Outcomes following coronary artery bypass grafting and percutaneous transluminal coronary angioplasty in the stent era: a prospective study of all 9890 consecutive patients operated on in Scotland over a two year period

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Abstract

Objective—To determine current outcomes of percutaneous transluminal coronary angioplasty (PTCA) and coronary artery bypass grafting (CABG).

Design—The Scottish coronary revascularisation register provided prospectively collected data on case mix and in-hospital complications for all revascularisation procedures between April 1997 and March 1999 (4775 PTCA; 5115 CABG). Linkage to routine hospital discharge and death data provided follow up information on survival and repeat revascularisation.

Results—Stents were used in 51% of PTCA procedures. CABG patients were older, had more severe coronary disease, and had greater comorbidity. PTCA was more likely to be undertaken as an urgent or emergency procedure. Perioperative death and urgent surgery followed 0.3% and 0.6% of PTCA procedures, respectively. Case fatality rates were higher following CABG, with 6.7% dead within two years compared with 3.4% following PTCA. PTCA was more often followed by readmission for ischaemic heart disease, repeat angiography, or revascularisation: 22.8% of patients had repeat revascularisation within two years, compared with 1.8% following CABG.

Conclusions—The severity of coronary heart disease was greater than in previously published registry studies and randomised trials. Despite this, overall survival figures were comparable and repeat revascularisation rates lower, particularly following PTCA. Perioperative death and urgent surgery following PTCA were also lower. These favourable outcomes may be attributable, in part, to increased use of bail out and elective stenting.

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Keywords: percutaneous transluminal coronary angioplasty; coronary artery bypass grafting; survival; outcome

Percutaneous transluminal coronary angioplasty (PTCA) and coronary artery bypass grafting (CABG) are the principal procedures by which coronary artery disease can be treated. Some patients are not suitable candidates for both procedures. In those who are, the choice between PTCA and CABG is dictated primarily by their relative risks and benefits in terms of survival, restenosis, recurrence of symptoms, and the need for further interventions.

Several randomised trials in the early 1990s compared the two procedures and concluded that CABG was associated with a higher perioperative mortality.[1–6] However, this was offset by more complete revascularisation, resulting in comparable overall mortality at 1–3 years of follow up. These studies showed higher rates of restenosis, recurrence of symptoms, and repeat revascularisation following PTCA. As a result PTCA was characterised by a lower procedural cost but comparable overall cost.[1]

Since then, there have been various technical and therapeutic developments that have improved the outcomes following both procedures, most notably the increased use of internal mammary artery grafts and coronary stents. Used as a bail out procedure, coronary stenting may avoid the need for urgent surgery for acute vessel closure or dissection following PTCA.[7 8] Used electively, coronary stents can reduce the rate of restenosis and repeat revascularisation following PTCA.

Our aim in this study was to report current outcomes after PTCA and CABG in terms of case fatality, readmission for ischaemic heart disease, repeat coronary angiography, and further revascularisation.

Methods

Since April 1997 data have been collected prospectively on all patients undergoing PTCA or CABG in Scottish NHS hospitals. This accounts for more than 90% of revascularisation procedures undertaken on Scottish residents (Redpath A, personal communication). The attending clinicians and audit staff collect information on demographic characteristics, cardiac disease severity, comorbidity, procedure details, past medical and surgical history, and in-hospital complications. These data are collated to form the Scottish coronary revascularisation register.

Routine data are collected prospectively on all patients discharged from Scottish NHS

hospitals as part of the Scottish morbidity record 1 system (SMR1). These are collated by the Information and Statistics Division (ISD) of the Common Services Agency. The hospital episodes relating to an individual patient are linked to each other and to death data obtained from the Registrar General for Scotland. The principal diagnosis is recorded using the *International classification of diseases* codes (ICD10) and any procedures undertaken during the admission are recorded using the Office of Population Censuses and Surveys codes (OPCS4).

Linkage of the Scottish coronary revascularisation register to the ISD database provided information on all cause deaths, admissions for a principal diagnosis of ischaemic heart disease, coronary angiograms, and coronary revascularisation procedures following the index revascularisation procedure. The results reported in this study relate to procedures performed between April 1997 and March 1999 inclusive.

Table 1 Characteristics of patients undergoing coronary revascularisation procedures

Variable		*PTCA (n=4775)*	*CABG (n=5115)*	*Significance†*
Age (years)‡	< 56	1529 (32)	1124 (22)	***
	56–65	1775 (37)	2110 (41)	
	66–75	1165 (25)	1657 (32)	
	> 75	289 (6)	224 (4)	
	Missing	17	0	
Sex	Male	3212 (67)	3872 (76)	***
	Female	1555 (33)	1243 (24)	
	Missing	8	0	
Urgency‡	Emergency	584 (12)	167 (3)	***
	Urgent	1356 (28)	891 (17)	
	Elective	2831 (59)	4057 (79)	
	Missing	4	0	
Left ventricular impairment‡	None	2174 (60)	2212 (56)	***
	Mild/moderate	1325 (37)	1519 (39)	
	Severe	98 (3)	212 (5)	
	Missing	1178	1172	
Number of arteries with significant stenoses	LMS	175 (4)	1052 (23)	***
	1	1747 (43)	198 (4)	
	2	1325 (33)	193 (4)	
	3	779 (19)	3048 (68)	
	Missing	749	624	
Previous AMI	No	2673 (58)	1638 (43)	***
	Yes	1927 (42)	2155 (57)	
	Missing	175	1322	
BMI ⩾ 30	No	2665 (75)	3469 (71)	***
	Yes	891 (25)	1421 (29)	
	Missing	1219	225	
Hypertension	No	2747 (68)	2951 (59)	***
	Yes	1310 (32)	2032 (41)	
	Missing	718	132	
Diabetes mellitus	No	3632 (89)	4490 (88)	NS
	Yes	441 (11)	618 (12)	
	Missing	702	7	
Severe respiratory disease	No	3952 (98)	3408 (93)	***
	Yes	76 (2)	241 (7)	
	Missing	747	1466	
Cerebrovascular disease	No	3971 (98)	4569 (96)	***
	Yes	68 (2)	208 (4)	
	Missing	736	338	
Smoking status‡	Non-smoker	1259 (32)	1454 (30)	***
	Ex-smoker	1758 (44)	1854 (38)	
	Current smoker	983 (25)	1563 (32)	
	Missing	775	244	
Number of antianginal drug treatments‡	0	229 (6)	342 (7)	NS
	1	874 (21)	930 (18)	
	2	1561 (38)	2008 (39)	
	3	1252 (31)	1742 (34)	
	4	187 (5)	93 (2)	
	Missing	672	0	

Values are n (%).
†Statistical significance of difference between PTCA and CABG on χ^2 and χ^2 for trend (‡) tests: *p < 0.05; **p < 0.01; ***p < 0.0001; NS, not significant.
AMI, acute myocardial infarction; BMI, body mass index; CABG, coronary artery bypass grafting; *cerebrovascular disease*, history of stroke or recurrent transient ischaemic attacks, or an internal carotid artery stenosis of ⩾ 70%; *emergency*, procedure required within 24 hours of referral; *current smoker*, smoking within one month of procedure; *hypertension*, systolic blood pressure ⩾160 mm Hg, diastolic blood pressure ⩾90 mm Hg, or current antihypertensive drugs; LMS, left main stem; PTCA, percutaneous transluminal coronary angioplasty; *severe respiratory disease*, forced expiratory volume in one second (FEV_1) < 1.5 l, FEV_1 ⩽75% of predicted, or regular use of bronchodilators or corticosteroids; *urgent*, patient unable to be discharged home between referral and operation on clinical grounds.

STATISTICS

PTCA and CABG procedures were compared in terms of case mix, perioperative death, and periprocedural myocardial infarction using χ^2, χ^2 for trend, and Mann–Whitney U tests. Kaplan–Meier analyses were used to estimate the crude outcomes up to two years. Multivariate binary logistic regression analysis and Cox's proportional hazards models were used to determine those factors that were independently associated with in-hospital and medium term outcomes, respectively.

Results

Over the period studied, 4775 PTCAs and 5691 CABGs were undertaken; 576 of the CABGs involved additional procedures such as valve replacement during the same operation and were excluded from further analysis. Of the 4775 PTCAs, 2417 (51%) included insertion of one or more stents. Of the 5115 CABGs undertaken as isolated procedures, 265 (5%) involved a single graft, 1284 (25%) two grafts, and 3566 (70%) three or more grafts. Three hundred and fifteen PTCAs (7%) were undertaken as primary or rescue procedures or for postinfarction angina, 1688 (35%) were performed for unstable angina, and 2089 (43%) for stable angina. By contrast, 3418 CABGs (67%) were undertaken for stable angina ($p < 0.0001$). Only 149 patients (3%) required intravenous nitrates before CABG, compared with 794 (17%) before PTCA ($p < 0.0001$). Seven hundred and two PTCA patients (15%) were on angiotensin converting enzyme (ACE) inhibitors, compared with 1142 CABG patients (22%) ($p < 0.0001$). PTCA was more likely to be undertaken as an emergency or urgent procedure (table 1).

The median age for PTCA was 61 years (interquartile range (IQR) 53 to 67) compared with 63 years for CABG (IQR 57 to 68) (Mann–Whitney U test, $p < 0.0001$). Significantly more PTCA patients were women (table 1). CABG patients had evidence of worse cardiovascular disease in terms left ventricular function and the presence of left main stem stenoses or triple vessel disease (table 1). Comorbidity and other risk factors, such as obesity, cigarette smoking, hypertension, severe respiratory disease, and cerebrovascular disease, were also more prevalent among CABG patients (table 1).

Table 2 Outcomes up to two years following coronary revascularisation procedures†

		All revascularisation procedures		*Elective first revascularisation procedures excluding patients with significant LMS stenoses*	
		PTCA (n=4775)	*CABG (n=5115)*	*PTCA (n=1732)*	*CABG (n=1168)*
Death within	30 days	1.3 (1.0 to 1.6)	3.2 (2.7 to 3.7)	0.4 (0.1 to 0.7)	2.7 (1.7 to 3.6)
	6 months	2.2 (1.8 to 2.7)	4.6 (4.0 to 5.2)	0.8 (0.4 to 1.2)	3.8 (2.7 to 4.9)
	12 months	2.8 (2.3 to 3.3)	5.5 (4.8 to 6.1)	1.5 (0.9 to 2.1)	4.4 (3.2 to 5.5)
	18 months	3.3 (2.8 to 3.9)	6.0 (5.4 to 6.7)	2.0 (1.2 to 2.8)	5.6 (4.2 to 7.0)
	2 years	3.4 (2.8 to 4.1)	6.7 (5.9 to 7.4)	2.2 (1.3 to 3.1)	6.4 (4.7 to 8.0)
Readmission for IHD within	30 days	11.0 (10.1 to 11.9)	1.6 (1.2 to 1.9)	6.5 (5.3 to 7.6)	1.1 (0.5 to 1.7)
	6 months	25.9 (24.5 to 27.2)	5.9 (5.2 to 6.5)	19.1 (17.1 to 21.0)	4.2 (3.0 to 5.3)
	12 months	34.1 (32.6 to 35.7)	9.5 (8.7 to 10.3)	27.1 (24.8 to 29.4)	7.3 (5.8 to 8.9)
	18 months	38.6 (36.9 to 40.3)	12.1 (11.1 to 13.0)	31.4 (28.8 to 34.0)	10.0 (8.1 to 11.9)
	2 years	42.2 (40.1 to 44.2)	14.1 (12.9 to 15.2)	33.8 (30.9 to 36.7)	13.3 (10.8 to 15.9)
Repeat coronary angiography within	30 days	7.0 (6.3 to 7.7)	0.1 (0.0 to 0.2)	4.2 (3.3 to 5.2)	0.2 (0.0 to 0.4)
	6 months	18.5 (17.4 to 19.7)	1.9 (1.5 to 2.2)	14.6 (12.9 to 16.4)	1.1 (0.5 to 1.7)
	12 months	27.3 (25.8 to 28.8)	3.7 (3.2 to 4.3)	23.2 (21.0 to 25.4)	2.5 (1.5 to 3.4)
	18 months	31.9 (30.2 to 33.5)	5.3 (4.6 to 5.9)	28.0 (25.4 to 30.5)	4.1 (2.8 to 5.3)
	2 years	34.7 (32.7 to 36.6)	6.6 (5.7 to 7.4)	29.6 (26.9 to 32.3)	5.8 (4.1 to 7.6)
Repeat coronary revascularisation within	30 days	5.4 (4.7 to 6.0)	0.0 (0.0 to 0.1)	3.5 (2.6 to 4.3)	0.1 (0.0 to 0.3)
	6 months	12.1 (11.2 to 13.1)	0.6 (0.4 to 0.8)	9.5 (8.1 to 10.9)	0.4 (0.0 to 0.7)
	12 months	17.1 (15.9 to 18.3)	1.1 (0.8 to 1.4)	14.1 (12.3 to 15.9)	0.6 (0.2 to 1.1)
	18 months	20.1 (18.7 to 21.5)	1.6 (1.2 to 1.9)	17.0 (15.0 to 19.1)	1.0 (0.4 to 1.6)
	2 years	22.8 (21.0 to 24.5)	1.8 (1.3 to 2.2)	19.5 (16.9 to 22.0)	1.2 (0.5 to 2.0)

Values are per cent (95% confidence interval).
†Derived from Kaplan–Meier probabilities.
CABG, coronary artery bypass grafting; IHD, ischaemic heart disease; LMS, left main stem; PTCA, percutaneous transluminal coronary angioplasty.

Previous attempts at coronary revascularisation were more common before PTCA procedures. Of the 4775 PTCAs, 513 (11%) had been preceded by CABG and 695 (15%) by a previous attempt at PTCA. The corresponding figures for CABG were 154 (3%) and 111 (2%), respectively. Overall, 1021 PTCAs (21%) and 253 CABGs (5%) followed at least one previous attempt at some form of revascularisation ($p < 0.001$).

Periprocedural myocardial infarction was reported for 47 PTCAs (1%) and 88 CABGs (2%) ($p < 0.01$). However, this difference was not significant after adjusting for case mix. One hundred and ninety one CABG patients (4%) had delayed closure or reopening of their sternal wounds. Thirty PTCA patients (0.6%) required urgent cardiac surgery. Periprocedural death occurred in 15 PTCAs (0.3%) and 166 CABGs (3.2%) ($p < 0.0001$).

On univariate analysis, patients who underwent PTCA were less likely to die within two years but more likely to be readmitted for ischaemic heart disease or undergo further angiography or revascularisation (table 2). The overall likelihood of suffering any further event, whether death, readmission, coronary angiography or revascularisation, was higher following PTCA (table 3). Restriction of the analyses to elective procedures undertaken on patients who did not have a significant left main stem stenosis and had not previously undergone revascularisation reduced the frequency of end points in both groups but not the direction of the differences.

Table 3 Event-free survival up to two years following coronary revascularisation procedures†

	All revascularisation procedures		*Elective first revascularisation procedures excluding patients with significant LMS stenoses*	
	PTCA (n=4775)	*CABG (n=5115)*	*PTCA (n=1732)*	*CABG (n=1168)*
30 days	85.3 (84.3 to 86.4)	95.3 (94.7 to 95.9)	91.4 (90.1 to 92.7)	96.2 (95.1 to 97.3)
6 months	70.1 (68.8 to 71.5)	89.6 (88.8 to 90.5)	78.3 (76.3 to 80.3)	92.2 (90.6 to 93.7)
12 months	61.6 (60.1 to 63.2)	85.2 (84.2 to 86.2)	69.8 (67.4 to 72.1)	88.4 (86.5 to 90.2)
18 months	56.5 (54.8 to 58.2)	82.1 (80.9 to 83.2)	64.5 (61.8 to 67.2)	84.5 (82.2 to 86.7)
2 years	52.8 (50.7 to 55.0)	79.6 (78.3 to 80.9)	61.6 (58.5 to 64.8)	80.9 (78.0 to 83.7)

Values are per cent (95% confidence intervals).
†Derived from Kaplan–Meier probabilities.
CABG, coronary artery bypass grafting; LMS, left main stem; PTCA, percutaneous transluminal coronary angioplasty.

After adjustment for age, sex, left ventricular function, the number of arteries with significant stenoses, operative urgency, and comorbidity, CABG was associated with higher overall case fatality, a reduced likelihood of readmission, repeat angiography, and further revascularisation (table 4), and a lower overall risk of suffering any event (table 4).

The presence of diabetes mellitus was associated with poorer survival. On subgrouping, the risk of dying up to two years was significantly higher following CABG than PTCA in non-diabetic patients. By contrast, it was lower in diabetic patients but this did not reach significance (hazard ratio 0.59, 95% confidence interval 0.32 to 1.09).

Discussion

CABG and PTCA have been used to treat coronary artery disease for more than 30 years and 20 years, respectively. Various randomised controlled trials in the early 1990s[1–6] and subsequent meta-analyses[9 10] concluded that there was no significant difference in overall survival, but PTCA was more likely to be followed by symptom recurrence, restenosis, and repeat revascularisation. Our ability to generalise the results of trials to everyday practice is limited by their use of restrictive and varying selection criteria.

Observational data have been published from two registries in the USA.[10 11] The case mix of patients in the Scottish register differs

Table 4 Multivariate Cox proportional hazards models of the factors associated with outcomes up to two years following elective first coronary revascularisation procedures†

		Death	*Readmission for IHD*	*Repeat angiography*	*Repeat revascularisation*	*Any event*
Age (years)	< 56‡	1.00	1.00	1.00	1.00	1.00
	56–65	1.42 (0.69 to 2.92)	0.77 (0.61 to 0.97)*	0.76 (0.58 to 0.98)*	0.90 (0.65 to 1.24)	0.81 (0.66 to 1.01)
	66–75	2.27 (1.10 to 4.68)*	0.87 (0.67 to 1.12)	0.70 (0.52 to 0.94)*	0.68 (0.46 to 1.02)	0.97 (0.77 to 1.22)
	> 75	2.77 (0.85 to 9.04)	0.58 (0.33 to 1.00)*	0.48 (0.25 to 0.90)*	0.39 (0.15 to 1.00)*	0.69 (0.43 to 1.11)
Sex	Male‡	1.00	1.00	1.00	1.00	1.00
	Female	2.01 (1.23 to 3.28)**	1.38 (1.12 to 1.69)**	1.33 (1.05 to 1.68)*	0.97 (0.70 to 1.33)	1.41 (1.16 to 1.69)***
Left ventricular impairment	None‡	1.00	1.00	1.00	1.00	1.00
	Mild/moderate	1.85 (1.12 to 3.08)*	1.09 (0.88 to 1.33)	0.90 (0.70 to 1.16)	0.97 (0.70 to 1.33)	1.15 (0.95 to 1.39)
	Severe	3.40 (1.45 to 7.96)**	0.70 (0.33 to 1.50)	0.50 (0.16 to 1.59)	0.34 (0.05 to 2.47)	1.11 (0.65 to 1.92)
No of arteries with significant stenoses	1‡	1.00	1.00	1.00	1.00	1.00
	2	0.96 (0.38 to 2.43)	1.20 (0.95 to 1.51)	1.19 (0.93 to 1.53)	1.19 (0.86 to 1.65)	1.09 (0.87 to 1.33)
	3	1.53 (0.59 to 3.97)	1.55 (1.15 to 2.09)**	1.62 (1.15 to 2.29)**	1.97 (1.30 to 2.98)**	1.41 (1.06 to 1.85)*
Hypertension	No‡	1.00	1.00	1.00	1.00	1.00
	Yes	1.58 (0.98 to 2.53)	1.13 (0.93 to 1.38)	1.16 (0.92 to 1.46)	1.23 (0.92 to 1.66)	1.16 (0.98 to 1.39)
Diabetes mellitus	No‡	1.00	1.00	1.00	1.00	1.00
	Yes	2.20 (1.28 to 3.78)**	0.98 (0.73 to 1.33)	0.91 (0.64 to 1.31)	1.14 (0.74 to 1.76)	1.04 (0.80 to 1.35)
Smoking status	Non-smoker‡	1.00	1.00	1.00	1.00	1.00
	Ex-smoker	1.07 (0.59 to 1.93)	0.99 (0.80 to 1.24)	0.87 (0.68 to 1.12)	0.91 (0.66 to 1.25)	1.02 (0.83 to 1.25)
	Current smoker	1.46 (0.72 to 2.96)	0.91 (0.69 to 1.20)	0.80 (0.58 to 1.09)	0.70 (0.46 to 1.07)	–
Cerebrovascular disease	No‡	1.00	1.00	1.00	1.00	1.00
	Yes	1.43 (0.64 to 3.21)	1.44 (0.84 to 2.49)	1.12 (0.49 to 2.54)	1.33 (0.42 to 4.22)	1.43 (0.90 to 2.27)
Procedure type	PTCA‡	1.00	1.00	1.00	1.00	1.00
	CABG	2.10 (1.01 to 4.34)*	0.24 (0.18 to 0.32)***	0.11 (0.08 to 0.17)***	0.03 (0.01 to 0.07)***	0.33 (0.25 to 0.43)****

Values are hazard ratios (95% confidence interval).
†Excluding patients who had significant left main stem stenoses.
‡Referent categories: *p < 0.05, **p < 0.01, ***p < 0.0001
CABG coronary artery bypass grafting; *cerebrovascular disease*, history of stroke or recurrent transient ischaemic attacks, or an internal carotid artery stenosis of ⩾ 70%; *current smoker*, smoking within one month of procedure; *hypertension*, systolic blood pressure ⩾160 mm Hg, diastolic blood pressure ⩾90 mm Hg, or current anti-hypertensive drugs; IHD, ischaemic heart disease; PTCA, percutaneous transluminal coronary angioplasty; *severe respiratory disease*, FEV_1 <1.5 l, FEV_1 ⩽75% of predicted, or regular use of bronchodilators or corticosteroids.

greatly from these series. In the New York register, 40% of all revascularisation procedures were performed for single vessel disease and 32% for triple vessel disease.[11] Exclusion of left main stem stenoses from our own data produces corresponding figures of 23% and 45%, respectively. The differences in case mix are even greater for PTCA. In Scotland, 43% of PTCA patients had single vessel disease and 19% triple vessel disease. This compares with 71% and 4%, respectively, in New York.

These differences may, in part, reflect a higher threshold for revascularisation in Scotland owing to a higher incidence of coronary artery disease combined with a lower intervention rate. The difference may also reflect trends over time. The Duke University data relate to 1984–1990,[10] the New York data to 1993–1995,[11] and our own data to 1997–1999. Worsening case mix over time has been reported for both PTCA[12] and CABG.[13]

Despite our worse case mix, our in-hospital complication rates following PTCA compared favourably with previously published results. Only 0.6% of patients required urgent referral for cardiac surgery, compared with 4.3% in the meta-analysis by Pocock and colleagues.[9] Similarly, our perioperative mortality rate of 0.3% is lower than the rate of 1.0% reported by Pocock and associates,[9] and comparable with the figure of 0.4% in the New York register,[11] despite their better case mix. Pocock and colleagues reported a one year survival rate following PTCA of 2.9%.[9] Our figures of 2.8% in all procedures and 1.5% in the subgroup suggest that medium term survival is at least as good and may be superior. Previous studies suggested that around one third of PTCA patients required further revascularisation within one year,[9–11] compared with 14.1% in our study.

Our favourable results following PTCA despite a poorer case mix may in part reflect increased use of stenting. Stents were used in 12% of PTCAs performed in New York between 1993 and 1995.[11] Lee and colleagues reported an increase from 4% to 46% between 1993/1994 and 1995/1996[12] and in our own study they were used in 51% of cases between 1997 and 1999. Elective stenting can reduce the risk of restenosis and avoid the need for repeat revascularisation.[7 8] Bail out stenting may reduce the need for urgent surgery by avoiding dissection or acute vessel closure following PTCA. Two ongoing trials will determine whether stenting significantly improves survival following PTCA.[14 15]

On subgroup analysis, 4.4% of CABG patients were dead at one year. The meta-analysis by Pocock and colleagues reported an overall figure of 2.3%.[9] However, this included trials restricted to patients with single vessel disease who account for only 6% of our CABGs. Two of the component trials reported figures of 4.7%[6] and 5.1% in patients with multivessel disease.[3] Therefore, our results appear to be in line with previously published figures. In our study 0.6% of CABG patients required further revascularisation within one year compared with 3% in previously published studies.[9–11]

As with previous studies, our results showed significantly higher repeat revascularisation rates after PTCA than after CABG. The number of arteries with significant stenoses does not necessarily equate to the number of arteries which are tackled or successfully revascularised during PTCA or CABG, and more complete revascularisation may be easier to achieve by surgery. Subsequent revascularisation procedures are not necessarily directed at

a lesion operated on during the index procedure. Repeat revascularisation may be undertaken because of restenosis or disease progression or to tackle multiple lesions as a staged procedure. Technical improvements cannot be expected to affect those procedures required because of progression of the underlying atherosclerotic disease elsewhere in the coronary arterial tree. Conversely, not all patients who experience restenoses undergo further revascularisation procedures and there may be a bias between the procedures in terms of threshold for reintervention. The higher risk of perioperative death associated with redo surgery may result in a greater reluctance to undertake further revascularisation in those who have previously undergone CABG than in those who have undergone PTCA.

Our finding of better overall survival following PTCA reflected better survival in the 88% of patients who did not have diabetes mellitus. Among those with diabetes mellitus, CABG was associated with non-significantly lower odds of dying. Previous studies have shown that diabetic patients have better medium term survival following CABG than following PTCA.[16–18]

The principal use of our study is to provide contemporary information on outcomes, as previously published results have been rapidly outdated by technical and therapeutic advances. Although we have compared overall outcomes between PTCA and CABG, the inherent limitations of using observational data for this purpose must be acknowledged. Overall results depend on patient selection which, as demonstrated, varies considerably between countries. Although some patients are eligible for both procedures, some are not. In addition to analysing all procedures, our analyses were repeated on a subgroup of patients which excluded patients who had had previous revascularisation procedures, those who had left main stem stenoses, and those who underwent urgent or emergency procedures. This was in part to provide a more meaningful comparison with previous studies, and in part to exclude patients who were not eligible for both procedures. Even restriction to a subgroup does not ensure that the two treatment groups are truly comparable. We have adjusted for case mix in so far as this was possible, but statistical adjustment within an observational study is never as robust as a randomised trial. Also, as with all registries, data completeness can always be improved.

Several factors influence the choice of PTCA or CABG in individual patients who are eligible for both procedures. Patient preference, availability, age, and waiting time are inevitably considered. However, the principal determinant is the relative outcomes of these procedures in terms of survival and the need for further interventions. The balance of risks and benefits is not the same in all patients. Previous studies suggested that CABG is associated with better survival in those with triple vessel disease and two vessel disease, which includes stenosis of the proximal left anterior descending artery, but poorer survival in those with single vessel disease.[10 11] Therefore it would be inappropriate to interpret our finding that PTCA is associated with better overall survival as supporting the choice of PTCA in all patients. The relative merits of these procedures must continue to be judged on an individual basis.

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