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Quality of life of chronic stable angina patients 4 years after coronary angioplasty or coronary artery bypass surgery

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Abstract. Brorsson B, Bernstein SJ, Brook RH, Werkö L (The Swedish Council on Technology Assessment in Health Care, Stockholm, Sweden; Norrland University Hospital, Umeå, Sweden; Veterans Affairs Health Services Research and Development Field Program, Ann Arbor, MI, USA; University of Michigan, Ann Arbor, MI, USA; Instituto de Salud Carlos III, Madrid, Spain; University of California, Los Angeles; and RAND Corporation, Santa Monica, CA, USA). Quality of life of chronic stable angina patients 4 years after coronary angioplasty or coronary artery bypass surgery. *J Intern Med* 2001; **249:** 47–57.

Objective. To evaluate the quality of life experienced by chronic stable angina patients with one- or two-vessel coronary artery disease treated with percutaneous transluminal coronary angioplasty (PTCA) or coronary artery bypass graft (CABG).

Design. Prospective survey and review of medical records.

Patients. Consecutive series of 601 Swedish chronic stable angina patients with one- or two-vessel disease who underwent CABG (n = 252) or PTCA (n = 349) between May 1994 and January 1995.

Main outcome measures. We assessed five components of the Swedish Quality of Life Survey, anginal frequency, sublingual nitroglycerin use, and survival at 6, 21 and 48 months following coronary revascularization.

Results. Anginal frequency and sublingual nitroglycerin use decreased for all patients by 6 months, but more amongst surgery patients than amongst angioplasty patients ($P < 0.05$). At 48 months, more bypass patients reported that they had not used sublingual nitroglycerin during the preceding 4 weeks (73.1 vs. 63.4%, $P < 0.05$). At 6 months, bypass patients had greater levels of improvement in physical functioning (15.3 vs. 10.5, $P < 0.05$) and general health perception (16.5 vs. 10.2, $P < 0.05$) than angioplasty patients. Bypass patients also had better relief from pain (19.4 vs. 14.6, $P < 0.05$), quality of sleep (17.6 vs. 4.6, $P < 0.05$) and general health perception (17.3 vs. 12.1, $P < 0.05$) at 21 months. By 48 months follow-up, there was no longer any difference in these measures between groups.

Conclusions. Both bypass surgery and angioplasty lead to improved quality of life for patients with chronic stable angina and one- or two-vessel coronary artery disease. Bypass surgery is associated with better quality of life at 6 months, but by 48 months quality of life is similar for patients initially treated by either procedure.

Keywords: coronary artery bypass graft surgery, outcomes, percutaneous transluminal coronary angioplasty, quality of life.

Introduction

Coronary artery disease is one of the leading causes of death and disability in the industrialized world. Randomized controlled trials have shown the effectiveness of coronary artery bypass surgery in improving survival for patients with severe coronary artery disease. Limited differences in survival have been shown in patients treated with percutaneous transluminal coronary angioplasty compared with

those treated by bypass surgery. There are fewer data regarding the comparative effects of these procedures on quality of life.

The Bypass Angioplasty Revascularization Intervention (BARI) trial demonstrated that patients randomized to bypass surgery had less angina and better functional status than those randomized to angioplasty for the first 3 years of follow-up but not after 4 years [1]. There were no significant differences between the two groups with respect to improvements in emotional health following revascularization. In contrast, the Revascularization Intervention Treatment of Angina (RITA) trial showed no significant differences between bypass surgery and angioplasty 2 years after randomization [2].

However, there is limited generalizability of these data to larger populations [3]. For this reason, we began the Swedish Coronary Revascularization – Swedish Council of Technology Assessment (SECOR/SBU) study, a prospective study to assess the appropriateness of use of coronary angioplasty and bypass surgery and to assess their effects on long-term functional status and quality of life in a population-based cohort of Swedish patients who underwent revascularization. The effects of these procedures on functional status and quality of life are an important factor in the decision-making of doctors and patients, especially when both treatments are an option, such as in those patients with single- or double-vessel coronary artery disease undergoing non-emergent revascularization. In this report, we discuss these outcomes through 4 years in patients with one- or two-vessel coronary artery disease who presented with chronic stable angina.

Methods

Study design overview

The study design and data collection have been reported previously [4]. In brief, we screened 4398 patients who underwent coronary angiography in seven of the eight public Swedish heart centres in 1994 and 1995. Patients were excluded if they declined to participate; had previously undergone coronary artery bypass graft surgery (CABG); had undergone percutaneous transluminal coronary angioplasty (PTCA) within the previous 6 months: were referred for evaluation of congestive heart failure, dysrhythmia or for possible cardiac transplantation; had valvular heart disease and were considered candidates for valvular surgery; had emergency coronary angiography; were non-Swedish residents; had incomplete medical data; or were enrolled in other research projects. We also excluded those patients whose primary symptom was not chronic stable angina and those with chronic stable angina who were not referred for revascularization. The remaining 1485 chronic stable angina patients were asked to participate in this observational study and to complete several standardized questionnaires regarding their symptoms, functioning and well-being before coronary angiography and 6, 21 and 48 months following revascularization. Eight hundred and eighty-four additional patients were excluded because they had left main or three-vessel disease ($n = 774$), did not undergo the recommended procedure ($n = 30$), or did not complete the baseline questionnaire ($n = 80$). Our final population consisted of 601 chronic stable angina patients with one- or two-vessel coronary artery disease who underwent CABG ($n = 252$) or angioplasty ($n = 349$).

The response rate amongst surviving patients was 92.7% to the second survey, 91.1% to the third survey and 85.7% to the fourth survey; 78% of the surviving patients responded to all three follow-up surveys. There were no significant differences between respondents and non-respondents with respect to the procedure to which they were referred, age, gender, severity of coronary disease or ejection fraction. Non-responders were more likely than responders to have comorbid medical conditions such as hypertension ($P < 0.01$), kidney disease ($P < 0.01$), peripheral vascular disease ($P < 0.001$), congestive heart failure ($P < 0.01$) or a history of a stroke ($P < 0.01$).

Patients who died were identified by computerized linkage to the Swedish national population register. Patients who underwent further interventions within the first 2 years of follow-up were identified by computerized linkage to the Swedish national hospital discharge register. The regional ethics committee at the Karolinska Hospital, Stockholm, approved the study.

Data collection – medical record

We collected each patient's relevant clinical and

laboratory information using a standardized form. Data collection started when the patient was referred for coronary angiography by his or her cardiologist. The cardiologist entered the patient's clinical and sociodemographic characteristics. Further information, such as the severity of the coronary artery disease, was collected following coronary angiography by the study team. All terms were explicitly defined and have been previously published [4, 5]. Data were reviewed for completeness and accuracy before being entered into a computerized database.

Data collection – symptoms, functioning and satisfaction

Patients assessed the frequency of their anginal symptoms and sublingual nitrate use on six-point Likert scales ranging from none to four or more times per day during the past 4 weeks. We report the frequency of those who had no symptoms or nitrate use and those who had symptoms or required nitrates three or more times per week. To identify factors associated with improvement in anginal frequency, the anginal frequency scale was transformed to a scale reflecting the frequency of anginal symptoms each week, with a minimum score of 0 and a maximum score of 28. Higher scores reflect more severe angina. Satisfaction was assessed with a single item six-point Likert scale ranging from 'very satisfied' to 'extremely dissatisfied'. This item was dichotomized into those who were satisfied (i.e. very satisfied or rather satisfied) and those who were not satisfied.

The patients' health-related functioning and well-being were measured with five components of the Swedish Quality of Life Survey (SWED-QUAL) [6], which included (i) physical functioning, a seven-item scale that assesses ability to perform physical activities; (ii) relief from pain, a six-item scale that measures relief from physical discomfort; (iii) sleep, a six-item scale that addresses problems with sleep initiation, maintenance and adequacy, and somnolence; (iv) emotional well-being, a 12-item scale that assesses positive and negative affect; (v) and a single-item question assessing the patient's general health perception. The scales measuring pain and emotional well-being were only measured at 21 and 48 months follow up. The scores on each scale ranged from 0 to 100, with higher scores reflecting better health. The Cronbach's alpha of the multi-item scales range from 0.80 to 0.88 [6].

Statistical analysis

Only surviving patients were included in the analyses of symptoms, functioning and well-being on each follow-up survey. Categorical variables were compared with the chi-square statistic or Fisher's exact test when both variables were binary. Ordinal variables (functioning and well-being scales) were analysed with Wilcoxon's signed rank test for repeated measures and with the Mann–Whitney *U*-test for independent samples. Trends in quality of life scores were analysed with a General Linear Model Repeated Measures test. Significant (i.e. *P*-value of less than 0.05) baseline predictors of anginal frequency and of functioning and well-being scores at 6 or 48 months on univariate analysis were included in a multiple linear regression model to identify independent predictors of change. The strength of association between angina frequency and quality of life scores was estimated using the Spearman's rho (two-sided). Given the multiple comparisons in these analyses, we only considered those coefficients that had a *P*-value of 0.01 or less as significant. All statistics were performed using SPSS 9.0 (Chicago, IL).

Results

Baseline characteristics of patients referred for CABG and PTCA are shown in Table 1. Forty-two per cent of the patients were referred for bypass surgery. The proportion of CABG patients who received at least one arterial graft was 92.6%, and 96% received at least one venous graft. Of the PTCA patients, 14.2% received at least one stent. Overall, surgical patients were older, were more likely to have had a history of myocardial infarction, had more cerebrovascular and peripheral vascular disease and more significant coronary artery disease.

Angioplasty patients were significantly more likely to undergo at least one additional revascularization procedure compared with bypass surgery patients (33.5 vs. 2.5%, $P < 0.001$) within 2 years of their initial procedure. There was no significant difference in survival at 4 years follow-up.

Table 1 Characteristics of chronic stable angina patients with one- or two-vessel coronary artery disease referred for coronary revascularization in Sweden, 1994–95

Characteristic	Bypass surgery (n = 252)	Coronary angioplasty (n = 349)	P (two-tailed)
Mean age (years)	62.8	59.8	<0.001
Age ≥75 years (%)	4.8	4.9	1.000
Male (%)	77.8	75.1	0.497
Angina class III/IV[a] (%)	55.6	54.2	0.741
Comorbid illness (%)			
Prior myocardial infarction	50.0	37.5	0.003
Diabetes mellitus	16.7	13.2	0.244
Cerebrovascular disease	10.3	2.9	<0.001
Renal disease	2.4	1.4	0.539
Peripheral vascular disease	8.7	4.6	0.043
Congestive heart failure	9.5	8.3	0.663
Chronic obstructive lung disease	4.0	4.6	0.840
Hypertension	38.1	30.7	0.066
Current smoker	15.5	18.4	0.381
Very positive stress test (%)	61.9	59.9	0.664
Left ventricular ejection fraction <50% (%)	29.0	15.2	<0.001
Severity of coronary artery disease (%)			0.004
One- or two-vessel stenosis involving the PLAD	45.6	33.8	
One- or two-vessel stenosis not involving the PLAD	54.4	66.2	
Death rates amongst survivors of initial procedure (%)			
At 30 days	0.4	0.0	0.419
At 6 months	2.0	0.3	0.087
At 21 months	2.4	1.7	0.570
At 4 years	5.6	3.4	0.227

PLAD, proximal left anterior descending coronary artery.
[a]Angina class as defined by the Canadian Cardiovascular Society Angina Class.

Symptom relief

The frequency of anginal attacks and use of sublingual nitroglycerin decreased for all patients in the study by 6 months (Table 2). The improvement was substantially greater amongst patients treated by CABG compared with those treated by PTCA. For example, 11.5% of surgery patients experienced angina at least three times per week compared with 22.7% of angioplasty patients ($P < 0.05$). By 6 months, the proportion of patients with no angina and who had not used sublingual nitrates were significantly greater amongst patients who received stents compared with those who did

Table 2 Frequency of angina and sublingual nitroglycerin use at baseline and 6, 21 and 48 months following coronary revascularization amongst Swedish chronic stable angina patients with one- or two-vessel coronary artery disease by procedure

	Bypass surgery				Coronary angioplasty			
	Baseline	6 months	21 months	48 months	Baseline	6 months	21 months	48 months
Frequency of angina								
None	4.2[a]	62.3[b]	67.7[b]	57.3[b,c]	3.2[a]	42.1[b*]	51.8[c*]	51.0[c]
≥ three times per week	68.1[a]	11.5[b]	7.3[b]	12.4[b,c]	67.3[a]	22.7[b*]	14.6[c*]	14.8[c]
Sublingual nitroglycerin use								
None	16.7[a]	85.2[b]	80.3[b]	73.1[c]	20.0[a]	58.1[b*]	64.7[b*]	63.4[b*]
≥ three times per week	45.7[a]	4.4[b]	5.2[b]	7.3 [b]	45.0[a]	15.0[b*]	6.3[c]	8.2[c]

[a,b,c]Means within a row for each procedure that do not share at least one letter superscript differ significantly ($P < 0.05$) from one another by Wilcoxon's signed rank test.
*$P < 0.05$ for comparison with bypass surgery at the same time period by the Mann–Whitney U-test.

not ($P < 0.01$ for both comparisons). The relative benefit of surgery compared with angioplasty decreased over the follow-up period. By 48 months, 12.4% of surgery patients and 14.8% of angioplasty patients had angina at least three times per week ($P > 0.05$). Whilst there was no significant difference between treatments in the proportion of patients without angina by 48 months, more bypass patients reported that they had not used sublingual nitroglycerin during the preceding 4 weeks ($P < 0.05$). In multivariate analysis, undergoing bypass surgery ($P < 0.001$) and a history of a very positive stress test ($P < 0.05$) were both associated with lower angina frequency at six months (Table 3). As expected, greater frequency of angina preoperatively was associated with a greater frequency of angina at 6 months. After 4 years, only preoperative anginal frequency was associated with anginal frequency at follow-up ($P < 0.001$).

Quality of life – univariate analysis

Functional status and well-being improved on average for all patients following revascularization (Table 4). Bypass surgery patients experienced a greater level of improvement in physical functioning, pain relief and general health perception compared with PTCA patients. These differences were no longer significant by 48 months follow-up. There was a trend towards declining physical function amongst bypass surgery patients and improving physical function and general health perception amongst angioplasty patients from months 6–48 of the follow-up period, but these trends did not reach statistical significance.

Table 3 Multivariable predictors of angina frequency 6 and 48 months following coronary revascularization

	Angina frequency (coefficients[a])	
Baseline predictor	6 months	48 months
Age (per 10-year interval)	0.171	0.395
Male sex	–0.352	–0.540
Angina class III/IV	0.563	0.677
Very positive stress test	–1.21*	–0.523
Angina frequency at baseline[b]	0.188***	0.142***
Bypass surgery	–1.74***	–0.493

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.
[a]Entries are the coefficients of a multivariable linear regression of the baseline predictors on the frequency of angina at follow-up. Anginal frequency over the previous week was measured on a scale ranging from 0 (no angina) to 28 (four or more episodes of angina per day). *P*-values are for the comparison with 0 (the value obtained by the null hypothesis).
[b]The frequency of angina at baseline (i.e. preoperatively)

Symptoms and quality of life

The RITA trial found a consistent relationship between a patient's grade of angina and quality of life at baseline and by 2 years follow up, as measured by the Nottingham Health Profile [2]. We replicated their analysis, based on the patients' report of angina frequency and responses to the SWED-QUAL questionnaire. As seen in Fig. 1, we found a strong association between angina frequency and both physical functioning and general health perception. A similar association was found for pain (data not shown). However, there was less of a relationship between angina frequency and emotional well-being (see Fig. 1) and quality of sleep (data not shown). In addition, a correlational analysis including all five SWED-QUAL scales showed weaker associations at baseline as compared with 48 months (physical functioning, – 0.40 at baseline vs. – 0.53 by 48 months; pain, – 0.57 vs. – 0.62; quality of sleep, – 0.20 vs. – 0.36; emotional well-being, – 0.16 vs. – 0.35; and general health perception, – 0.24 vs. – 0.48; $P < 0.001$ for all correlation coefficients).

Quality of life – multivariate analysis

Because this study was not a randomized controlled trial, but a study of care received by all chronic stable angina patients with one- or two-vessel disease, the characteristics of those referred for bypass surgery differed for several items significantly from those patients referred for angioplasty (Table 1). We therefore performed a multivariate analysis to control for these differences and to identify which baseline characteristics and revascularization procedure predicted better outcomes (Table 5).

Preoperative quality of life was the most consistent predictor of postoperative quality of life at both 6 and 48 months for all five quality of life scales. Bypass surgery patients experienced greater improvement in their physical functioning and general health perception at 6 months than did angioplasty

Table 4 Quality of life at baseline and 6, 21 and 48 months following coronary revascularization amongst Swedish chronic stable angina patients with one- or two-vessel coronary artery disease, by procedure

	Bypass surgery				Coronary angioplasty			
	Baseline	6 months	21 months	48 months	Baseline	6 months	21 months	48 months
Physical functioning	71.5[a]	86.7[b]	86.4[b]	81.4[c]	72.1[a]	82.6[b*]	83.7[b]	83.0[b]
Relief from pain	63.8[a]	–	83.9[b]	80.4[c]	65.0[a]	–	79.3[b*]	80.5[b]
Quality of sleep	58.8[a]	65.1[b]	66.2[b]	65.8[b]	55.0[a]	63.2[b]	60.7[b*]	61.4[b]
Emotional well-being	67.9[a]	–	74.3[b]	73.6[b]	65.2[a]	–	72.3[b]	71.1[b]
General health perception	57.8[a]	73.6[b]	74.3[b]	69.7[c]	55.9[a]	65.6[b*]	68.4[c*]	68.3[b,c]

Scores: minimum score = 0; maximum score = 100.
[a,b,c]Means within a row for each procedure that do not share at least one letter superscript differ significantly ($P < 0.05$) from one another by Wilcoxon's signed rank test.
*$P < 0.05$ for comparison with bypass surgery at the same time period by the Mann–Whitney *U*-test.

patients, but this difference was no longer present at 48 months. Male patients improved to a greater degree with respect to physical functioning at both 6 and 48 months, and in relief from pain at 48 months follow-up, compared with women patients. Increasing age was associated with lower levels of physical functioning by 48 months, but age had no significant effects on other quality of life scales. Patients with heart failure had significantly (i.e. $P < 0.01$) lower levels of physical functioning at both 6 and 48 months, and in general health perception at 48 months. There were no differences (i.e. $P < 0.01$) in degree of improvement on any of the scales based on history of smoking, hypertension, chronic obstructive pulmonary disease (COPD) or history of a very positive stress test. We also found that there were no differences between those patients with and without diabetes mellitus.

Satisfaction with treatment

Six months after revascularization, those patients initially treated with bypass surgery were more satisfied with the treatment they received since their coronary angiography than those initially treated with angioplasty (94.4 vs. 81.5%; $P < 0.001$). There was no significant difference between groups after 48 months (83.1 vs. 85.5%; $P > 0.05$).

Discussion

In this study, we compared clinical outcomes following coronary revascularization in a population-based cohort of chronic stable angina patients with one- or two-vessel coronary artery disease. We found that coronary artery bypass surgery improved physical functioning and overall general health perceptions more that angioplasty within 6 months of revascularization, but that by 4 years of follow-up there were no significant differences in outcomes between procedures.

As with reports from several randomized controlled trials, bypass surgery relieved angina and reduced nitroglycerin use to a greater degree than did angioplasty at 6 months follow-up. Although significantly more bypass patients remained free of angina and did not require sublingual nitroglyerin use after 4 years, there was no significant difference in the proportion experiencing angina or requiring nitroglycerin at least three times per week.

We also found significant variation in the outcomes experienced by patients related to their underlying clinical characteristics. Patients with mild to moderate angina experienced greater improvement in their general health perception at 6 months than those with more severe angina. Congestive heart failure patients had worse physical functioning and lower levels of general health perception at 48 months, but were similar to other patients at 6 months. Male patients, conversely, experienced greater improvement in physical functioning and relief from pain at 48 months than did women patients. The most consistent predictor of postoperative functional status and quality of life was the patient's preoperative condition on these instruments.

Based on finding marked associations between angina severity and HRQOL, the RITA trialists

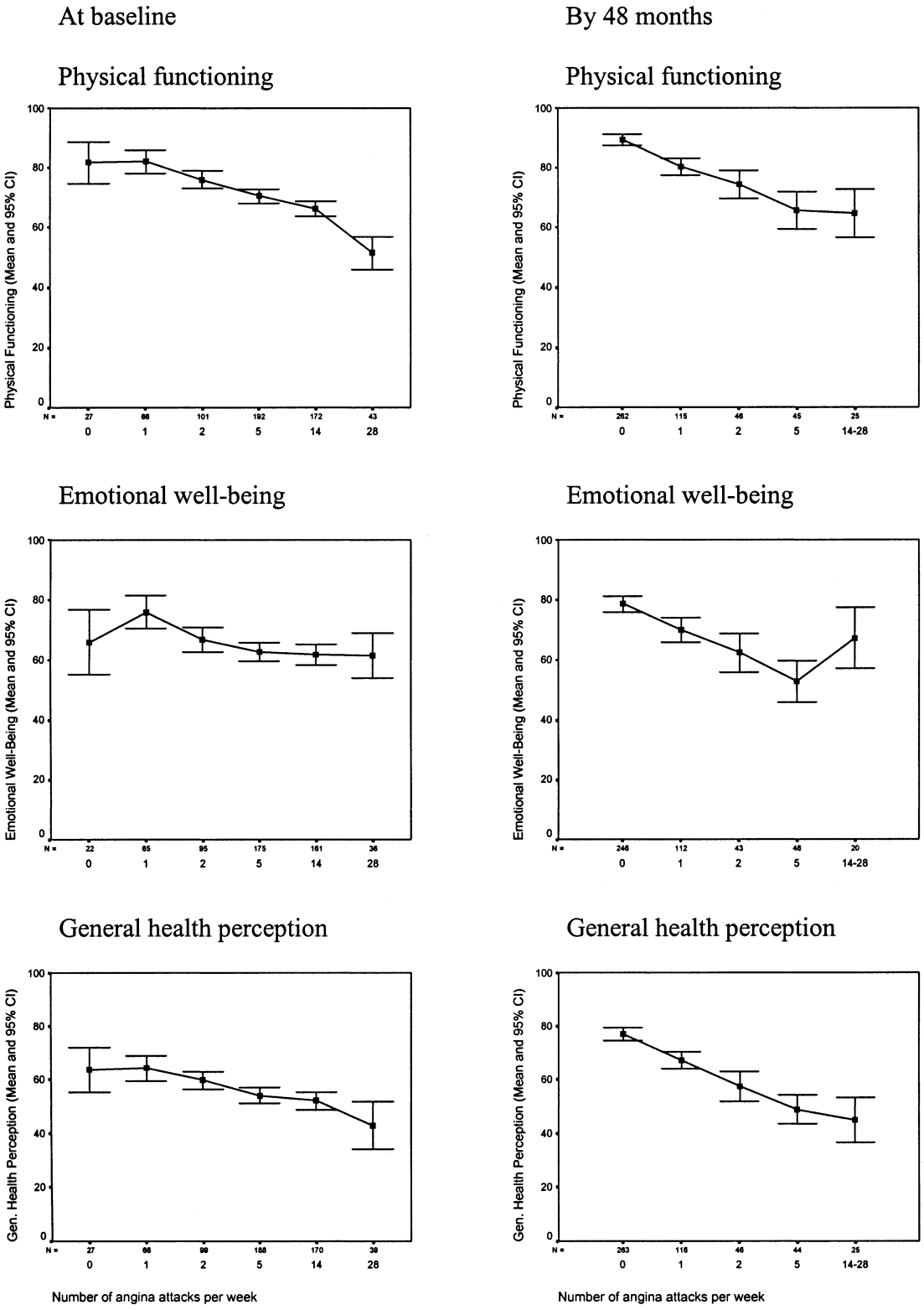

Fig. 1 Relationship between number of angina attacks per week and physical functioning, emotional well-being and general health perception at baseline and by 48 months amongst patients with chronic stable angina who underwent coronary artery bypass surgery or percutaneous transluminal angioplasty.

Table 5 Multivariable predictors of quality of life scores 6 and 48 months following coronary revascularization[a]

	Physical functioning		Relief from pain		Quality of sleep		Emotional well-being		General health	
Baseline predictor	6 months	48 months	6 months	48 months	6 months	48 months	6 months	48 months	6 months	48 months
Age (per 10-year interval)	–0.021	–2.69**	–	–1.48	–0.212	1.32	–	–1.41	2.78*	–0.885
Male sex	5.06**	6.07**	–	8.41**	4.70	5.63	–	2.33	1.77	1.75
Angina class III/IV	–1.20	–1.01	–	0.084	–0.729	–0.032	–	–1.06	–4.23*	–3.13
Prior myocardial infarction	–2.42	–1.45	–	1.71	–3.18	–1.68	–	1.48	–2.92	2.57
Diabetes mellitus	–1.38	–1.41	–	–1.55	–0.840	–2.25	–	–2.92	–2.10	–4.10
Congestive heart failure	–8.19**	–11.1**	–	–6.46	–9.56*	–11.28*	–	–8.51	–3.48	–13.77**
Chronic lung disease	–1.81	–7.77	–	11.80	5.36	5.98	–	6.33	–7.11	–9.95
Hypertension	–0.956	–3.17	–	–1.98	–4.26	–4.79	–	–0.153	–1.65	0.467
Current smoking	1.15	–0.317	–	–3.80	–1.60	0.602	–	–4.35	2.42	–1.38
Very positive stress test	2.77*	1.06	–	2.23	3.76	4.82	–	2.57	0.717	4.85*
Preoperative QOL[b]	0.409***	0.377***	–	0.470***	0.581***	0.497***	–	0.495***	0.426***	0.334***
Bypass surgery	3.98**	–1.06	–	–0.325	0.558	1.59	–	0.900	7.25***	0.229

[a]Entries are the coefficients of a multivariable linear regression of the baseline predictors on the quality of life scales . *P*-values are for the comparison with 0 (the value obtained by the null hypothesis). Two scales, relief from pain and emotional well-being, were not measured at 6 months. Given the multiple comparisons, we only consider those coefficients with *P*-value < 0.01 as significant.

[b]The preoperative quality of life value was the value for each scale at baseline.

*$P < 0.05$, ***$P < 0.01$, ***$P < 0.001$.

questioned if measuring quality of life is necessary in patients with coronary artery disease [2] Our results, covering a longer time of follow-up, confirm their findings, especially as regards the physical dimensions of health-related quality of life. The effects of anginal pain seem to exert increasingly negative effects on health-related quality of life the longer the observed time span, and it may be speculated that the deleterious effects generalize to most health-related quality of life measures over time. The 4.1 point decrease we found in physical functioning for bypass patients between 6 and 48 months following revascularization, at the level of the scale, represents a significant decline in functional ability. For example, a 4.3 point decrease in the overall physical functioning scale (composed of seven items) would occur if the proportion of respondents who had no difficulty performing moderately strenuous physical activity (i.e. one item on the scale) decreased from 60 to 25%.

One of the merits of this study is that it is likely to include patients who are more representative of the routine practice than those included in randomized controlled trials. This analysis was also restricted to chronic stable angina patients, and patients who presented with other clinical indications for revascularization were excluded (e.g. unstable angina following a myocardial infarction). This represents a more homogeneous patient population. We also restricted this report to those patients with one- or two-vessel coronary artery disease for whom there may be a greater choice between angioplasty and bypass surgery than patients with more severe coronary artery disease.

Although our study was based on a national sample of consecutive patients recruited about 5 years after the randomized controlled trials, our findings are similar to those reported by the randomized controlled trials. The CABRI study reported that both CABG and PTCA patients had a significant improvement in their quality of life at 1 year compared with baseline. They found no difference in QOL between groups at follow-up after correction for baseline values [7]. In the BARI trial, patients randomized to bypass surgery had less angina and better functional status than those randomized to angioplasty for the first 3 years of follow-up but not after 4 years [1]. There were no significant differences between the two groups with respect to improvements in emotional health following revascularization. Similarly, the RITA trial showed no significant differences between bypass surgery and angioplasty 2 years after randomization [2], and although we found some differences persisting at 21 months, they declined by 48 months. In an observational study, Caine *et al.* [8] also noted that there was a decline in physical mobility and energy scores between 1 and 5 years following bypass surgery.

We differ in our findings compared with those reported by Herlitz *et al.* [9] who examined 5-year outcomes in a Swedish population enrolled between 1988 and 1991. They reported on factors that were associated with an 'inferior' quality of life, which they defined as a quality of life score below the median for their patient population, 5 years after revascularization. They found that female sex, a history of diabetes, a history of COPD and a preoperative quality of life score less than the median for their patient population prior to revascularization were all independent predictors of a quality of life score below the median at 5 years follow-up [9]. The difference in findings between our study and Herlitz *et al.*'s may be because we report on the actual changes in quality of life scores for our patients whilst they described patients who were above or below the median quality of life score for their population.

Our findings are not surprising given the underlying nature of coronary artery disease and the treatment options that are available. Coronary artery disease is a chronic illness that will recur if one only attempts a mechanical intervention such as revascularization. The period of time before restenosis occurs may differ between bypass surgery and angioplasty but restenosis will occur. The gradual decline in quality of life and recurrence of symptoms over time for bypass surgery patients is most likely related to recurrent obstruction. For angioplasty patients, the lack of decline in quality of life comes at the expense of undergoing additional procedures.

In our study, patients initially treated by angioplasty had a 13-fold greater chance of undergoing a repeat revascularization procedure within 2 years of their initial procedure compared with bypass surgery patients. In absolute terms, 67 out of every 200 patients treated with angioplasty and five out of every 200 bypass surgery patients would have undergone an additional revascularization proce-

dure. Yet, restenosis rates in angioplasty patients will probably decline as more patients are treated with intracoronary stents and glycoprotein IIB/IIIA antagonists, and overall restenosis rates may decline with more aggressive treatment of hyperlipidaemia [10, 11].

Do these findings indicate which procedure should be used for future patients? No – we found that outcomes may differ based on a patient's underlying clinical characteristics. Other factors that may influence treatment selection include resource availability, patient suitability (i.e. are they equally suitable candidates for angioplasty and bypass surgery?) [12] and patient preference (i.e. some patients may prefer to undergo bypass surgery because of the need for fewer repeat procedures). An informed patient in consultation with his or her physician must make the ultimate decision on which treatment should be selected. If the patient is a candidate for both procedures, then this study could support selecting either procedure.

Our study has several limitations. First, it was an observational study and although we collected detailed clinical and sociodemographic information and controlled for them in our analyses there may have been unmeasured differences that could account for the differences we observed. Second, we did not collect follow-up data at 6 months for two of the five scales and thus we do not know to what degree these items improved. Third, our data are on outcomes for chronic stable angina patients with one- or two-vessel coronary artery disease from Sweden, and may not be generalizable to other countries. Lastly, we did not collect information on suitability of a patient for either procedure. However, if we assume that PCTA and CABG are equally suitable for all patients with one- or two-vessel disease, then our results would apply to almost half of all Swedish chronic stable angina patients referred for revascularization.

In conclusion, we found that both bypass surgery and angioplasty lead to improved quality of life for patients with chronic stable angina and one- or two-vessel coronary artery disease. Bypass surgery leads to greater short-term improvements but this advantage declines over time. What remains unanswered is how newer technologies and more aggressive treatment of hyperlipidaemia will affect these results. Further studies will be needed to answer these questions.

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