ORIGINAL RESEARCH

CORONARY REVASCULARIZATION WITH THE LEFT INTERNAL THORACIC ARTERY AND RADIAL ARTERY. COMPARISON OF SHORT-TERM CLINICAL EVOLUTION BETWEEN ELECTIVE AND EMERGENCY SURGERY

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BACKGROUND: Left internal thoracic artery-to-left anterior descending artery grafting has become a fundamental part of coronary artery bypass grafting. This grafting has led to increased use of other arterial conduits, of which the radial artery is most popular. Whether radial grafting can be used in the emergency patient is not known. This study compares the short-term clinical evolution between elective vs emergency coronary artery bypass grafting surgery with left internal thoracic artery and radial artery.

METHODS: A retrospective study of 47 patients who underwent elective or emergency coronary artery bypass grafting from 1996 to 2003. All patients had coronary stenosis ≥70% in all target vessels. Only the left internal thoracic artery and radial artery were used as grafts. Patients were divided into elective group (23 patients) and emergency group (24 patients). Emergency criteria were unstable angina and/or critical coronary stenosis with high risk for acute myocardial infarction. Groups were similar for age and number of diseased vessels.

RESULTS: The mean number of left internal thoracic artery grafts per patient in the elective and emergency groups were respectively 1.17 and 1.38 (P = .17). The mean number of radial artery grafts per patient in the elective and emergency groups was respectively 2.26 and 2.08 (P = .48). The 30-day mortality was 0. There was no postoperative cardiogenic shock. The elective group had 1 acute myocardial infarction (4.4%) postoperatively, and emergency group had 5 (20.8%). A nonsignificant trend towards acute myocardial infarction was noted in the emergency group (P = .18). Intensive care unit and postoperative stay were similar in both groups.

CONCLUSION: Coronary artery bypass grafting using left internal thoracic artery and radial artery accomplishing complete revascularization can be performed in emergency patients with results similar to those for elective patients.


The left internal thoracic artery (LITA) is the conduit of choice in coronary artery bypass grafting (CABG) because of superior graft patency, reduced cardiac events, and enhanced short- and long-term survival.1 In the search for other conduits for total arterial revascularization, Acar5 reintroduced the radial artery (RA) graft after long-term observation of patent RA conduits that were thought to have been occluded in the early postoperative period.

Other studies3,4,9 demonstrated RA patency rates of 82% to 98% up to 5 years after surgery, results that suggest that the RA is an excellent choice for CABG.
However, Khot\(^9\) reported a 51% patency rate for the RA conduit in a study where all coronary angiography procedures were reviewed. Legare\(^10\) reported enhanced morbidity with complete arterial revascularization compared to conventional use of saphenous vein conduits, but without a difference in mortality. Tatoulis\(^11\) reported that higher RA patency rates were associated with more severe coronary stenosis; they also reported variable patency as a function of the grafted target coronary. Their 1- and 4-year patency rates were respectively 96% and 89%. Gaudino\(^12\) demonstrated that the main determinant of higher RA patency rate is the level of coronary stenosis. Zacharias\(^13\) demonstrated that the use of the RA compared to saphenous veins as a second conduit associated to LITA-left anterior descending artery (LADA) decreases long-term mortality.

There are few reports on the use of arterial conduits in emergency CABG, but reported outcomes are good.\(^14\)-\(^15\) Hayashi\(^16\) reported complete arterial revascularization in 9 emergency patients with good outcome. Nishida\(^17\) in a similar study with 37 patients, reported a 5-year survival rate of 97.1% and a patency rate of 100% for RA 3 to 4 weeks after surgery.

There are no comparative reports for complete arterial revascularization with the LITA and RA in elective vs emergency surgery.

**OBJECTIVE**

The main objective of this study was to compare the short-term clinical evolution between elective vs emergency surgery in patients undergoing complete arterial revascularization with the left internal thoracic artery (LITA) and radial artery (RA).

**MATERIALS AND METHODS**

A retrospective study in which all patients who were undergoing complete arterial revascularization with the exclusive use of LITA and RA performed by the same surgeon, were included. The criterion for the use of this technique was the presence of coronary stenosis \(\geq 70\%\) in all target vessels. Forty-seven patients were included; surgery was performed from 1996 to 2003.

Patients were classified into 2 groups, an elective group with 23 patients (17 males) and an emergency group with 24 patients (22 males). Emergency inclusion occurred in this series whenever unstable angina refractory to medical therapy and/or critical stenosis in coronary arteries imposing high risk for acute myocardial infarction (AMI) was present.

The main preoperative characteristics of both groups were similar and are summarized in Table 1. Most of the patients were men (39/47), were between 50 and 60 years of age, and had triple-vessel coronary artery disease (38/47). Patients in the emergency group underwent surgery for unstable angina, and 1 had an associated hemodynamic instability (cardiac index of 1.9 L·min\(^{-1}\)·m\(^{-2}\) with dopamine infusion of 10 mg·kg\(^{-1}\)·min\(^{-1}\)). Eleven of these patients (46%) underwent CABG up to 21 days after an acute myocardial infarct (AMI). There was no preoperative use of an intraaortic balloon pump (IAB).

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<th>Table 1 - Preoperative characteristics.</th>
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<td>Group</td>
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\(^*^\)Fisher’s exact test; **ANOVA

Two patients in the elective group and 1 in the emergency group had left ventricular aneurysms. The aneurysms were diagnosed during surgery.

The surgical approach was through sternotomy with cardiopulmonary bypass (CPB). From March 2003, off-pump surgery was performed when possible. The elective and emergency groups had off-pump surgery in 4/7 (57%) and 7/12 (58%) respectively.

The LITA was harvested in all but 1 case (reoperation with patent LITA-LADA graft). The RA was harvested in all cases. After harvesting, the grafts were left in situ with topical papaverine until the initialization of coronary grafting. The LITA was grafted to the LADA and (when needed and possible) to the diagonal branch (sequential anastomosis). The RA was grafted to all other target vessels except the LADA. When more than 1 target vessel was grafted with the RA, sequential anastomoses were performed. Each distal anastomosis was considered an independent graft. The RA was anastomosed proximally to the LITA as a Y graft in 21/23 and 20/24 in the elective and emergency groups respectively. In the other 6 cases, the RA was proximally anastomosed to the aorta because the LITA was subjectively evaluated as having a small caliber.

The 2 patients in the elective group and the 1 in the emergency group with ventricular aneurysms had left ventricular aneurysmectomies.
The two groups were compared for: (i) CPB time, duration of ischemia, number of grafts (LITA and RA grafts per patient), bleeding volume, days under vasoactive drugs, ICU stay, and hospital stay through ANOVA; (ii) occurrence of AMI, reoperations, arrhythmia, pulmonary thromboembolism, pneumonia, neurologic complications, and mediastinitis through the Fisher exact test. For both tests a P value < .05 was considered statistically significant.

RESULTS

The 30-day mortality rate was 0 in both groups. There was 1 late death in each group both due to pulmonary complications. In the elective group death occurred on the 49th day as a consequence of atypical pneumonia.

The mean number of LITA grafts per patient in the elective and emergency groups were respectively 1.17 ± 0.49 and 1.38 ± 0.49 (P = .17). The mean number of RA grafts per patient in the elective and emergency groups were respectively 2.26 ± 0.75 and 2.08 ± 0.93 (P = .48). There was no difference between groups for LITA, RA, or total number of grafts.

Intensive care unit stay and postoperative stay were similar in both groups (Table 2). There was no postoperative use of an IAB, nor did low cardiac output syndrome occur. The postoperative use of catecholamines in the elective and emergency groups ranged from 0 to 3 days (1.0 ± 1.0 days) and 0 to 4 days (1.2 ± 1.0 days) respectively (P = .58).

Two patients in the elective group had CKP-MB elevation postoperatively, but with only 1 AMI confirmation (4.4%) by pyrophosphate scintigraphy. This last case presented ventricular fibrillation during graft harvesting and urgent CPB initiation was necessary. Neither patient had postoperative electrocardiographic or echocardiographic alterations. In contrast, the emergency group had 5 patients with sustained AMI in the same period (20.8%); all of them had postoperative electrocardiographic and/or echocardiographic alterations. 1 went to surgery in cardiogenic shock, 1 presented ventricular fibrillation during graft harvesting and required urgent CPB initiation, and 3 underwent surgery 1 to 5 days after an AMI associated with unstable angina. A nonsignificant trend toward AMI was noted in the emergency group (P = .18).

The CPB and ischemic time for both groups was similar (Table 2).

One patient in the emergency group presented a bleeding volume of 2730 mL up to the end of the day after surgery. Since he had an associated coagulopathy, re-intervention was postponed to the second postoperative day, and no active bleeding was found; neither was any blood clot found near the grafts, but only directly behind the sternum. All other patients had postoperative bleeding compatible with the procedure (Table 2).

There were 3 postoperative neurological complications: (i) transient mental confusion that lasted 1 day (elective group); (ii) seizure in a patient with previous history of seizures (emergency group); (iii) low level of conscience due to cardiogenic shock entering surgery with a full week before recovering normal mental status. This last patient was having an AMI and required rescue CABG surgery. This patient had a previous history of insulin-dependent diabetes mellitus, required prolonged mechanical ventilation, and was the only one who developed mediastinitis, which was successfully treated with antibiotic therapy. Later, an abdominal muscle rotation was used to cover the open wound.

There was 1 case of pulmonary thromboembolism during the second postoperative day (emergency group). The patient had previous significant ventricular dysfunction, moderate tricuspid valve insufficiency, and a definitive implanted pacemaker for 8 years. He underwent off-pump surgery and had a postoperative period without CPK-MB or electrocardiographic alteration. He recovered well and was discharged from the hospital on the 11th day. Table 2 lists all observed complications. No statistical differences between groups occurred for any of these.

DISCUSSION

No immediate mortality and no low cardiac output syn-
drome occurred in either the elective or the emergency group, suggesting that complete arterial revascularization can be used in patients with multiple and critical stenosis in emergencies as well as in elective scenarios. The 2 late deaths were due to pulmonary complications.

No differences were noted between groups in the type or number of grafts, suggesting that the emergency situation does not limit the use of arterial conduits for complete revascularization.

Considering that: (i) all patients had critical coronary stenosis in all target vessels; (ii) RA conduits represented more than 60% of all grafts in both groups; (iii) the postoperative period evolved with no cardiogenic shock, no use of IAB, and a low need for catecholamines, it may be concluded that the patency and flow in the RA grafts must have been adequate for these critical patients.

The transient postoperative mental confusion is attributable to the use of CPB.\(^1\) The other neurological complications were attributable to the preoperative conditions of the patients. All of these complications were transient and reversed with no sequelae.

The only case of mediastinitis was in a patient who had rescue emergency surgery in cardiogenic shock. He also had prolonged mechanical ventilation because of a low level of consciousness, with a history of insulin-dependent diabetes mellitus, all of which represent strong risk factors for infection.\(^1\)

The only case of pulmonary thromboembolism occurred in a patient with previous ventricular dysfunction, tricuspid valve disease, and a definitive implanted pacemaker. As his surgery was uneventful, this complication may be attributed to his previous heart condition.

Transoperative AMI occurred in 1 patient of the elective group (4.4%), which is in accordance to the 0.8% to 7.7% found in other published series.\(^20-21\) The emergency group had a higher rate of AMI (5 patients—20.8%), but these patients presented signs of significant ischemia (cardiogenic shock, ventricular fibrillation, and refractory angina) before coronary grafting. As none evolved with postoperative cardiogenic shock, the CABG brought beneficial effects to the ischemic muscles, probably reducing cardiac tissue loss. This morbidity difference, which was not statistically significant, was not unexpected because of the intrinsically higher severity of the conditions of the emergency group.\(^22\)

Even though bleeding control of the RA conduit is more time consuming because of its numerous branches, there were no bleeding complications attributable to the use of RA grafting. Total arterial myocardial revascularization may be achieved safely and effectively with the use of 1 RA in conjunction with the internal thoracic artery.\(^23\) Consequently, RA harvesting is a perfectly sound indication even in emergency surgery.

The superiority of LITA as a graft for CABG is beyond dispute.\(^1\) However, there is controversy over the kinds of grafts that should be associated with LITA, especially in the emergency scenario. Patients included in this report had excellent immediate clinical evolution with CABG using exclusively LITA and RA for complete revascularization in elective as well as emergency surgeries. These cases still require angiographic study for demonstration of graft patency. If postoperative angiography patency is demonstrated, the long-term evolution should be similar to that of elective surgery, which is excellent in most reports.\(^24\)\(^11-13\)

**CONCLUSION**

CABG using LITA and RA grafts to accomplish complete revascularization can be performed in emergency patients with results similar to those obtained in elective patients.
grupos: eletivo (23 casos) e emergência (24 casos). Critérios de emergência foram angina instável e/ou estenose coronariana crítica com alto risco de infarto agudo do miocárdio. Os grupos eram homogêneos para idade e artérias acometidas.

**RESULTADOS:** A média de enxertos de artéria torácica interna esquerda por paciente eletivo e de emergência foi respectivamente 1,17 e 1,38 (**P**=0,17). A média de enxertos de artéria radial por paciente eletivo e de emergência foi respectivamente 2,26 e 2,08 (**P**=0,48). A mortalidade até 30 dias foi zero. No pós-operatório não ocorreram casos de choque cardiogênico. Um paciente eletivo (4,4%) e 5 pacientes de emergência (20,8%) apresentaram infarto agudo do miocárdio no pós-operatório; tendência não significativa para ocorrência de infarto agudo do miocárdio no grupo de emergência (**P**=0,18). Tempo de internação na unidade de terapia intensiva e hospitalar foi semelhante nos dois grupos.

**CONCLUSÃO:** A revascularização do miocárdio com utilização de artéria torácica interna esquerda e artéria radial pode ser realizada em pacientes de emergência com resultados equivalentes aos pacientes eletivos.


**REFERENCES**


Coronary revascularization with the left internal thoracic artery and radial artery
Rocha-e-Silva R et al.


