

Immediate and long term results of percutaneous coronary angioplasty in patients aged 70 and over

Peter de Jaegere, Pim de Feyter, Ron van Domburg, Haryanto Suryapranata, Marcel van den Brand, Patrick W Serruys

Abstract

Objective—To study the immediate and long term clinical success of percutaneous transluminal coronary balloon angioplasty in patients over 70 years old.

Design—Patients undergoing percutaneous transluminal angioplasty were prospectively entered in a specially designed database. The clinical and angiographic data of all patients over 70 were reviewed. Follow up data were collected by interview during outpatient visits, by questionnaire, or through the referring physician.

Setting—A tertiary referral cardiac centre.

Patients—166 patients over 70 (median 73, range 70–84) underwent coronary angioplasty because of unstable angina (81 patients), stable angina (76 patients), or acute myocardial infarction (nine patients).

Results—The initial clinical success rate was 86% (142 of 166 patients). A major procedural complication occurred in 10 patients (6%): four patients (2%) died, six patients (4%) underwent emergency bypass surgery, and five patients (3%) sustained an acute myocardial infarction. In 14 patients (8%) coronary angioplasty did not significantly reduce the diameter stenosis but there were no associated complications. A total of 226 lesions were attempted. The initial angiographic success rate was 192 out of 226 lesions (85%). The median follow up was 21 (range 0.5–66) months. Sixteen patients (10%) died during follow up, eight patients (5%) sustained a non-fatal myocardial infarction, 21 patients (13%) underwent a second or third balloon dilatation, and 17 patients (10%) underwent elective bypass surgery. Of the 146 survivors, 99 patients (68%) had sustained clinical improvement. The estimated survival at four years (Kaplan-Meier method) was 89 (SD 4)%. The event free survival at four years for the total study population was 61 (8)%. Multivariate logistic regression analysis showed that the extent of vessel disease was the only independent predictive factor for event free survival: the event free survival rate was 81 (10)% at four years for patients with single vessel disease, compared with 45 (12)% for patients with multivessel disease.

patients over 70 was a safe and effective treatment for obstructive coronary artery disease. The extent of vessel disease, and not the completeness of revascularisation, was the only independent predictive factor for event free survival.

An increasing proportion of the population consists of elderly people.¹ Because the incidence of coronary heart disease increases with age, it is not surprising that more and more elderly patients are referred for coronary angiography.² As a consequence, the numbers of coronary angioplasty procedures and coronary artery bypass operations in this subgroup of the population will increase as well. Coronary artery bypass grafting in geriatric patients is associated with increased morbidity and mortality.^{3–5} Coronary angioplasty is a less invasive procedure and may be an attractive non-surgical alternative. In general, the elderly patient has more advanced coronary artery disease and lesions that are more calcified. Sometimes the coronary arteries are rigid and tortuous.^{5–7} These morphological and angiographic characteristics make coronary angioplasty technically more difficult to perform and may lead to less satisfactory results.

We examined the safety and efficacy of coronary angioplasty in elderly patients in terms of the initial angiographic and clinical success rate and the long term results.

Patients and methods

Between January 1983 and September 1988 coronary angioplasty was performed in 166 patients over 70 years old. They represent 8% of the total coronary angioplasty population (n = 2002) during the same period. Table 1 shows the clinical and angiographic character-

Table 1 Clinical and angiographic characteristics

Characteristic	Patients n (%)
Total number of patients	166
Age (yr):	
Median	73
Range	(70–84)
Male	86 (52)
Previous myocardial infarction	65 (39)
Previous coronary artery bypass surgery	17 (10)
Vessel disease:	
Single	87 (52)
Double	52 (31)
Triple	27 (16)
Ejection fraction (%):	
Median	59
Range	(18–77)

Catheterisation Laboratory, Thoraxcentrum, University Hospital Rotterdam-Dijkzigt, The Netherlands

P de Jaegere
P de Feyter
R van Domburg
H Suryapranata
M van den Brand
P W Serruys

Correspondence to Dr Peter de Jaegere, Thoraxcentrum, Catheterisation Laboratory, University Hospital Rotterdam-Dijkzigt, Dr Molewaterplein 40, 3015 GD Rotterdam, The Netherlands.

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istics. The indication for coronary angioplasty was unstable angina in 81 patients (49%), stable angina in 76 patients (46%), and acute myocardial infarction in nine patients (5%). Until 1988, patients with an acute myocardial infarction were treated with intravenous and intracoronary streptokinase followed by angioplasty if the residual stenosis was $> 50\%$. Unstable angina pectoris was defined as angina at rest associated with reversible changes in the ST segment or T wave without evidence of ensuing myocardial necrosis as assessed by increased cardiac enzyme activity or the development of new Q waves. Seven patients underwent coronary angioplasty of a stenosis in the left main stem. Two patients had a left main stem artery protected by the presence of a patent bypass graft, one patient was admitted because of an acute myocardial infarction complicated by cardiogenic shock, and four patients were regarded as high risk surgical cases because of severe peripheral vascular disease, renal insufficiency, obstructive lung disease, or previous stroke.

The global ejection fraction was calculated from a single plane left ventricular angiogram in the 30° right anterior oblique view according to Simpson's rule.

CORONARY ARTERIOGRAPHY

Coronary arteriography was performed via the femoral approach, with multiple views that included hemiaxial projections. The degree of stenosis was expressed as the percentage reduction in the diameter of the coronary artery lumen. A reduction in diameter of $> 50\%$ was regarded as significant. The culprit lesion in patients with acute myocardial infarction or unstable angina and multivessel disease was identified by relating the site of changes in the resting ST segment and T wave on the standard 12 lead electrocardiogram to the angiographic findings. ST-T segment changes in leads I, aVL, and V1-6 were related to lesion(s) of the left anterior descending coronary artery. Changes in leads II, III, and aVF were related to lesion(s) of the right or circumflex coronary artery. A total occlusion was defined as the absence of antegrade flow, and a functionally occluded artery was defined as the incomplete opacification of the distal vessel.

CORONARY ANGIOPLASTY

Coronary angioplasty was performed with preformed guiding catheters, steerable dilating balloon catheters, and a pneumatic inflation device. Before the dilatation, a 7 French pacing electrode was positioned in the right atrium, and 10 000 units of heparin and 250 mg of aspirin were administered intravenously. Intracoronary isosorbide dinitrate was given to prevent coronary spasm. Four electrocardiographic leads and the aortic pressure were monitored continuously. Balloon inflation started at a pressure of 2 atm and was increased to 12 atm if necessary. The inflation was stopped when electrocardiographic changes, a considerable drop in blood pressure, or pain developed. The dilatation was

repeated until there was a significant reduction of the diameter stenosis. Angioplasty was considered to be angiographically successful when obstruction of the luminal diameter was reduced to $< 50\%$. A dissection was defined as the presence of intimal damage producing an intraluminal defect on the coronary angiogram, or extraluminal extravasation of contrast material, or the presence of linear luminal density or luminal staining, or a combination of these.

A clinically successful angioplasty was defined as an angiographically successful dilatation free of procedure related complications that led to acute myocardial infarction, emergency bypass surgery, or death. A peri-procedural infarction was determined by the development of new Q waves (0.04 s) or an increase in serum cardiac enzyme activities of more than twice the upper limit of normal. A perioperative myocardial infarction was defined by the development of new Q waves.

Dilatation within two or more major coronary arteries was described as multivessel angioplasty. Revascularisation was considered complete when all stenoses leading to a diameter reduction of $> 50\%$ were successfully dilated.

FOLLOW UP

Procedural details, including immediate complications, were prospectively recorded in a computer database at the time of balloon angioplasty. The median follow up time was 21 (range 0.5-66) months. Patients were screened for the occurrence of death, acute myocardial infarction, and recurrent angina necessitating repeat angioplasty or bypass surgery. Clinical follow up information was obtained at interview during outpatient visits, by questionnaire, or through the referring physician. Information was complete for all patients. Patient survival curves and event free plots were constructed by the Kaplan-Meier method.

Results

ANGIOGRAPHIC RESULTS

Percutaneous transluminal coronary angioplasty was performed in 166 patients over 70 years old. Angioplasty was attempted on a total of 226 lesions (one lesion in 117 patients (70%), two or more lesions in 49 patients (30%)). Revascularisation was complete in 101 patients (61%) and partial in 65 patients (39%).

Of the 226 stenoses, 192 were successfully

Table 2 Distribution, aspect, and angiographic success of lesions on which angioplasty was attempted

	No (%)	Success rate (%)
Total number of lesions	226	192 (85)
Site:		
LAD	128 (57)	114 (89)
CX	49 (22)	40 (82)
RCA	38 (17)	18 (74)
Left main stem	7 (3)	6 (86)
Venous graft	4 (2)	4 (100)
Functionally occluded artery	11 (5)	9 (82)
Totally occluded artery	15 (7)	9 (60)

LAD, left anterior descending coronary artery; CX, circumflex coronary artery; RCA, right coronary artery.

Table 3 Clinical success of coronary angioplasty and procedure related major complications in 166 patients over 70

Patients over 70	No (%)
Total number of patients	166
Clinical success	142 (86)
Unsuccessful angioplasty without complications	14 (8)
Unsuccessful angioplasty with complications:	10 (6)
Death	4 (2)
AMI	5 (3)
CABG	6 (4)

AMI, acute myocardial infarction; CABG, coronary artery bypass grafting.

Table 4 Clinical success of coronary angioplasty according to indication in 166 patients aged ≥ 70

Indication	No of patients in which angioplasty was attempted	Success (%)
UAP	81	73 (90)
AP	76	61 (80)
AMI	9	8 (81)

UAP, unstable angina pectoris; AP, stable angina pectoris; AMI, acute myocardial infarction.

dilated. The overall primary angiographic success rate was 85%. Table 2 shows the distribution of the lesions and the success rate per lesion. The lesion could not be crossed in four patients (2%). In three of these the attempt to cross the lesion with the guide wire resulted in dissection and subsequent occlusion. These three patients died of acute myocardial infarction complicated by cardiogenic shock. The fourth patient was referred for emergency bypass surgery. Abrupt closure of the artery immediately after attempted dilatation occurred in 10 patients (6%). In three patients a major coronary dissection was found, but in the other seven patients the mechanism of the acute occlusion was uncertain. They were all successfully redilated. A dissection was seen in another 14 patients (8%). One patient died, one sustained an acute myocardial infarction, and three underwent emergency bypass surgery.

CLINICAL RESULTS

The primary clinical success rate for the total study population was 86% (table 3). In 14 patients (8%) the angioplasty did not significantly reduced the diameter stenosis, but there were no complications. Ten patients (6%) had a major procedure related complication. Acute myocardial infarction was seen in four patients, of whom one died and two were referred for emergency bypass surgery. Another four patients underwent urgent bypass surgery, of these one patient died of a

Table 5 Complication rate of single vessel and multivessel angioplasty in patients aged ≥ 70

	Single vessel (%)	Multivessel (%)
Total number of patients	146	20
Death	3 (2.1)	1 (5)
AMI	4 (2.7)	1 (5)
CABG	5 (3.4)	1 (5)

AMI, procedure related acute myocardial infarction; CABG, emergency bypass surgery.

perioperative myocardial infarction. Two other patients had ventricular fibrillation during angioplasty and subsequently died. A total of 15 complications occurred in 10 patients (6%). Table 4 shows the clinical success according to indication. One patient sustained a transient ischaemic cerebrovascular accident and another patient required surgical repair of a pseudoaneurysm of the right femoral artery. Single vessel and multivessel angioplasty were performed in 146 (88%) and 20 patients (12%) respectively. Of the 146 patients who underwent single vessel angioplasty, one lesion was attempted in 117 patients (80%), and two or more lesions were attempted within the same coronary artery in 29 patients (20%). A total of 12 events occurred in eight patients undergoing single vessel angioplasty and three events occurred in two patients undergoing multivessel angioplasty (table 5).

FOLLOW UP

Table 6 lists the data from the clinical follow up after successful and unsuccessful angioplasty. There were 16 deaths (10%) of which 10 were cardiac and six non-cardiac. Eight patients (5%) sustained a late non-fatal acute myocardial infarction. Symptoms recurred in 44 patients (27%). Six patients (4%) were treated medically. Repeat angioplasty was carried out on 21 patients (13%) (the same lesion in 13 patients and a newly acquired lesion in eight patients), of whom one died and four underwent a third uncomplicated coronary angioplasty. Seventeen patients (10%) underwent elective bypass surgery; one of these patients had an uncomplicated perioperative myocardial infarction. Table 6 shows the interval between the first coronary angioplasty and the cardiac events during follow up.

The mean (SD) estimated survival at four years from the first angioplasty for the entire study population was 89 (4)% (fig 1). The event free survival at four years (free of myocardial infarction, bypass surgery, and repeat angioplasty) was 61 (8)% (fig 1). To determine independent predictors for event free survival, multivariate logistic stepwise regression analysis was performed. Several variables were selected—namely, age > 75 years, sex, previous myocardial infarction, previous bypass surgery, ejection fraction $< 55\%$, stable *v* unstable angina, completeness of revascularisation, and extent of vessel disease (single *v* multivessel disease). The extent of vessel disease was the only independent predictive factor. The probability of sustaining a cardiac event was 4.7 fold higher (95% confidence interval 2.3–9.3) in patients with multivessel

Table 6 Major cardiac events during follow up of 166 patients aged ≥ 70 who underwent coronary angioplasty

Event	Group 1 (%)	Group 2 (%)	Group 3 (%)	Total (%)	Interval (months) Median (range)
	142 (86)	14 (8)	10 (6)	166	
Death	13	3	—	16 (10)	9 (0.5–39)
AMI	3	4	1	8 (5)	3 (2–13)
Re PTCA	21	—	—	21 (13)	5 (1–32)
CABG	12	2	3	17 (10)	6 (1–35)

Group 1, successful coronary angioplasty; group 2, unsuccessful coronary angioplasty without complications; group 3, unsuccessful coronary angioplasty with major complications; AMI, acute myocardial infarction; Re PTCA, repeat coronary angioplasty; CABG, coronary artery bypass grafting.

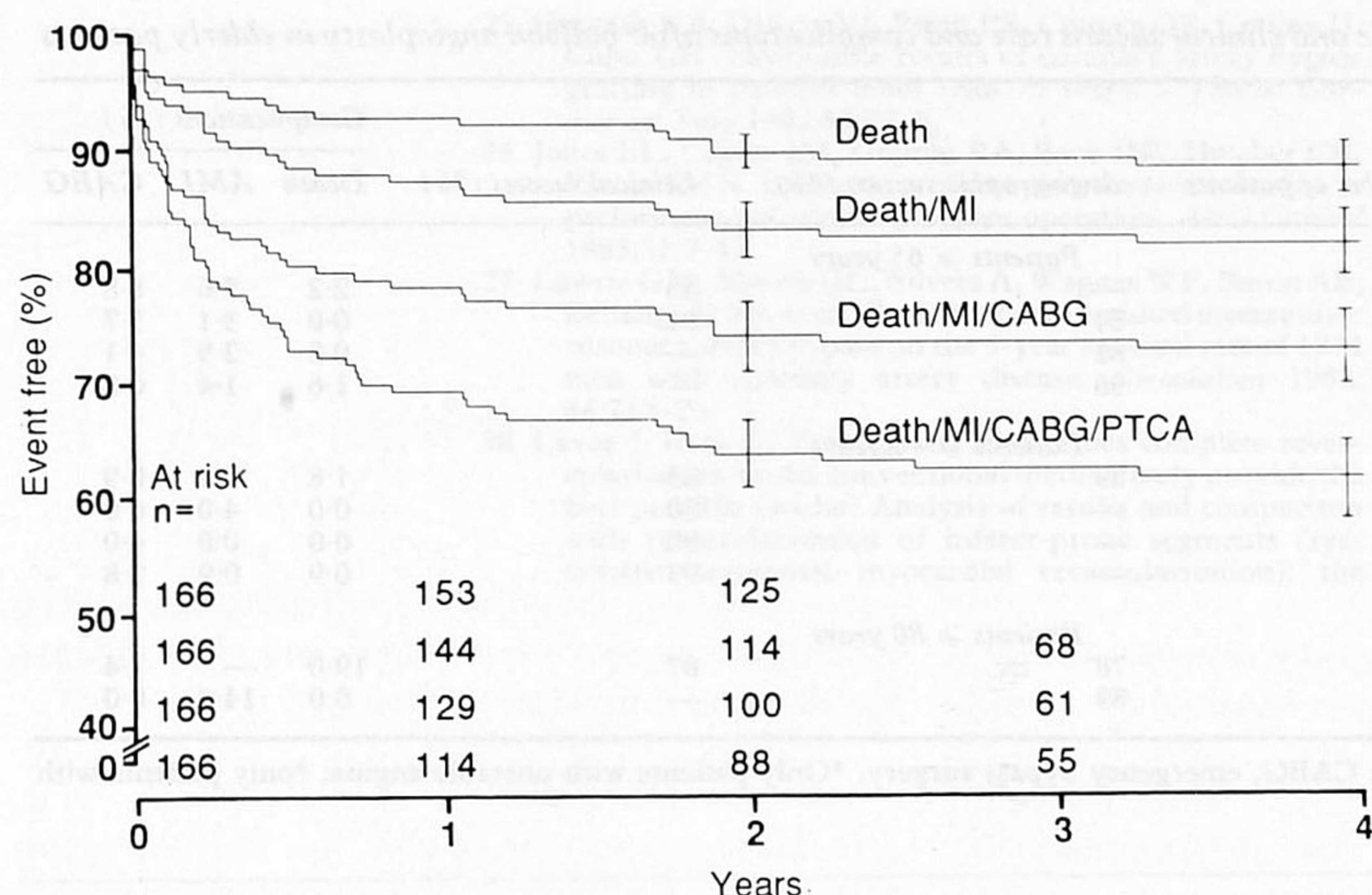


Figure 1 Overall long term cumulative survival and event free survival curves after balloon angioplasty according to the Kaplan-Meier method for patients aged ≥ 70 . Vertical bars denote the 95% confidence intervals. For abbreviations see table 6.

disease compared with those with single vessel disease. Event free survival at four years was 81 (10)% in patients with single vessel disease compared with 45 (12)% in patients with multivessel disease (fig 2).

At the end of follow up 146 patients (88%) were still alive. Ninety nine patients (68%) were improved clinically. This was associated with an appreciable reduction in antianginal therapy. Before angioplasty, 136 patients were being treated with β blockers, 107 with nitrates, and 145 patients with calcium antagonists. At the end of follow up only 41 patients still took β blockers (a reduction of 70%), 18 still took nitrates (a reduction of 83%), and 106 patients took calcium antagonists (a reduction of 27%).

Discussion

As the population of developed countries ages the number of elderly patients referred for diagnostic and therapeutic cardiac catheterisations continues to increase. From January 1983

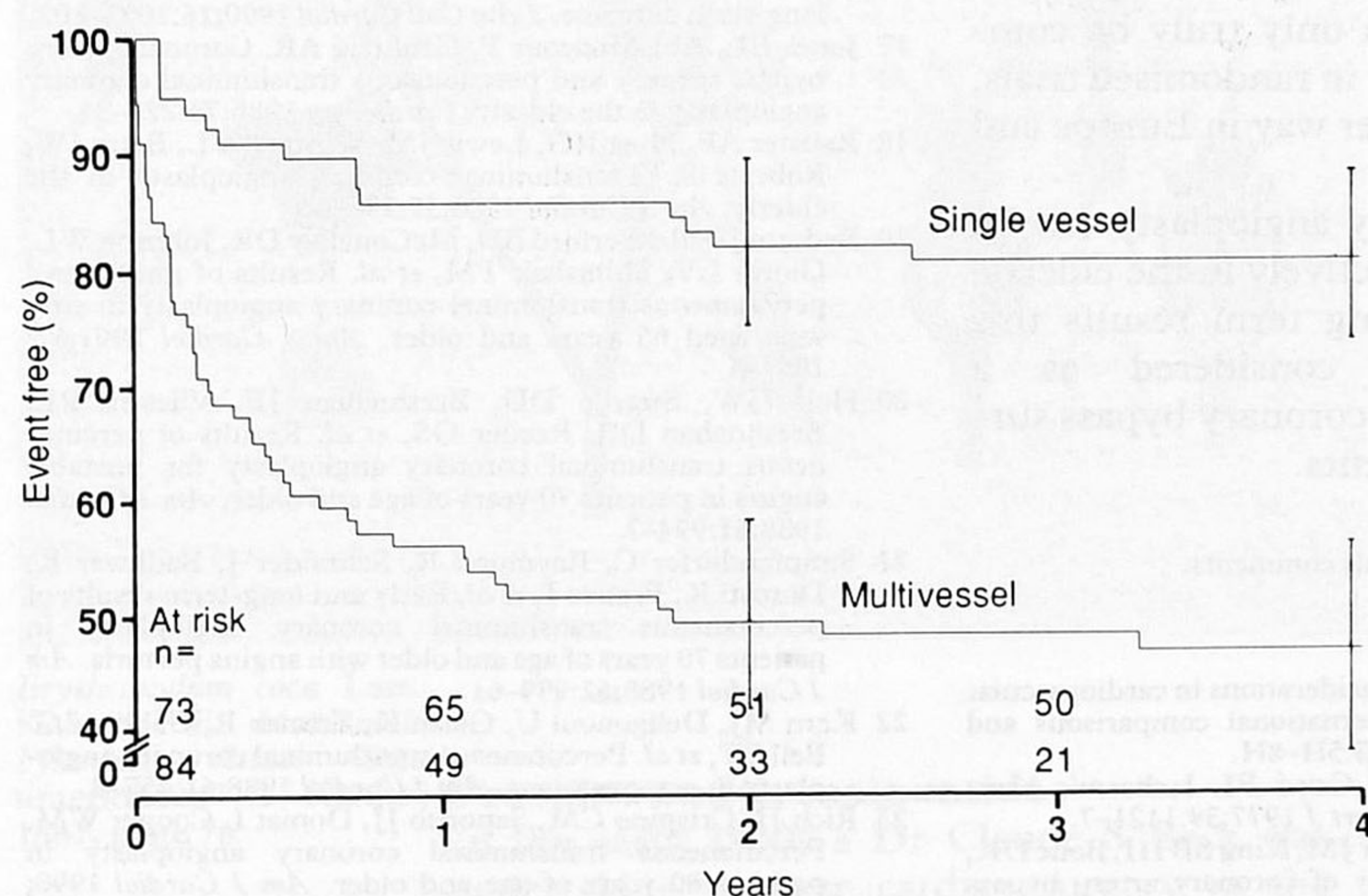


Figure 2 Event free survival after balloon angioplasty according to the Kaplan-Meier method for patients aged ≥ 70 with single or multivessel disease. Vertical bars are 95% confidence intervals.

to August 1988, 2002 coronary angioplasties were performed in our hospital and the percentage of patients over 70 who underwent balloon angioplasty increased from 7% to 15%. In the United States one third of the cardiac catheterisations and one third of the coronary artery bypass operations are performed on elderly patients.^{8,9} Coronary artery bypass grafting in the elderly is an effective method of myocardial revascularisation, providing symptomatic relief and good long term results.¹⁰⁻¹² Cardiac surgery in the geriatric patient is, however, associated with increased morbidity and mortality.^{3,12,13} In view of this high operative risk, coronary angioplasty is particularly attractive as a less invasive alternative. It offers the potential for myocardial revascularisation with certain advantages over bypass grafting such as the avoidance of a thoracotomy, shorter time in hospital, and lower costs.^{6,7,14} A lower success rate may be expected for balloon angioplasty performed in the elderly. As well as the increased procedural mortality known to occur in patients over 70, other clinical variables noted more often in the elderly, such as depressed left ventricular function and left main and three vessel coronary artery disease, increase the risk associated with balloon angioplasty.^{15,16} Elderly patients also have more tortuous coronary arteries and more calcified lesions, which create troublesome angles and bends to negotiate.⁵⁻⁷ Our data from this study indicate that coronary angioplasty can be performed with a high initial success rate and an acceptable incidence of complications in patients over 70. These data accord with previous reports (table 7). Three earlier studies compared the primary success rate and incidence of complications of balloon angioplasty between patients younger than and older than 65.^{14,17,18} Only the National Heart, Lung and Blood Institute (NHLBI) percutaneous transluminal coronary angioplasty registry showed a significantly lower initial success rate and a higher mortality in the elderly patients.¹⁴ The population of the NHLBI study, however, differed from the other studies in that the data were collected from many institutions during the period 1977 to 1981. The higher success rate reported in the other studies can in part be explained by improved angioplasty equipment and increased operator experience. Also in this study and in other reports no patients sustained an irreversible cerebrovascular accident whereas 2.7-7.5% of patients in surgical series did.^{6,11,21}

Though it is difficult to compare different studies, especially when there is selection bias, there is a striking similarity between the overall and the event free survival rates in our patient group and those reported by others.¹⁹⁻²¹ Also, the estimated survival at four years of 89 (4)% compares favourably with the survival rate for elderly patients who undergo bypass surgery.^{11,24,25} The importance of complete revascularisation after bypass surgery is well documented.^{26,27} It has been shown that complete revascularisation is associated with improved long term survival and freedom from late cardiac events.²⁸⁻³⁰ Variables other than the

Table 7 Reported angiographic and clinical success rate and complications after balloon angioplasty in elderly patients

Author	Number of patients	Angiographic success (%)	Clinical success (%)	Complications (%)		
				Death	AMI	CABG
Patients ≥ 65 years						
Mock <i>et al</i> ¹⁴	1984 370	—	53	2.2	5.6	6.8
Jones <i>et al</i> ¹⁷	1986 159	84	81	0.0	3.1	5.7
Raizner <i>et al</i> ¹⁸	1986 119	81	—	0.8	2.5	4.1
Bedotto <i>et al</i> ¹⁹	1991 1373	96	—	1.6	1.4	0.8
Patients ≥ 70 years						
Dorros and Janke ⁶	1986 109	89	83	1.8	2.8	0.9
Holt <i>et al</i> ²⁰	1988 54*	—	80	0.0	4.0	6.0
Simpfendorfer <i>et al</i> ²¹	1988 124†	—	90	0.0	0.8	4.0
	212*	—	93	0.9	0.9	2.8
Patients ≥ 80 years						
Kern <i>et al</i> ²²	1988 21	78	67	19.0	—	1.4
Rich <i>et al</i> ²³	1990 22	89	—	0.0	14.0	0.0

AMI, acute myocardial infarction; CABG, emergency bypass surgery. *Only patients with unstable angina; †only patients with stable angina.

degree of revascularisation, however, may influence the long term outcome. Moreover, there may be substantial differences in baseline characteristics between patients with complete and incomplete revascularisation.^{31 32} In this respect, conclusions about long term outcome based only on the degree of revascularisation may be misleading. It has been shown that after adjustment of such baseline differences in patients with multivessel disease undergoing balloon angioplasty, the completeness of revascularisation has no independent predictive value for event free survival.^{31 32} The data from this study indicate that the extent of vessel disease and not the degree of revascularisation is the only independent predictor for event free survival.

STUDY LIMITATIONS

The group of patients we describe is clearly a selected population. Patients were not randomised to either angioplasty or bypass surgery. Therefore, no attempt was made to compare the results of balloon angioplasty with those achieved by bypass surgery. Published data on angioplasty and coronary artery bypass surgery, however, provide some insight into the benefit:risk ratio when choosing which treatment should be used for the geriatric patients. Angioplasty can only truly be compared with bypass surgery in randomised trials, such as are currently under way in Europe and The United States.

In conclusion, coronary angioplasty can be performed safely and effectively in the elderly. Given the favourable long term results this procedure should be considered as a therapeutic alternative to coronary bypass surgery in this group of patients.

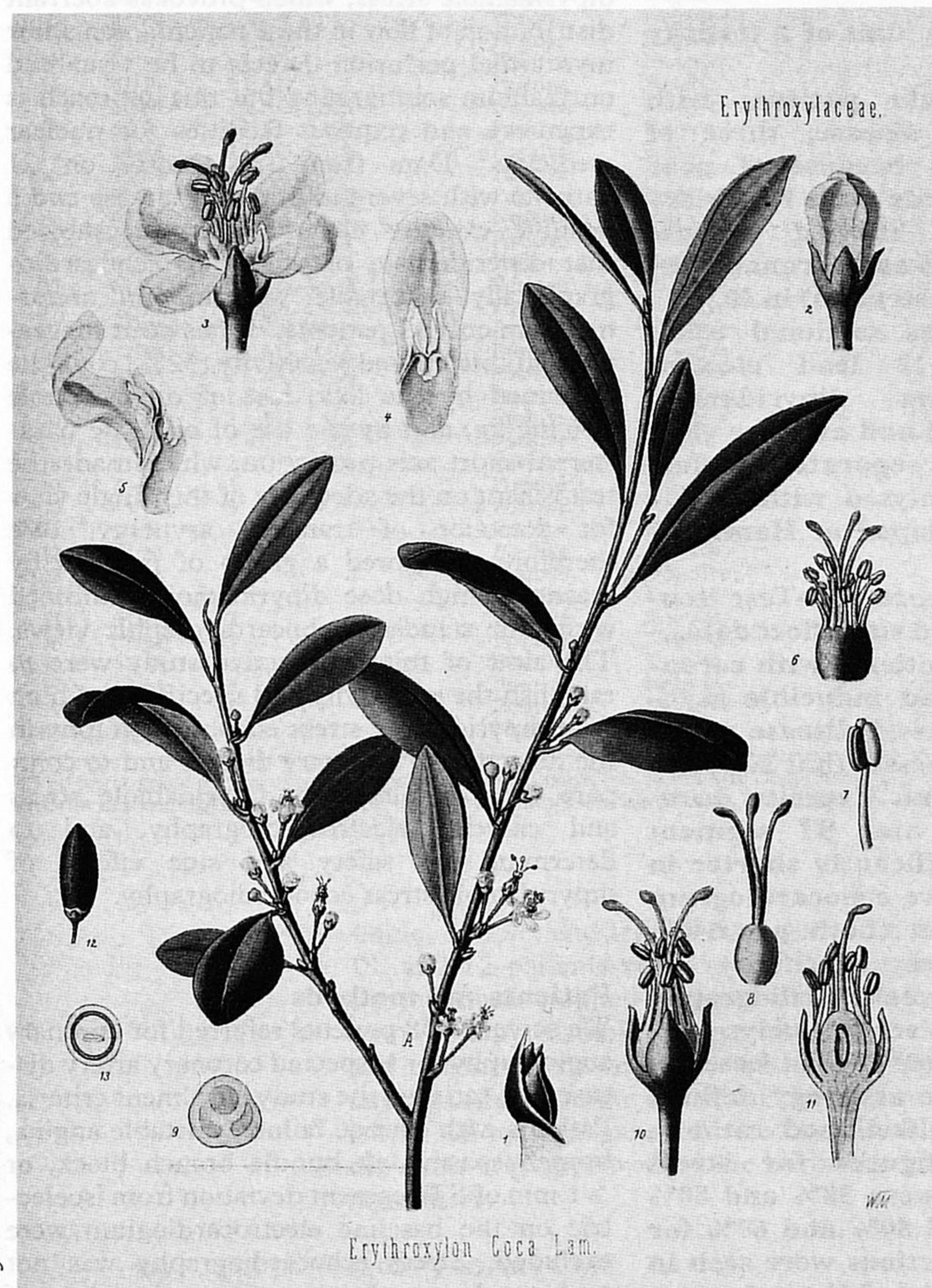
We thank Dr Donald Mcleod for his comments.

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PLANTS IN CARDIOLOGY



Royal Botanic Gardens Kew

Erythroxylum coca Lam.
Kohler F E. *Medizinal-Pflanzen, Atlas*. Gera untermhaus: E Kohler, 1887, plate 76.

Procaine and procainamide

In the early 1930s a Dr Claude S Beck was undertaking pioneer cardiac surgery at the Lakeside Hospital in Cleveland, Ohio. He was attempting to revascularise the heart in angina pectoris by putting a pedicle graft of pectoralis

muscle onto the left ventricle and he was also doing pericardiectomy for constrictive pericarditis.

But arrhythmias during and after surgery presented an important problem which was investigated experimentally by Dr Frederick R Mautz. For this study he chose drugs in the cocaine group because they were readily absorbed from mucous membranes and were already known to have some effect on the myocardium. Mautz showed that in dogs procaine produced a monophasic local injury current in the epicardial electrogram and that it prevented extrasystoles when the heart was stimulated electrically (*Journal of Thoracic Surgery* 1936;5:612-28). Procaine had a quinidine-like effect but its action was short-lived owing to esterase action. Its analogue procainamide (Pronestyl) introduced in 1951 had the advantages of being enzyme resistant and active by mouth.

Cocaine was isolated in 1860 from the South American coca plant *Erythroxylum coca* (Erythroxylaceae). This shrub, the "divine plant of the Incas", grows in the eastern Andes and had been used since ancient times to induce a pleasant mental state, to combat fatigue, and increase physical endurance. This folk medicine interested Sigmund Freud and in 1884 he studied the properties of cocaine with the help of his Viennese colleague Carl Koller who was an eye surgeon. When it was found that cocaine numbed the tongue Koller at once realised its potential in ophthalmic surgery. It soon became widely used as the first ever local anaesthetic but its stimulant effect on the nervous system was unwelcome—though Sherlock Holmes took advantage of it. The less toxic synthetic compound procaine was made in 1905.

The small tropical family Erythroxylaceae has no other species with medical uses. It is interesting that two other antiarrhythmic compounds namely lignocaine and quinine are also local anaesthetics (*British Heart Journal* 1991; 65:165 and 66:301).

A HOLLMAN