# Coronary artery endarterectomy during coronary artery bypass grafting - A solution for complete revascularization

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**ABSTRACT**

***Background:*** Performance of CABG with concomitant coronary artery endarterectomy in patients with severe coronary disease provides more complete revascularization. We examined the technique and early outcomes of CABG with endarterectomy (CE).

***Subjects and method:*** 24 patients (20 males, 4 females) with severe coronary disease undergoing CABG operations with concomitant coronary artery endarterectomy. They were in a selected cohort with minimum of three grafts for three main vesseles. All patients were operated on by the same group of surgeon. .

***Results****:* Mean age was 63,8 years. Number of grafts: 4,3 ± 0,7 vessels per patient. CE was performed on right coronary artery 45,8%, on left anterior descending artery 29,1%, circumflex artery 16,6% and diagonal artery 29,1%. Cross-clamp times 147,2 ± 26,0 minutes, perfusion times 180,9 ± 28,2 minutes, ventilated time: 18,9 ± 10,5 hours, ICU stays: 4,8 ± 0,9 days. Operative mortality: 2 patients (8,3%), no technical complication.

***Conclusion:*** Coronary endarterectomy should be considered an acceptable adjunct to CABG for patients with extensive coronary artery disease to achieve complete revascularization.

***Keywords*****:** endarterectomy, CABG

## 1. BACKGROUND

Coronary artery bypass grart (CABG) surgery 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 endarectemy (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 about this technique. Our study aims at describing the technique, investigating the indications as well as evaluating the early post-operative outcomes.

## 2. SUBJECTS AND METHOD

An observational study of 24 patients with severe CAD underwent CABG surgery with at least 3 grafts into three main coronary arteries and concomitant CE from 2011 to 2014 at Cardiovascular Center, E Hospital. The patients were operated on according to the classical surgical method with extracorporeal circulation, aortic cross clamp on the arrested heart. These operations were performed by the same group of surgeons. Parameters before, during and after the operation were collected based on a unified form. The data was analyzed by medical statistic using SPSS software.

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## 3. RESULTS

**Table 1.** General characteristics, medical history

| **Characteristics** | | **n =24 (%)** | **Mean (Min - Max)** |
|---|---|---|---|
| Age (years) | | | 63,8 ± 7,5 (52 - 81) |
| BMI | | | 22,7 ± 2,79 (17,6 – 27,5) |
| Sex | Male | 20 83,3% | |
| | Female | 4 16,7% | |
| Hypertension | | 17 70,1% | |
| Diabetes mellitus | | 6 25 % | |
| Smoking | | 11 45,8 % | |
| Renal failure | | 2 8,3% | |
| Prior MI | | 3 12,5 % | |
| Prior PCI | | 4 16,7 % | |
| CVA | | 3 12,5% | |
| EURO Score | 0-2 | 5 20,8% | 5,1 ± 3,6 (0 -14) |
| | 3-5 | 10 41,7% | |
| | ≥ 6 | 9 37,5% | |

**Table 2:** Pre-operative symptoms

| **Pre-operative symptoms** | | **n** | **(%)** |
|---|---|---|---|
| NYHA | I,II | 18 | 75(%) |
| | III,IV | 6 | (25%) |
| CCS | I,II | 15 | (62,5%) |
| | III, IV | 9 | (37,5%) |

**Table 3:** Surgical results

| **Surgical results** | | **n** | **(%)** |
|---|---|---|---|
| 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%) |

| | | |
|---|---|---|
| Number of grafts ( x± SD) | 4,3 ± 0,7 | ( 3 – 5 ) |
| CPB time (minutes) | 180,9 ± 28,2 | ( 147 - 252) |
| Aortic clamp time (minutes) | 147,2 ± 26,0 | (111 - 209) |
| **Post-operative period** | **Survival to discharge (n=22)** | **Deaths (n=2)** |
| Ventilated time (hours) | 18,9 ± 10,5 (4-50) | 1128 ± 577 (720 – 1536) |
| ICU length of stay (days) | 4,8±0,9 ( 3-6 ) | 47 ± 24 (30 -64) |
| Hospital length of stay (days) | 18,9 ± 10,3 ( 8-33 ) | 47 ± 24 (30 -64) |

*LAD: left anterior descending coronary artery, RCA: right coronary artery, LCx: left circumflex coronary artery; Diag: diagonal, LIMA: left internal mammary artery, RA: radial artery, SV: saphenous vein.*

**Table 4:** Complications or adverse events

| **Complications or adverse events** | **n** | % |
|---|---|---|
| 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 |

## 4. DISCUSSION

**4.1 Surgical indications**: Cornary endarterectomy was first introduced in 1957 by Bailey and was perfomed without extracorporeal circulation, and was not combined with coronary artery bypass surgery[3]. He reported a sucessful 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 perfomed safely with satisfactory results[3],[5]. Nevertheless, until now this issue is still controvesary, many surgeons are still concerned about applying this procedure[6]. According to Schmitto, cardiovascular surgery has experienced substantial modifications, with the development of technology, cardiovascular medications, 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 perfomed once indicated[7]. The important thing is 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 unablility 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 Damien's study: all CE was perfomed in arteries with diffuse lesion, completely or nearly completely occluded, the minimum outer diameter was 2 mm and the myocardial area supplied by the target artery must be viable or had the ablity to recover after revascularization[6]. Signs suggestive of the severity of atherosclerosis were addressed: history of cerebrovascular accident, myocardial infarction, percutanous coronary intervention, angina pectoris unresponsive to medications; emergency surgery; coronary angiographic characteristics.

**4.2 Technical aspect:** there are two main methods of endarterectomy (which can be perfomed in single or in combination in one surgery):

**1. Closed technique**: the coronary ateries are opened in less than 2 cm, the endothelium is dissected retrogradely from the inside, result in complete removal of atheromatous plaque in tapered shape. Coronary aterial anastomosis is made directly at the arteriotomy site or indirectly at the venous patch in case of long ateriotomy. This method has the advantages of shorter time and lower risks of bleeding. Disadvantages of this technique includes the difficulty to perform and to control whether the atheroma is completly removed or not, requiring experiences and skills of the surgeons.

**2. Open technique**: coronary artery is opened along the length of the lesion, and the endothelian dissection is performed under direct control, venous patch is used along the length of the artery. Advantages: complete removal of atheroma, easily performed and controlled. Disadvantages: longer duration, risks of bleeding. What technique should we choose, which one has more advantages? There was a report based on the summary of a variety of researches showed that open CE has lower incidence rate of postoperative events: myocardial infarction, arrythmia, 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 technique chosen but also be greatly affected by the diseased vessel, the technique performed, experiences of surgeon[1]. We used the pure closed CE technique if the atheroma achieved the described results: tapered end (completely disseted endothelium). In 3 cases, atheromatous plaques were too long, we performed the closed CE technique at different arteriotomy sites in the same vessel to avoid opening all the length of the vessel, which can prolong surgical time and increase the risk of bleeding. In these cases, distal coronary-graft anastomosises were done at the proximal coronary arteriotomy sites. Other arteriotomy

sites were patched by saphenous vein patch. We call it "interrupted closed CE technique".

**4.3 Surgical outcomes:** The complete revascularization is the optimal goal we wanted to achieve to improve the short term as well as long term outcomes after CABG surgery. Nevertheless, in the current conditions, when the complexity of lesions is increasing, elder patients, more comorbidities, and many patients had prior PCI – surgery for complete resvascularization faces many challenges. The combination of CE with CABG is a solution to achieve complete revascularization in severely and diffusely diseased vessels. There are still concerns about whether the combination increases the rate of complications, death and long-term outcomes of grafts. Studies showed that operation time was relatively long: 119 ± 31,6 mins; CBP time was 192 ± 56,5 minutes; ventilated time was 52,9 ± 100,8 hours, ICU length of stay was 5,6 ± 8,4 days; hospital deaths was 5%; 95% patients had three-vessel disease, the mean number of grafts was 4±0,95[7]. Damien compared two group patients undergoing isolated CABG (operations from 2003 to 2008): 99 patients who underwent CE and 297 with CABG surgery alone[6]. Results are shown in the table below:

| **Results** | | **CABG + CE n = 99** | **CABG alone n = 297** | **p** |
|---|---|---|---|---|
| Number of grafts | 1 | 0 (0%) | 15 (5,1%) | 0,02 |
| | 2 | 12 (12,1%) | 54 (18,2%) | 0,02 |
| | **3** | 87 **87,9%)** | 228 **(76,7%)** | **0,02** |
| LIMA graft | | 98 (99%) | 289 (97,3%) | 0,37 |
| IABP use | | 15 (15,2%) | 40 (13,5%) | 0,74 |
| Aortic cross clamp (minutes) | | 95,6 ± 2,8 | 71,8 ± 1,6 | **0,001** |
| CBP time (minutes) | | 121,8 ± 3,8 | 92,7 ± 1,9 | **0,001** |

The operation time of CE group was longer, yet this group had more diseased vessels (the majority of patients needed 3 grafts). There were no differences in mortality rate, post-operative complications (Death: CABG alone 1,3% and with CE 4%, p=0,112). The ICU length of stay and ventilated time were significantly longer in the CE group compared to the control subjects: 75,1±11,1hrs vs 48,6±2,8hrs, p <0,001 and 16,2% vs, 8,1%, p=0,03

In our study, the CPB time, duration of aortic clamp and and the incidence of post-operative death was higher than those of Damien's study. This can be explained in part of the more severe lesions of patients enrolled in our study, who need at least 3 grafts into 3 main vessels with the average number of grafts higher than that of Damien's study, 2 patients died had preoperative renal failure, unstable angina CCS class 3, EURO score 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; 1 patients died of heart failure). On the other hand, the number of patients in our study is smaller as well as the general conditions are limited compared to European, American authors…, all of which are responsible for the above different results.

**5. CONCLUSIONS**

Concomitant coronary endarterectomy is a reasonable solution in CABG surgery in order to achieve complete revascularization. In spite of that, the endarterectomy poses several risks and possibly prolongs operation time, affecting the surgical outcomes. Therefore, the indications for this procedure is limited to cases with severe and diffuse lesions result in complete or nearly complete occulsion, severely atherosclerotic vessels which are difficult to make high-quality anastomoses. The decision is made by the surgeon during operation. The choice of method is based on surgeon's experience. Open endarterectomy is more easily and completely controlled in cases the procedure is perfomed on a long vessel. Surgical outcomes are affected by a variety of factors, including the experiences of surgeons.

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