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Long-term follow-up of patients undergone coronary artery bypass grafting with exclusive use of arterial grafts

Seguimento a longo prazo de pacientes submetidos à revascularização do miocárdio com uso exclusivo de enxertos arteriais

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Abstract

Objective: **To evaluate the long-term results of coronary artery bypass grafting with the exclusive use of arterial grafts for patients with triple vessel disease.**

Methods: **We evaluated 136 patients who underwent isolated coronary artery bypass grafting between January 1995 and December 1997. A total of 353 grafts were used for revascularization of 449 arteries (mean: 3.30 per patient). Grafts used were the left internal thoracic artery (99.2%), right internal thoracic artery (56.6%), radial artery (87.5%), right gastroepiploic artery (20.5%) and one inferior epigastric artery. Seventy-six (55.8%) patients received composite grafts ("Y-shape") and 66 (48.5%) patients received sequential anastomoses.**

Results: **Hospital mortality was 4.4%. In the long-term follow-up (9.5 to 12.8 years), 82.1% of the patients were free of cardiac events. Twenty (17.9%) patients had hospital readmission due to cardiac events: 15 presented angina and five presented acute myocardial infarction, with three of them presenting with associated heart failure. Eight (7.1%) patients needed coronary re-interventions: one underwent coronary bypass reoperation and the others underwent coronary angioplasty with stent implantation. Estimated probability of being event-free was 98.2%, 95.4% and 84.2% at 1, 5 and 10 years of follow-up respectively. There were 16 (14.2%) late deaths with four of them (3.6%) being cardiac-related. Actuarial 12.8-year survival of all types of death was 85% in this group.**

Conclusion: **Coronary artery bypass grafting with the exclusive use of arterial grafts is a safe procedure for patients with triple vessel coronary disease with good long-term results.**

Descriptors: **Myocardial revascularization. Arteriosclerosis/ surgery. Mammary arteries. Radial artery.**

Resumo

Objetivo: **Avaliar os resultados a longo prazo da cirurgia de revascularização do miocárdio com o uso exclusivo de enxertos arteriais em pacientes com doença coronariana triarterial.**

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Métodos: **Avaliamos 136 pacientes submetidos a cirurgia de revascularização do miocárdio isolada, no período janeiro de 1995 e dezembro de 1997. Utilizaram-se 353 enxertos para revascularizar 449 artérias (média: 3,30 por paciente). Foram utilizadas a artéria torácica interna esquerda (99,2%), artéria torácica interna direita (56,6%), artéria radial (87,5%), artéria gastroepiplóica direita (20,5%) e uma artéria epigástrica inferior. Setenta e seis (55,8%) pacientes receberam enxertos compostos (em "Y") e 66 (48,5%) receberam anastomoses seqüenciais.**

Resultados: **A mortalidade hospitalar foi de 4,4%. No seguimento a longo prazo, (9,5 a 12,8 anos), 82,1% dos pacientes não apresentaram nenhum evento cardíaco. Vinte (17,9%) pacientes necessitaram de reinternação por eventos cardiovasculares; 15 com angina e cinco com infarto agudo do miocárdio, sendo que três apresentaram insuficiência cardíaca associada. Oito (7,1%) pacientes necessitaram de reintervenção por doença coronariana, sendo um reoperado e os demais submetidos a angioplastia com stent. A probabilidade estimada livre de eventos cardíacos foi de 98,2%, 95,4% e 84,2% em 1, 5 e 10 anos, respectivamente. Ocorreram 16 (14,2%) óbitos tardios, sendo quatro deles (3,6%) de causa cardíaca. Sobrevida actuarial em 12,8 anos por todas as causas foi de 85% neste grupo.**

Conclusão: **Revascularização do miocárdio com o uso exclusivo de enxertos arteriais em pacientes com doença coronariana triarterial é um procedimento seguro, com bons resultados a longo prazo.**

Descritores: **Revascularização miocárdica. Arteriosclerose/ cirurgia. Artéria torácica interna. Artéria radial.**

INTRODUCTION

Surgical coronary artery bypass grafting (CABG) has attained great importance since its beginning in the middle of the 1960s. The saphenous vein was always the most commonly used graft for CABG [1,2], but at the end of the 1970s the left internal thoracic artery (LITA) graft started to be utilized more frequently [3]. Since then, myocardial revascularization surgery utilizing a combination of the LITA with saphenous vein bypasses became the standard procedure in the treatment of coronary artery disease; a conduct that persists until today in the majority of heart surgery centers.

However, in long-term follow-ups after the surgery, we have observed, in some cases, relapse of cardiovascular events due to the progression of coronary atherosclerotic disease and the deterioration of the grafts utilized for myocardial revascularization [4,5]. Compared to the LITA, that has excellent indexes of patency at ten years – greater than 90% – the patency of the saphenous vein over the same period is around 50% to 70% [5,6]. Many works have reported better results with the use of the LITA [6]. An additional benefit in respect to the morbidity and mortality has also been reported with revascularization of the left coronary artery branches employing the two mammary arteries [7,8]. There is, thus, the expectation that myocardial revascularization with the exclusive use of arterial grafts will improve these results even further, a view supported by some studies [9-12].

The aim of this study is to evaluate the long-term results of myocardial revascularization in triple vessel coronary artery disease with the exclusive use of arterial grafts.

METHODS

One hundred and thirty-six patients who were submitted to CABG, without associated procedures, using only arterial grafts in the period from January 1995 to December 1997 in the Heart Institute of the Hospital das Clinicas, Medicine School of the University of Sao Paulo were evaluated. The research project was approved by the Scientific Ethics Committee of the Institution (protocol number 2051/02/58).

All the procedures were elective, the first CABG of the participants and were performed by the surgeons of the Coronary Disease Surgery Unit of the institution. Patients submitted to emergency surgeries, with mechanical respiratory assistance or with ejection fractions of less than 35% in the preoperative period, incomplete CABG, reoperations or with an associated surgical procedure were excluded from the study. The characteristics of the patients are described in Table 1. The patients were operated using cardiopulmonary bypass CPB with myocardial protection being achieved by intermittent aortic clamping in 44.1% of the patients and by anterograde blood cardioplegia in 55.9%.

A total of 353 grafts were utilized for the revascularization of 449 arteries (mean 3.3 anastomoses per patient), with 135 (99.2% of the patients) LITAs, 77 (56.6%) right internal thoracic arteries, 119 radial arteries - RA (87.5% - 118 left

RA and one right RA), 28 (20.5%) right gastroepiploic arteries – RGEA and one inferior epigastric artery. A total of 76 (55.8%) patients received at least one compound graft ('Y-shaped') and 66 (48.5%) received sequential grafts of two or three arteries.

Less than half the patients came from the city of Sao Paulo (49.2%), with the others coming from other cities and states and one patient from another country, which made the follow up difficult. Patients were contacted by telephone or during check ups in the outpatient clinic. Thus, data on the long-term evolution of patients, including total survival, cardiac-related death and the occurrence of cardiac events such as angina, myocardial infarction, heart failure and the necessity of re-interventions (surgery or angioplasty) were evaluated. The mean time of follow-up time was 10.9 years (range 9.5 to 12.8 years). Overall survival free of coronary events and re-interventions, as well as the probabilities of staying free of events and cardiac interventions were obtained using the Kaplan-Meier method.

Table 1. Pre-operative characteristics of the patients

Characteristics	Number of patients (%)
Age	56.8 years (29 to 77)
Men	109 (80.14%)
Women	27 (19.86%)
Systemic hypertension	77(56.6%)
Dyslipidemia	70 (51.5%)
Diabetes mellitus	33 (24.2%)
Smokers	52 (38.2%)
Myocardial infarction (total)	52 (38.2%)
Recent myocardial infarction (< 30 days)	15 (11.0%)
Previous angioplasty	14 (10.3%)
Previous bilateral Saphenectomy	7 (5.2%)

RESULTS

Of the 136 patients that fulfilled the inclusion criteria for the study, 111 (81.6%) evolved without any complications in the hospital postoperative period. Twenty-five (18.4%) patients presented with some type of complication; six patients died (hospital mortality of 4.4%). The most common complications were pulmonary infection (eight cases), infection of the operative wound (eight cases – one mediastinitis, one re-suture of the sternum and six superficial infections treated clinically), arrhythmia (five cases – all arterial fibrillation) and two ischemic strokes. Hospitalization varied from 6 to 66 days (mean 9.15 days). Of the 130 patients who were discharged from hospital, complete follow ups (9.5 to 12.8 years) were possible for 112, that is, 86.2% of the study group.

In the long-term follow up, 82.1% of the patients did not present with any type of cardiac event over 12.8 years. Twenty (17.9%) patients were hospitalized for cardiological problems: 15 patients (13.4%) presented with the reoccurrence of angina and five (4.5%) evolved with acute myocardial infarction. Of these patients, three evolved with difficult-to-control heart failure, with one dying seven years after the initial surgery. All these patients were re-evaluated by means of coronary cineangiography and eight (7.1%) patients required re-interventions: one patient needed a reoperation 8 months after the surgery and the other seven were submitted to angioplasty with stent implantation. Of these, three underwent angioplasty of arteries that had not been revascularized during the surgery as they had not presented apparent lesions at that time. The time from the first procedure to the onset of symptoms varied from 6 to 147 months (mean: 84 months or 7 years) and the time until re-intervention ranged from 8 to 150 months (mean: 92 months or 7.8 years).

The estimated probabilities free from cardiac events were 98.2%, 95.4% and 84.2% at 1, 5 and 10 years, respectively and the estimated probabilities free from coronary re-interventions were 99.1%, 99.1% and 92.8% at 1, 5 and 10 years, respectively. Sixteen (14.2%) late deaths occurred, with four (3.6%) being heart related. The actuarial survival at 12.8 years for all causes was 85% in this group (Table 2 and Figures 1 to 5)

Table 2. Estimated probabilities free from cardiological events and from re-interventions, as well as the overall survival and survival free from events and re-interventions. The data in the table are also illustrated in the figures

		Survival		Estimated probability	
Time (years)	General	Free from coronary events	Free from re-intervention	Free from coronary events	Free from re-intervention
0	1.00	1.00	1.00	1.00	1.00
2	0.98	0.96	0.97	0.97	0.99
4	0.97	0.95	0.96	0.96	0.99
6	0.92	0.86	0.90	0.92	0.98
8	0.89	0.78	0.84	0.86	0.95
10	0.85	0.72	0.79	0.84	0.93
12	0.85	0.71	0.79	0.83	0.93

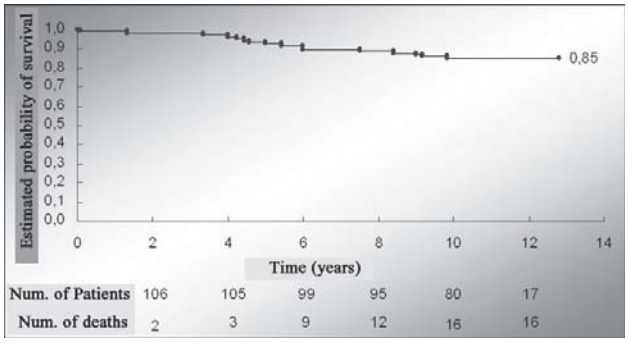

Fig. 1 – Estimated probability of survival

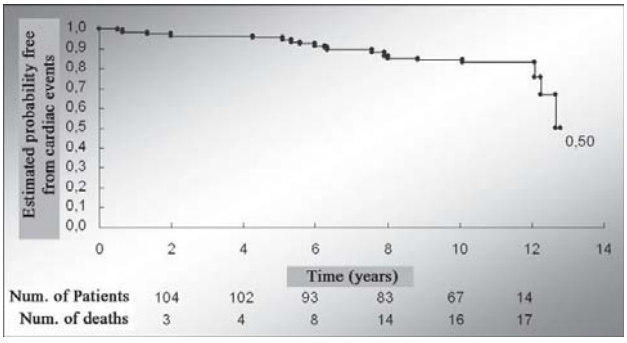

Fig. 4 – Estimated probability free from cardiac events

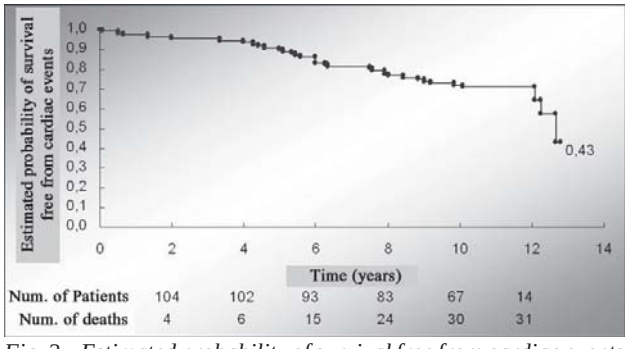

Fig. 2 – Estimated probability of survival free from cardiac events

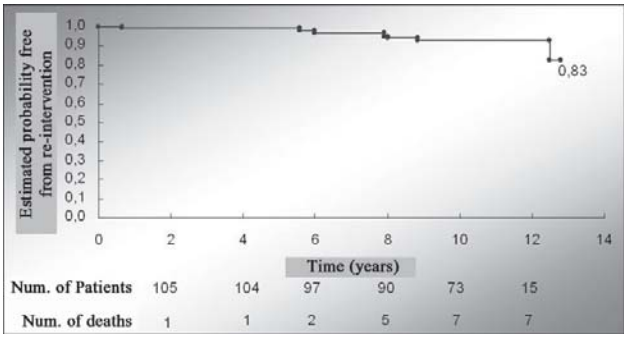

Fig. 5 – Estimated probability free from re-intervention

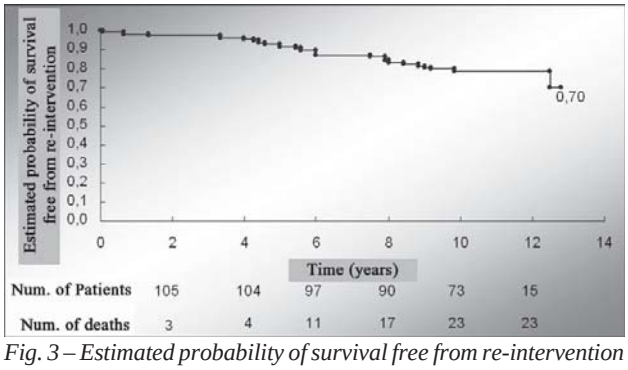

Fig. 3 – Estimated probability of survival free from re-intervention

DISCUSSION

The success of myocardial revascularization surgery, the gold standard for the treatment of multiple vessel coronary disease, is limited by the progress of coronary arteriosclerosis and by the degeneration of the grafts utilized – in particular when saphenous vein grafts are assessed over the long term [4,5]. Saphenous vein bypasses are the first line grafts in most institutions because of the accessibility, facility to use and the good results in the short-term follow up. However, as more experience is gained in respect to the patency of grafts over 5 to 10 postoperative

years, saphenous vein grafts cause a certain amount of concern in respect to their durability.

Three different processes are pathophysiologically interlinked in the evolution of the disease of saphenous vein grafts: thrombosis, intimal hyperplasia and arteriosclerosis. Although the factors that predispose these grafts to deterioration are apparent in coronary artery disease, the pathogenic effects of these risk factors are amplified by deficits inherent in veins when transferred to the coronary artery circulation [4]. Some recent studies have demonstrated good results for valve-less saphenous veins – the so-called 'good veins' (88% of patency over 9 years of follow up) [13]. However, most surgeons have observed patency indexes that vary between 50% and 70% over ten years of follow up, even when they are used in the revascularization of the major arteries, such as the anterior descending artery, with the resulting reoccurrence of angina and the necessity of re-interventions [4,5].

In contrast, the LITA has proved to have better patency with excellent clinical results [3,6]. Based on the clinical advantages of the LITA, there was, over the last decade, a reappearance of the use of other arterial grafts as an option to improve the long-term results of surgery [7,8,14-17]. Revascularization utilizing only arterial grafts (bilateral internal thoracic arteries, radial artery, gastroepiploic artery and the inferior epigastric artery) should produce an ideal prognosis. This procedure, however, requires a greater operative time and may be technically more demanding compared to the procedure previously considered the standard (LMA with saphenous vein grafts). There is, thus, a concern in relation to the increase in complication rates, which has restricted, in many centers, the utilization of multiple arterial grafts in young patients with less morbidities.

Since the start of the 1970s, when many publications [3,6] confirmed the benefits of the use of the internal thoracic artery (better survival, reduced operative morbidity, lower rate of peri-operative infarction, and greater patency of the LITA), this graft became practically obligatory in all CABGs. In another publication in 1994, the Cleveland Clinic reported the results of the long-term follow up (18 to 20 years) of patients that received the LITA compared to those that received saphenous vein bypasses to revascularize the anterior descending artery, with and without additional grafts for the revascularization of the right coronary artery or branches of the circumflex artery. Survival at 18 years was 76% for the patients who received the LITA and 47% for those that received saphenous vein grafts, again proving the benefits of the utilization of the LITA [6].

Then in the 1990s, publications appeared demonstrating the improvement in survival and lower necessity of re-interventions for patients treated with the bilateral internal thoracic arteries, when compared to the unilateral use of this graft [7,8]. The demonstration that sequential, "Y-shaped" and "T-shaped" grafts are possible with the LITA [18], and the use of the transverse sinus as access of the right internal thoracic artery to the left side of the heart [19], contributed to a broader use of the internal thoracic arteries.

The RA was the second most frequently used graft (in 87.5% of our patients). Its use for CABG was first proposed by Carpentier et al. in 1971 but was abandoned two years later due to the incidence of the formation of filaments or occlusion of 35% of grafts identified by control angiographies. Twenty years later, the growing interest of complete revascularization with the use of only arterial grafts, the better handling of grafts and the advances in antispasmic pharmacological agents stimulated the revival of the use of the RA. Carpentier et al. observed a 100% patency rate in early control angiographies and a rate of 93.5% at 9.2 months free of spasms [14]. Since then, many other centers, mainly in Europe, Australia, Asia and Brazil started to utilize the RA as the second arterial graft with good results. A recent study in Brazil proved patency of 84% to 92% of the RA at five years of follow up [15].

In 1987, a ground-breaking work by Suma et al. [16] demonstrated the viability of using the RGEA in CABG with good results. Other groups have also adopted this graft in large series of patients with good clinical and angiographical results [20], and in association with both internal thoracic arteries [12,21]. In the same year, Puig et al. [17] demonstrated the viability of using the inferior epigastric artery in another effort to increment the utilization of arterial arteries in CABG. The results using the inferior epigastric artery have improved with experience in its handling and this artery, previously only employed as an aorto-coronary graft, is now being utilized in the preparation of compound grafts.

At the start of the 1990s, some surgeons started to utilize compound grafts (anastomosed in "Y" or "T") with the objective of greater revascularization employing arterial grafts. The utilization of "T-shaped" arterial grafts with the free right internal thoracic artery anastomised to the LITA in situ, started to be more widely used in 1993, when Tector et al. [18] presented a large series utilizing this technique with good results. By anastomosing the free right internal thoracic artery to the LITA in situ, its reach is increased by up to 10 cm with the possibility of arriving at any branch of the circumflex and right coronary arteries. This technique made revascularization of almost all triple coronary artery patients possible by just using grafts of the internal thoracic arteries, without anastomosis in the ascending aorta, thereby reducing the risk of embolization and neurological events.

With all these possibilities available, several groups started to utilize only arterial grafts in preference to saphenous grafts. Taloulis et al. [9] obtained total CABG

with the use of only the two internal thoracic artery grafts and the left RA in 3220 patients in a determined period in 1998; the hospital mortality rate was 0.75% and patency was good at 5 years of follow up; 97% for the LITA, 89% for the right internal thoracic artery and 91% for the RA. Bergsma et al. [12] performed surgeries with only arterial grafts utilizing the two internal thoracic arteries and the RGEA. In these patients, the cumulative probabilities of remaining free from acute myocardial infarction, re-interventions and angina at 7 years of follow up were 97.3%, 95.4% and 85.4%, respectively. In 1994, Tagusari et al. [10] demonstrated a low hospital mortality rate (1.3%) and patent grafts in 98% of the early evaluations of 223 patients submitted to revascularization using both internal thoracic artery, RA and RGEA grafts only (mean anastomoses per patient: 3.7). In another populational study of 53,727 patients carried out in Ontario, Canada (1991-2001), patients that received two or more arterial grafts were admitted to hospital for cardiac events less frequently and had better survival rates [11]. Works with up to 25 years of follow up demonstrated that the wider use of arterial grafts in primary CABGs results in a reduced rate of coronary reoperations [22].

This is a procedure widely utilized in other countries, however little employed in Brazil even though good results over the short and medium terms have been published [23,24]. Kobayashi [25] concluded, in a population study, that off-pump CABG using only arterial grafts has become the standard procedure in Japan, where 60% of all CABG procedures are performed off-pump and 52% are performed only with arterial grafts giving a mortality rate of less than 1% including with urgent surgeries.

Our research has limitations as it is a retrospective study, with criteria of indication of this surgical technique and choice of grafts being difficult to elucidate. Despite of the time since surgery, all the data were up-dated by telephone or checked in the institution. There was a loss of follow up of 13.8% of the patients, a figure considered acceptable as all the patients have different telephone numbers, 84% moved and 50.8% live in other cities or states (including one patient from another country – Chile) during this follow up, which made finding these patients difficult.

Our study demonstrated that CABG with the exclusive use of arterial grafts in triple vessel patients can be performed with good results in the immediate and long-term follow ups, similar to other studies. However, different to what has been happening in most other countries, this technique has not been adopted as the standard, and is only indicated in restricted cases. The surgeon should make a decision to choose the best grafts based on the preoperative data and intra-operative findings in order to perform the best surgery for each patient and thereby provide the best long-term results. Future studies should compare these results with those obtained using conventional surgery (LITA with saphenous vein grafts) to more clearly define the role of arterial grafts in our population and the necessity of increasing the utilization of these techniques.

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