Early and Late Results of Coronary Artery Bypass Grafting in the Elderly

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This study is a review of our experience with elderly patients, who have undergone coronary artery bypass grafting (CABG). Of 357 patients who underwent elective CABG from April 1982 to May 1986, 50 patients (14.0%) were 65 years old or older. The incidence of preoperative cardiac conditions in the elderly was almost the same as that in patients less than 65 years of age. The incidence of noncardiac preoperative conditions in the older patients, such as diabetes mellitus, renal dysfunction, concomitant malignant disease, atherosclerotic lesion of the ascending aorta, was significantly higher than that in the younger age group. Early surgical mortality was 4.0% (2 cases) in the older group, and 1.3% (4 cases) in the younger group. There was no significant difference in statistics. The incidence of major postoperative complications was not significantly different between the two age groups, except that of cerebral infarction, which was significantly higher in the elderly group (6.0% vs 0.3%, $p < 0.001$). The rate of a long postoperative hospital stay was also significantly higher in the older group (43.8% vs 30.0%, $p < 0.05$). Long-term results, such as late mortality, symptom-free rate and graft patency, showed no significant differences between the two age groups. It is concluded that CABG can be performed in selected older patients with relatively low mortality and morbidity. Special attention should be paid to prevent perioperative cerebral infarction.

CORONARY artery bypass grafting has now become a routine surgical procedure in Japan.¹⁻³ The increasing safety of CABG is due to the advances made in all aspects of coronary care, such as improved surgical techniques, myocardial protection, as well as better anesthetic and medical management.¹

As atherosclerosis is an inevitable process accompanying aging, the incidence of ischemic heart disease increases year by year, with the increase of the mean life span.⁴ Therefore, CABG has also become common in the elderly.^{2,3}

When recommending CABG to a particular patient, especially an older patient, however, careful consideration is required of the risk-benefit ratio of the surgical procedure to the continued medical treatment. We reviewed our experiences with coronary bypass surgery and its early and late results in 50 patients aged 65 years or more.

MATERIALS AND METHODS

Patient selection: Between April 1982 and May 1986, 50 consecutive patients aged from 65 to 74 years underwent elective CABG at Toranomon Hospital. Of this group, 44 were male and 6 female (1:0.14), and their mean age was 67.4 ± 1.9 years. During the same period, a total of 307 younger patients (less than 65 years) underwent CABG in our institution. Of

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Fig.1. Rate of older patients undergoing CABG.

this group, 281 were male and 26 female (1 : 0.09). The annual number of elderly patients is shown in Fig. 1. There was a progressive increase in the number of elderly patients over the years. The elderly patients comprised 14.0% of the overall 357 patients who underwent elective CABG.

Preoperative cardiac conditions: A history of myocardial infarction, which was determined by ECG or definite enzyme elevation, was found in 44.0% of the aged group and in 46.6% of the younger group. Unstable angina pectoris, which was uncontrollable under full medication, was observed in 8.0% of the older group, and in 5.5%

of the younger group. The incidence of triple vessel disease was 56.0% in the aged group and 53.4% in the younger group. Left main trunk lesion was found in 16.0% of the elderly and in 14.3% of the younger group. Poor left ventricular function, whose ejection fraction was less than 0.40, was observed in 8.0% of the older group, and in 7.8% of the younger group. As far as all these preoperative cardiac-related conditions were concerned, there were no statistically significant differences between the two groups (Table I).

Preoperative non-cardiac conditions: The incidence of complication with diabetes mellitus was 34.0% in the elderly, while it was 20.2% in the younger group. Poor renal function, which was determined by a high serum creatine level (≥ 2.0 mg/dl), was also noted more frequently in the aged group than in the younger group (22.0% vs 8.1%). There were four elderly patients (6.0%) who underwent CABG before surgical resection of malignant tumors, while there was only one such patient (0.3%) in the younger group. In all patients, severe coronary artery disease was suspected by the routine preoperative positive Master's exercise test. A severe atherosclerotic change in the ascending aorta was observed during the operation in 16.0% of the aged group and in 5.1% of the younger group. These preoperative systemic conditions were significantly worse in the older group than in the younger group (Table I).

Surgical technique: Most patients underwent

TABLE I PREOPERATIVE CONDITIONS

	< 65 y.o.	≥ 65 y.o.	p value
History of MI	46.6% (143/307)	44.0% (22/50)	N.S.
Unstable AP	5.5% (17/307)	8.0% (4/50)	N.S.
Triple Vessel Disease	53.4% (164/307)	56.0% (28/50)	N.S.
LMT Lesion	14.3% (44/307)	16.0% (8/50)	N.S.
Poor LV Function (E.F. < 0.40)	7.8% (24/307)	8.0% (4/50)	N.S.
DM	20.2% (62/307)	34.0% (17/50)	$p < 0.02$
Poor Renal Function (S-Cr. ≥ 1.5 mg/dl)	8.1% (25/307)	22.0% (11/50)	$p < 0.005$
Malignancy	0.3% (1/307)	6.0% (3/50)	$p < 0.001$
Atherosclerotic Lesion of Ascending Aorta	5.1% (16/307)	16.0% (8/50)	$p < 0.001$

MI = myocardial infarction; AP = angina pectoris; LMT = left main trunk; LV = left ventricle; E.F. = ejection fraction; DM = diabetes mellitus; S-Cr = serum creatinine level; N.S. = not significant

TABLE II POSTOPERATIVE COMPLICATIONS

	< 65 y.o.	≥ 65 y.o.	<i>p</i> value
LOS	2.6% (8/307)	4.0% (2/50)	N.S.
Perioperative MI	2.3% (7/307)	2.0% (1/50)	N.S.
Cerebral Infarction	0.3% (1/307)	6.0% (3/50)	<i>p</i> < 0.001
Transient Psychosis	0% (0/307)	4.0% (2/50)	<i>p</i> < 0.001
Acute Renal failure	0.3% (1/307)	0% (0/50)	N.S.
Hepatitis	2.3% (7/307)	4.0% (2/50)	N.S.

LOS = low output syndrome

TABLE III POSTOPERATIVE COURSE

	< 65 y.o.	≥ 65 y.o.	<i>p</i> value
Artificial Ventilation (≥ 24 hours)	3.6% (11/307)	4.0% (2/50)	N.S.
ICU Stay (≥ 3 days)	6.5% (20/307)	8.0% (4/50)	N.S.
Postop. Hospital Stay (≥ 3 weeks)	30.0% (91/303)	43.8% (21/48)	<i>p</i> < 0.05

ICU = intensive care unit

TABLE IV LATE RESULTS

	< 65 y.o.	≥ 65 y.o.	<i>p</i> value
Late Death	2.9% (9/307)	4.0% (2/50)	N.S.
Symptomfree Rate	89.8% (229/255)	93.6% (44/47)	N.S.
Graft Patency	91.2% (445/488)	88.3% (68/78)	N.S.

aorto-coronary bypass with the use of a reversed saphenous vein graft: only three patients underwent one or two internal mammary graftings (1 in the elderly, 2 in the younger group). Operations were performed using total cardiopulmonary bypass with hemodilution technique. In addition to a moderate degree of whole body hypothermia (27–30°C), cold cardioplegia (modified St. Tomas' solution) and topical cooling of the heart with ice slush were employed for myocardial protection.

Follow-up: Most of the patients (79%) were re-studied cineangiographically 6 to 8 months postoperatively and the graft patency was examined. Other follow-up information was gathered by means of direct contact with patients in the out-patient clinic of our institution, or questionnaires sent out just before this study.

Statistical analysis was performed by Student's *t*-test for parametric determinations and a chi-square test for non-parametric determinations.

RESULTS

Number of bypasses: The mean number of bypasses performed in the elderly patients was 2.1 ± 0.8 grafts/patient, and that in the younger patients was 2.0 ± 0.8 grafts/patient.

Early results: Surgical mortality (death within 30 days after operation) occurred in 4.0% (2 cases) of all elderly patients. The early mortality for patients less than 65 years of age was 1.3% (4 cases). There was no statistical difference between the two groups. Four patients died of severe low output syndrome and 2 other patients (one third of total deaths) died of post-

TABLE V LATE DEATH

Name	Age · Sex	Cause of Death	Postop. (mos)
W.A.	69 M	Pulmonary Tbc.	24
K.T.	67 M	AMI*	23
S.N.	52 M	Sudden Death*	48
H.M.	63 M	Cerebral Infarction	10
S.K.	58 M	Gallbladder Ca.	22
Y.M.	60 M	Cerebral Hemorrhage	6
S.A.	60 M	Sudden Death*	36
T.S.	56 M	Cerebral Hemorrhage	24
T.H.	57 M	Hepatic Failure	5
S.S.	58 M	Cerebral Infarction	10
S.E.	46 M	Tachyarrhythmia (VT)*	2

* = cardiac-related or apparently cardiac-related;
AMI = acute myocardial infarction; VT = ven-
tricular tachycardia

transfusion graft-versus-host reaction (GVHR).

Low output syndrome, which required administration of epinephrine and/or norepinephrine over 24 hours and/or insertion of IABP, occurred in 2 patients (4.0%) in the elderly group, and in 8 patients (2.6%) in the younger group (Table II). Perioperative myocardial infarction, which was diagnosed by the appearance of persistent new Q waves in the electrocardiogram, occurred in 1 case (2.0%) in the older group, and in 7 cases (2.3%) in the younger group. There were no statistically significant differences between the 2 groups.

The incidence of cerebral infarction in patients 65 years of age or older, however, was significantly higher than that in patients aged less than 65 years (6%, 3 cases vs 0.3%, 1 case, $p < 0.01$). The incidence of transient psychosis in the elderly patients was also significantly higher than that in the younger patients (4.0%, 2 cases vs 0%, $p < 0.001$).

Acute renal failure, which required dialysis, developed in only one of the patients, who was 53 years old. Serum hepatitis occurred in 4.0% (2 cases) of the elderly group, and in 2.3% (7 cases) of the younger patients.

Long postoperative artificial ventilation (≥ 24 hours) was necessary for 2 patients (4.0%) of the elderly group, and for 11 patients (3.6%) of the younger group (Table III). Long stay at an

intensive care unit (≥ 3 days) was necessary for 4 patients (8.0%) 65 years and older, and for 20 patients (6.5%) aged less than 65 years. Although there were no significant differences between these figures, the rate of a long hospital stay after operation (≥ 3 weeks) was significantly higher in the older than in the younger patients (43.8% vs 30.0%, $p < 0.05$).

Late results: Two patients (4.0%) in the elderly, and 9 patients (2.9%) in the younger group died 2 to 48 months postoperatively (Table IV). Their causes of death are listed in Table V. Four patients (1 in the elderly, 3 in the younger group) died of either cardiac-related or apparently cardiac-related cases. The other 4 patients died of cerebrovascular accidents.

93.6% of the older group and 89.8% of the younger group had no cardiac symptoms.

As to the graft patency, 68 of 78 grafts (88.3%) in the aged group and 445 of 488 grafts (91.2%) in the younger group were patent. There were no significant differences in late results between the two age groups.

DISCUSSION

With the continual aging of the population of Japan, it is likely that increasing numbers of elderly individuals will have symptomatic coronary artery diseases and become potential candidates for CABG.⁴ Our surgical experience has documented a substantial annual increase in the number of patients 65 years of age or older having CABG during the 5-year study interval. In 1986, this subset comprised 20.5% of 39 patients having isolated CABG. This increased percentage of elderly patients has also been noted in other countries.^{5,6}

Fries and Katz and associates emphasized that the quality as well as quantity of life is important in the elderly, and emphasis should be placed on increasing the physical, emotional, and intellectual vigor until shortly before death.^{7,8} Although the prognosis of medical treatment of coronary artery disease in Japanese has been reported to be much better than that of Caucasians,⁹ the objective of CABG is not only to increase longevity but also to lengthen the "active" life expectancy (duration of well-being, with the end point being loss of independence in the activities of daily life) as emphasized by Katz and coworkers.⁸ Therefore, one should be very careful in deciding the indication for CABG, especially in the elderly, considering not only

cardiac status and graftability but also general health, mode of daily living, social activities and philosophy of life. An appropriate patient selection is quite important to obtain a lower incidence of postoperative complications as well as lower surgical mortality.

Among the elderly group, significantly higher percentages of female, as well as patients with unstable angina, left main coronary disease or three-vessel disease, were reported by several authors^{2,10,11}. Although our data showed a similar tendency, we could not see any significant difference between the two groups concerning the preoperative cardiac conditions. The rather small number of patients in our study is presumably the reason for this discrepancy.

A high percentage of our elderly patients had other serious coexisting illnesses. In comparison with patients less than 65 years of age, the elderly group contained a significantly greater percentage of patients with diabetes, poor renal function, unresected malignant tumors and atherosclerotic lesion of the ascending aorta. Gersh et al also pointed out a significantly greater prevalence of cerebro-vascular disease.¹¹ When a patient who has a malignant tumor also has a significant coronary artery disease, we compare the urgency of the resection of the tumor with the severity of the coronary disease. CABG is preferentially performed, if the coronary artery disease is critical.

Despite the increased operative risks with these variables, the overall surgical mortality was low (4.0%). In 1979, Kirklin et al reported a high surgical mortality for CABG patients more than 70 years of age, and assumed a negative attitude toward CABG in the elderly.¹² Propensity of the elderly to have multiple chronic diseases and to have a decrease in the reserve of most organ systems may account for this increased risk of death or postoperative complications with open-heart surgery.¹³ The introduction of cold cardioplegia, however, enables surgical mortality to be lowered significantly,⁶ and several recent studies have shown that CABG can be performed with acceptable operative risks in selected older patients.^{5,14-17} Out of the total of six early deaths, two were lost by post-transfusion GVHR at the age of 66 and 64 years. As posttransfusion GVHR is likely to occur in elderly patients, whose immune activity is decreased,¹⁸ we now try to reduce homologous transfusion and use frozen autologous blood.

Among major postoperative complications, the

incidence of low output syndrome, perioperative myocardial infarction, acute renal failure and serum hepatitis was almost the same between the 2 age groups. However, cerebral infarction and transient psychosis occurred in a significantly higher percentage of patients in the aged group. A permanent neurological deficit caused by cerebral infarction is the extreme opposite expectation we pursue, because the "active" life expectancy is almost nil in that situation. As there is a close correlation between atherosclerotic or calcified lesions of the ascending aorta and postoperative cerebral infarction, it is quite important to determine the nature of the ascending aortic wall preoperatively. First of all, the presence of calcification of the ascending aorta should always be checked with chest X-rays or cineangiograms. As CT-scanning is quite useful for determining the presence and location of calcification,¹⁹ we routinely order CT-scanning of the thorax for patients aged 65 years or older. Careful palpation of the ascending aorta just before cannulation during the operation is also useful for checking a wall lesion. When a severe atherosclerotic lesion is suspected, it is important to minimize the manipulation of the ascending aorta, that is, application of internal mammary artery graft instead of SVG,¹⁹ or proximal anastomoses under single cross-clamping, or less proximal anastomotic sites with the use of Y-graft or sequential graft. Gann et al also reported that only cerebral infarction occurred significantly more often in the elderly among postoperative complications,²⁰ and Knapp et al asserted that severe calcification of the ascending aorta is a relative contraindication of saphenous vein bypass surgery in this age group.¹⁴

Stenosis or obstruction of intra-cranial arteries is also dangerous, because hypoperfusion during the cardio-pulmonary bypass could also provoke a cerebral infarction. Therefore, when a history of transient ischemic attack or cerebral infarction is present, or when the vascular bruit at the neck is audible, brain CT-scanning and four-vessel study of intracranial arteries are inevitable. We have actually rejected two cases for this reason.

Although the incidence of long artificial ventilation and long ICU stay was not significantly higher in the aged group, that of a long hospital stay was significantly higher in the elderly group than in the younger group. Besides a higher incidence of cerebrovascular accidents, the reduced reserve of general organ function is assumed to be the major reason for this longer

hospital stay¹³

As for the late results, graft patency, late mortality and symptom-free rate in the elderly were similar to those in the younger age group, and were fairly satisfactory. This confirms the observation made by Gersh et al, who showed better event-free survival in the elderly than in the younger patients.²¹ It might be due to lower level of activity in older patients. Out of a total of 11 late deaths, four were due to cardiac related causes and another four were due to cerebrovascular accidents. Therefore, one should also be careful to prevent cerebro-vascular diseases.²²

The results of our surgical experience, as well as those of others, indicate that with the current operative techniques, CABG can be safely applied to patients 65 years of age and older with mortality and morbidity only slightly higher than those of younger patients, and it has the potential to improve both the quality and quantity of life. In this case, the importance of an appropriate patient selection cannot be overemphasized. Not only functions of major organs, but also calcification of the ascending aorta and patency of intracranial arteries should be checked to avoid a cerebral infarction.

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