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RESEARCH ARTICLE

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Health-related quality of life is improved after coronary artery bypass graft surgery: a 1-year follow-up study

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ABSTRACT

Objectives: The purpose of this study was to detect changes in QoL after coronary artery bypass grafting surgeries (CABG) in one year, and to identify the possible predictive factors associated with the change.

Design: A single-center prospective study of 501 patients was conducted between 2013 and 2018 using the EQ-5D VAS questionnaire for estimating the QoL. The patients filled in a questionnaire preoperatively, at 6 and at 12 months postoperatively. Univariate and multivariable logistic regression analyses were used to find out if certain pre-selected factors or EQ5D dimensions had independent effects on the observed EQ VAS scores.

Results: QoL improved in all EQ-5D dimensions and in EQ VAS scores at 6 and at 12 months: the greatest changes in the number of reported problems were in the dimensions "mobility" (–34.2%, $p<.001$), "self-care" (–36.7%, $p=.001$) and "pain or discomfort" (–31.0%, $p<.001$). With the multivariable regression model, we could show that normal left ventricle ejection fraction (LVEF) and improvement in mobility and pain/discomfort dimensions were in association with improvement of EQ VAS score at 6 months. At 12 months this association was no longer detectable.

Conclusions: CABG procedure can improve patient's QoL when judged with EQ5D dimensions and related overall self-rated health (VAS). This improvement was seen both at 6 and at 12 months postoperatively. Except for LVEF, the other patient-specific risk factors we examined did not seem to affect QoL in the long term.

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Health-related quality of life; coronary artery bypass grafting; EQ5D; open-heart surgery; postoperative

Introduction

In this patient-centred era, importance of quality of life (QoL) as a patient-specific parameter assessing outcome of the treatment is increasing. It is important to recognize patients who would probably be in a greater risk for postoperative complications but also to detect those, who do not benefit from surgical treatment in terms of longevity and QoL. QoL indicates the patient's own perception of the impact of a clinical condition to their lives in addition to clinical or physiological status. QoL can be defined as an entity, which comprises of physical, mental and social dimensions [1–3]. Improving QoL by reducing limiting symptoms is one of the aims of coronary artery bypass grafting surgery, and in certain instances it may also reduce mortality to coronary artery disease (CAD) [4].

Complications and mortality of the CABG are well described, but there is only limited data available in for identification of patient subgroups, who achieve the best or leas benefit from surgery in terms of QoL. This study was conducted to evaluate patient-reported changes in QoL immediately prior to CABG procedure and during the following year.

Materials and methods

This is a single-centre prospective study. The data was collected from patients who underwent CABG surgery in the Tampere University Hospital Heart Centre on elective or urgent basis between 13 May 2013 and 31 December 2018. The study was approved by the local ethical committee (protocol R12265) and was conducted in agreement with the principles of the Helsinki declaration. Written informed consent to participate was acquired from all participants before the procedure. All 501 patients, who underwent elective or urgent CABG and filled in the baseline questionnaire were included. Those, who did not get or fill in the preoperative questionnaire, for example,, because of an emergency operation during evening or weekend, were excluded from the further analysis. To study if any selection bias was involved, some data from all other patients undergoing a similar operation at the time of our research were used for comparisons of patient and operation characteristics.

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Baseline patient data included age, sex, body mass index (BMI, kg/m2), EuroSCORE II, left ventricular function based on preoperative ultrasonographic evaluation of the left ventricular ejection fraction (EF). EF 50% or more was considered normal, and EF <50% as decreased, and co-morbidities (such as diabetes mellitus, hypertension, dyslipidaemia) were recorded. These predictor variables were measured at baseline prior to surgery. A summary of the preoperative data is shown in Table 1.

For estimating the HRQoL we used the EuroQol Instrument (EQ-5D-3L), which is a non-disease-specific standardised measure of health status developed by EuroQol Group [5]. EQ-5D-3L includes a descriptive profile and a visual analogue scale (VAS). Descriptive profile consisted of five dimensions: "mobility", "self-care", "usual activities", "pain/discomfort" and "anxiety/depression". In each dimension there were three severity levels "no problems", "some problems" and "extreme problems". The respondent's health state was defined by their chosen appropriate options in each of the five dimensions. The VAS measures respondent's health-state on a vertical scale from 0 to 100, where the endpoints are labelled as on the top "The best health you can imagine" and in the bottom "The worst health you can imagine". The information from EQ-VAS can be analysed as a quantitative measure of health outcome. [6]

The patients received the EQ-5D questionnaires in three time points: a day prior to the operation and six months and twelve months after the CABG surgery. The Finnish translation of the questionnaire was used with the permission from the Euro QoL Group. The data was transferred to the hospital database and was combined with the electronic patient research document files in a safe access-limited hospital server.

Cross-tabulations and binary logistic regressions were done including age-group, sex, ejection fraction, Euroscore II and Body mass index (kg/m^2) as variables in the model. The age groups were defined as less than 60-year-olds, between 60- and 69-year-olds and 70-year-olds or older. Gender was dichotomous (female and male), based on patient-derived determination. Ejection fraction was split into two groups which were "ejection fraction <50%" and "ejection fraction 50% or more". Operative risk was determined as "low risk", when the preoperative Euroscore II risk score was less than 2% and "intermediate or high risk", when the preoperative score was 2% or more. Body size was used as a trichotomous variable and determined as body mass index "normal weight or below", with cut point <25 kg/m^2, "overweight" 25–30 kg/m^2 and "obese">30 kg/m^2, respectively.

For comparing the preoperative values to those at 6 months or 12 months postoperatively, responses to the studied dimensions of QoL were dichotomized to "no problems" and "any problems" and analysed with nonparametric Related-Samples Cochran's Q-test. For crosstabulations the patient-reported corresponding EQ5D-dimensions (each 1,2 or 3) were compared as follows: 6 months postoperative to preoperative and 12 months postoperative to preoperative, and the comparations were labelled "QoL improved", "no change in QoL" and "impaired QoL". Categorical variables between the groups were compared using Chi-Square test, or using Fisher's exact test, when the criteria for Chi-Square test were not met. For comparing means between participants and non-participants, we used Mann-Whitney U-test.

For determining if some pre-selected factors or dimensions had independent effects on EQ VAS score results, we

Table 1. Patient and operation related characteristics in the study participants and in those not included in the study cohort and thereby QoL analysis (non-participants).

	Participants				Non-participants	
	Female $n = 82$		Male $n = 419$		Total $n = 840$ (172 female, 668 male)	
	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD
Age (years)	69.4	9.0	66.9	8.3	68.5	9.0
Timing of operation						
Elective	66	80.5	351	83.8	227	27.0
Urgent	12	14.6	66	15.8	329	39.2
Emergency	4	4.9	2	0.5	284	33.8
BMI (kg/m^2)	27.6	4.3	28.3	4.2	29.1	14.4
EF (%)	58.4	7.4	56.0	10.1	52.6	12.0
EuroSCORE II (%)	2.9	6.7	1.6	3.4	4.4	6.4
Smoking						
Yes	6	7.3	58	13.8	152	18.1
None	53	64.6	201	48.0	379	45.1
Ex-smoker	14	17.1	124	29.6	198	23.6
n.a.	9	10.0	36	8.6	111	13.2
Hypertension						
Yes	46	16.4	269	71.9	556	66.2
None	17	25.4	98	26.2	199	23.7
n.a.	4	6.0	7	1.9	85	10.1
Dyslipidaemia						
Yes	57	69.5	327	78.0	600	71.4
None	11	13.4	50	11.9	123	14.6
n.a.	14	17.1	42	10.1	117	13.9
Diabetes						
Yes	19	28.8	113	30.4	303	36.1
None	44	66.7	259	69.6	455	54.2
n.a.	3	4.5	0	0	82	9.8

BMI: body mass index; EF: Left ventricular ejection fraction; EuroSCORE II: EuroSCORE II risk score; n.a.: not available; n: number of patients.

used single step multivariable logistic regression. Based on univariate analysis of our data and known risk factors for adverse outcomes after open heart surgery, predicting patient-related factors in the logistic regression model were patient's age, sex, ejection fraction, Euroscore II and BMI and the dependent outcome variable was a favorable change of QoL between two time points in each of the five dimensions. The EQ5D-dimensions variable classes "no change in QoL" and "QoL deteriorated" were combined to one class "no change in or deteriorated QoL". For the multivariable analysis of improvement of EQ-VAS as a dependent variable, explanatory variables in the model were the changes in EQ5D-dimension. Odds ratio (OR) with 95% confidence intervals (95% CI) was used when reporting the results of the logistic regression model. Hosmer and Lemeshow tests were used to measure the goodness of fit of the logistic regression model to our data. For evaluating the patient related factors to quality of life determinants (separate five categories in the EQ-5D), we used pre-determined factors, such as age, gender, preoperative LVEF, obesity, and Euroscore II risk status score at the operation in the model. The analysis was performed using the single step method and separately to the individual dimensions that were dependent variables. Secondly, these patient-related characteristics were similarly analysed as categorical independent variables against binary VAS score change as the dependent variable in binary logistic regression analysis. Thirdly, to compare the effects these five determinants had on the overall quality of life at 6 months, we compared in a binary logistic multivariable model the changes in the five dimensions as independent variables against binary VAS score change as the dependent variable.

P-values of 0.05 or less and values outside 95% CI were considered statistically significant. All statistical analyses were performed using IBM SPSS Statistics for Windows, version 28 (IBM Corp., Armonk, N.Y., USA).

Results

A total of 501 patients initially undergoing isolated CABG filled in the baseline questionnaire. The age range of the participating patients was from 39 to 89 years with the median age of 67 years. There were 419 (83.5%) male patients, and 83.1% of the patients were operated on elective basis. The participation rate at 6 months after the surgery was 84.3% (423 patients), and at 12 months it was 59.2% (297 patients).

The survival rate after 12 months was 99% (with 5 deaths in the cohort). Major postoperative complications were atrial fibrillation ($n = 74$, 14.8%), minor respiratory or other infections ($n = 15$, 3.0%) and pleural effusion ($n = 13$, 2.6%). In 279 patients (55.7%) the postoperative recovery was uneventful and completely free of adverse events. In 93 patients (18.6%) the patient files contained only partial primary surgical outcome information.

In the group of emergency or urgent operations not included in our analysis, there were 172 women and 668 male non-participants. Characteristics of study participants are shown in Table 1. When evaluating the differences between groups of participants and non-participants (excluded due to non-elective status) age was found to be higher among non-participants (mean age being 68.5) than among non-participants (mean 67.3, $p = 0.014$). Also, Euroscore II was higher (mean Euroscore II 4.4%) in non-participants than in participants (with mean Euroscore II 1.8%, $p = 0.003$). Ejection fraction was also lower among non-participants (mean ejection fraction 52.6% as compared to 56.4%, $p < 0.001$ among participants, respectively).

EQ-VAS overall self-rated health status in the study cohort

EQ-VAS score changed significantly from the baseline to 6 and 12 months postoperatively. The improvement was largest from baseline to six months, and the significant improvement continued to 12 months. The change as compared to the preoperative subjective score (with mean EQ-VAS score 60.5; 95% CI 58.4 to 62.7) was positive and the overall increase was statistically significant (with mean EQ-VAS score 80.1; 95% CI 78.4 to 81.7 and 82.6; 95% CI 81.0 to 84.4) both at 6 months and at 12 months, respectively. The boxplot illustrating the dispersion of the values is shown in Figure 1.

EQ5D-dimensions of quality of life in the study cohort

The patients reported overall less QoL-related problems in all the EQ5D-questionnaire dimensions at 6 and 12 months postoperatively. Information from the questionnaires preoperatively, 6 months postoperatively and 12 months postoperatively are shown in Table 2. The greatest decrease in the proportion of patients reporting problems were seen in the dimensions of "mobility", "self-care" and "pain or discomfort". Also, in the dimensions "usual activities" and "anxiety or depression" patients reported less QoL-related problems at 6 months and at 12 months postoperatively, but the absolute change was smaller than in the other dimensions.

Univariate analysis

The quality of life was studied in univariate setting by comparing the preoperative self-assessed value of each of the five dimensions of QoL to the 6- and 12-month postoperative assessments. The results at 6 months have been summarized in Table 3. When these changes were compared with patient-specific factors, we could note a statistically significant association with younger age to improvement in self-care, whereas in the elderly the change was only modest. Higher body mass index seemed to be related statistically significantly to increase in QoL in daily activities whereas the slight overweight group achieved better scores in the dimension "Pain and discomfort". Other patient related preoperative factors, such as sex, LVEF or operation risk score were not linked to marked changes in the QoL dimensions either in 6 month or in 12-month postoperative assessments.

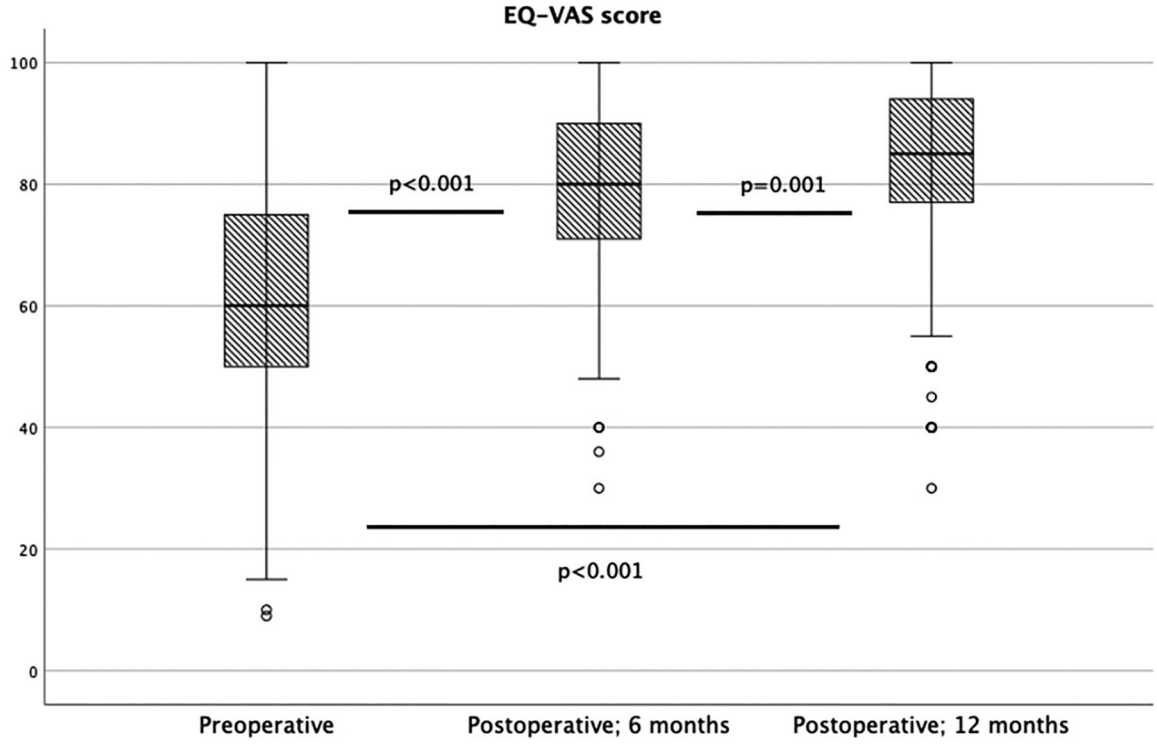

Figure 1. The boxplot illustrating the overall distribution of values of the EQ-VAS scores preoperatively, and at 6 and 12 months after surgery.

Table 2. Results of the self-reported status in five EQ-5D determinants at three study time-points.

EQ5D determinant	No problems n (%)	Reporting any problems[a] n (%)	Change in proportion reporting problems[b]	p-value
Mobility				
Preop.	210 (42.2 %)	288 (57.8 %)		
6 months postop.	310 (73.5 %)	112 (26.5%)	−31.3%	<.001
12 months postop.	227 (76.4%)	70 (23.6%)	−34.2%	<.001
Self-care				
Preop.	272 (54.5%)	227 (45.5%)		
6 months postop.	341 (80.6%)	82 (19,4%)	−26.1%	<.001
12 months postop.	271 (91.2%)	26 (8.8%)	−36.7%	.001
Usual activities				
Preop.	455 (91.0%)	45 (9.0%)		
6 months postop.	401 (94.8%)	22 (5.2%)	−3.8%	<.001
12 months postop.	285 (96.0%)	12 (4.0%)	−5.0%	<.001
Pain/Discomfort				
Preop.	198 (39.9%)	298 (60.0%)		
6 months postop.	284 (67.1%)	139 (32.9%)	−27.1%	<.001
12 months postop.	211 (71.0%)	86 (29,0%)	−31.0%	<.001
Anxiety/Depression				
Preop.	421 (84.5%)	77 (15.5%)		
6 months postop.	387 (91.5%)	36 (8.5%)	−7%	.007
12 months postop.	279 (93.9%)	18 (6.1%)	−9.4%	<.001

[a]Some problems + extreme problems.
[b]Compared to preoperative situation n.

The improvements in dimensional QoL and in EQ-VAS score by determinants in binary logistic regression

These multivariable models showed that improvement of QoL status in mobility and pain/discomfort dimensions were statistically significantly associated to improved VAS score at 6 months postoperatively. These results are summarized in the Table 4. This earlier significant effect in the VAS score caused by "mobility" and "pain/discomfort" dimensions was no longer seen at 12 months.

When observing the patient-related characteristics against the change in the VAS score, we found that at 6 months postoperatively, normal left ventricular ejection fraction was related to improvement in the improved EQ-VAS score (with OR 2.29; 95%CI 1.02–5.14; $p = 0.045$). This marked association between normal ejection fraction and improvement in EQ-VAS was no longer apparent at 12 months postoperatively. When it comes to other characteristics observed, they didn't appear as predictors for better or worse VAS score at 6 or at 12 months postoperatively.

Table 3. The effects of age and body mass index as significant predictors of the improved QoL in the EQ-5D dimensions at 6 months postoperatively.

			Decrease in QoL		No change in QoL		Increase in QoL		
Variable	Dimension		*n*	%	*n*	%	*n*	%	p-value
Age									
	Self-care								0.008
		<60 years	6	9.23	29	44.62	30	46.15	
		60–69 years	7	3.91	113	63.13	59	32.96	
		≥70 years	8	4.52	123	69.49	46	25.99	
BMI									
	Daily activities								0.013
		<25	1	1.05	86	90.53	8	8.42	
		25–30	6	2.88	193	92,79	9	4,33	
		>30	8	6.84	95	81.20	14	11.97	
	Pain or discomfort								0.018
		<25	10	10.8	53	57.0	30	32.3	
		25–30	13	6.3	110	53.1	84	40.6	
		>30	5	4.3	82	70.1	30	25.6	

BMI: body mass index, QoL: quality of life.

Table 4. Results of single step multivariable logistic regression analysis of improved self-reported VAS score at 6 months postoperatively. Covariates with multi- and univariable are shown.

Covariate	β	Wald	*p*	OR	CI 95 %
Improved mobility, (multivariable)	1.630	10.096	**.001**	5.102	1.867–13.943
• univariable			.	7.730	3.015–19.816
Improved pain or discomfort, (multivariable)	.947	5.237	**.022**	2.579	1.146–5.806
• univariable			.	3.981	1.832–8.651
Improved usual activities, (multivariable)	.049	.004	.951	1.051	0.215–5.129
• univariable			.	2.713	0.630–11.683
Improved self-care, (multivariable)	.565	1.429	.232	1.759	0.697–4.439
• univariable			.	4.500	1.985–10.201
Improved anxiety or depression, (multivariable)	.489	.570	.450	1.630	0.458–5.796
• univariable			.	2.272	0.677–7.631

-Single step multivariable logistic regression analysis of postoperative EQ VAS at 6 months as dependent variable and the dimensions of EQ-5D as explanatory (independent) variables.
-Hosmer-Lemeshow test was used to determine the goodness of fit of the model with 5 d.f., $p = .430$.

Discussion

The aim of this study was to evaluate QoL after an open-heart surgery for coronary artery disease and to detect the possible predictive factors affecting it. In this inclusive single centre study, we perceived that most of the patients did benefit from the surgery when observing the dimensions and general summative scores of QoL in the 3 L- EQ-5D.

Our main result was that QoL improved in all dimensions at 6 and at 12 months postoperatively. By using multivariable regression model, we also found out that improvement in mobility and pain/discomfort dimensions were in association with improvement of EQ-VAS score at 6 months after surgery. This impact was no longer seen at 12 months. This can probably be explained by the fact that at 6 months after revascularization the physical parameters, such as patient's ability to move or how painful/discomfortable everyday life is, had improved first. At 12 months postoperatively habituation to these improvements of more physical aspects of QoL apparently is covered and evened out by the influence many factors, such as memorization, overall habituation and the changes in the other life quality dimensions.

Left ventricular function of the heart

Preoperative normal left ventricular ejection fraction was associated with improvement of VAS score at 6 months postoperatively. Normal ejection fraction is a patient-related factor indicating that coronary artery disease has not yet injured permanently or temporarily the contractility of the left ventricle, and it is quite essential predictor of the overall wellbeing of the heart and the physical or mental performance of the patient. However, it is interesting that this association was not significantly visible in our results at 12 months. Blokzjil et al. noticed that left ventricular ejection fraction being 30-50% was an independent risk factor for lower score of QoL (in both mental and physical parameters) and in their patient material this association was seen at 1-year postoperatively [7]. Our finding possibly indicates that the majority of mostly elective CABG patients in our study experienced first the improved overall QoL at the early recovery. However, the significant effect dilutes during the first year if no preoperative myocardial infarctions had occurred. This potentially reflects the fact that the majority of the mostly elective study patients preoperatively had existing limited but still symptomatic coronary artery disease, and similarly also the frequency of major transmural myocardial infarctions has been limited with emergent PCI procedures, such as is the case in our hospital area.

It also may be that the individuals who have experienced myocardial infarction prior to the operation already have adapted their lifestyle and limited many activities in such a way that the first 6 months after treatment did not improve

their self-assessed VAS score in such an extent than what was seen in those with normal LVEF. It is possible, that any of the observed significant associations related to LVEF in this study may biased, either because of adaptation or due to the relatively small number of patients with a low LVEF in our material.

Sex

Previous studies suggest that female gender is associated with a higher rate of complications, poorer functional capacity, and poorer mental status after CABG [8]. It has been reported that women experienced slower recovery during the first year after cardiac surgery and their QoL was decreased compared to men [9]. It has been considered that the reason for women's lower benefit could possibly be women's smaller size, later diagnosis of coronary artery disease or their tendency to monitor their physical symptoms more closely [10–12]. Schaal et al. on the other hand, found male gender to be a risk factor for impaired QoL [13] However, in our study population sex didn't seem to be an independent factor affecting QoL after CABG. As opposed to the previously listed observations, in previous studies women seemed to have had less diseased coronary arteries [14]. That may have affected the results in our clinic's population too.

Obesity

In general, obesity is associated with a diminished improvement in the quality of life [15]. Previous studies also suggest that in CABG and other cardiac surgery patients, obesity is patient-related factor, which is connected to less improvement in QoL [16,17]. In our research, univariate analysis implied that at 6 months postoperatively, obesity (BMI $>$ 30) may be a factor affecting QoL negatively. However, when comparing this factor to other patient-related risk factors of outcome in a multivariable model, it did not show independent effect on QoL.

Age

The number of elderly patients undergoing open heart surgery is increasing as demographic shifts continue to unfold. For elderly patients, traditional outcome measures, such as long-term survival, are less valuable than relief of symptoms and achieving good quality life years. Studies suggest that elderly patients also gain good QoL from the CAGB procedure 18]. That also happened in our study data. Elderly patients benefitted from CABG in the terms of QoL as much as the rest of the study population. In the multivariable model, age was not found to be an independent factor influencing quality of life. In previous research there are contradictory results about age in general. Some authors suggest that younger age is a factor which indicates higher improvement in QoL [19,20] and some indicate that age doesn't have an impact on QoL [21,22]. Our study supports the previously stated fact, that in terms of surgical outcome, it is important to emphasize that age is not a factor predicting the likelihood of positive or negative postoperative outcome.

Strengths and weaknesses of the study

The general applicability of our results is good for chronically ill and mostly elective CABG patients. Our results may still underestimate the true benefit of CABG surgery in the longer term QoL results. We found out, that in our study the participants and non-participants were different with regards to age, left ventricular ejection fraction and Euroscore II risk score values. Since most of the emergency surgery patients were excluded from our study due to their inability to participate by filling in the preoperative questionnaire or participating in the informed consent protocols. Acutely ill patients in general are probably more likely to have low ejection fraction and higher preoperative risk rating, as was the case in our series. They were also older, as our comparative data indicates. It would be interesting to know, how the results could have changed, if we had had the option to include also the acutely very ill patients at higher risk into our cohort. They probably would have mostly indicated worse QoL preoperatively. Since there is no reason to believe, that they would not benefit from the results of surgery similarly to the others in our analysis, also in terms of later QoL, their results may even have been improved until the 6-month evaluation. Unfortunately, this study failed to confirm this interesting extended hypothesis in the emergency patients.

The findings of this research strengthen the clinician's ability to make decisions based on scientific evidence, mainly in terms of patients' symptom relief and better survival, but also based on a marked improvement of their overall well-being.

The survival rate was 99% after 12 months. Thus, the mortality was not a remarkable modifier of the results, but the later participation was affected by the response rate. Response rate for the first follow-up questionnaire at 6 months postoperatively was good (84,3%). For the second follow-up inquiry at 12 months postoperatively 59,2% of participants answered. For a better response rate, we could have sent reminder for participants, but the study protocol and the limited study personnel restrained this option.

Also, the EQ-5D-3L is prone to a ceiling effect, where a significant proportion of respondents score at the maximum of the scale, and this can impact the sensitivity to detect small changes in HRQoL [23]. In total, five broad significant health areas are covered as well as the EQ5D VAS score in this study. In previous research it has been demonstrated that EQ5D-VAS is greatly associated with overall QoL. Our results add to these observations and show, that also in coronary artery disease, the value of surgical care can be evaluated by using EQ-5D-3L as a comprehensible tool also in the clinical practice.

Conclusions

CABG procedure can improve patient's QoL in most of the EQ5D dimensions and in overall self-rated health (EQ-VAS

score). This improvement can be seen both at 6 months and at 12 months postoperatively. The patient-specific risk factors we examined did not seem to affect QoL in the long term. The initial improvement in the EQ-VAS score was related significantly with improvements in the EQ-5D QoL dimensions of mobility and pain/discomfort.

Disclosure statement

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