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Redo Coronary Artery Bypass Grafting with and without Cardiopulmonary Bypass in the Elderly

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Martin Czerny, MD, Daniel Zimpfer, MS, Juliane Kilo, MD, Roman Gottardi, MS, Ernst Wolner, MD, Michael Grimm, MD

Department of Cardiothoracic Surgery, University of Vienna Medical School, Vienna, Austria

Dr. Czerny

ABSTRACT

Objectives: Morbidity and mortality rates rise with increasing age in patients undergoing conventional redo coronary artery bypass grafting (CABG). The aim of this study was to compare our experience of minimal tissue dissection and target vessel revascularization without cardiopulmonary bypass (CPB) with the standard procedure of total dissection of the heart and complete revascularization with CPB for a population of elderly patients undergoing elective redo coronary artery CABG.

Methods: We retrospectively analyzed morbidity, mortality, and functional status of 47 patients older than 75 years who underwent redo CABG between January 1995 and June 2002. Thirty-one patients underwent redo CABG with CPB, and 16 patients underwent redo CABG without CPB. Follow-up end points were defined by patient survival, freedom from recurrence of angina (Canadian Cardiovascular Society [CCS] score), freedom from rehospitalizations and reinterventions, and the need for antianginal medication.

Results: There were 2 perioperative deaths (2 in the CPB group versus 0 in the group without CPB; $P = .151$). Nonfatal myocardial infarction occurred in 3 patients (3 in the CPB group versus 0 in the group without CPB; $P = .082$). Major adverse cardiac events occurred in 5 patients (5 in the CPB group versus 0 in the group without CPB; $P = .058$). At the time of follow-up, the mean CCS score of patients who underwent redo CABG with CPB was 1.5 ± 0.8 and was 1.6 ± 0.7 for patients who underwent redo CABG without CPB ($P = .432$). The rates of angina recurrence (16% with CPB versus 13.3% without CPB; $P = .243$), use of nitrates (8.7% with CPB versus 14.3% without CPB; $P = .542$), and survival (89% with CPB versus 93% without CPB; $P = .238$) were very comparable for the two groups.

Conclusions: In this high-risk subgroup of patients, those patients who underwent target vessel revascularization without CPB showed a trend toward a lower rate of major adverse cardiac events, and this procedure seems promising with regard to long-term outcome. Therefore, target vessel revascularization may be offered liberally to elderly patients who are at high risk in surgeries involving complete revascularization with CPB. Further studies are needed to elucidate the long-term outcome of target vessel revascularization for elderly patients undergoing redo CABG.

INTRODUCTION

Longer life expectancy has led to an increased incidence of cardiovascular disease and consequently to an increasing number of primary and secondary coronary artery bypass grafting (CABG) operations in the elderly [USBC 1991].

In elderly patients, redo CABG with cardiopulmonary bypass (CPB) is associated with higher rates of hospital morbidity and mortality than those of primary CABG because of the increased level of comorbidities in this patient group [Loop 1983, Schaff 1983, Verheul 1991, Hannan 1994]. Single-vessel redo CABG without CPB can be performed safely and reduces the morbidity associated with conventional single-vessel redo CABG [Allen 1997]. Redo CABG without CPB may even prove to be more effective in reducing morbidity and mortality in a high-risk population, eg, the elderly, who are generally more frail and have a diminished physiologic reserve compared with their younger counterparts [Bergsland 1998]. Complete revascularization with the use of CPB remains the main objective in primary CABG [Buda 1981, Bell 1992, Jones 1996]. Target vessel revascularization without CPB has been proven a promising option for selected high-risk patients undergoing primary CABG, predominantly because of lower perioperative mortality rates [Kilo 2001]. However, the adverse effect of stenoses in addition to the left anterior descending coronary artery (LAD) in patients undergoing grafting of only the left internal thoracic artery to the LAD has called into question the long-term appropriateness of interventions whose strategy includes leaving unrevascularized segments in territories not in the distribution of the LAD [Scott 2000]. Nevertheless, the main objective of redo CABG is to relieve symptoms, because the survival benefit of the procedure has not yet been clearly demonstrated [Buda 1981].

The aim of this study was to compare our experience of minimal tissue dissection and target vessel revascularization without CPB with the standard procedure of total dissection of

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Address correspondence and reprint requests to: Dr. Michael Grimm, Waehringer Guertel 18-20, A-1090 Vienna, Austria; 43-1-40-400-5643; fax: 43-1-40-400-5642 (e-mail: michael.grimm@akh-wien.ac.at).

Table 1. Patient Demographics*

	With CPB (n = 29)	Without CPB (n = 15)	*P*
Age, y	76.6 ± 2.0	77.3 ± 2.5	NS
Diseased vessels, n	2.7 ± 0.5	2.6 ± 0.6	NS
Ejection fraction, %	55 ± 13	52 ± 14	NS
Time since previous CABG, y	13.1 ± 4.9	12.6 ± 5.1	NS
EuroSCORE	7.5 ± 2.3	8.2 ± 2.5	NS
Parsonnet score	19.6 ± 4.9	20.8 ± 5.1	NS

*Data are presented as the mean ± SD. CPB indicates cardiopulmonary bypass; NS, not significant; CABG, coronary artery bypass grafting.

the heart and complete revascularization with CPB for a population of elderly patients undergoing elective redo CABG.

MATERIALS AND METHODS

The cases of 47 patients older than 75 years who underwent elective redo CABG between January 1995 and June 2002 were analyzed. Thirty-one patients underwent redo CABG with CPB, and 16 patients underwent redo CABG without CPB. In this retrospective study, emergency cases and patients with unstable angina were excluded from the analysis. Preoperative patient characteristics included all features contributing to the EuroSCORE and the Parsonnet score, as well as the number of diseased vessels [Parsonnet 1989, Nashef 1999]. Patient demographics are shown in Table 1.

Operative Technique

A median sternotomy approach was used in all cases. In patients undergoing target vessel revascularization, we dissected just the area of the target anastomosis and left the whole mediastinum undissected. A myocardial coronary artery stabilizer system (CardioThoracic Systems, Cupertino, CA, USA) was used in all patients. In most cases, the LAD was revascularized first. The vessel was stabilized, surrounded distally and proximally to the chosen anastomotic site with 2 5-0 polypropylene sutures, and snared. No tolerance test for regional ischemia was performed. Afterwards, anastomosis of the left internal mammary artery (LIMA) to the LAD was performed on the beating heart. Thereafter, further distal anastomoses were performed with the same myocardial coronary artery stabilizer system. In cases for which a proximal aortic anastomotic site was needed, a small part of the ascending aorta was additionally dissected just to apply a side-biting clamp.

Parameters of Clinical Outcome

In-hospital death, myocardial infarction, and stroke were defined as major adverse perioperative outcomes. Perioperative myocardial infarction was defined as any new Q wave or loss of R in the electrocardiogram, significant elevation in creatine kinase/creatine kinase–MB levels (creatine kinase–MB >40 U/L), or an infarction validated at autopsy. Postoperative bleeding was defined as bleeding requiring rethoracotomy. Minor adverse outcome was defined as wound infections and/or postoperative atrial fibrillation. We also recorded the number of bypass grafts, requirements for blood units, intubation time, and intensive care unit and hospital stays. We studied both perioperative and long-term outcomes.

Follow-up

End points were defined by survival, freedom from the recurrence of angina (Canadian Cardiovascular Society [CCS] score), and freedom from rehospitalizations and reinterventions, as well as freedom from the need for antianginal medication. Follow-up was complete in all patients.

Completeness of Revascularization and Definition of the Culprit Lesion

Revascularization was considered incomplete when a territory was judged not surgically reconstructable or when a suitable vessel was discarded. The decision regarding which lesion was definitely the culprit lesion was based on accurate clinical investigation, including angiography, electrocardiography, and scanning techniques.

Previous Graft Status

There were no significant differences between the two groups with regard to the frequencies of patent, significantly stenosed (>70%), or occluded grafts. The previous LAD graft was a saphenous vein in 69% of the patients and was a LIMA in 31%. Forty-five percent of vein grafts were patent; however, 73% of these grafts showed hemodynamically significant stenoses at the time of redo CABG. Nineteen percent of vein grafts to the circumflex system were patent and showed hemodynamically significant stenoses. Only 17% of vein grafts to the right coronary artery were patent, and 74% of these grafts showed a subtotal occlusion.

Statistical Analysis

Demographic, medical, intraoperative, and postoperative data were collected for all patients. All clinical data are expressed as the mean ± SD. Statistical analysis was performed with SAS statistical software (SAS Institute, Cary, NC, USA). The Mann-Whitney test was used to calculate differences between the two groups. The χ^2 test was used to compare categorical variables. Survival analysis and freedom from recurrence of angina were calculated by means of Kaplan-Meier analysis. A P value <.05 was considered statistically significant.

RESULTS

Perioperative Outcome

In this series of patients who underwent redo CABG, there were 2 perioperative deaths (2 in the CPB group versus 0 in the group without CPB; P = .151). The 2 patients who died after redo CABG with CPB experienced myocardial infarction. Both of these patients had a left ventricular ejection fraction below 30% (Table 2). Nonfatal myocardial infarction occurred in 3 patients (3 in the CPB group versus 0 in the group without CPB; P = .082). Major adverse cardiac events occurred in

Table 2. Risk Scores and Left Ventricular Ejection Fraction for Survivors and Nonsurvivors*

	Survivors	Nonsurvivors	*P*
EuroSCORE	7.3 ± 2.1	10.5 ± 0.7	.0001
Parsonnet score	19.4 ± 5.0	22.5 ± 3.5	NS
LVEF <30%, %	20.3	100	.001

*Data are presented as the mean ± SD where appropriate. NS indicates not significant; LVEF, left ventricular ejection fraction.

5 patients (5 in the CPB group versus 0 in the group without CPB; *P* = .058). Adverse perioperative cerebrovascular events were not observed in this series. The duration of surgery (300 ± 54 minutes with CPB versus 188 ± 59 minutes without CPB; *P* = .004) and the intubation time (21.2 ± 17.5 hours with CPB versus 4.6 ± 4.3 hours without CPB; *P* = .003) were shorter in the patient group without CPB. Five reexplorations occurred because of bleeding (5 in the CPB group versus 0 in the group without CPB; *P* = .058). The mean length of stay in the intensive care unit was comparable for the two groups (2.2 ± 5.7 days with CPB versus 1.9 ± 4.3 days in the group without CPB; *P* = .381). The incidence of minor adverse outcomes is shown in Table 3. Patients had significantly fewer episodes of atrial fibrillation after redo CABG without CPB than after redo CABG with CPB (*P* = .02).

Completeness of Revascularization

In the group of patients operated on with CPB, 93% of patients received as complete a degree of revascularization as expected by the intention to perform complete revascularization in this group. In the patients who underwent redo CABG without CPB, only 20% of patients underwent as complete a degree of revascularization as expected from the intention to perform target vessel revascularization. The LIMA was used as the LAD graft in 90% of cases. The right internal mammary artery was used in 5% of cases, and the saphenous vein was used in 5%. The saphenous vein was used in 6% of grafts to revascularize the circumflex system and in 100% of grafts to revascularize the right coronary artery. The average number of grafts and the distribution of myocardial territories grafted are shown in Table 4.

Table 3. Clinical Outcome*

	With CPB (n = 29)	Without CPB (n = 15)	*P*
Death, %	6.9	0	NS
Myocardial infarction, %	17.8	0	.082
Major adverse cardiac events, %	20.7	0	.058
Stroke, %	0	0	
Wound infections, %	6.9	6.7	NS
Atrial fibrillation, %	34.6	13.8	.020
Duration of surgery, min	300 ± 54	188 ± 59	.004
Intubation time, h	21.2 ± 17.5	4.6 ± 4.3	.003
Reexploration for bleeding, n	5	0	.058
Intensive care unit stay, d	2.2 ± 5.7	1.9 ± 4.3	NS
Hospital stay, d	12 ± 6	8 ± 7	.03

*Data are presented as the mean ± SD where appropriate. CPB indicates cardiopulmonary bypass; NS, not significant.

Follow-up

The mean follow-up period was 50 ± 21 months in the CPB group and 34 ± 12 months in the patient group without CPB (*P* = .003). At the time of follow-up, the mean CCS score was 1.5 ± 0.8 for the patients who underwent redo CABG with CPB and 1.6 (0.7 for the group of patients who underwent redo CABG without CPB (*P* = .432). The frequency of late cardiac-related death was 3.6% in the CPB group. In the group of patients who were operated on without CPB, no late cardiac-related deaths occurred. The frequencies of non–cardiac-related death in the patient group without CPB and in the group with CPB were 0% and 6.7%, respectively (Figure, A). Interestingly, rehospitalization for cardiac causes was not observed. The frequencies of angina recurrence were 16.0% in the CPB group and 13.3% in the group without CPB (*P* = .233) (Figure, B). Finally, the rates of nitrates use in the two groups were comparable at follow-up (8.7% in the CPB group versus 14.3% in the group without CPB; *P* = .542).

COMMENT

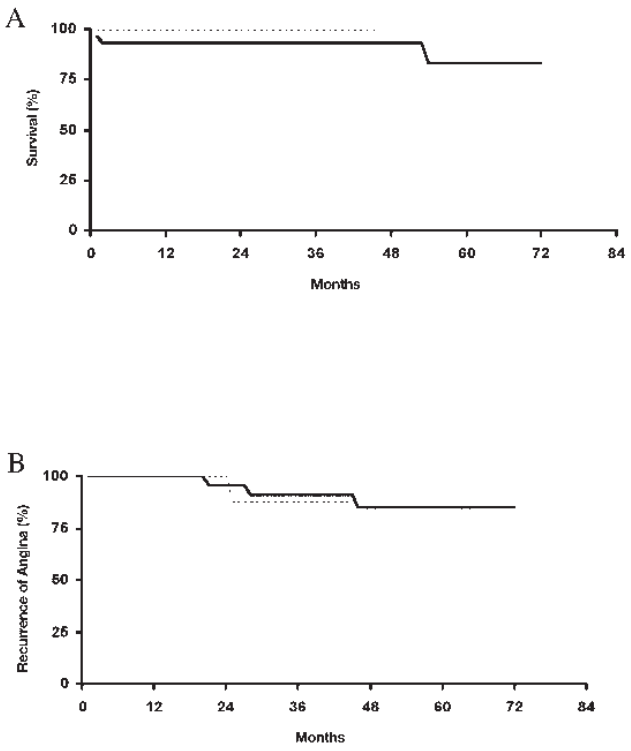
In this high-risk subgroup of patients, target vessel revascularization without CPB showed a trend toward a lower rate of major adverse cardiac events and seems promising with regard to long-term outcome. Therefore, target vessel revascularization may be offered liberally to elderly patients at high risk in operations involving complete revascularization with CPB.

Perioperative morbidity and mortality rise with increasing age for patients undergoing CABG with or without CPB [Weintraub 1991, Edmunds 1998]. A rising trend has been noted in both elderly patients undergoing primary CABG and those undergoing redo CABG. In this particular subset of patients, a strong focus on less invasive techniques, especially the avoidance of CPB, has been observed in the last few years [Akins 1997, Kilo 2001]. Our mortality rate of 6.9% for

Table 4. Coronary Territories Grafted*

	With CPB (n = 31)	Without CPB (n = 16)	*P*
Complete revascularization, %	93	20	.001
No. of grafts	2.9 ± 1.0	1.4 ± 0.5	.0001
Left anterior descending artery, %	93	100	NS
Diagonal branches, %	37	8	.052
Circumflex artery, %	78	15	.001
Right coronary artery, %	74	23	.002
Conversion to CPB, %		0	

*Data are presented as the mean ± SD where appropriate. CPB indicates cardiopulmonary bypass; NS, not significant.



Survival (A) and recurrence of angina (B) in elderly patients who underwent coronary artery bypass grafting with cardiopulmonary bypass (solid line) and without cardiopulmonary bypass (dashed line).

elderly patients undergoing redo CABG with CPB is well in line with the rates of other recent series. Blanche and coworkers reported a mortality rate of 8% for 49 octogenarians who underwent redo CABG with CPB [Blanche 1999]. Interestingly, when the focus was on younger patients, mortality rates after redo CABG with CPB were similar. Allen and coworkers reported a mortality rate of 16.7% in 12 patients with a mean age of 60 years who underwent redo CABG with CPB [Allen 1997]. Stamou and coworkers reported a mortality rate of 10% in a group of 41 patients with a mean age of 65 years who underwent redo CABG with CPB [Stamou 2000]. We tried to analyze and compare perioperative mortality by scoring our patients by means of the EuroSCORE and the Parsonnet score to predict risk. The mean Parsonnet score of our patients was 20, whereas the mean Parsonnet score in the series of Stamou and colleagues was 26. In contrast, the Parsonnet score in the series of Allen and colleagues was 9. The difference in Parsonnet score levels between the series of Allen and colleagues and ours series can be well explained by the fact that this risk score strongly focuses on patient age rather than on comorbidities. The mean EuroSCORE in our patient series was 7.5. The mean EuroSCORE of surviving patients was 7.3 and 10.5 for nonsurvivors, indicating a breakpoint of operative risk at this value.

Patients who undergo primary CABG without CPB have been suggested to have a smoother early postoperative period and a shorter hospital stay compared with patients undergoing primary CABG with CPB [Gu 1998]. Recent studies have focused on the lower degree of myocardial injury after CABG without CPB, as well as on a reduced cytokine response after such surgery [Wan 1999, Czerny 2000]. Although redo CABG without CPB has been associated with relatively higher early mortality rates than primary CABG, recent reports also indicate that redo CABG without CPB significantly reduces morbidity and mortality compared with redo CABG with CPB [Allen 1997, Stamou 2000]. In our series, no perioperative deaths were observed in patients after redo CABG without CPB. The mean Parsonnet score of our patients was 21. In the series of Bergsland and colleagues, the risk-adjusted mortality rate was 1.3% for 105 patients with a mean age of 66 years. Stamou and coworkers reported a mortality rate of 1% and a mean Parsonnet score of 24 ± 8 for 91 patients with a mean age of 65 years who underwent redo surgery without CPB [Stamou 2000]. Allen and colleagues reported a mortality rate of 4.3% and a mean Parsonnet score of 8.4 ± 2.5 for 23 patients with a mean age of 65 years who underwent redo CABG without CPB [Allen 1997]. Although few data exist with regard to early mortality in elderly patients after redo CABG, it seems likely that avoiding CPB is of particular benefit, especially in a high-risk subgroup of patients such as the elderly. Minimizing the dissection of adhesions (and thereby reducing the risk of embolization), avoiding the cross-clamping of a diseased ascending aorta, and using the adhesions from previous sternotomies as a local stabilizing effect in addition to epicardial stabilizer systems may well explain the success of redo CABG without CPB.

The incidence of myocardial infarction following redo surgery is higher in most reported series than for primary surgery and varies from 6.4% to 8.1% [Foster 1984, Pidgeon 1985]. In our series, the incidence of perioperative infarction was higher for patients with CPB than for patients without CPB. The difficulties with myocardial protection secondary to progression of native arterial disease and occluded vein grafts, as well as with embolization from atheromatous vein grafts, have been defined as the main factors responsible for the increased risk of perioperative myocardial infarction [Awad 1997]. Avoiding cardiac cannulation and the complete dissection of the heart required in complete revascularization in redo CABG with CPB may eliminate the repeated lifting and manipulation of the heart that has been strongly related to increased risk of embolization of the native coronary arteries arising from the dislodging of atherosclerotic debris from the old but still patent grafts [Jain 1995].

Complete revascularization with the use of CPB remains the main objective of primary CABG [Buda 1981, Jones 1996, Kilo 2001]. The main objective of redo CABG, however, is to relieve symptoms, because the survival benefit of the procedure has not yet been demonstrated [Bell 1992]. Symptom relief is not exclusively achieved by complete revascularization but may also be gained by incomplete target vessel revascularization [Kilo 2001, Scott 2000]. A complete revascularization, although feasible, is not always justified, because the potential risks of a long operation with complete revascularization outweigh the potential benefits in high-risk patients [Buda 1981]. The decrease in perioperative mortality in patients undergoing CABG without CPB has been

demonstrated for primary CABG for low-risk patients despite the lower number of grafts performed [Gundry 1998] and to an even greater extent for high-risk patients [Bergsland 1998, Stamou 2000, Kilo 2001].

Interestingly, at follow-up in our series, the rates of angina recurrence and the use of nitrates, as well as CCS scores, were comparable for elderly patients after redo CABG with and without CPB despite a lower number of grafts. However, the follow-up period was shorter for patients after redo CABG without CPB than for patients after redo CABG with CPB. Therefore, it remains to be shown in extended follow-up whether these findings remain similar for both groups or whether patients after redo CABG without CPB experience adverse outcomes from leaving unrevascularized segments in territories not in the distribution of the LAD.

Limitations of the Study

This study shows all the limitations of a retrospective analysis. First, our patient number is low. However, elderly patients undergoing redo CABG represent a subgroup of the minority of patients undergoing redo CABG each year. Second, because the decision of which surgical strategy to use, minimal tissue dissection and target vessel revascularization without CPB or dissection of the entire heart and complete revascularization with CPB, was that of the surgeon, our investigation of nonrandomized patient groups is a limitation of this study. There is certainly a selection bias when clear evidence exists that the LAD is the culprit lesion. In such cases, the patient may be scheduled for surgery of the isolated LIMA to the LAD without CPB, because there is little doubt that this operation is related to low complication rates. In addition, follow-up is shorter in patients who undergo surgery without CPB, and follow-up has to remain open if a longer follow-up period reveals a worsening of symptoms or a trend toward adverse chances of survival in patients who have undergone target vessel revascularization without CPB. Finally, the follow-up did not include angiography, which would have enabled a group comparison of early and late graft patency.

Taking these limitations into account, we conclude that target vessel revascularization without CPB in this high-risk subgroup of patients showed a trend toward a lower rate of major adverse cardiac events; thus, this surgical procedure seems promising with regard to the long-term outcome. Therefore, target vessel revascularization may be offered liberally to elderly patients who are at high risk in surgeries involving complete revascularization with CPB. Further studies are needed to elucidate the long-term outcome of target vessel revascularization for elderly patients undergoing redo CABG.

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