

Intracoronary shunt reduces postoperative troponin leaks: a prospective randomized study

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Abstract

Objective: The purpose of this study was to evaluate whether intracoronary shunt usage reduced the myocardial damage on the basis of the cardiac markers when compared with the shuntless anastomosis in off-pump coronary artery bypass grafting (OPCABG) surgery of isolated left anterior descending artery lesions. **Methods:** Forty patients who had stable angina with isolated left anterior descending (LAD) coronary artery lesion undergoing OPCABG surgery were randomized into two groups. Shunt group consisted of 20 patients who had OPCABG using intracoronary shunt, whereas the shuntless group consisted of 20 patients who underwent OPCABG without using intracoronary shunt. Cardiac troponin I, CK, and CK-MB before and 24 h after the surgery were assessed in the groups. **Results:** There were no deaths in the study. The two groups were similar with respect to sex and age. Duration of LIMA-LAD anastomosis was significantly higher in the shunt group ($p = 0.01$). There was no significant difference between the groups concerning the preoperative and postoperative CK and CK-MB levels. The preoperative troponin I levels of the groups were not different ($p = 0.238$; NS), whereas postoperative levels of this marker was significantly higher in the shuntless group ($p = 0.003$). **Conclusion:** Intracoronary shunt reduced the postoperative troponin I levels significantly, so it may be indicated in the patients who are thought to be susceptible to transient ischemia.

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1. Introduction

Occlusion of the coronary artery, which is necessary to control blood flow during distal anastomoses can produce temporary regional ischemia. Intravascular coronary shunts have been introduced into practice in order to limit the regional ischemia and to make a bloodless distal anastomosis [1,2]. Intracoronary shunts have been proved to be beneficial during off-pump coronary artery bypass grafting (OPCABG) operations in patients with isolated left anterior descending (LAD) coronary artery lesion [3].

The hypothesis in our study was that intracoronary shunt usage reduced the myocardial damage when compared with the shuntless anastomosis in OPCABG surgery of isolated LAD lesions on the basis of cardiac markers.

2. Patients and methods

2.1. Patients

During the study period, between May 2002 and February 2003, 460 CABG procedures were performed of which 40 were included in the study (8.6%). The patients in the study population who had stable angina with isolated LAD coronary artery lesion (angiographic evidence of >70% luminal diameter narrowing) underwent OPCABG surgery. The LAD artery was not totally occluded in the patients and antegradely filled in the coronary angiographies. The patients were prospectively randomized into one of the two groups. Group 1 consisted of 20 patients who had OPCABG using intracoronary shunt during the distal LAD anastomosis, whereas the control group, Group 2, consisted of 20 patients who underwent OPCABG without using intracoronary shunt during the distal LAD anastomosis. The exclusion criteria were multivessel disease, age over 75 years, severe LV dysfunction (ejection fraction <20% by echocardiogram), reoperative operation, emergency operation, elevated cardiac enzymes, and recent myocardial infarction (MI). The informed consents of the patients were

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obtained before the operation. The same surgical team performed the operations with and without the shunt.

2.2. Surgical technique

Anesthetic technique was standard for all patients. General anesthesia and intratracheal intubation were done. The chest was opened by median sternotomy. Left internal mammary artery was harvested before the pericardiotomy. Systemic hypothermia was avoided by adjusting the operating room temperature. Medications including B-blockers and calcium-channel blockers were not used for heart rate control during the operation. Alpha stat acid–base management was adopted and partial anticoagulation was accomplished with 1 mg/kg body weight of heparin until a target activated clotting time of 250–350 s was achieved. Heart rate, systemic arterial pressure, central venous pressure, pulmonary arterial pressure, and pulmonary capillary wedge pressure were continuously monitored. All patients in both groups had LIMA-LAD coronary artery bypass grafting using the OPCABG technique. Following exposure and stabilization of the LAD, preparations were made for the coronary arteriotomy. Cardiac stabilizers were used during the distal anastomosis. 7-0 polypropylene suture was used for the anastomosis. After arteriotomy, in order to obtain a bloodless anastomotic field, a bulldog clamp was applied to LAD just proximal to the arteriotomy in the patients in whom intracoronary shunt was not used. The vessel was occluded throughout the anastomosis. The LAD was declamped after the last suture of the anastomosis. In the shunt group, after opening the LAD artery, an intracoronary shunt (2.0, 2.5, or 3 mm in size according to the lumen of the LAD) (Clearview intracoronary shunt, Medtronic Inc.) was inserted into the coronary artery. Proximal end of the shunt was inserted first. The shunt was removed after the last suture just before knotting the suture. The duration of anastomosis was noted in both groups. Heparin was not neutralized by protamine sulfate at the end of the operation. The chest was closed in a standard fashion.

2.3. ECG

All patients underwent ECG assessment before surgery and daily after the surgery. Clinical diagnostic criteria for perioperative myocardial infarction were new Q waves of greater than 0.04 ms or a reduction in R waves greater than 25% in at least two leads, or both, new STelevation in at least two contiguous leads measuring more than 0.2 mV in leads V1–V3 or more than 0.1 mV in all other leads, or new left bundle branch block [4].

2.4. Markers of myocardial damage

Two samples of cardiac troponin I, CK, and CK-MB were measured half an hour before the operation and 24 h after the operation. Serum CK and CK-MB levels were studied by enzymatic immunoassay (AU640e[®] Chemistry Immuno Analyzer, Olympus America Inc., Melville, NY, USA). Troponin levels were assessed by electrochemiluminescence in immunoassay analysis (Modular Analytics E 170, Roche Diagnostics, Basel, Switzerland). Normal values of the cardiac markers were 0.00–0.04 ng/mL for cardiac troponin

I, 30–200 IU/L for CK, and 0–25 IU/L for CK-MB. Increase in CK-MB levels of more than 100 IU/L was considered diagnostic of MI.

2.5. Statistical analysis

Statistical analysis was done with SPSS 10.0 statistical software program (SPSS Inc., Chicago, IL, USA). Randomization was done with this program. Patients who met the study inclusion criteria were randomized prospectively. The patients were included in the group as assigned by the program according to the consequence of operation.

The difference between the groups according to gender was analyzed by χ^2 -test. Continuous variables were expressed as mean \pm 1 SD. Continuous variables were compared by the Mann–Whitney *U*-test. *p* values less than 0.05 were considered to be statistically significant.

3. Results

There were no deaths in the study. Mean age of the patients was 60.6 \pm 10.6 years in Group 1 and 57.6 \pm 9.1 years in Group 2 (*p* = 0.233, NS). There were five females in Group 1 and seven females in Group 2 (*p* = 0.366, NS). The two groups were similar with respect to sex and age. LIMA-LAD anastomosis duration was significantly higher in Group 1 (*p* = 0.012). This little but significant difference was due to the time spent for insertion and displacement of the shunt.

The biochemical studies revealed no significant difference between the groups concerning the preoperative and postoperative CK and CK-MB levels. The preoperative troponin I levels of the groups were not different (*p* = 0.356, NS), whereas postoperative levels of this marker was significantly higher in Group 2 (*p* = 0.003). The increased enzyme markers were thought not to be due to the thrombosis of the graft although there was not a confirmation by angiography; however, there was no ECG abnormalities, severe CK-MB elevation, or hemodynamic deterioration after the operation. The postoperative echocardiographies also did not reveal hemodynamic deterioration. Preoperative and postoperative data of the patients are presented in Table 1.

Out of the 40 patients of the study population, none of the patients had pathological ECG tracing that was associated with perioperative MI. Because there was not a finding which was related to graft failure, that is, no ECG abnormalities, no severe CK-MB elevation, or no hemodynamic deterioration

Table 1
Postoperative data of the patients according to the groups

	Group 1 (n: 20)	Group 2 (n: 20)	<i>p</i>
Mean age (years)	60.6 \pm 10.6	57.6 \pm 9.1	0.233
Mean anastomosis time (min)	6.6 \pm 0.9	5.8 \pm 1.0	0.012
Mean preoperative CK (IU/L)	80.5 \pm 60.8	58.6 \pm 29.4	0.386
Mean postoperative CK (IU/L)	727.4 \pm 756.9	867.4 \pm 701.0	0.110
Mean preoperative CK-MB (IU/L)	18.5 \pm 4.6	18.7 \pm 8.2	0.392
Mean postoperative CK-MB (IU/L)	36.5 \pm 14.9	45.0 \pm 13.0	0.058
Mean preoperative troponin I (ng/mL)	0.0357 \pm 0.0211	0.0286 \pm 0.0156	0.356
Mean postoperative troponin I (ng/mL)	0.2723 \pm 0.2526	0.6385 \pm 0.4323	0.003*

* Statistically significant.

was met in the postoperative period, we decided not perform postoperative coronary angiography to determine the graft patency. Besides, this avoided an additional invasive intervention and contrast agents administration.

4. Discussion

Our results did not confirm the primary hypothesis that OPCABG surgery using the intracoronary shunt reduced the myocardial damage during the anastomosis; however, it did successfully demonstrate that the patients who underwent off-pump CABG with shunt had less troponin leaks after surgery. The two groups were well matched according to the age, gender, primary cardiac pathology, perioperative MI, and postoperative outcome.

Bleier et al. [5] stated that the large increases of serum troponin I in the setting of coronary surgery indicated perioperative myonecrosis as indicated by contrast-enhanced CMRI. However, they found that in patients with no new hyperenhancement, there had been a wide spread of aortic unclamping troponin values, clearly indicating that not all of the postoperative serum troponin I release represented irreversible myocardial injury. They speculated that some of the troponin leak probably represented protein release from non-structurally bound cytosolic pools rather than true myocardial necrosis [5].

Sadony et al. [6] reported that for discrimination of patients with and without perioperative myocardial infarction by one cardiac troponin I determination, the use of cutoff values of 6.5 ng/mL at 8 h, 9.8 ng/mL at 12 h, and 11.6 ng/mL at 24 h after aortic unclamping had resulted in a diagnostic efficiency of 88, 94, and 98%. They stated that a cardiac troponin I value at 24 h had had a sensitivity of 100% and a specificity of 97% [6]. Carrier et al. [7] in their study reported that serum troponin T levels higher than 3.4 µg/L 48 h after CABG correlated best with the diagnosis of perioperative MI. However, they also stated that a larger experience was needed to confirm the validity of the chosen cutoff value [7]. The present study confirmed a significant increase in the troponin I levels in the shuntless group. However, in light of these data, this increase was not so high and was not correlated with the other markers of MI such as CK-MB levels, hemodynamic findings, and ECG findings. So, it can be said that the troponin I elevation in the recent study represents a reversible myocardial damage not an irreversible necrosis.

Lucchetti et al. [3] found similar results of the present study in terms of the use of an intracoronary shunt. They reported that intracoronary shunt prevented impairment in left ventricular function during construction of the LIMA-LAD anastomosis. Therefore, they advised the use of intracoronary shunt in patients with unstable angina, poor left ventricular function, or in cases in which a longer time to perform the anastomosis was anticipated [3]. We are also of the same opinion. Our study population did not include unstable angina cases, but the duration of the anastomosis was higher in the shunt used group which meant that shunt usage although increased the duration of anastomosis, decreased the myocardial damage which was confirmed by lower troponin I levels.

Intracoronary shunt has been shown to prevent regional myocardial dysfunction and hemodynamic deteriorations

during the coronary anastomosis in OPCABG surgery [8]. However, it brings about some technical and financial problems. Its positioning into the coronary artery through a limited arteriotomy has been considered troublesome and time consuming [9]. Some techniques have been introduced to overcome the technical difficulties. Yokoyama et al. [10] commented that the major advantages of intraluminal shunt in OPCAB were distal coronary perfusion and clear visualization of the anastomosis. Another way to do anastomosis without shunt is the utilization of CO blower, which can provide a bloodless field in off-pump surgery. We consider that the intracoronary shunt provides a clear visualization, but it brings about a new problem in that it avoids the movements of the needle of the suture. But this problem may be overcome in time by surgical experience.

Hangler et al. [11] reported that the insertion of intracoronary shunts during beating heart surgery lead to severe endothelial denudation in human coronary arteries and therefore they recommended using intracoronary shunts selectively in patients with critical ischemia or in patients with technical difficulties as a result of anatomic conditions. However, whether the endothelial injury yielded early or late thrombosis of the coronary artery is unclear.

Dapunt et al. [12] reported in his experimental porcine model that intra-LAD shunt insertion significantly preserved the myocardial energy stores when compared with LAD occlusion and concluded that intracoronary shunt insertion improved myocardial protection during off-pump revascularization. Similar findings have been found in our study group.

In conclusion, the protective effect of the intracoronary shunt on myocardium which was shown in our study may serve as a good indication of its usage in OPCABG surgery.

5. Limitations of the study

Postoperative angiography is a very important diagnostic test for evaluating the graft patency. However, this brings about some ethical problems. This is an invasive procedure. Is there really a need for a postoperative coronary angiography for the patients who do not have any signs or symptoms of graft occlusion? Besides, a postoperative coronary angiography would probably negatively affect the patients' mood.

The cardiac markers measured repeatedly would probably give a better assessment of the postoperative release. However, Sadony et al. [6] reported that a cardiac troponin I value at 24 h had had a sensitivity of 100% and a specificity of 97% for discrimination of patients with and without perioperative myocardial infarction.

Another limitation of this study was that the anastomosis was only limited to the anterior wall of the heart, where it is the easiest to do anastomosis especially when the other coronary arteries were patent.

A study population with a larger size would probably give more accurate results.

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