Cognitive Self-Assessment One Year After On-Pump and Off-Pump Coronary Artery Bypass Grafting

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Background. **Coronary artery bypass grafting (CABG) is associated with significant cerebral morbidity. This is usually manifested as cognitive decline and may be caused by cardiopulmonary bypass. The primary objective of this study was to explore whether patients report more cognitive failures 1 year after CABG than preoperatively. Secondary objectives were to evaluate whether there is a difference in reported cognitive failures between patients undergoing on-pump and off-pump CABG and whether a difference between CABG patients and healthy control subjects exists. Finally the relation between objective and subjective cognitive functioning was quantified.**

Methods. **In this prospective study, the Cognitive Failures Questionnaire (CFQ) was assigned preoperatively and 1 year postoperatively to 81 patients who were randomly assigned to undergo off-pump (n = 45) or on-pump (n = 36) CABG. A control sample of 112 age-matched healthy subjects was included who were administered the CFQ once.**

Results. **No difference was found in the total CFQ score (p = 0.222) and CFQ worry score (p = 0.207) between 1 year after CABG and before CABG. There was no difference between on-pump and off-pump CABG (total score, p = 0.458; worry score, p = 0.563). A significant difference was found in CFQ total score between CABG patients and control subjects (p < 0.001), with control subjects reporting more cognitive failures than CABG patients. Finally, patients who showed cognitive decline in the Octopus trial did not have a higher CFQ total score (p = 0.671) and CFQ worry score (p = 0.772) than patients without cognitive decline 1 year after CABG.**

Conclusions. **The present findings suggest that CABG does not result in a substantial proportion of patients with subjectively experienced cognitive decline 1 year after the procedure, irrespective of the type of surgical technique (on-pump versus off-pump).**

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Coronary artery bypass grafting (CABG) is associated with significant cerebral morbidity, usually manifested as cognitive decline or stroke. Cerebral morbidity after CABG has largely been attributed to the use of cardiopulmonary bypass [1]. The incidence of cognitive decline ranges from 3% to 50% of subjects, depending on the type of patient, definition of decline, and timing of neuropsychological assessment [1]. A pooled analysis of six comparable studies yielded a proportion of 23% of patients with cognitive decline 2 months after operation [2]. A recent study by Newman and colleagues [3] reported that 6 months after CABG, 24% of the patients suffered from cognitive decline whereas after 5 years this percentage increased to 42%. Another study from the same group demonstrated a lower quality of life in patients with neurocognitive dysfunction 5 years after operation [4].

Recently, cardiac stabilization devices were developed to facilitate CABG on the beating heart (off-pump CABG). Diegeler and associates [5] found marked improvement of cognitive outcome by using off-pump CABG, but the study sample was small (n = 40). In the Octopus randomized trial (n = 281), the effect of CABG with and without cardiopulmonary bypass on cognitive outcome was also compared. After 3 months a small, nonsignificant difference was found between the two groups (29% and 21%). At 12 months the difference became negligible, but the incidence of cognitive decline increased (off-pump 31% and on-pump 34%) [6]. These figures should be interpreted with caution, as in most patients cognitive decline, as measured with neuropsychological tests, does not affect the patient in functional terms [6]. A few studies have reported on the incidence, extent, and course of subjective cognitive functioning after CABG to gain insight into the functional cognitive consequences of CABG. Newman and coworkers [7] found a discrepancy between objective and subjective functioning: CABG patients who reported cognitive complaints did not show a decline in performance on appropriate neuropsychological tests. Similarly, in two other studies differences have been reported between cognitive self-assessment and neuropsychological performance af-

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Table 1. Demographics[a]

Variable	Controls (n = 112)	All CABG Patients (n = 81)	On-Pump (n = 36)	Off-Pump (n = 45)
Age (y)	60.5 ± 6.2	60.8 ± 9.4	59.8 ± 9.7	61.7 ± 9.1
Education (y)	11.6 ± 3.1	9.9 ± 2.4	10.1 ± 2.5	9.8 ± 2.3
Male sex (%)	50.5	74	83	67

[a] Values are mean ± standard deviations or percentages.

CABG = coronary artery bypass grafting.

ter CABG [8, 9]. This discrepancy might be related to the fact that performance on neuropsychological tests does not necessarily reflect abilities required in daily life. Neuropsychological tests tend to induce specific test-related strategies, and they are administered under conditions of minimal distraction and stress [10]. To overcome these limitations of laboratory paradigms in assessing everyday cognitive competence, self-report questionnaires have been developed. One of these questionnaires is the Cognitive Failures Questionnaire (CFQ), a self-administered 25-item instrument designed to assess the frequency of failures of memory, attention, action, and perception in everyday life.

The primary objective of this study was to explore whether patients report more cognitive failures 1 year after CABG than preoperatively. Secondary objectives were to evaluate whether there is a difference in reported cognitive failures between patients undergoing on-pump and off-pump CABG and whether a difference between CABG patients and healthy control subjects exists. Finally the relation between objective and subjective cognitive functioning was quantified.

Patients and Methods

A subgroup (n = 81) of CABG patients from the Octopus trial, in which patients were randomly assigned to undergo off-pump (n = 45) or on-pump (n = 36) CABG [6], was included in the analysis of the present study. The protocol was approved after the Octopus trial had been started, and therefore the CFQ was assigned preoperatively and 1 year after operation to the last 81 patients who were consecutively included in the trial. The design of the Octopus trial was described in detail elsewhere [11], and the principal results were recently published [6]. Student's *t* tests revealed no differences in neuropsychological performance between this subgroup and the patient group of the Octopus trial.

A control sample consisted of 112 middle-aged healthy subjects who were assigned the CFQ once. The sample was age-matched to the CABG patient sample. Subjects were recruited through an advertisement in a local newspaper and were screened by telephone. The same exclusion criteria that were used in the CABG patient sample were applied to the healthy subjects: a history of CABG, need for concomitant major surgery, and concomitant medical disorders. Evidence of psychiatric or neurologic pathology and alcohol and drug abuse were additional reasons for exclusion. Institutional approval for the study was obtained June 15, 1999.

The subjects completed a slightly modified, validated version [12] of the Dutch translation [13] of the original CFQ [14]. The CFQ is a self-administered 25-item instrument designed to assess the frequency of failures of memory, attention, action, and perception in everyday life (CFQ total score). On four additional items subjects indicated whether an increase of cognitive failures was experienced during the past 5 years and the extent to which they were hampered, worried, and annoyed by these failures on a five-point Likert scale [12], further referred to as CFQ worry score. High scores reflect low performance.

The results were analyzed using the Statistical Package for the Social Sciences for Windows (SPSS PC+, version 9.0, Chicago, IL). Demographic variables were compared using Student's *t* test and χ^2 test as appropriate. Multivariate repeated measures analyses of variance were performed with CFQ total score and CFQ worry score as dependent variables, and group as the independent variable. The patients of this subgroup who showed cognitive decline in the Octopus trial were compared with the patients not showing cognitive decline with respect to the CFQ total score and CFQ worry score by the use of a Student's *t* test.

Results

Demographic characteristics are summarized in Table 1. As indicated, CABG patients and control subjects were age-matched (60.8 and 60.5 years; $p = 0.778$). Controls had a higher level of education than CABG patients did (11.6 and 9.9 years; $p < 0.001$). The proportion of men was higher in the patient group than in the control group (74% and 50.5%; $p = 0.001$). Sixty-eight subjects of 81 filled out all CFQ items completely before and after operation. Ninety-five of 112 control subjects filled out all CFQ items completely. Off-pump CABG patients were 2 years older than on-pump CABG patients (61.7 and 59.8 years; $p = 0.354$). On-pump patients and off-pump patients had the same education level (10.1 and 9.8 years; $p = 0.579$).

No difference was found in the total CFQ score (23.6 before and 22.9 after operation; $p = 0.222$) and CFQ worry score (7.1 before and 7.4 after operation; $p = 0.207$) 1 year after CABG. In addition, there was no difference between on-pump and off-pump CABG (total score, $p = 0.458$;

Table 2. Preoperative and Postoperative Scores on the Cognitive Failures Questionnaire[a]

Variable	Controls (n = 112)	All CABG Patients (n = 81)	On-Pump (n = 36)	Off-Pump (n = 45)
CFQ total score preoperative[b]		23.6 ± 8.6	24.4 ± 8.7	23.1 ± 8.5
CFQ total score postoperative	28 ± 8.2[c]	22.9 ± 9.2[c]	23.1 ± 9.4	22.8 ± 9.2
CFQ worry score preoperative[b]		7.1 ± 3	7.2 ± 3.2	7 ± 2.9
CFQ worry score postoperative	7.6 ± 2.8	7.4 ± 2.9	7.5 ± 3.1	7.3 ± 2.7

[a] High scores represent low performance. [b] Control subjects were administered the CFQ once at 1-year follow-up. [c] $F = 13.389$; $p < 0.001$.

CABG = coronary bypass grafting; CFQ = Cognitive Failures Questionnaire.

worry score, $p = 0.563$). On-pump patients scored 24.4 preoperatively and 23.1 postoperatively. Off-pump patients' scores were 23.1 preoperatively versus 22.8 postoperatively. On-pump worry scores were 7.2 preoperatively and 7.5 postoperatively, whereas off-pump patients scored 7.0 preoperatively versus 7.3 postoperatively. (Table 2)

A significant difference was found in 1-year CFQ total score between CABG patients and control subjects ($F = 13.389$; $p < 0.001$), with control subjects reporting more cognitive failures than CABG patients. This higher CFQ total score in control subjects was not reflected in a higher worry score. (Table 2)

Finally, patients who showed cognitive decline in the Octopus trial did not have a higher CFQ total score (22.4 versus 23.4; $p = 0.671$) and CFQ worry score (7.2 versus 7.5; $p = 0.772$) than patients not showing cognitive decline 1 year after operation.

Comment

Coronary artery bypass grafting patients did not report significantly more cognitive failures 1 year after operation as compared with before the procedure. In addition, there was no difference in self-reported cognitive failures between patients undergoing on-pump and off-pump CABG. These findings seem to differ from the neuropsychological test results of the Octopus trial, which we reported earlier [6]. Here, we found an incidence of cognitive decline of 31% in off-pump patients and 34% in on-pump patients. Although a substantial number of individuals performed worse 1 year after operation, it should be noted, however, that there was no decrease in the mean performance of all patients, from preoperative to 1 year after operation.

An unexpected but interesting finding is that the healthy control subjects reported significantly more cognitive failures than CABG patients do 1 year after operation. One possible explanation was given by Rabbitt [10], who noted that subjective self-ratings could not reflect absolute levels of everyday competence, but only the relative success of individuals' adaptation to specific environments. Healthy control subjects are more likely to function in demanding environments than patients do and therefore are more likely to be confronted with their cognitive weaknesses. Another problem could be that individuals with poor memory function are more likely to ″forget what they forgot' and therefore may underreport their lapses [10]. In addition, CABG patients might value life and their functioning differently because they have faced a serious, life-threatening disease and survived a major operation. Moreover, in the Octopus trial the relief of angina resulted in improved health-related quality of life as measured with the Short Form Health Survey (SF-36) [6]. This finding raises the question whether recruiting healthy control subjects through an advertisement in a local newspaper leads to a selection of people who were overly interested in their own cognitive functioning and more prone to report cognitive lapses.

Consistent with findings from others [7, 8], we did not find associations between objective and subjective cognitive functioning. Possibly, everyday functioning rated, as it is, by using self-rating questionnaires may be related to emotional state rather than to actual cognitive abilities. Both Newman and associates [7] and Vingerhoets and colleagues [8] found that patients who reported cognitive failures after CABG were found to have higher levels of depression and state anxiety. This has led some authors to suggest that subjective measures should not be relied upon to assess postoperative cognitive decline [15]. However, when we examined the relationship between depression as measured with the mental health scale of the SF-36 questionnaire and CFQ scores, we only found a weak relation with CFQ total score ($r = 0.174$; $p = 0.043$). Thus, different mechanisms seem to be involved in objective cognitive functioning in CABG patients and the way that it is evaluated. Therefore, the CFQ has an additional value in measuring cognitive functioning and quality of life.

It should be noted that the reported cognitive failures of all groups were within the range of what is considered normal for healthy individuals [12]. Thus, in none of the groups were large cognitive lapses reported.

Limitations of the study are the small patient sample size and the fact that patients were not blinded for randomization. Besides, there were differences in education level and proportion of men and women between patients and control subjects. Post hoc comparisons between men and women revealed no different response style.

Another limitation of the study is that we lack CFQ data earlier after operation. By measuring cognitive failures 1 year after CABG, it is conceivable that we missed differences between groups that might have existed earlier after the procedure. This was suggested by the neuropsychological results of this group, in which a small difference in incidence of cognitive decline between patients undergoing on-pump and off-pump procedures was found 3 months after CABG, which almost disappeared 1 year after operation [6]. Finally, it is conceivable that a higher incidence of self-reported cognitive failures can be found in older CABG patients with more comorbidity.

In conclusion, we did not find an increase in self-reported cognitive failures in CABG patients 1 year after operation. Moreover, there was no difference in reported cognitive failures between patients undergoing on-pump and off-pump CABG. In contrast, we found a higher rate of self-reported cognitive failures in healthy control subjects than in CABG patients. The present findings suggest that CABG does not result in a substantial proportion of patients with subjectively experienced cognitive decline 1 year after operation, irrespective of the type of surgical technique (on-pump versus off-pump).

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INVITED COMMENTARY

"Measure all that is measurable, and make those things measurable, which have hitherto not been measured."
Galileo Galilei

For those investigators trying to assess neurobehavioral outcomes following cardiac surgery, the traditional use of stroke rates to determine outcome has become obsolete unless the number of patients in the study is quite large. This is because stroke, as assessed by neurological examination, is rare in most modern clinical series. Thus it has been necessary to use more intricate testing to measure subtle neurobehavioral outcomes, and this study is no exception. The authors found no differences in quality of life as assessed, at one year postoperatively, by Cognitive Failures Questionnaire (CFQ) and the so-called Worry Index. In addition, there were no differences between patients operated on using cardiopulmonary bypass or an off-pump technique in this small patient sample. The neurobehavioral outcome of this particular data set has been reported in several different journals using several different measuring techniques. This patient group is relatively young and has few co-morbidities, and thus good results should be expected; for this, the authors should be congratulated.

Of interest, a group of "healthy controls" had more cognitive deficits, as measured by the CFQ, than the surgical group. The authors present numerous reasons why this may have been the case but, suffice it to say, the group contained more females and were more highly educated, and thus may have been more aware of their own personal health status and more likely to report cognitive difficulties. Anecdotal reports from patients regarding cognitive failures are fortunately quite rare in our specialty. Thus measuring tools, which rely on patient self-assessment, are the least accurate outcome measure. A more accurate instrument has been developed to assess cognitive performance, which is usually referred to as neuropsychological tests. When batteries of these tests are given pre- and postoperatively to patients having cardiac operations, a substantial number demonstrate postop deficits, particularly early after operation. It has been the goal of cardiac surgical teams to reduce these deficits by altering intraoperative anesthetic and surgical techniques to ameliorate brain dysfunction early after operation and to limit the size of ischemic lesions in the brain induced by particulate embolism.

In our own institution, the neuropsychological deficit

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