Original Article

Right Coronary System Grafts: Alone or Together with Left System Grafts — Angiographic Results

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Purpose: The aim of this study is to compare the long-term graft patency between patients who had sequential or individual right posterior descending artery (RPDA) anastomosis.
Materials and Methods: Two hundred and forty-two patients underwent coronary artery bypass grafting (CABG) between June 1994 and December 2003. They were examined retrospectively with respect to coronary angiograghic data. [Group 1] Individually right system grafts in RPDA position (n=139). [Group 2] RPDA anastomosis sequentially with left system (n=103). Patency rates for posterior descending arteries in each group were separately calculated for each vessel quality category.
Results: The mean interval from operation to angiography was 50.6±48.9 months in group 1 vs 57.5±39.2 months in group 2 respectively. The overall patency rate was 66.2% (92/139) in group 1 and 78.6% (81/103) in group 2 (p=0.04). When the RPDA has good run-off capacity, the patency rate was 69.1% in group 1 and 85.2% in group 2.
Conclusion: When the RPDA has good run-off capacity, snake grafts show excellent results and right and left coronary systems could be anastomosed sequentially. (Ann Thorac Cardiovasc Surg 2007; 13: 27–31)

Key words: coronary artery bypass grafting, individual, sequential

Introduction

Most surgeons are hesitant to use snake grafting in routine coronary artery bypass grafting (CABG) cases because the revascularization of a large part of the myocardium becomes dependent on a single proximal anastomosis. However, sequential grafting has some major advantages over the single graft and allows revascularization of myocardial segments that would otherwise not be revascularized. This is due to limited run-off and highly expected graft failure rates, with a reduced number of proximal anastomoses.[1)]

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However, some authors have asserted that the patency of sequential end-to-side anastomoses was less than that of single end-to-side anastomoses.[2)] This may be of concern with regards to the long-term patency of these conduits.[3)] In this retrospective study we aimed to compare the long-term graft patency rate between a right posterior descending artery (RPDA) anastomosis with sequential to the left system and individual right system grafts in RPDA position.

Materials and Methods

Between June 1994 and December 2003, 4,637 patients with coronary artery disease underwent isolated CABG. Six hundred and thirty-five patients underwent reevaluation with coronary angiography and 242 of them were included in this study whose anastomoses were core on the RPDA. Patients who had individual right system grafts in RPDA position (group 1, n=139) and who had only a RPDA anastomosis with sequential to the left system

Table 1. The causes of angiography

Cause	Group 1	Group 2	p value
Before a major surgical procedure	5.0%	2.9%	NS
Typical/atypical symptoms			
Stable angina	28.8%	32.0%	NS
Unstable angina	19.4%	18.4%	NS
MI	9.4%	8.7%	NS
Positive treadmill test	15.1%	12.6%	NS
Control angiography	5.0%	4.9%	NS
Newly developed ECG changes	17.3%	20.5%	NS

MI, myocardial infarction; ECG, electrocardiography; NS, not significant.

(group 2, n=103) were evaluated according to the angiographic results. Patency rates for each group were separately calculated for each vessel quality category.

Definitions

Individual risk factors were as follows; Hypercholesterolemia: cholesterol level greater than 200 mg/dl, hypertension: diastolic blood pressure of 95 mmHg or greater, smoking: use of cigarette more than one pack per day, positive family history: atherosclerotic coronary artery disease in a first-degree relative.

Ventricular performance score (VPS) is a scoring system of left ventricular function due to wall motion of the 7 segments (antero-basal, antero-lateral, apical, inferior, potero-basal, postero-lateral, and septal segments) of the heart at the left and right oblique ventriculography and defined as; normal: 1, hypokinesia: 2, akinesia: 3, dyskinesia: 4, aneurysm: 5.[4)]

Operative technique

All the operations were performed by the same surgeons (Yaman Zorlutuna and Kaya Süzer). Complete revascularization was the goal in all patients. The left internal mammarian artery (LIMA) was the graft of choice for revascularization of the left anterior descending artery whereas saphenous vein grafts were used for revascularization of the remaining coronary vessels. The choice between the individual and sequential techniques was primarily based on the anatomical position and neighborhood of the vessels to be grafted. Quality assessment of the each anastomosed native coronary artery had been defined during the operation according to the diameter and plaque formation in the vessel. The plaque formation was evaluated visually and by palpation of the vessel, and the diameter was assessed using 1-, 1.5- and 2-mm metal-tipped coronary probes.[5,6)] The findings were noted as follows;

Grade 1: normal distal run-off, coronary artery > 1.5 mm

Grade 2: intimal proliferation + minimal plaque formation, coronary artery ≥ 1.5 mm.

Grade 3: intimal proliferation + multiple plaque formation, coronary artery ≤ 1.5 mm.

Grade 4: endarterectomy

All coronary anastomosis were performed using a double-armed 7-0 polypropylene suture with a continuous suturing technique.

The distal anastomosis on a sequential graft was performed in end-to-side fashion. Side-to-side anastomoses were performed in a diamond-shape and end-to-side anastomoses were performed parallel to the native coronary vessel axis. Proximal anastomoses were constructed on the ascending aorta with continuous double-armed 6-0 polypropylene sutures using a single side-biting clamp during the rewarming period.

Control angiograms

Postoperative angiographic examination was performed in patients who gave consent for routine postoperative angiographic studies, as well as in patients who had typical/atypical symptoms and newly developed electrocardiography (ECG) changes, and in patients for a major cardiac assessment before a major surgical procedure (abdominal, vascular, neurological, etc.)(Table 1).

Coronary angiograms were performed by the Judkins technique in four planes: antero-posterior, left lateral, right anterior-oblique and left anterior-oblique positions. For the patients who underwent repetitive postoperative control catheterization, only the last examination was included in the study. Patency rates for the posterior descending arteries in each group were separately calculated for each vessel quality category.

Table 2. Postoperatively patient's demographic data

	Group 1 (n=139)	Group 2 (n=103)	p value
Age (years)	60.0±10.3	59.1±9.3	NS
Sex (male)(%)	86.3	92.2	NS
DM (%)	23.7	24.4	NS
Family history (%)	26.6	27.2	NS
Obesity (%)	3.6	1.0	NS
Smoke (%)	24.5	22.3	NS
Cholesterol level (mg/dl)	198.4±40.3	191.0±42.8	NS
Antilipidemic treatment	88 (63.3%)	66 (64.1%)	NS
Antihypertensive treatment	60 (43.2%)	43 (41.7%)	NS
VPS	8.9±2.1	9.0±2.2	NS

DM, diabetes mellitus; VPS, ventricular performance score; NS, not significant.

Table 3. Operative data's

	Group 1 (n=139)	Group 2 (n=103)	p value
Number of bypassed vessels			
2	54 (38.8%)	20 (19.4%)	
3	50 (36.0%)	65 (63.1%)	
4	25 (18.0%)	10 (9.7%)	
5	10 (7.2%)	8 (7.8%)	
Use of LIMA	138 (99.3%)	101 (98.1%)	
Use of SVG			
LAD	1	2	
diagonal	44	42	
intermediate	15	12	
Cx branches	122	107	
RCA	2	5	
RPDA	139	103	
Total	323	271	
Vessel quality	1.65±0.5	1.75±0.9	NS
Grade 1	49 (35.3%)	50 (48.5%)	
Grade 2	74 (53.2%)	31 (30.1%)	
Grade 3	14 (10.1%)	16 (15.5%)	
Grade 4	2 (1.4%)	6 (5.8%)	
Preop. MI	0.8%	1%	

LIMA, left internal maminarian artery; SVG, saphenous vein graft; LAD, left anterior descending artery; RCA, right coronary artery; RPDA, right posterior descending artery; preop., preoperative; MI, myocardial infarction; NS, not significant.

Statistical analysis

All statistics were performed using SPSS statistical software (release 13.0, SPSS Inc., Chicago, IL). Mean ± standard deviation (SD) is presented. The unpaired t-test and the χ^2-test were used in statistical analysis and a p value equal to or smaller than 0.05 was considered statistically significant.

Results

The groups were similar with regards to age, sex, atherosclerotic risk factors, graft age and symptomatology. Postoperatively patient demographic data and risk factors are shown in Table 2.

The mean duration between the operation and control

Table 4 . The relationship between vessel quality and patency of RPDA

Vessel quality	Patency of RPDA		p value
	Group 1	Group 2	
Good run-off (grade 1, 2)	69.1% (85/123)	85.2% (69/81)	**0.01**
Bad run-off (grade 3, 4)	43.8% (7/ 16)	54.5% (12/22)	0.7

RPDA, right posterior descending artery.

angiography was 50.6±48.9 months in group 1 and 57.5±39.2 months in group 2 (p=0.2). Operative data is summarized in Table 3.

Angiographic findings

The overall patency was 66.2% (92/139) in single graft anastomosis to the RPDA and 78.6% (81/103) in end to side anastomosis to RPDA on sequential grafts (p=0.04). There were 54 anastomosis on 22 sequential grafts which had an occluded RPD anastomosis. From these anastomosis, 40 were occluded and 14 were patent. Eight of the 22 sequential grafts were totally occluded (36.4%).

Among different predictors, the overall patency of RPDA anastomosis was not affected by any of the presumed risk factors such as antilipid treatment, diabetes mellitus (DM), and hypertension and vessel quality of RPDA were found as an independent risk factors for graft patency. The relationship between vessel quality and patency rates is shown in Table 4.

Discussion

The sequential bypass grafting technique is widely used in myocardial revascularization since it was first described by Flemma et al.[7] and amplificated by Bartley et al.[8] This technique has many advantages such as decreased total resistance to graft flow, minimized impedance mismatch, facilitated anastomosis to smaller coronary arteries in patients with diffuse coronary artery disease and complete revascularization with shorter vein segments in shorter operation times.[1,9] The main drawback of sequential bypass grafting is the hazard of blood flow to a large mass of myocardium when the proximal conduit fails. However, it has been reported that the risk is minimal, particularly in the postero-lateral position, and provided that some surgical precautions are taken.[10]

The major factor in patency rates is the velocity of blood flow. Rittgers et al.[11] presented a reverse relationship between the flow rate and intimal proliferation. Faulkner et al.[12] also suggested that increased velocity of flow results in less intimal proliferation in chronic venous grafts, although velocity was not directly measured or calculated in their report. Rammos et al.[13] demonstrated that post-stenotic, diastolic pressures in sequential grafts tend to be higher than the corresponding presures when using single grafts using a computer model.

Postoperative angiographic studies by Grondin and Limet,[1] and recently by Vural et al.[5] have demonstrated higher patency rates in the proximal anastomoses of sequential grafts the distal anastomosis of sequential grafts or single grafts. Increased blood flow in the proximal segments of a sequential graft is directly related to the reduction in the resistance. Vural et al.[5] suggested that anastomosing a poor quality artery at the distal end of a sequential graft must be avoided, because this decreases the blood flow rate throughout the entire conduit and thrombosis may occur. If the most distal anastomosis has a good run-off, total blood flow is increased throughout the graft and this helps to decrease the incidence of thrombosis in the whole conduit, as well as in an anastomosis to a poor quality vessel which is proximal or medially located on the sequential graft.[14] Hence, some authors advocate separate grafts for each major coronary system especially when the distal coronary artery has poor run-off capacity.[5,6]

Kieser et al.[2] reported a long-term follow-up of 212 double sequential grafts at 1 and 5 years postoperatively and compared with 424 single grafts anastomosed to the same vessels. The patency rate of side-to-side anastomoses (85%) was better than that of end-to-side anastomoses (66%) for sequential grafts at 5 years (p<0.05). As a group, the 5-year patency of all side-to-side anastomoses was better than that of all the single end-to-side anastomoses (85% vs. 76%, p<0.05). The patency of sequential end-to-side anastomoses, however, was less than that of single end-to-side anastomoses (66% vs. 76%, p<0.05). Side-to-side double sequential grafts were reported to have better patency than end-to-side anastomoses. Single grafts have better patency than end-to-side anastomoses of sequential grafts, and therefore, that author recommended single grafts, unless there are other considerations such as limited availability of graft material.

In our study, we demonstrated that the overall patency was 66.2% (92/139) in individual anastomoses to RPDA and 78.6% (81/103) in end-to-side anastomoses to RPDA in sequential grafts (p=0.04). These rates appear more significant when the RPDA has good run-off capacity (85.2% vs. 69.1% p=0.01). On the contrary to previous reports, when the RPDA has poor run-off capacity, patency rates in sequential end-to-side anastomoses was 54.5% and 43.8% in single graft anastomoses despite no statistical significance.

Graft thrombosis is an important factor after CABG in the first years. When distal anastomosis has good run-off, graft thrombosis in sequential grafts is less than seen in individual grafts. After 5 years, atherosclerosis becomes more important than thrombosis and sequential grafts lost its advantages. When atherosclerosis affects the saphenous vein graft, more than 1 coronary artery could be at risk and this may be considered when using sequential grafting technique.

In conclusion, sequential grafting is technically more demanding than individual grafting, and the technical expertise in constructing a sequential anastomosis is among the major determinants of short- and long-term patency. When the RPDA has good run-off capacity, snake grafts show excellent results and right and left coronary systems may be anastomosed sequentially.

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