1-2	15 (62.5)
3-4	9 (37.5)

BMI, body mass index; MI, myocardial infarction; PCI, percutaneous intervention; CVA, cerebrovascular accident; NYHA, New York Heart Association classification; CCS, Canadian cardiovascular society angina severity classification.

Table 2. Intraoperative patient characteristics.

Intraoperative patient characteristics	Patients (N=24)
Coronary artery with CE (%)	
LAD	7 (29.1)
RCA	11 (45.8)
CX	4 (16.6)
Diag	7 (29.1)
Graft (%)	
LIMA	20 (83.3)
RA	14 (58.3)
SV	24 (100.0)
Number of grafts	
Mean ± standard deviation	4.3±0.7
Range	3-5
CPB time	
Mean ± standard deviation – mins	180.9±28.2
Range-mins	147-252
Cross-clamp time	
Mean ± standard deviation – mins	147.2±26.0
Range-mins	111-209

CE, coronary endarterectomy; LAD, left anterior descending artery; RCA, right coronary artery; CX, circumflex artery; Diag, diagonal; LIMA, left internal mammary artery; RA, radial artery; SV, saphenous vein; CPB, cardiopulmonary bypass.

Discussion

CE was first introduced in 1957 by Bailey and was performed without extracorporeal circulation, and was not combined with coronary artery bypass surgery.[3] He reported a successful case of a male patient with severely stenotic atherosclerotic CAD with symptoms of unstable angina. On the other hand, this surgery had been soon replaced by CABG operations with the introduction of cadiopulmonary bypass machine. Should we combine CE with CABG surgery? Initial studies documented a higher risk postoperatively,[2,4] while recent studies showed that this technique can be performed safely with satisfactory results.[3,5] Nevertheless, until now, this issue is still controversial; many surgeons are still concerned about applying this procedure.[6] According to Schmitto *et al.*, cardiovascular surgery has experienced substantial modifications, with the development of technology, cardiovascular medications, and experiences of surgeons as well as cardiologists – current conditions are not the same as the time when the technique was first introduced. Therefore, the combination of CE in CABG operation should be performed once indicated.[7] The important thing is that the indication is appropriate. Almost all authors agree that indications for concomitant CE are limited to patients with severe and diffuse lesions, the difficulties or inability to anastomose due to atheromatous plaque. The decision was made during the operation, based on the surgeon's evaluation of lesions of severely stenotic atherosclerotic arteries. In LaPar *et al.*'s study, all CE were performed in arteries with diffuse lesions, completely or nearly completely occluded, the minimum outer diameter was 2 mm and the myocardial area supplied by the target artery had to be viable or had the ability to recover after revascularization.[6] Signs suggestive of the severity of atherosclerosis were addressed: i) history of cerebrovascular accident, myocardial infarction, percutaneous coronary intervention, angina pectoris unresponsive to medications; ii) emergency surgery; iii) coronary angiographic characteristics.

Regarding the technical aspect, there are two main methods of endarterectomy which can be performed in single or in combination in one surgery. First, for the closed technique, the coronary arteries are opened in less than 2 cm, and the endothelium is dissected retrogradely from the inside, resulting in a complete removal of atheromatous plaque in tapered shape. Coronary arterial anastomosis is made directly at the arteriotomy site or indirectly at the venous patch in case of long arteriotomy. This method has the advantages of shorter time and lower risks of bleeding. Disadvantages of this technique include the difficulty to perform and to control whether the atheroma is completely removed or not, requiring experiences and skills of the surgeons. Second, for the open technique, the coronary artery is opened along the length of the lesion, the endothelial dissection is performed under direct control, and the venous patch is used along the length of the artery. Its advantages are complete removal of atheroma, easily performed and controlled. Besides, the disadvantages of this technique are longer duration and risks of bleeding. What technique should we choose, which one has more advantages? There was a report based on the summary of previous studies showing that open CE had a lower incidence rate of postoperative events such as myocardial infarction, arrhythmia, use of inotropes, intra-aortic balloon pump, cerebral vascular accident, early mortality rate in the first postoperative month. However, the differences were not statistically significant. The author also noted that surgical outcomes did not only depend on the selected technique but were also greatly affected by the diseased vessel, the technique performed, and the experience of the surgeon.[1] We used the pure closed CE technique if the atheroma achieved the described results: tapered end (completely dissected endothelium). In three cases, atheromatous plaques were too long, so we performed the closed CE technique at different arteriotomy sites in the same vessel to avoid opening at all the length of the vessel, which can prolong surgical time and increase the risk of bleeding. In these cases, distal coronary-graft anastomoses were done at the proximal coronary arteriotomy sites. Other arteriotomy sites were patched by a saphenous vein patch. We call it the "interrupted closed CE technique".

Surgical outcomes also need to be discussed in the context of our resource-scare setting. Complete revascularization is the optimal goal we wanted to achieve to improve the short-term as well as long-term outcomes following CABG surgery. Nevertheless, in our current conditions, when the complexity of lesions is increasing, elder patients, more comorbidities, and many patients who had prior PCI – surgery for complete revascularization – face many challenges. The combination of CE with CABG is a solution to achieve complete revascularization in severely and diffusely diseased

Table 3. Post-operative parameters.

Post-operative parameters	Survival to discharge (N=22)
Ventilated time	
Mean ± standard deviation – hours	18.9±10.5
1128±577	
Range-hours	4-50
720-1536	
ICU length of stay	
Mean ± standard deviation – days	4.8±0.9
47±24	
Range-days	3-6
30-64	
Hospital length of stay	
Mean ± standard deviation – days	18.9±10.3
47±24	
Range-days	8-33
30-64	

ICU, intensive care unit.

Table 4. Complications or adverse events.

Complications or adverse events	Patients (N=24)
Reoperation due to uncontrolled bleeding (%)	1 (4.1)
Renal failure leading to peritoneal dialysis (%)	2 (8.3)
Local infection (%)	2 (8.3)
Pneumonia (%)	3 (12.5)
Sternitis (%)	1 (4.1)
Death (%)	2 (8.3)

vessels. There are still concerns about whether the combination increases the rate of complications, mortality, and long-term outcomes of grafts. Our results were acceptable compared to previous studies.[7-10] LaPar compared two groups of patients undergoing isolated CABG (operations from 2003 to 2008): 99 patients who underwent CE and 297 with CABG surgery alone.[6] The operation time of CE group was longer, yet this group had more diseased vessels (most patients needed 3 grafts). There were no differences in mortality rate and post-operative complications. The ICU length of stay and ventilated time were significantly longer in the CE group compared to the control subjects.

In our study, the CPB time, duration of aortic clamp, and the incidence of postoperative death were higher than those of LaPar's study.[6] This can be explained in part of the more severe lesions of patients enrolled in our study, who needed at least three grafts into three main vessels with the average number of grafts higher than that of LaPar's study, two patients who died had preoperative renal failure, unstable angina CCS class 3, EuroSCORE 4-6, eventful postoperative period: bleeding required reoperation, sternitis, acute kidney injury required peritoneal dialysis (one patients died from infection of the lung, sternitis, renal failure; one patient died of heart failure). On the other hand, the number of patients in our study was small, and the general conditions were limited compared to those of European and American authors. These factors may contribute to the different results observed.

Conclusions

Although the concomitant CE poses several risks for the surgical outcomes, this procedure is a reasonable solution in CABG surgery in order to achieve complete revascularization. The indications for this procedure are limited to cases with severe and diffuse lesions resulting in complete or nearly complete occlusion, as well as severely atherosclerotic vessels which are difficult to make high-quality anastomoses. The decision needs to be made by the surgeon during the operation, and the choice of method is based on the surgeon's experience. Open endarterectomy is more easily and completely controlled in cases where the procedure is performed on a long vessel.

References

1. Soylu E, Harling L, Ashrafian H, Athanasiou T. Does coronary endarterectomy technique affect surgical outcome when combined with coronary artery bypass grafting? Interactive Cardiovasc Thorac Surg 2014;19:848-55.
2. Minale C, Nikol S, Zander M, et al. Controversial aspects of coronary endarterectomy. Ann Thorac Surg 1989;48:235-41.
3. Kumar S, Agarwala S, Talbot C, Nair RU. Long term survival after coronary endarterectomy in patients undergoing combined coronary and valvular surgery--a fifteen year experience. J Cardiothorac Surg 2008;3:15.
4. Ferraris VA, Harrah JD, Moritz DM, et al. Long-term angiographic results of coronary endarterectomy. Ann Thorac Surg 2000;69:1737-43.
5. Schwann TA, Zacharias A, Riordan CJ, et al. Survival and graft patency after coronary artery bypass grafting with coronary endarterectomy: role of arterial versus vein conduits. Ann Thorac Surg 2007;84:25-31.
6. LaPar DJ, Anvari F, Irvine JN, et al. The impact of coronary artery endarterectomy on outcomes during coronary artery bypass grafting. J Card Surg 2011;26:247-53.
7. Schmitto JD, Kolat P, Ortmann P, et al. Early results of coronary artery bypass grafting with coronary endarterectomy for severe coronary artery disease. J Card Surg 2009;4:52.
8. Tiruvoipati R, Loubani M, Lencioni M, et al. Coronary endarterectomy: impact on morbidity and mortality when combined with coronary artery bypass surgery. Ann Thorac Surg 2005;79:1999-2003.
9. Ferraris VA, Harrah JD, Moritz DM, et al. Long-term angiographic results of coronary endarterectomy. Ann Thorac Surg 2000;69:1737-43.
10. Marinelli G, Chiappini B, Di Eusanio M, et al. Bypass grafting with coronary endarterectomy: immediate and long-term results. J Thorac Cardiovasc Surg 2002;124:553-60.