Experience and early results of second reoperations for coronary artery disease

Should patent vein grafts be replaced during reoperation?

Reoperation for coronary artery disease has become a routine procedure; however, a second reoperation is exceptional. In this report we describe our experience with 16 patients undergoing a second reoperation for coronary atherosclerosis. The absence of operative mortality is certainly related to the patient selection. The number of patients is still too small to draw major conclusions. Striking, however, is that the first reoperation was usually done for angina because of progression of atherosclerosis in the native coronary system and the second reoperation was done because of graft failure. This experience supports the idea that the replacement of old, even patent, venous grafts and the choice of the best available conduits are of great importance at the first reoperation and may prevent a second reoperation. (J THORAC CARDIOVASC SURG 1994;107:684-9)

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Despite the increasing number of reoperations for coronary revascularization and of studies analyzing the problems concerning this subject, only a little is known about the results of a third or fourth operation.¹⁻⁹ Of course re-reoperations are not frequent; however, it is clear that the patients who do undergo re-reoperation constitute a special group, which may be increasing in the coming years. In this report we describe our experience and early results with 16 patients who underwent a second reoperation for coronary artery disease.

Materials and methods

Patient population. Of the 2636 patients who underwent an isolated myocardial revascularization procedure between January 1987 and December 1992 in our department, 16 patients (0.6%) underwent a second coronary reoperation (Re-re-group). All preoperative, perioperative, and postoperative data were collected in and retrieved from the coronary databank

“CORRAD” (Coronary Surgery Database—Radboud Hospital, Nijmegen, The Netherlands). Table I presents preoperative data of the Re-re-group and also the comparative data of the patients undergoing a first coronary reoperation (Re-group) and the patients undergoing a primary aorta-coronary bypass operation (P-group) during the same period. Obesity was defined as more than 10% over normal body weight and diabetes as a positive result to glucose tolerance test, peroral antidiabetic medication, or insulin dependency. Hypertension was defined as a systolic blood pressure higher than 160 mm Hg or a diastolic pressure exceeding 100 mm Hg. Hyperlipidemia was defined as a cholesterol level greater than 6.4 mmol/L or triglyceride level greater than 2 mmol/L. Poor left ventricular function was noted when ejection fraction was below 0.35%.

The clinical indication for a second reoperation in all patients was angina satisfying criteria for at least New York Heart Association (NYHA) class III despite medical therapy with Ca^{++} -entry blockers, nitrates, and β -blockers. Eleven patients were in NYHA class III and five in NYHA class IV. Further analysis of these patients showed that 12 of the 16 patients had a “good,” not-replaced venous graft to the left anterior descending coronary artery (LAD) at the first reoperation. Three of these 12 patients had an anterior myocardial infarction between the first and the second reoperation. Thallium exercise testing showed that in 10 of the 12 the ischemia was located in the anterior wall.

The angiographic indications for the first and the second reoperations are summarized in Table II. Venous grafts were only considered to be *good* when angiograms showed no abnormalities.

Surgical technique. The sternum was longitudinally opened with an oscillating saw and the aorta and right atrium were dissected free. Subsequently, one or both internal mammary

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Table I. Preoperative variables

Variables	Re-re-group		Re-group		P-group	
	n = 16	%	n = 258	%	n = 2362	%
Sex (male/female)	13/3		167/91		1651/711	
Age at primary op. (yr)						
Mean $\pm$ SD	49 $\pm$ 9		52 $\pm$ 8		64 $\pm$ 9	
Range	32-67		33-74		31-83	
Age at reop. I (yr)						
Mean $\pm$ SD	52 $\pm$ 9		60 $\pm$ 9			
Range	34-76		38-79			
Age at reop. II (yr)						
Mean $\pm$ SD	60 $\pm$ 7					
Range	46-78					
Obesity	6	36	122	47	690	30
Diabetes	5	31	58	22	269	12
Hypertension	10	62	192	74	1086	46
Hyperlipidemia	6	36	170	66	993	42
Smoking	11	68	214	83	1892	80
Family history	12	75	228	88	1748	74
Per. vasc. atheroscl.	6	36	90	34	459	20
Poor LV function	6	36	57	22	117	5
Myocardial infarction						
Previous primary op.	6	36	162	63	1289	54
Between primary and reop. I	6	36	50	19		
Between reop. I and II	5	31				

Op., Operation; SD, standard deviation; reop. I, first reoperation; reop. II, second reoperation; per. vasc. atheroscl., peripheral vascular atherosclerosis; LV, left ventricular.

arteries (IMAs) were harvested synchronously with the necessary length of saphenous vein. After adequate heparinization was achieved the ascending aorta was cannulated and a two-stage cannula was inserted into the right atrium for venous return. A left ventricular vent was inserted through the right superior pulmonary vein. The patient was first cooled to a core temperature of 30° C and the heart was further dissected free. Then the patient was further cooled to a core temperature between 26° C and 28° C and slushed ice was used as topical cooling. Myocardial protection during aortic crossclamping was accomplished with infusion of cold (4° C) St. Thomas' Hospital cardioplegic solution until asystole occurred and was maintained by reinfusion of solution, 100 ml/m², every 25 to 30 minutes or less as needed in 14 of the 16 patients. In nine patients cardioplegic solution was delivered retrogradely by means of a coronary sinus cannula¹⁰ and in five the solution was delivered anterogradely. Intermittent aortic crossclamping was used in two patients.

At the initial and the first reoperation only venous grafts were used. At the second reoperation in 14 of 16 patients an IMA was used as a graft—in six patients unilaterally and in eight bilaterally, either as a single or as a sequential graft. Nineteen (64%) of the 36 distal anastomoses were done with an IMA.

The mean bypass time was 156 $\pm$ 32 minutes (range 90 to 230 minutes), and the mean duration of aortic crossclamping was 72 $\pm$ 14 minutes (range 35 to 122). There was a mean of 2.0 $\pm$ 0.7 grafts (range 1 to 3) and a mean of 3.3 $\pm$ 1.7 distal anastomoses (range 1 to 6).

Patient follow-up. Postoperative data were retrieved from the coronary artery surgery databank "CORRAD," supplemented with follow-up information from cardiologists and by telephone interview with the patients or family.

Table II. Angiographic indication for reoperation

Indication	Re-re-group	
	n = 16	%
First reoperation		
PA	7	44
GF	2	12
PA and GF	7	44
Second reoperation		
PA	0	0
GF	12	75
PA and GF	4	25

PA, Progression of atherosclerosis in native coronary vessels; GF, graft failure.

Results

There was no hospital mortality. Four patients had low cardiac output syndrome (a dopamine dosage >4 μ g/min for at least 12 hours), and three patients needed intraaortic balloon pump support. Four patients had a perioperative myocardial infarction, defined as new postoperative Q-wave or T-wave changes accompanied by elevated cardiac enzyme levels. Two patients needed ventilatory support for more than 3 days. Two patients underwent reoperative for bleeding, but wound problems were not encountered.

The follow-up of the 16 patients was complete. The mean duration was 24 $\pm$ 10 months (range 2 to 74

Fig. 1. Interval in months between initial operation and first reoperation (*first interval*) and between first and second reoperations (*second interval*).

Table III. Angiographic findings of the grafts

	LAD (-D)	CX	RC	Total	%
First reoperation					
Patent	12	4	1	17	57
Stenosis <50%	1	1	1	3	10
Stenosis ≥50%	2	2	2	6	20
Occluded			4	4	13
Total No.	15	7	8	30	100
Second reoperation					
UCGNR					
Patent	2	0	0	2	12
Stenosis <50%	3	1	0	4	24
Stenosis ≥50%	4	2	0	6	35
Occluded	3	1	1	5	29
Total No.	12	4	1	17	100
NG-first reoperation					
Patent	5	5	4	14	45
Stenosis <50%	1	1	2	4	17
Stenosis ≥50%	1	5	1	8	27
Occluded	0	2	1	3	11
Total No.	7	14	8	29	100

LAD, Left anterior descending coronary artery; D, diagonal branch; CX, circumflex coronary artery; RC, right coronary artery; UCGNR, uncompromised grafts not replaced at the first reoperation; NG, new grafts constructed at the first reoperation.

months). Three patients died during this period of cardiac-related causes. Interesting is that those three patients had a perioperative myocardial infarction, with a postoperative low cardiac output syndrome, and two of them needed intraaortic balloon pump support after operation. Among the 13 other patients, seven improved one NYHA class, four improved more than one NYHA class, and in two patients there was no relief of the symptoms.

Fig. 1 shows the interval between the primary operation and the first reoperation (mean 69 ± 30 months) and

between the first and the second reoperations (mean 69 ± 31 months) for each patient. At the first reoperation 8 (50%) of the 16 patients received supplementary venous grafts; 5 (33%) of 16 received supplementary grafts and replacement of atherosclerotic grafts. However, the progression of atherosclerosis in the native coronary artery system was prominent in this group. The fate of the constructed grafts is summarized in Fig. 2. Of the 30 constructed grafts at the initial operation, 17 (56%) were considered to be good and were not replaced, 13 were

Fig. 2. Fate of grafts constructed at initial operation and first reoperation. *UCGNR*, Uncompromised grafts not replaced; *UCGR*, uncompromised grafts replaced; *CGR*, compromised grafts replaced; *NG*, new grafts to not previously bypassed coronary arteries.

replaced, and 16 new grafts were constructed at the first reoperation. At the second reoperation, only two of the initial constructed grafts were considered to be good and left in place: of the 29 constructed grafts at the first reoperation, 13 (44%) were considered to be good, however, because of damage to one of these grafts, only 12 were not replaced, so that 17 grafts were replaced and 5 new grafts were constructed at the second reoperation. Table III shows the angiographic findings of the grafts, and Table IV shows the individual fate of the initial constructed grafts and the sites they were grafted to.

Discussion

Despite the increasing prevalence of reoperation for coronary artery disease and the multiple studies elucidating the operative risks, reoperation is still associated with a higher mortality and morbidity rate than the initial procedure.¹⁻⁹ The higher-risk character of second reoperations is stressed by Loop, Lytle, and Cosgrove¹¹ in an editorial in which they stated that a second reoperation is possible, but that the associated risk is higher than that of the first reoperation and that it frequently is an undesirable event for surgeon and patient. Also, the fact that in larger studies analyzing perioperative morbidity and mortality of reoperations patients with three or more coronary artery operations were excluded shows that they must be considered as a special group.^{1,3}

The limited number of patients undergoing a second coronary artery reoperation and the complexity of factors influencing the results are of course restricting factors in analyzing the problem of these patients. Therefore in our report we did not make comparative statistical analyses with patients having primary operations or with patients undergoing a first reoperation.

Our prevalence of second reoperations and the young ages of these patients at the initial operation correlate with other studies.⁶⁻⁹ The prevalence of the registered risk factors is comparable between the Re-re-group, the

Table IV. Review of the individual fate of the grafts constructed at the initial operation

Patient	No. of grafts	Distal anast.	UCGNR reop. I	UCGNR reop. II
1	3	LAD CX RC	LAD CX	
2	1	LAD-D	LAD-D	LAD-D
3	3	LAD CX-CX RC		
4	2	LAD RC	LAD	
5	2	LAD CX	LAD CX	
6	1	LAD	LAD	LAD
7	1	LAD-D	LAD-D	
8	1	RC	RC	
9	2	LAD RC	LAD	
10	1	LAD	LAD	
11	1	LAD		
12	2	LAD-D CX		
13	2	LAD-D-D RC	LAD-D-D	
14	2	LAD CX	LAD CX	
15	3	LAD CX-CX RC	LAD	
16	3	LAD CX RC	LAD CX	

Distal anast., Site of the distal anastomosis; *UCGNR reop. I*, uncompromised grafts not replaced at the first reoperation; *UCGNR REOP. II*, uncompromised grafts constructed at the initial operation and not replaced at the second reoperation; *D*, diagonal branch; *CX*, circumflex coronary artery; *RC*, right coronary artery.

Re-group, and the P-group. However, it must be noted that only "good candidates" were accepted for a second reoperation. That between each operation nearly one third of the patients had a new myocardial infarction

corresponds with the idea that between the initial and the first reoperation nearly one third of the patients lose previously normal left ventricular function.¹¹ That only 36% of the Re-re-group had a myocardial infarction before the initial operation has certainly also to do with the selection of the "good candidates." The change in angiographic indication for the first and the second reoperation conforms with the global evolution of the angiographic indication in reoperations from progression of atherosclerosis in the native coronary vessels to venous graft failure and a combination of both.^{1, 3} The mean interval (69 ± 30 months) between the initial operation and the first reoperation in our patients is comparable with a mean interval of 72 ± 44 months for the reoperations between 1979 and 1981 described by Lytle¹ and Loop³ and their colleagues. The mean interval of 68 ± 31 months between the first and the second reoperations in our patients seems relatively short. However, the interval between the initial operation and the second reoperation was 141 ± 41 months, and this is comparable with the increasing of the intervals during the initial operation and the reoperations described by Loop and associates.³ The mean intervals between the initial operation and the first reoperation and between the first and the second reoperations of our patients were comparable (5 to 6 years).

The clinical indication for a new coronary angiography (and reoperation) was the same. At the first reoperation angiography showed that the symptoms were mostly caused by progression of the pathologic conditions, but also that only 57% of the initial constructed grafts were good. At the second reoperation, also, half of the grafts constructed at the first reoperation were diseased. The reduction of the patency of 50% for venous grafts over 5 years has been described.^{12, 13} This global reduction of the venous patency rate is also found when we evaluate the graft patency and the site they were grafted to. The prevalence of occlusion of venous grafts to the right coronary artery constructed at the initial operation is probably because most of these grafts were constructed to the proximal right coronary artery and this coronary artery showed new abnormalities at the distal site, resulting in a flow obstruction through the previously constructed venous graft. The superior patency of the venous grafts to the LAD is known^{12, 13} and also clear in our angiographic evaluation; however, at the time of the second reoperation, 10 of 12 LAD grafts were diseased. This angiographic finding, in combination with the clinical findings (anterior infarction, ischemia) of the patients with a not-replaced LAD graft, suggests that a second reoperation could have been prevented if the LAD graft was replaced at the first reoperation.

This confirms of course the statement that vein grafts

in place for more than 5 years should be replaced during reoperation, regardless of the reason for reoperation,¹² especially vein grafts to the anterior descending coronary artery because they are prognostically more dangerous than native vessel atherosclerosis.^{14, 15} However, it must be clear that replacing open venous grafts calls for extreme care, because of the risk of intraoperative atheroembolization into the coronary microcirculation resulting in myocardial infarction during dissection of the distal anastomosis.¹⁶ Proximal ligation of those veins before manipulation does not totally prevent this risk, inasmuch as embolization of debris is possible even with occluded venous grafts.¹⁷

The IMA is the graft of choice also in reoperation, and when used in reoperation it will possibly reduce the need for a second reoperation.^{1, 3, 11, 18, 19} Although the smaller lumen of the IMA results in a limited blood flow capacity, measurements of flow characteristics of the IMA in dogs demonstrated that this graft could match or exceed the flow rate required by the myocardium.^{20, 21} The situation in reoperations, however, is different, certainly when there is a vein graft to the LAD that is not totally occluded.¹⁵

The fact that there was no operative mortality in this study is of course relative, because the number of patients was small and only "good candidates" were accepted for a second reoperation. The morbidity, prevalence of perioperative myocardial infarction, need for intraaortic balloon pump support, and need for reoperation for bleeding were somewhat high and, as in first reoperations, the morbidity was especially cardiac-related. These complication rates, however, are difficult to place into context because of the small number of patients and the lack of other series. The problem of effective myocardial protection, embolization of debris from atherosclerotic vein grafts, difficulties with vessel identification, and lack of bypass conduits resulting in an incomplete revascularization will certainly be even more important than in first reoperations.^{1, 3}

Our follow-up shows three deaths, all cardiac-related and occurring in the first 6 months after the operation. The three patients had a difficult postoperative recovery and they never did well after the operation, whereas the other patients are doing well. Eighty-four percent of our patients received IMA grafts and because the postoperative patency rate of an isolated IMA graft in reoperation is comparable with the results in primary revascularization, we suppose that the long-term follow-up may be excellent.¹³

In conclusion, a second reoperation for coronary atherosclerosis is possible; however, the fact that the first reoperation is done mostly for progression of the athero-

sclerosis in the native system and the second for graft failure suggests that, at the first reoperation, the choice of the best conduits available and replacement of even patent venous grafts (to the LAD) are essential to avoid a second reoperation.

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