Long-term survival and quality of life after cardiac resuscitation following coronary artery bypass grafting

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Abstract

**Objective:** Follow-up studies of patients surviving emergency resternotomy, open cardiac massage, and additional emergency cardiac surgery following coronary artery bypass grafting (CABG) remain sparse and studies focusing on health-related quality of life are lacking. Our aim was to elucidate the long-term course of patients experiencing this hazardous complication. **Methods:** Between 1988 and 1999, 76 patients suffered sudden hemodynamic collapse following isolated CABG. All patients underwent emergency resternotomy and open cardiac massage. An emergency cardiac reoperation was performed in the 62 (82%) primary survivors. Additional 76 patients were pair-matched to the study patients on the basis of their preoperative characteristics and served as controls. Of the study patients, 41 (54%), and of the controls, 76, (100%) were discharged. In December 2009, all patients were traced with respect to mortality data and the health-related quality of life of living patients was studied using the RAND-36 Item Health Survey questionnaire. **Results:** Altogether 19 (73%) of the 26 study patients, and 38 (84%) of the 45 controls were available. After exclusion of the early deaths, the life expectancy was similar between the groups: neither overall (p = 0.60) nor cardiac (p = 0.64) survival differed significantly after a mean follow-up time of 15.1 ± 3.5 years. In addition, cardiac re-interventions were equally frequent in both the groups. The RAND-36 scores were congruent (p = ns) between the groups and the age- and sex-matched national reference population in the health-related quality-of-life dimensions describing physical, mental, and social domains. **Conclusions:** Patients who have survived severe hemodynamic collapse, open cardiac massage, and emergency cardiac reoperation following CABG achieve similar long-term prognosis in terms of survival and cardiac interventions as the pair-matched control patients. In addition, 15 years postoperatively, they have a good health-related quality of life, similar to that of an age- and sex-matched national reference population.

Keywords: Health-related quality of life; Survival; Cardiac arrest; Coronary artery bypass grafting; RAND-36

1. Introduction

Early postoperative hemodynamic collapse leading to resuscitation and open cardiac massage (OCM) is a most hazardous complication following coronary artery bypass grafting (CABG). Its incidence ranges from 0.7% to 3%, and emergency resternotomy is performed in 21–61% of these patients [1–5]. The etiology of unexpected postoperative cardiac arrest or hemodynamic collapse is considered multifactorial and often interdependent pathophysiologic mechanisms potentiate each other in this situation, causing a vicious circle. Possible graft and non-graft-related causes of this severe postoperative complication are early graft failure due to graft thrombosis, spasm, suboptimal anastomosis suturing, and kinking. Non-graft-related causes include incomplete revascularization, suboptimal myocardial preservation, reperfusion injury, pericardial tamponade, and bleeding. Clinical events preceding hemodynamic collapse are myocardial ischemia, myocardial infarction, and recurrent, uncontrollable ventricular tachycardia, or fibrillation [2,4,5].

Although it has been shown that the occurrence of cardiac arrest after cardiac surgery is invariably associated with high in-hospital mortality, ranging from 30% even to 70% [2,3,5], only little is known about the long-term prognosis of the surviving patients in terms of health-related quality of life (HRQoL). It has been demonstrated that cardiac-resuscitated patients frequently suffer from severe renal, gastrointestinal, and, especially, neurological dysfunction that extensively impair the subsequent level of cognitive, physical, and social functioning [2,6–8]. However, these studies have investigated post-resuscitation HRQoL within a relatively short follow-up period of 6 months to 3 years.
The aim of this study was to investigate the long-term prognosis of patients who have survived after cardiac resuscitation, resternotomy, OCM, and additional emergency cardiac surgery in the early postoperative course after CABG. Our special emphasis was on the late (15-year) postoperative HRQoL of the cardiac-resuscitated patients who were compared with matched control patients, and an age- and sex-matched reference population [9].

2. Methods

2.1. Patients

Altogether 8807 patients underwent isolated CABG at the Helsinki University Hospital between 1988 and 1999. The study population consisted of 76 (0.9%) patients (OCM group) who suffered from severe hemodynamic collapse after admission to the intensive care unit and underwent immediate emergency resternotomy, OCM, and re-admission to the operating theater. Patients who had undergone intraoperative resuscitation in the operating theater and patients who suffered from hemodynamic collapse due to bleeding or pericardial tamponade were excluded. Thus, the etiology of hemodynamic collapse included both graft and non-graft-related causes, that is, early graft failure, malignant ventricular arrhythmias, and low cardiac output syndrome. In some cases, the ultimate reason for hemodynamic collapse remained unidentified. The median time interval between the end of surgery and resuscitation was 3.0 h (interquartile range (IQR): 2.0–5.75 h). There were 62 (82%) primary survivors who underwent immediate re-exploration and additional emergency cardiac surgery in the operating theater. Additional grafting or graft repair was needed in 42 (55%) patients.

For each patient in the study group, a pair-matched control was selected among the patient cohort who underwent CABG during the same 3-month period (control group). Matching criteria included age, sex, diabetes, number of diseased coronary arteries, left ventricular ejection fraction, and New York Heart Association (NYHA) class. Preoperative patient characteristics are given in Table 1. The study was approved by the ethics committee of the Helsinki University Hospital and informed consent was obtained from all patients.

2.2. Data collection and follow-up

Initially, the medical records of the patients of the OCM and control groups were reviewed retrospectively and altogether 43 preoperative, intraoperative and postoperative variables were collected into a computerized database and analyzed in terms of predictive factors of hemodynamic collapse after CABG. The results of this analysis have been published previously [5]. In December 2009, all patients were cross-sectionally traced with respect to mortality data from the continuously updated National Causes of Death Register. During the closing interval between January and April 2010, the medical records of all patients were reviewed again and the original data were updated regarding cardiac interventions performed during the follow-up. In addition, the RAND-36 Item Health Survey questionnaire [9] that surveys the patients’ current HRQoL was mailed to all living patients. Seven OCM patients and seven patients in the control group could not be reached or refused to participate, which yielded a follow-up rate of 73% (19/26) and 84% (38/45), respectively. The mean follow-up time in the OCM and control groups was 14.5 ± 3.3 years (range: 10.4–22.0 years) and 15.6 ± 3.7 years (range: 10.2–21.8 years), respectively, and the mean age of patients at follow-up was 70 ± 9 years and 72 ± 7 years, respectively.

2.3. Quality of life

The RAND-36 Item Health Survey instrument was selected to measure HRQoL because it has been applied previously to a random population sample and validated for the Finnish adult population (n = 531). This has resulted in a standardized questionnaire with specified mean and standard deviation values for the different dimensions of the instrument per age and sex cohorts [9]. The RAND-36 items are organized into eight dimensions that measure (1) physical functioning, (2) role-physical (role limitation as a result of physical impairment), (3) bodily pain, (4) general health, (5) vitality, (6) social functioning, (7) role-emotional (role limitation as a result of emotional impairment), and (8) mental health. The scores obtained from the dimensions are then transformed to a 0–100-point scale. The lower the score, the greater the limitations are regarding the person’s activity or distressing social and emotional problems.

2.4. Statistics

Qualitative data are expressed as frequencies and percentages. Normally distributed quantitative data are expressed as mean ± standard deviations and skewed data are presented as median with its IQR. At baseline, differences between the OCM and control groups were compared with paired sample Wilcoxon’s signed-rank test for continuous variables and with McNemar’s test for dichotomous variables. Summary scores and 95% confidence intervals for the RAND-36 instrument were calculated for both the OCM and control groups, and then compared to the Finnish age- and sex-matched reference population using unpaired Student’s t-test for parametric data and Mann–Whitney U-test for skewed data, as appropriate. Late survival and time-dependent events were assessed by Kaplan–Meier’s survival analysis, and the log-rank test was used to analyze the difference in mortality between the groups. Differences with a p-value < 0.05 were considered statistically significant. The SPSS version 16.0 was used as the statistical software (SPSS Inc., Chicago, IL, USA).

3. Results

3.1. Early mortality

Overall early mortality (within 30 days of the operation) was 23% (35 of 152 patients). All deaths occurred in the OCM group (46%; 35 of 76 patients) and were all categorized as ischemic cardiac-related deaths. The difference in the early
mortality rate between the groups was statistically significant ($p < 0.0001$).

3.2. Overall survival

The 5-, 10-, 15-, and 20-year survival including all causes of death was 50%, 49%, 40%, and 18% in the OCM group, and 95%, 74%, 59%, and 49% in the control group, respectively ($p < 0.0001$; Fig. 1A). After exclusion of the 30-day mortality, the corresponding late survival figures were 93%, 90%, 74%, and 33% in the OCM group and 95%, 74%, 59%, and 49% in the control group, respectively ($p = 0.60$; Fig. 1B).

3.3. Cardiac survival

After exclusion of all other than cardiac-related deaths, the 5-, 10-, 15-, and 20-year cardiac survival was 50%, 49%, 41%, and 18% in the OCM group, and 94%, 83%, 71%, and 61% in the control group, respectively ($p < 0.0001$; Fig. 1C). After exclusion of the 30-day mortality, the corresponding late cardiac survival figures were 95%, 95%, 78%, and 35% in the OCM group and 94%, 83%, 71%, and 61% in the control group, respectively ($p = 0.64$; Fig. 1D).

3.4. Late non-cardiac mortality

There were 15 late non-cardiac deaths (10%; 15 of 152 patients). Late non-cardiac mortality was 3% (2 of 76 patients) in the OCM group and 17% (13 of 76 patients) in the control group ($p = 0.092$). Non-cardiac deaths were attributable to perforated diverticulitis in one patient (1%) and polycythemia in one patient (1%) in the OCM group. In the control group, causes of late non-cardiac deaths were malignancy in nine patients (12%), Alzheimer’s disease in three patients (4%), and severe renal failure in one patient (1%).

3.5. Cardiac interventions

The number, type, and time frame of late cardiac interventions are given in Table 2. There was no statistically significant difference in either the rate or timing of late cardiac interventions between the groups, albeit the patients in the OCM group underwent re-CABG more often
Table 2. Postoperative late cardiac interventions of 76 patients who underwent open cardiac massage (OCM group) after isolated CABG and corresponding data of 76 control patients (Control group).

<table>
<thead>
<tr>
<th>Interventions</th>
<th>OCM group (n = 76)</th>
<th>Control group (n = 76)</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM or ICD implantation</td>
<td>4 (5%)</td>
<td>6 (8%)</td>
<td>0.51</td>
</tr>
<tr>
<td>Time frame (years)</td>
<td>7.2 ± 5.2</td>
<td>13.5 ± 5.2</td>
<td>0.07</td>
</tr>
<tr>
<td>PCI</td>
<td>2 (3%)</td>
<td>4 (5%)</td>
<td>0.41</td>
</tr>
<tr>
<td>Time frame (years)</td>
<td>15.3 ± 2.1</td>
<td>13.3 ± 3.6</td>
<td>0.27</td>
</tr>
<tr>
<td>Number of objects</td>
<td>2.5 ± 0.7</td>
<td>1.3 ± 0.5</td>
<td>0.25</td>
</tr>
<tr>
<td>re-CABG</td>
<td>5 (7%)</td>
<td>1 (1%)</td>
<td>0.10</td>
</tr>
<tr>
<td>Time frame (years)</td>
<td>6.5 ± 3.7</td>
<td>18.1</td>
<td>0.08</td>
</tr>
<tr>
<td>Number of bypasses</td>
<td>2.8 ± 0.8</td>
<td>3.0</td>
<td>0.83</td>
</tr>
<tr>
<td>Laser revascularization</td>
<td>1 (1%)</td>
<td>—</td>
<td>0.32</td>
</tr>
<tr>
<td>Time frame (years)</td>
<td>4.5</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Heart transplantation</td>
<td>—</td>
<td>1 (1%)</td>
<td>0.32</td>
</tr>
<tr>
<td>Time frame (years)</td>
<td>—</td>
<td>7.8</td>
<td>—</td>
</tr>
</tbody>
</table>

Values denote number of patients (percentage) or mean ± standard deviation. CABG, coronary artery bypass grafting; ICD, implantable cardioverter defibrillator; OCM, open cardiac massage; PCI, percutaneous coronary intervention; PM, pacemaker.

Fig. 2. The RAND-36 health-related quality of life scores for the OCM and control groups (Control group) together with an age and sex-matched Finnish reference population [9]. There were no statistical differences between or within the groups with regard to any health dimension.

than the patients in the control group (7% vs 1%, p = 0.10). On the contrary, patients in the control group underwent percutaneous coronary intervention (PCI) more often than patients in the OCM group (5% vs 3%, p = 0.41). Of the four PCI patients in the control group, altogether eight interventions were done during the follow-up. Coronary stents were used in all PCI cases in both the groups.

3.6. Health-related quality of life

Fig. 2 shows the RAND-36 scores in the OCM group and Control group together with an age and sex-matched reference population [9]. There were no statistical differences between or within the groups with regard to any health dimension.

4. Discussion

This study demonstrates that the majority of CABG patients who have survived unexpected hemodynamic collapse resulting in OCM and additional emergency cardiac surgery within the immediate postoperative course will achieve similar HRQoL as an age- and sex-matched reference population and equal long-term survival as control patients who have recovered from CABG without major complications.

Good QoL after 6-month to 8-year follow-up has been reported in patients surviving cardiopulmonary resuscitation [8,10,11]. Only a few follow-up studies with a prospective design with follow-up periods from 6 months to 2 years have focused on this patient cohort with an initial poor over-all survival [12,13]. Results of QoL similar to the national norm support efforts for both out-hospital and in-hospital resuscitation [12,13]. On the contrary, survivors after cardiopulmonary resuscitation have also been reported to have a worse QoL in comparison to the general population [14]. Reports of hazardous complications in cardiac surgery remain sparse [1—5] and follow-up times in studies of patients surviving sudden postoperative hemodynamic collapse are limited to 24—36 months [2,4]. These studies do not focus on HRQoL. In addition to providing information of HRQoL of those surviving OCM following CABG, the present study also elucidates the long-term outcome of patients, who underwent a mostly uneventful postoperative course, that is, the patient group of 76 controls. HRQoL similar to the general population [9] was measured at 15 years postoperatively in both the groups. Prior studies reporting improvement of HRQoL following CABG did not exceed 18-months of follow-up [15,16]. In elderly patients more than 75 years old, immediate postoperative improvement in HRQoL was not permanent [15,16]. On the contrary, in a prospective assessment long-term survival and HRQoL of octogenarians who underwent cardiac surgery were similar to age- and sex-matched controls after 8 years [17].

In the present study, when the early 30-day mortality was excluded, the long-term survival was similar between the OCM patients and the controls. In our previous study, event-free survival of patients undergoing cardiac arrest and emergency re-revascularization or interventions in the intensive care unit following cardiac surgery were compared during a 37-month follow-up [4]. Patients, who underwent emergency re-revascularization, were significantly in favor. In our patient cohort, all patients who survived from OCM underwent additional emergency cardiac surgery and this might be a major cause of the excellent long-term survival rate and HRQoL. Interestingly, the combined rate of cardiac re-interventions, that is, PCI and re-CABG, did not differ statistically between the groups. However, re-CABG during long-term follow-up was required more frequently in the OCM group (5 vs 1, p = 0.10) (Table 2). Furthermore, although there was a higher incidence of mortality in the control group due to non-cardiac causes than the patients in the OCM group (17% vs 3%), the difference did not reach statistical significance (p = 0.092).

4.1. Importance of the study

This study reports previously unknown long-term data regarding HRQoL and survival of 76 patients who have undergone emergency re-sternotomy, OCM, and additional cardiac procedure after CABG. Most importantly, HRQoL of
resuscitated patients was not only similar, compared to the HRQoL of patients who had been recovered without major complications, but also correlated with the HRQoL of an age- and sex-matched Finnish reference population 15 years after CABG. Thus, good HRQoL could be achieved in the long run, although such a hazardous complication, that is, sudden hemodynamic collapse and cardiac resuscitation after CABG, had occurred in the early postoperative phase. Second, long-term survival and the need for subsequent cardiac procedures in resuscitated patients turned out to be comparable to the controls. Although early mortality is high among the resuscitated patients [2,3], 46% in this study, the excellent long-term results in terms of HRQoL and survival advocate that all efforts should be put on patient rescue during the early postoperative phase.

4.2. Limitations of the study

The data collection was initially retrospective, even though there are no missing data concerning the preoperative variables, the initial cardiac operation, or the immediate postoperative course. A prospective study design could have provided an opportunity to enlarge the focus of the study also on cost effectiveness during long-term follow-up. The overall number of patients was relatively small and the loss of participation to the HRQoL evaluation was 20%. This may have a biasing effect on the HRQoL results: the HRQoL might have been overestimated, because the patients who either had deceased or were unable to respond might have had the poorest HRQoL. On the other hand, the lack of difference in HRQoL between the groups might be a consequence of the insufficient number of patients. However, we have calculated the 95% confidence intervals of these data (Fig. 2), and it is probable that there would not have been any statistical or clinical significance between the groups even if the patient cohorts had been larger. Causes of death, mortality data, and data concerning cardiac procedures, that is, catheter interventions and surgery, were successfully obtained from national (National Centre of Statistics) and hospital records in addition to the patient questionnaires. However, information concerning other cardiac events such as recurrent angina and myocardial infarction was considered incomplete and, thus, was not included.

5. Conclusion

In conclusion, the incidence of cardiac procedures and the mortality rate of patients surviving postoperative OCM were similar to control patients during long-term follow-up. Importantly, the HRQoL at 15 years after such a hazardous complication was similar not only to patients with an uneventful postoperative recovery but also to an age- and sex-matched general national population [9]. Further studies with a prospective design and cost-utility analysis might be valuable, especially, because outcomes of HRQoL studies will have a role in future health-care policy [18]. However, the results of our study do support unyielding efforts focused on the rescue of patients suffering from unexpected cardiac arrest or sudden hemodynamic collapse after CABG.

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References


Appendix A. Conference discussion

Dr G. Gerosa (Padova, Italy): You have shown that long-term survival and quality of life of patients surviving OCM are comparable to those patients undergoing CABG with an uneventful postoperative course. So the take-home message is, if your patient survives, he will live as long as the other patients. So I would like to go back, not to the long-term results, but to the short-term results.
According to the manuscript, out of the 76 patients, there were 62 primary survivors who underwent immediate additional emergency cardiac surgery. Regarding those patients, how did you rule out the diagnostic evaluation in those emergency cases? And which type of procedure did you perform on those patients?

In your manuscript you stated that the early deaths accounted for 46%, so that means one out of two patients had died in the early phase. Which type of support did you use for those patients immediately after surgery and how do you explain such a high rate?

And finally, have you changed your current practice in case you face a problem like that?

Dr Jokinen: My first answer concerns the last question of yours. The patient data was collected over quite a long period, between the years 1988 up to 1999. And there were only 76 patients in that period, out of over 8,000 patients operated during that time. And so we were not able to change any practice, because I think that that rate is quite reasonable and still acceptable.

And the previous question?

Dr Gerosa: The previous question was how did you rule out the diagnostic examination? Because you took those patients back to theater for regrafting. Did you perform coronary angiography in all those patients?

Dr Jokinen: In the operating room, no. Patients were opened and the graft flow was measured by using the ultrasound device.

Dr D. Toggart (Oxford, United Kingdom): If I can make one brief comment. I think what you described in your paper is that there are two types of cardiac arrest after operations. There is one where there is a fundamental problem with your graft and therefore you end up with essentially a dead heart. You may resuscitate them for a while, but they will die of multiorgan failure within a week or so.

Another type of arrest is the short arrest from something unexpected like hypokalemia. These patients you resuscitate. And once you’ve resuscitated them, they’re perfectly normal.

So I think what you’ve selected out is that those patients whose arrest was due to a primary cardiac problem, even although you may get them back for a short period, they die of multiorgan failure and they don’t get out of hospital. And the others who arrested for easily correctable things, if you resuscitate them quickly, have a very good long-term outcome. Is that what you’re describing, or is that too simple?

Dr Jokinen: No, I agree with that. It could be a possible reason. Because the early graft failure detected in the majority of the cases was thrombosis, which is probably due to graft failure, and it was quite often correctable.

Dr E. Kapetanakis (London, United Kingdom): My question concerns the significant downtime that these patients experienced until you got them to theater, up and then back again, revascularize them again: have you looked at their postoperative mental status and functioning after going through this whole ordeal? Have they shown differences, compared to their previous preoperative state? And compared to the control group, has there been a difference in their mentality? How did you account for that and how did you measure it, the mental function/brain function?

Dr Jokinen: That’s a good question and that’s the way it should go. But unfortunately, it won’t. Because we do not routinely collect data, perioperative data, on the quality of life or neurocognitive function, so this was a snapshot of the current moment and, unfortunately, we were not able to compare, for example, the neurocognitive function of the control patients because we don’t have that data.

Dr J. Ennker (Lahr, Germany): I have one question: what can you learn? You described a nearly 1% open cardiac massage out of 8,000 patients. This happened to us also, acute open massage after bypass surgery. We then employed flow measuring for every anastomosis. Acute fibrillation, and open cardiac massage in coronary artery bypass patients doesn’t happen any longer. So I think this is a very important difference which we learned. And my question is, are you measuring flow nowadays in your bypass graft nowadays?

Dr Jokinen: Yes, routinely, yes.

Dr Ennker: Sometimes, of course.

Dr Toggart: The ones you see are for the metabolic problems and not the graft problems. And that’s why they do well, you can resuscitate them easily.

Dr S. Jain (New Delhi, India): I just wanted to know one thing. In the OCM group your average ejection fraction is around 55% to 60%. Right? Then I’m not able to understand how 66 patients required open cardiac massage after the surgery. Because the ejection fraction is around 55% to 60%, there are now two problems: either the graft has been not properly placed or the vessels are very well calcified. In my present practice, I’ve got 99% with ejection fraction around 60%, who go very smoothly to discharge.

Dr Toggart: I think you’re saying that if you start with a ventricle with an ejection fraction of 50%, when you leave the operating room the ventricular function should still be at least 50%.

Dr Jain: Exactly.

Dr Toggart: And if it’s not, it’s because you’ve got a graft problem. Let me ask the audience, how many people in this audience routinely image their grafts by whatever modality?

(Show of hands.)

So very small minority. So most of us know that we don’t have to prove we’re doing a great job.