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Improved graft patency rates and mid-term outcome of diabetic patients undergoing total arterial myocardial revascularization

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ABSTRACT: Objectives: *Diabetes negatively affects the outcome of patients undergoing percutaneous transluminal coronary angioplasty (PTCA) or coronary surgery. However, data are lacking with respect to the impact of arterial revascularization in the diabetic population.*
Methods: *Between 1999 and 2003, 100 of 491 diabetics underwent coronary artery bypass graft surgery (CABG) with total arterial grafting (Group 1, G1); these patients were compared with 100 diabetics undergoing conventional CABG with saphenous veins (Group 2, G2), who were matched for Euroscore and other risk factors such as age, obesity, hypertension, left ventricular ejection fraction (LVEF), previous myocardial infarction and chronic obstructive pulmonary disease (COPD).*
Results: *Both groups had a similar number of diseased coronary vessels (G1=2.6 vs G2= 2.7) and received a similar degree of myocardial revascularization (grafted vessels: G1=2.2 vs G2=2.4). Early outcome was comparable between the groups in terms of ventilatory support (G1=10.8±6 vs G2=10.4±5 hours), intensive care unit (ICU) stay (G1=24±12 vs G2=25±14 hours) and major post-operative complications such as atrial fibrillation (G1=26% vs G2=28%), peri-operative myocardial infarction (G1=1% vs G2=2%)and prolonged ventilatory support (G1=6% vs G2=5%). Hospital mortality was 2% in G1 and 3% in G2. Angiography was performed at a mean follow-up of 34 months in 65.9% and 71.1% of hospital survivors of G1 and G2 respectively: patients of G1 showed a significantly higher patency rate (G1=96% vs G2=83.6%, p=0.02). Additionally, patients of G1 showed a significantly lower incidence of recurrent myocardial ischemia (G1=7 pts. vs G2=18 pts., p=0.03), late myocardial infarction (G1=2 pts. vs G2=10 pts., p=0.03) and need for coronary reintervention (G1=1 pt. vs G2=12 pts, p=0.004).*
Conclusions: *Total arterial grafting in diabetic patients significantly improved the benefits of coronary surgery providing at mid term a higher graft patency rate with a lower incidence of cardiac related events. (Heart International 2006; 3-4: 136-40)*

KEY WORDS: Coronary surgery, Diabetes, Arterial conduits, Composite grafts

INTRODUCTION

Diabetes mellitus is a well-recognized risk factor for the development of atherosclerotic coronary artery disease. The prevalence of diabetes in the general population ranges around 5% worldwide, increasing up to 30% in patients referred to cardiac surgery for myocardial revascularization (1, 2). Previously reported prospective randomized trials (such as the BARI or the ARTS) depicted the superior outcome of coronary surgery when compared to percutaneous interventions in diabetic patients (3, 4).

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Despite coronary artery bypass surgery being superior to angioplasty, among those patients undergoing surgical myocardial revascularization diabetics still hold higher risk of morbidity and mortality than the non-diabetic population (5, 6). Total arterial myocardial revascularization proved to be safe and effective and to give superior results than conventional myocardial revascularization (with left internal thoracic artery on the LAD and additional saphenous vein grafts) (7, 8). Advantages of arterial revascularization seem to be evident especially in the case of small target coronary vessels with low run-off, which is a common scenario in diabetics.

We therefore sought to investigate whether total arterial grafting with composite grafts may improve the outcome in the diabetic subset of patients undergoing CABG surgery.

METHODS

Study population

Between 1999 and 2003, 100 of 491 diabetics underwent CABG with total arterial grafting (Group 1, G1); these patients were compared with 100 diabetics undergoing conventional CABG with left internal thoracic artery (LITA) on left anterior descending (LAD) and additional saphenous vein grafts (Group 2, G2), who were matched for Euroscore and other risk factors such as age, obesity, hypertension, LVEF, previous myocardial infarction and COPD. Baseline characteristics of patients in both groups are depicted in Table I.

Surgical technique

Following median sternotomy, arterial conduits (LITA and RITA) were harvested together with the Radial Artery (RA). Internal thoracic arteries were prepared as skeletonized conduits, while the radial artery (RA) was harvested with its surrounding fascia and satellite veins. Total arterial composite grafts were realized in three different fashions, which have been previously described (9). Briefly, in type 1 configuration the right internal thoracic artery (RITA) is anastomosed as Y or T graft to the *in situ* LITA, whereas the RA is used as a free graft for the right coronary system. In type 2 configuration a simple Y/T graft created with the RA anastomosed on the *in situ* LITA; finally, type 3 configuration was created anastomosing both the RITA and the RA on the *in situ* LITA, in a double Y/T graft fashion. All Y/T grafts anastomoses were performed with a 8/0 polypropylene running suture.

Whenever patients underwent cardiopulmonary bypass, standard extracorporeal circulation was instituted, under mild hypothermia with a mean arterial blood pressure of 50 mmHg.

In the case patients were planned to undergo myocardial revascularization off-pump, once two or three pericardial Lima stitches were placed for exposure of lateral and posterior vessels, target coronary vessel stabilization was achieved with the Guidant Axius Vacuum Stabilizer System (Guidant Corporation – Cardiac Surgery, Santa Clara, CA, USA). Whenever required, the operating table was maintained in Trendelemburg position and rotated to the left or right side according to the different target vessel location. Additionally, the vacuum-assisted Xpose system (Guidant Corporation – Cardiac Surgery, Santa Clara, CA, USA) was used in some cases of patients undergoing revascularization of the postero-lateral vessels.

Distal anastomoses were performed end-to-side or side-to-side (diamond-shaped for sequential anastomoses) with a 8/0 polypropylene running suture. We performed proximal anastomoses under aortic side clamping with a 6/0 (for saphenous vein grafts) or a 7/0 (for arterial conduits) polypropylene running suture, during rewarming. In patients receiving RA grafts, Diltiazem was continued orally for at 6 months postoperatively.

TABLE I - PRE-OPERATIVE CHARACTERISTICS OF DIABETIC PATIENTS ENROLLED IN THE STUDY

	Group 1	Group 2	p
Age (yrs.)	68±4	69±5	0.43
Gender (Male/Female)	59/41	57/43	0.76
Diabetes mellitus			
Type 1	12 %	14 %	0.59
Type 2	88 %	86 %	0.82
Smoking hystory	12 %	14 %	0.59
Previous MI	57 %	55 %	0.78
Hypertension	85%	84 %	0.91
Ejection Fraction <30%	10 %	12 %	0.56
COPD	27 %	25 %	0.69
Obesity	10 %	12 %	0.56
Peripheral vascular disease	26 %	29 %	0.57
Euroscore	6.3±2.5	6.1±2.8	0.46

MI= myocardial infarction; COPD= chronic obstructive pulmonary disease

Statistical analysis

Continuous variables were analyzed with the Wilcoxon test, while the Fisher's exact test or the chi-square test were used for discrete variables. A p value less than 0.05 was considered to be significant. SPSS software was used for statistical analysis (SPSS 11.0, SPSS Inc., Chicago, Ill).

RESULTS

Perioperative data

Both groups had a similar number of diseased coronary vessels (G1=2.6±0.7 vs G2= 2.7±0.5; p=0.42) and received a similar degree of myocardial revascularization (grafted vessels: G1=2.2±0.4 vs G2=2.4±0.5; p=0.34). In patients of Group 1 the different composite arterial grafts configurations were used as follows: 75% of patients received type 2 configuration while type 1 and 3 configurations were used in 7% and 18% of patients respectively.

Forty-two percent of patients receving total arterial grafting underwent off-pump coronary surgery, while 5% of patients of Group 2 were operated without cardiopulmonary bypass (p<0.001). Aortic cross clamping time was similar in both groups while (G1: 28±7 min vs G2: 32±9 min; p=0.33) while cardiopulmonary bypass time was higher in G2 (G1: 55±15 min vs G2: 78±31 min; p<0.001) reflecting the additional time required to perform saphenous vein grafts (SVGs) proximal anastomoses.

Early outcome

Early postoperative outcome was comparable between the groups in terms of ventilatory support (G1=10.8±6 vs G2=10.4±5 hours), ICU stay (G1=24±12 vs G2=25±14 hours) and major post-operative complications as atrial fibrillation (G1=26% vs G2=28%), perioperative myocardial infarction (G1=1% vs G2=2%) and prolonged ventilatory support(G1=6% vs G2=5%): a more detailed description of early post-operative complications is depicted in Table II.

Hospital mortality was 2% in G1 and 3% in G2: causes of death were sepsis (1 pt in each group), abdominal ischemia (1 pt in each group) and multi organ failure (1 pt in Group 2). Prolonged mechanical ventilation secondary to respiratory failure was the primary cause leading to sepsis and multiple organ failure.

It is worthy of note that no patient receiving total arterial grafting experienced wound complications at the site of radial artery harvesting; conversely, 9 patients in Group 2 had leg wound complications related to saphenous vein graft harvesting (p=0.002).

Mid-term outcome

Angiography was performed at a mean follow-up of 34 months in 63 patients (65.3%) and 71 patients (71.7%) of hospital survivors of G1 and G2 respectively: graft patency rates were considerable higher in Group 1 when compared to Group 2 (G1=96.4 % vs G2=83.2%, p=0.02). Occluded grafts were 5 in Group 1 (3 radial arteries and 2 right ITAs) while in Group 2 there were 27 occluded saphenous vein grafts and 1 occluded left ITA.

Additionally, patients receiving total arterial grafting had a better mid-term outcome with respect to incidence of recurrent myocardial ischemia (G1=7 pts vs G2=18 pts, p=0.03), late myocardial infarction (G1=2 pts vs G2=10 pts, p=0.03) and need of coronary reintervention (G1=1 pt vs G2=12 pts, p=0.004).

DISCUSSION

Diabetes mellitus is a widely established risk factor for the development of atherosclerotic coronary artery disease. In addition, atherosclerosis is more aggressive

TABLE II - MAJOR PERI-OPERATIVE MORBIDITIES

	Group 1	Group 2	p
Atrial fibrillation	26 %	28 %	0.70
Perioperative MI	1 %	2 %	0.48
Prolonged MV	6 %	5 %	0.65
ARF	3 %	4 %	0.61
SWC	3 %	2 %	0.47
Pulmonary infections	10 %	12 %	0.56
CVAs	-	1 %	0.31
Bleeding	1 %	1 %	1

MI= myocardial infarction; MV= mechanical ventilation; ARF= acute renal failure; SWC= sternal wound complications; CVAs= cerebrovascular accidents

in diabetics, showing a more severe narrowing of the native coronary vessels than in patients without diabetes. Several reports evidenced that the prevalence of diabetes in the population of patients referred for myocardial revascularization, either surgical or interventional, raise to 30% (1, 2). Previously reported prospective randomized trials (such as the BARI and the ARTS trials) demonstrated the superior outcome of coronary surgery when compared to percutaneous interventions in diabetic patients (3, 4).

Despite the improved outcome following coronary artery bypass surgery when compared to interventional strategies, patients undergoing surgical myocardial revascularization diabetics are at higher risk of morbidity and mortality than the non diabetic population (5-6, 10). Since total arterial myocardial revascularization proved to have a superior clinical outcome in the general population than conventional coronary surgery (with LITA on the LAD and additional saphenous vein grafts) (7, 8), the aim of our study was to assess the advantages of total arterial myocardial revascularization in a population of diabetic patients when compared to conventional CABG. We therefore compared a group of diabetics receiving total arterial grafting with patients undergoing conventional myocardial revascularization, who were matched for pre-operative characteristics such as Euroscore and other risk factors as age, obesity, hypertension, LVEF, previous myocardial infarction and COPD (Tab. I). Total arterial myocardial revascularization did not increase hospital mortality (2% in Group 1 and 3% in Group 2), which was comparable to our previous reported experiences with the general population undergoing coronary surgery with composite arterial grafts (11). The rate of early post-operative complications was similar in both groups, in particular with respect to incidence of perioperative myocardial infarction (G1=1% vs G2=2%; p=0.48), prolonged ventilatory support (G1=6% vs G2=5%; p=0.65) and sternal wound complications (G1=3% vs G2=2 %; p=0.47). Conversely, a considerable number of patients undergoing conventional grafting with saphenous veins experienced leg wound complications related to vein harvesting (p=0.002), while no patient receiving total arterial grafting showed wound problems at the site of radial artery harvesting. At mid-term, total arterial myocardial grafting clearly demonstrated incremental benefits when compared to conventional coronary surgery, in terms of higher graft patency rates (Group 1=96.4 % vs Group 2=83.2%, p=0.02) and a lower incidence of late cardiac related events as recurrent myocardial ischemia (G1=7 pts vs G2=18 pts, p=0.03), late myocardial infarction (G1=2 pts vs G2=10 pts, p=0.03) and need of coronary reintervention (G1=1 pt vs G2=12 pts, p=0.004).

In conclusion, diabetes affects a steadily higher number of patients undergoing coronary artery bypass surgery and the aggressiveness and the degree of atheromatous degeneration in those patients is more significant with an important reduction of both coronary artery diameter and run-off. Percutaneous interventions proved to have less efficacy than surgical myocardial revascularization (3, 4) in this specific subset of patients. However, it should be stressed that the patients enrolled in prospective, randomized trials like the BARI and the ARTS, underwent coronary surgery with the conventional technique (LITA on LAD plus additional saphenous vein grafts). Total arterial myocardial grafting proved to be a safe and effective technique even in the diabetic population, providing incremental benefits and better mid-term outcome when compared to the conventional CABG surgery. It could therefore be foreseen that the advantages of total arterial multivessel grafting may hold more striking evidence of the benefits of surgical revascularization over percutaneous interventions.

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REFERENCES

1. Endo M, Tomizawa Y, Nishida H. Bilateral versus unilateral internal mammary revascularization in patients with diabetes. Circulation 2003; 108: 1343-9.
2. Kapur A, Bartolini D, Beatt KJ. Has anything changed in multivessel coronary artery revascularization in diabetes since BARI? Ital Heart J 2004; 5: 358-63.
3. The Bypass Angioplasty Revascularization Investigation (BARI) Investigators. Comparison of coronary bypass surgery with angioplasty in patients with multivessel disease. N Engl J Med 1996; 351: 859-67.
4. Abizaid A, Costa MA, Centemero M, et al. Clinical and economic impact of diabetes mellitus on percutaneous and surgical treatment of multivessel coronary disease patients. Insights From the Arterial Revascularization Therapy Study (ARTS) Trial. Circulation 2001; 104: 533-8.
5. Fietsam RJ, Basset J, Glover JL. Complication of coronary artery surgery in diabetic patients. Am Surg 1996; 57: 551-7.
6. Cohen Y, Raz I, Gideon M, Mozes B. Comparison of factors associated with 30-day mortality after coronary artery bypass grafting in patients with versus without diabetes mellitus. Am J Cardiol 1998; 81: 7-11.
7. Lytle BW, Blackstone EH, Loop FD, et al. Two internal thoracic artery grafts are better than one. J Thorac Cardiovasc Surg 1999; 117: 855-72.
8. Muneretto C, Negri A, Bisleri G, et al. Is total arterial myocardial revascularization with composite grafts a safe and useful procedure in the elderly? Eur J Cardiothorac Surg 2003; 23: 657-4.
9. Muneretto C, Bisleri G, Negri A, et al. Total arterial myocardial revascularization with composite grafts improves results of coronary surgery in elderly. Circulation 2003; 108: II-29 - II-33.
10. Barsness GW, Peterson ED, Ohman EM, et al. Relationship between diabetes mellitus and long-term survival after coronary bypass and angioplasty. Circulation 1997; 96: 2551-6.
11. Muneretto C, Negri A, Manfredi J, et al. Safety and usefulness of composite grafts for total arterial myocardial revascularization: A prospective randomized evaluation. J Thorac Cardiovasc Surg 2003; 125: 826-35.