Patient-related outcomes five years after coronary artery bypass graft surgery

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Summary

For five years, we prospectively studied 353 consecutive patients undergoing first-time coronary artery bypass graft surgery (CABG) for stable angina in the North of England. Angina was present before surgery in nearly all patients, in 20% 3 months after surgery, and in 48% after 60 months. The Nottingham Health Profile, showed a significant improvement in perceived health status (PHS) 12 and 60 months after surgery compared with preoperation. However, PHS at 60 months was worse than at 12 months in the dimensions ‘pain’ and ‘physical mobility’ in part 1, and in ‘looking after the home’ and ‘taking holidays’ in part 2. Employment rates were 36%, 34% and 21%, before, and 12 and 60 months after surgery, respectively. Working at 12 and 60 months was associated with age below retirement age, work preoperation and absence of angina, and at 12 months also with male gender and waiting time <6 months. This study describes everyday clinical practice. The significant improvement in angina symptoms and PHS after CABG persists for at least 5 years. However, only one third of patients in this geographical area return to work, and this is not solely dependent on clinical symptoms.

Introduction

Coronary artery bypass graft surgery is an effective treatment for patients with symptomatic coronary artery disease and in a subgroup, improves survival. However, it does not cure the underlying disease, and analyses of outcome are important to define the long-term efficacy of coronary artery surgery. Reports of outcome may be restricted to major cardiac events, to selected patients recruited to a clinical trial, or to patients treated within different health care systems. It is only from the study of unselected patients managed within our own individual health-care systems that we are able to define the efficacy of the surgical treatment we offer to our patients.

We have prospectively studied the outcome of 353 consecutive patients undergoing elective first-time coronary artery bypass graft surgery at the Freeman Hospital in North East England, and in this paper we report the prevalence of angina symptoms, perceived health status and employment status in patients 5 years after surgery.

Methods

Patients

The study population has been described before. Briefly, during the period 25 October 1988 to 4 December 1989, 367 consecutive patients were admitted for elective, first-time coronary artery bypass graft surgery to the Freeman Hospital. Coronary artery bypass graft surgery was performed for chronic stable angina or after unstable angina had settled. Fourteen patients were excluded. Eight lived outside the former Northern region, three had simultaneous valve surgery performed, and three refused to participate. Thus, 353 patients (297 male, 56 female)
consented and were recruited to this prospective study. The protocol for the study to 5 years was approved by the Newcastle Joint Ethics Committee.

Procedures

Patients were seen on the ward immediately before surgery, and 3, 6, 12 and 60 months after surgery. After surgery, the majority of patients were seen in a morning research clinic, but those unable to attend were either visited at home or asked to complete questionnaires at home.

Patients were asked about symptoms of angina. These were either typical symptoms or, if symptoms were atypical, the same as those experienced preoperatively. The severity of angina was classified using the Canadian Cardiovascular Society functional classification. Employment status and reasons why patients were not employed were established.

Attendance at a cardiac rehabilitation programme at any time was established for patients seen 60 months after surgery. Waiting time for surgery was defined as the time between the diagnostic coronary angiogram and coronary artery bypass graft surgery.

Self-perceived health status was assessed before surgery, and 12 and 60 months after surgery using the self-administered Nottingham Health Profile (NHP) questionnaire. The NHP is composed of two sections which are designed to measure perceived health problems and the effect of these on the activities of daily living. The first section has 38 statements to be answered either yes or no, and assesses six different dimensions of normal living—energy, pain, emotional reactions, sleep, social isolation and physical mobility. Individual statements within each dimension do not contribute equally to the total score for that dimension. Thus an affirmative answer to an individual statement receives the appropriate weighted score for that statement. The scores for the statements within each dimension are added to yield a total score between zero and 100. The higher the score, the worse the perceived health problems within that dimension. The second section is composed of seven single statements about seven areas of daily living—job of work, looking after the home, social life, relationships at home, sex life, interests and hobbies, and the ability to take holidays. Patients are asked to record a simple ‘yes’ or ‘no’ answer as to whether their health causes problems in any of these areas. Median scores for part 1 of the NHP for a group of control subjects without symptomatic coronary artery disease living in the North East of England were available (M. Farrer, personal communication).

Before surgery, baseline characteristics were recorded. Hypertension was defined as patients previously diagnosed as hypertensive, whether treated or not, and any patients in whom the systolic blood pressure was >160 mmHg or diastolic blood pressure >90 mmHg, measured after 10 min rest. Diabetes and hypercholesterolaemia were defined as patients who had previously so diagnosed. The severity of preoperative coronary artery disease was recorded using a modification of the Brandt scoring system. Significant coronary artery disease was defined as reduction in artery luminal diameter of 75% or more, in an epicardial coronary artery or a major branch supplying at least 25% of either the left anterior descending and diagonal territory, the circumflex territory or the inferior territory (or 50% reduction luminal diameter of the left main stem). Left ventricular function was assessed from regional wall motion abnormalities seen during left ventriculography in the 30-degree right anterior oblique projection.

Statistics

Data manipulation and analyses used two statistical packages, Statview (Abacus Concepts) and STATA 3.1 (STATA Corporation). Continuous variables were described as mean (standard deviation) or median (25th to 75th percentiles) as appropriate and categorical variables as number (%). Survival was calculated using life-table methods. The Wilcoxon signed rank test was used to compare weighted scores for each dimension within part 1 of the NHP between different time intervals before and after surgery. McNemar’s test was used to compare groups in part 2 of the NHP and to compare differences in the number of patients employed and not employed between different time intervals before and after surgery. Waiting time for coronary artery bypass graft surgery was highly skewed, and differences in waiting time between patients employed/not employed at different time intervals after surgery were analysed using the Mann-Whitney U test. Where odds ratios (OR) are calculated, 95% confidence intervals (CI) are given. Potential covariates for working 12 and 60 months after surgery were examined using univariate logistic regression analysis. A forward stepwise regression analysis evaluated independent covariates for working at 12 and 60 months. Alpha <0.05 was considered significant.

Results

Patient characteristics preoperation and operation details

The clinical and angiographic characteristics of the 353 patients studied are summarized in Table 1. Two
Outcome 5 years after CABG

Table 1 Clinical characteristics and severity of coronary artery disease prior to coronary artery bypass graft surgery, and operation details

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<thead>
<tr>
<th>Clinical characteristics</th>
<th>297 (84%)</th>
<th>133 (38%)</th>
<th>22 (6%)</th>
<th>121 (35%)</th>
<th>214 (61%)</th>
<th>57 (16%)</th>
<th>278 (80%)</th>
<th>11 (3%)</th>
<th>18 (5%)</th>
<th>58 (17%)</th>
<th>215 (61%)</th>
<th>19 (5%)</th>
<th>4 (1%)</th>
<th>68 (20%)</th>
<th>138 (40%)</th>
<th>94 (27%)</th>
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<th>141 (41%)</th>
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<td>Obesity (BMI &gt; 25 kg/m²)</td>
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<td>Never smoked</td>
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<td>Smoker at operation</td>
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<td>History of stroke/TIA</td>
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<td>Renal disease (dialysis or transplant)</td>
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<td>Severity of coronary artery disease*</td>
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<td>Single-vessel disease</td>
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<td>Two-vessel disease</td>
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<td>Three-vessel disease</td>
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<td>Left main-stem disease</td>
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<td>Normal LV</td>
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<td>Only hypokinetic LV segments</td>
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<td>Akinetic or dyskinetic LV segment</td>
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<td>Mean (SD) number of graft conduits</td>
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<td>Mean (SD) number of distal anastomoses</td>
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<td>Patients with vein graft</td>
<td>332 (94%)</td>
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<td>Patients with LIMA</td>
<td>266 (75%)</td>
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<td>Patients with RIMA</td>
<td>46 (13%)</td>
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BMI, body mass index; TIA, transient ischaemic attack; LV, left ventricle; LIMA, left internal mammary artery; RIMA, right internal mammary artery. * See text for details.

hundred and ninety-seven patients were male, 56 female. Mean (SD) age at the time of surgery was 57.2 (7.3) years. Hypertension was present in 38%, more than 60% had a history of preoperative myocardial infarction and 5% a history of heart failure.

More than one quarter had three-vessel disease and 13% had left main-stem disease. Left ventricular function was normal in 41% patients, 29% patients had only hypokinetic segments, while in 29% akinetic or dyskinetic segments were also present. A left internal mammary artery conduit was used in 75% of patients, and in only 6% patients were internal mammary artery grafts the only conduits used.

Outcomes

Survival outcome is known for all patients. Forty-one patients died and three patients had second-time cardiac surgery within 5 years of coronary artery bypass graft surgery. Actuarial survival without further cardiac surgery was 87%. Questionnaires were completed by 307 (90%) survivors at 1 year after CABG surgery (mean 13.8 months, SD 2.0) and by 291 (94%) survivors at 5 years (mean 59.1 months, SD 1.4).

Thirty-one (11%) patients 5 years after surgery could recall having attended a cardiac rehabilitation programme, 29 (10%) after surgery and two (1%) before surgery.

Angina

The prevalence of angina before surgery, and 3, 6, 12 and 60 months after surgery is presented in Figure 1. Before surgery, nearly all patients had angina. After surgery, the prevalence of angina fell markedly and at 3 months only 20% had angina.

Thereafter, there was a steady rise in angina prevalence, reaching 48% at 60 months (Figure 1). The proportion of patients with angina with severe symptoms (grade 3 and grade 4) was greatest before surgery (74%). Three, 6, 12 and 60 months after surgery, 45%, 29%, 42% and 35% patients with angina had severe symptoms, respectively (Figure 1).

Perceived health status

Compared with preoperation, there was a significant improvement in perceived health status 1 year after surgery within all dimensions of part 1 of the NHP (all p < 0.001) (Table 2). After 1 year, perceived health status deteriorated within some dimensions and at 5 years was worse within the dimensions of pain (p < 0.001) and physical mobility (p < 0.01) (Table 2). One year following surgery, patients had fewer problems within all seven areas of daily living in part 2 of the NHP compared with before surgery (all p < 0.001) (Figure 2). Five years after surgery, fewer patients had problems with their job of work compared with 1 year after surgery (p < 0.01), but more patients reported problems looking after the home and in their ability to take holidays (both p < 0.05) (Figure 2).

Perceived health status and angina

Within the five dimensions (energy, pain, emotional reactions, sleep and physical mobility) of part 1, patients with more severe angina had a worse perceived health status than those with no or milder angina (Figure 3). This trend was seen both before and after surgery. However, the difference in perceived health status in patients with more severe angina compared to those with no or only mild angina tended to be greater after surgery than before (Figure 3) and after surgery, the perceived health status of patients without angina or with very mild angina was similar to that of controls (Figure 3).
There was a similar trend for the activities of daily living in part 2 of the NHP with patients with more severe angina reporting more problems within each area of daily living (Figure 4).

**Employment status**

Figure 5 shows the number of patients working and not working before and at time intervals after coronary artery bypass graft surgery. Three months after surgery, there was a significant fall in the proportion of patients employed compared with preoperation (44 (14%) vs. 123 (36%), $p<0.001$; OR 0.13 (95% CI 0.06–0.25)). Thereafter there was a significant increase (44 (14%) at 3 months vs. 98 (32%) at 6 months, $p<0.001$; OR 7.00 (95% CI 3.46–16.00)). Six and 12 months after surgery, there was no significant difference in the proportion of patients employed, but there was a significant fall by 60 months (104 (34%) at 12 months vs. 60 (21%) at 60 months, $p<0.001$; OR 0.15 (95% CI 0.06–0.34)).

**Reasons for not working**

Before surgery, approximately 40% of the population were not working because of health problems, rising to approximately 50% at 3 months (Figure 5). However, thereafter the proportion of patients not working due to poor health fell to approximately 30% and was fairly constant, and 60 months after surgery the fall in the number of patients working is mirrored by an increase in the proportion of patients not working for other reasons, mainly because patients had reached retirement age (Figure 5).

Of those patients who were employed 5 years after surgery, more were in non-manual jobs than in manual jobs (44 (73%) vs. 16 (27%)), and 17 (28%) were self-employed. Nineteen (32% of those working) patients had changed their jobs post operation. Six (32%) were doing lighter work, but the same hours, four (21%) were working shorter hours and four (21%) were doing both. Forty-two (71%) patients said they enjoyed their work ‘most of the time’, 11 (19%) ‘some of the time’ and six (10%) ‘none of the time’.

Patients who were working before surgery were more likely to do so after surgery. Eighty-one (74%) patients working before surgery were working 12 months after surgery compared with only 22 (12%) of those not working before surgery. Similarly, 44 (42%) patients who were working before surgery were also working 60 months after surgery, but only 15 (8%) patients who had not been working before surgery were doing so.

**Waiting time for surgery**

The median (interquartile range) waiting time for surgery was 7.23 (9.02) months. The median waiting
time of patients not working was longer than those working before (8.4 vs. 4.4, \( p < 0.001 \)), and 3 (8.1 vs. 4.3, \( p < 0.05 \)), 6 (8.2 vs. 5.5, \( p < 0.05 \)), and 12 (8.3 vs. 5.0, \( p < 0.01 \)) months after surgery. Sixty months after surgery, this difference was no longer significant (7.7 vs. 4.9).

**Employment and angina**

One year after surgery, 20 (19%) employed patients had angina: two with grade 1 angina, 14 with grade 2 and four with grade 3. Similarly, 5 years after surgery, 12 (20%) employed patients had angina; six with grade 1 angina, two with grade 2, two with grade 3, and two with grade 4.

**Covariates for working**

The following were considered as potential covariates for employment at 12 and 60 months; age below retirement age at 12 and 60 months respectively, gender, working preoperation, angina symptoms at 12 and 60 months respectively, and waiting time for surgery <6 months.

Twelve months after surgery, age below retirement age (41% vs. 10%, OR 6.28 (95% CI 2.60–15.16), \( p < 0.001 \)), male gender (39% vs. 8%, OR 7.74 (95% CI 2.32–25.75), \( p < 0.01 \)), working preoperation (74% vs. 12%, OR 22.09 (95% CI 11.91–40.99), \( p < 0.001 \)), freedom from angina (41% vs. 22%, OR 2.49 (95% CI 1.41–4.40), \( p < 0.01 \)) and waiting time <6 months (43% vs. 28%, OR 1.87 (95% CI 1.15–3.02), \( p < 0.05 \)) were significantly associated with working in univariate analysis. In forward stepwise logistic regression analysis, male gender (\( p < 0.05 \)), working preoperation (\( p < 0.001 \)) and freedom from angina (\( p < 0.05 \)) remained as independent predictors.

Sixty months after surgery, age below retirement age (30% vs. 5%, OR 7.63 (95% CI 3.16–18.44), \( p < 0.001 \)), working preoperation (42% vs. 8%, OR 7.71 (95% CI 4.01–14.85), \( p < 0.001 \)) and freedom from angina at 60 months (32% vs. 9%, OR 4.98 (95% CI 2.51–9.87), \( p < 0.001 \)) were significantly associated with working in univariate analysis, and in forward stepwise logistic regression analysis remained as independent predictors (all \( p < 0.001 \)).

**Discussion**

In this paper we report angina symptoms, perceived health status and employment status in an unselected group of patients up to 5 years after elective, first-time coronary artery bypass graft (CABG) surgery. CABG surgery is most frequently performed to relieve angina. Clinical trials of medical and surgical management of patients with coronary artery disease
Figure 2. Proportion of patients reporting problems with activities of daily living in part 2 of the NHP before, and 12 and 60 months after coronary artery bypass graft surgery.

Figure 3. Median NHP scores within part 1, stratified by prevalence and severity of angina before and 60 months after coronary artery bypass graft surgery (EN, energy; ER, emotional reactions; SL, sleep; SI, social isolation; PM, physical mobility).

have shown that surgery is superior to medical treatment for at least 5 years.\textsuperscript{6,12,13}

Reports of freedom from angina 5 years after surgery vary widely, ranging from 46\% to 83\%.\textsuperscript{5,6,14–19} These differences probably reflect differences in definition, but also the different recruitment criteria of studies and possibly the rate of reintervention within the studies. In the present study of unselected patients, 52\% were free of angina 5 years after surgery and is comparable to others.\textsuperscript{6,18} However, the proportion with severe angina (Canadian Cardiovascular Class III and IV) may be higher in
Figure 4. Proportion of patients reporting problems with activities of daily living in part 2 of the NHP, stratified by prevalence and severity of angina before and 60 months after coronary artery bypass graft surgery.

Figure 5. Proportion of survivors working and not working before, and 3, 6, 12 and 60 months after coronary artery bypass graft surgery. The number of patients is shown at each time interval.
our patients than in other populations (35% vs. 25%).

There is increasing emphasis on measures of outcome which examine the patients perception of their own illness and outcome from treatment. Psychological well-being may be evaluated using questionnaires, but others have relied on more indirect measures such as relief from angina and exercise abilities, and assume that these translate into improved quality of life.

Health status improves following coronary artery surgery. This improvement has been seen within two and three months of surgery, and was also seen one and two and three years after surgery. However, there was less benefit for sexual relations one, two and three years after surgery. Five years after surgery, patients generally reported some degree of improvement compared to preoperation, with men fairing better than women, but detailed questionnaires were not used and patients were asked to evaluate their health status retrospectively as ‘greatly improved’, ‘slightly improved’ or ‘no better or worse’. A more favourable perceived health status was also reported 5 years after surgery in patients who had participated in a cardiac rehabilitation programme compared to those who had not, although the programme had a limited influence on return to work. In our study, we have assessed perceived health status prospectively up to 5 years after surgery using the NHP. This is a well-validated questionnaire and has been used in other cardiac studies. Compared with preoperation, there was a marked improvement in perceived health status one year after surgery in all areas evaluated by the NHP. Within some areas, perceived health status was worse 5 years after surgery than at 1 year, although it was still better than before surgery. Job of work was an exception, and fewer patients reported problems with their job of work at 5 years compared to 1 year. This may be partly due to the increasing number of patients who are retired, but patients with problems may have given up work months or years earlier, and no longer perceive that they have a current problem with their job of work. Too few of our patients had participated in a cardiac rehabilitation programme for the impact of this on perceived health status to be defined.

Thirty-six percent of our patients were working before surgery. Return to work after CABG has been reported more frequently in patients who are free of angina, and our patients were also more likely to be working both 1 and 5 years after surgery if they were free of angina. However, the highest proportion of survivors working after surgery was at 1 year, but even then there were only 34% working, even though nearly 70% were free of angina. Levels of return to work have varied widely between countries from below 50% to more than 90%, and medical parameters cannot explain these discrepancies. Thus its value as a measure of a successful long-term outcome from surgery is impaired by the impact of non-medical parameters such as a prolonged waiting time for surgery, the increasing age of the population and the economic environment. In our study, beyond 6 months after surgery, fewer patients were not working due to their health than for other reasons. It is inevitable that more patients will have retired as the time from surgery extends. Patients who have time away from work and who are close to retirement age may also elect to retire just below the normal retirement age. However, the importance of the economic environment as a confounding variable must not be underestimated. The present study was conducted at a time of high unemployment in the North of England, and failure to return to work may not indicate an unsuccessful outcome from surgery, but rather the prevailing high employment in the region.

Patients who wish to work after coronary artery surgery are more likely to do so than those who do not, and is another indication that factors other than functional status are important determinants of return to work. We did not ask our patients directly if they wished to work after surgery, but patients who were working at 5 years were asked if they enjoyed their jobs. The majority did so at least part of the time, and this indirectly suggests that patients who continue to work after surgery wish to do so.

The nature of work being undertaken also predicts return to work. Patients who return to work after surgery are more likely to be in non-manual jobs and they may also change to less manual work or reduce the number of hours they work. The majority of patients in our study who were working at 5 years were in non-manual jobs, and just under one quarter were doing lighter work, shorter hours or both than before surgery. Self-employment and professional and executive employment is predictive of return to work. Just over a quarter of our patients were self-employed and this high prevalence is likely to be multifactorial. Patients who are self-employed may have a greater incentive to return to work, both financially and for job satisfaction, and they may be more readily able to adapt their own working lives to their functional status.

In our study, a shorter waiting time and working before surgery both predicted a return to work after surgery. However, a shorter waiting time was not independently associated with return to work, and patients who were still working before surgery may have been given priority on the waiting list. However, the situation may be more complex. Patients with manual jobs are less likely to return to work and thus patients who were working may be in a higher
social class. The inverse care law reported for revascularization may also be seen in waiting times for surgery.

In conclusion, coronary artery bypass graft surgery is a valuable tool for treating patients with symptomatic coronary artery disease. Angina symptoms are palliated, and patients report that they feel their health is better. Return to work as an indicator of a successful surgical programme may be less pertinent. Undoubtedly patients who have severe restrictions to their functional status are unlikely to work, but it is too simplistic to conclude that functional status alone determines return to work, and there are a number of non-medical parameters to be considered. Promoting return to work after surgery cannot be simply based on improving functional status without addressing these other factors.

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