Subjective impairment after cardiac surgeries: the relevance of postoperative cognitive decline in daily living

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Abstract

OBJECTIVES: Postoperative cognitive decline (POCD) is a frequent complication after cardiac surgeries. It remains unclear how relevant this decline in psychometric results is for daily life. The aim of the study was to assess cognitive failures, as seen by patients and close relatives, on a quantitative level.

METHODS: In addition to an extensive neuropsychological test battery, we interviewed 82 patients with a modified version of the self-assessment cognitive failure questionnaire (s-CFQ) and 62 close relatives (mostly spouses) with the CFQ-for-others version (f-CFQ) before and 3 months after aortic valve replacement. The questionnaires evaluate the frequency of failures in daily living related to memory, attention, action and perception.

RESULTS: POCD occurred in all tests that had been applied to assess declarative memory functions; the mean performance dropped from baseline in these tests (P-values ranging from 0.033 and <0.001). The s-CFQ did not differ between baseline and postoperative assessment [baseline: mean 37.60, standard deviation (SD) 14.38; post: mean 36.22, SD 12.29] (t(0.05, 76) = 1.17; P = 0.246). However, the assessment by others was worse in the f-CFQ after surgery [baseline: mean 8.02, SD 4.51; post: mean 9.58, SD 6.11] (t(0.05, 61) = 2.61; P = 0.012). All changes were observed in questions related to memory and attention failures only. Higher (worse) rates in f-CFQ change scores correlated with neuropsychological change scores, namely in pictorial memory (mistakes) (r = 0.33; P = 0.003) and word fluency (correct answers) (r = −0.29; P = 0.014). Additionally, those patients with worse f-CFQ change scores (>1 SD) from baseline had clearly worse outcomes in word fluency (t(0.05, 60) = 2.53; P = 0.007) and non-verbal learning (t(0.05, 60) = 2.66; P = 0.005). The effects remained significant when controlled for depression/anxiety scores.

CONCLUSIONS: The result demonstrates that cognitive side-effects could have a perceivable impact on daily living functions. However, slight deficits are more realized by others than by the patients themselves. Correlations between ratings by others and psychometric cognitive measures indicate that assessment by others is more reliable than self-assessment.

Keywords: Cardiac surgery • Postoperative cognitive decline • Subjective assessment by self and others

INTRODUCTION

Mild changes in attention, distractibility, memory or personality are often realized by close relatives like spouses in the subclinical beginning stages of dementia, after mild brain injuries, strokes or other neurological diseases [1]. Since the beginning of on-pump heart surgeries in the 1960s, more or less subtle cognitive deficits are postulated as postoperative side-effects. It has been shown that postoperative cognitive decline (POCD) is related to multifactorial components, such as age, cerebral vascular risk factors or intraoperative microembolism, and that surgical strategies and the use of filter devices can mitigate neuropsychological side-effects [2–4]. On an objective level, POCD is substantiated by neuropsychological testing. It remains unclear whether relevance declined psychometric results have for the daily living. Clinicians are often confronted with subjective complaints about cognitive deficits from patients or close relatives of patients. However, are these complaints verifiable on a quantitative level? Are subjective ratings about cognitive failures in daily living associated with psychometrical decline after cardiac surgeries?

A variety of studies reported subjective cognitive complaints, indicating mostly an increase in memory complaints after heart surgeries [5–7]. Most studies focused on self-reported complaints, however, the reliability self-reported deficits remain questionable. One study that included rating by others reported that, in the eyes of patients and spouses, memory is poor after coronary artery bypass grafting (CABG) and angioplasty [5]. As a weakness of that study, the data were surveyed only retrospectively 1–2
years after intervention, thus stating no baseline status, and no
europsychological tests were applied to objectify cognitive
decline. The current study was conducted to elucidate subjective
complaints both by patients and by spouses 3 months after aortic
valve replacement, in comparison with the baseline level and in
relation to objective cognitive measures.

MATERIALS AND METHODS

Enrolment

A random sample of 82 patients, drawn from all patients listed
for elective aortic valve replacement surgery, is included in this
study. Selected patients are representative for all patients who
received isolated aortic valve replacement in the same time
period at our institution. All patients were medically stable at
inclusion. All patients completed a questionnaire related to cog-
nitive failures by self-assessment and psychometric cognitive
testing within 1 month before surgery and reassessed after
3 months (±1 week).

Additionally, at the same time interval, a cognitive failure
questionnaire (CFQ) for assessment by others addressed to
relatives of the patients has been dispatched by post. Twenty
relatives did not answer the questionnaires in a correct manner
(e.g. forgot their names) or refused/forgot to send back the
questionnaires. They had to be excluded from the statistical
analysis. Finally, 62 close relatives (38 females and 24 males) of
the patients completed the CFQ for others (f-CFQ). Most of the
relatives were spouses or long-term partners, only five children
and one sibling completed the questionnaire.

The present study complies with the Declaration of Helsinki. It
was approved by the ethics committee of the Justus-Liebig-
University Giessen. All patients gave signed informed consent.

Surgery

Biological valves were mostly used in patients of older age (≥65
years). However, the decision to use either mechanical or bio-
logical valves was left to the preference of the surgeon and
patient. Finally, 67 patients were selected for biological valve, and
15 were selected for the mechanical valve. For mechanical valves,
anticoagulation was performed by using vitamin K antagonist.

All procedures were performed with conventional full median
sternotomy under cardiopulmonary bypass. Extracorporeal per-
fusion was performed using a roller pump, a hollow fibre mem-
brane oxygenator with a hard shell venous reservoir at a
non-pulsatile flow rate of 2.4 l min⁻¹ × m⁻². The cardiopulmonary
bypass tubing contained a 40-µm heparin-coated arterial line
filter that was used in all patients. The standard cannulation
technique was performed with a single-end aortic arch cannula.
Furthermore, a two-stage venous cannula was placed through
the right atrium and systemic heparinization (400 U/kg). Ad-
ditional heparin was administered if necessary to maintain the
activated clotting time >400 s.

Myocardial protection was undertaken with anterograde and
retrograde warm-blood cardioplegia. Valve implantation was
performed by using the interrupted suture technique with posi-
tioning of subannular pledgets. The standard procedure of deair-
ing was Trendelenburg position and puncture of the apex of the
left ventricle. Operations were performed without of the
application of CO₂. Afterwards, the left ventricle was vented
using an aortic root cannula.

Questionnaires

The subjects completed a validated German version [8] of the
CFQ for self-assessment (s-CFQ) or the f-CFQ [9]. The question-
naires evaluate the frequency of failures in daily living related to
memory, attention, action and perception. As memory impair-
ment is most pronounced in POCD, the s-CFQ was slightly
modified by additional items related to memory failures, which
were included from the validated German version of the
Memory Complaint Questionnaire (MCQ) [10]. All scores were
summarized to a global sum score for both questionnaires.
Furthermore, as the s-CFQ is more extensive, items were
included in a factor analysis with varimax rotation. As the results
did not show additional meaningful outcomes in the main anal-
ysis, only global sum scores are presented. To score depression
and anxiety, the validated German version of the Hospital
Anxiety and Depression Scale (HADS) was used [11]. In all ques-
tionnaires, high scores represent bad outcome.

Neuropsychological assessment

Cognitive examination was performed using a battery of well-
established tests 1–4 weeks before cardiac surgery and 3 months
(±1 week) after intervention. In all domains, parallel test-forms
were used at follow-up. Attention was examined using a number
cancellation test. The patient was asked to cross-out all target
numbers on a test sheet. The performance time was stopped.
Word fluency as a component of executive functioning was
examined by the Regensburger word fluency test (RWT). The vol-
unteer needs to generate words with alternately changing initial
letters (e.g. G/H). Visual memory was examined using the non-
verbal learning test (NVLT) and the pictorial-memory subtests of
the German Syndrom-Kurztest (SKT). In the NVLT, a variety of
120 cards, showing abstract symbols, were presented to the
subject who was asked to recognize particular target symbols.
The SKT, the subject needed to recall objects of a picture list
and, after a delay, to detect the particular objects in a choice list
of pictures. Verbal memory was examined using the delayed rec-
ognition list of the verbal learning and recognition test (VLMT)—
a modified German version of the Rey Auditory Verbal Learning
Test. A list of 15 words was read to the subject in five trials, and
a choice list was read to the subject ~30 min after the first learn-
ing trials. False responses were subtracted from the total sum.

Statistics

Normality of distribution was tested by the Kolmogorov-
Smirnov test and homogeneity of variance by the Levene test.
Follow-up scores vs baseline scores were analysed by using the
t-test for paired samples. In the pre- and post-analysis, the effect
of potential confounder variables (e.g. depression) was con-
trolled by analysis of covariance in a general linear model with
repeated measures. Pearson correlation coefficients were used
to describe associations between variables. Group differences
were calculated by the t-test for independent samples. The
global α-criterion was set at P = 0.05.
RESULTS

Demographics and medical variables are presented in Table 1.

Neuropsychological scores

POCD occurred in all tests that had been applied to assess declarative memory functions; the mean performance dropped from baseline in these test (P-values ranging from 0.033 and <0.001; Table 2). In other tests or domains, no change from baseline was observed.

Questionnaires scores

In regard to cognitive failures, the s-CFQ did not differ between baseline and postoperative assessment (baseline: mean 37.60, standard deviation [SD] 14.38; post: mean 36.22, SD 12.29) (t(0.05, 76) = 1.17; P = 0.246). However, the assessment by others was worse in the f-CFQ after surgery (baseline: mean 8.02, SD 4.51; post: mean 9.58, SD 6.11) (t(0.05, 61) = 2.61; P = 0.012) (Fig. 1). All changes were observed in questions related to memory and attention failures only.

After surgery, in HADS, patients scored depression and anxiety lower (better) in comparison with the preoperative baseline assessment (depression scores, baseline: mean 4.43, SD 2.76; post: mean 3.63, SD 2.52; (t(0.05, 80) = 2.92; P = 0.005) and anxiety scores, baseline: mean 7.04, SD 3.34 (t(0.05, 80) = 4.42; P < 0.001).

Association between cognitive test scores/ depression/anxiety and cognitive failure questionnaires

Higher (worse) rates in f-CFQ change scores correlated with worse results in a few neuropsychological change scores. Patients for whom their relatives stated more cognitive failures postoperatively tended to worse results in SKT-pictorial memory delayed recall (mistake rate) (r = 0.35; P = 0.003) and word fluency (correct answers) (r = -0.29; P = 0.014). In the further analysis, f-CFQ was dichotomized between change scores from baseline >1 SD and less (defined as no change from baseline). Those patients with worse f-CFQ change scores had clearly worse outcomes in word fluency (t(0.05, 60) = 2.53; P = 0.007) and non-verbal learning (t(0.05, 60) = 2.66; P = 0.005) (Fig. 2). Regarding the gender of close relatives, f-CFQ change scores did not differ between female and male responses (r = 0.096; P = 0.459).

Furthermore, change scores in the s-CFQ correlated with higher postoperative anxiety scores (r = 0.30; P = 0.007). Change scores in the f-CFQ also correlated with higher postoperative scores in depression (r = 0.29; P = 0.022) and anxiety (r = 0.36; P = 0.003). However, when controlled for HADS scores, the assessment by others remained significantly worse after surgery when compared with baseline (t(0.05, 61) = 3.04; P = 0.003). Thus, the subjective worsening of memory functions in the eyes of patients correlates with higher f-CFQ change scores.

Table 1: Demographics and medical variables

<table>
<thead>
<tr>
<th>Baseline</th>
<th>Age, mean ± SD, years</th>
<th>68.8 ± 8.7</th>
<th>Males, n (%)</th>
<th>47 (57.3)</th>
<th>Females, n (%)</th>
<th>35 (42.7)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Insulin-dependent diabetes mellitus, n (%)</td>
<td>14 (17)</td>
<td>Arterial hypertension, n (%)</td>
<td>58 (7.3)</td>
<td>Hypercholesterolemia, n (%)</td>
<td>34 (41.5)</td>
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<td></td>
<td>Obesity, n (%)</td>
<td>16 (19.5)</td>
<td>Left heart insufficiency, n (%)</td>
<td>14 (17)</td>
<td>Operation</td>
<td></td>
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<tr>
<td></td>
<td>Total duration, mean ± SD, min</td>
<td>179 ± 46.5</td>
<td>CPB duration, mean ± SD, min</td>
<td>87.6 ± 27.2</td>
<td>Duration of aortic clamping, mean ± SD, min</td>
<td>67.7 ± 22.4</td>
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</table>

Table 2: Neuropsychological scores

<table>
<thead>
<tr>
<th>Test</th>
<th>Pre/post</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
<th>Mean diff.</th>
<th>SD diff.</th>
<th>t-value</th>
<th>df</th>
<th>P-value</th>
<th>Change to worse?</th>
</tr>
</thead>
<tbody>
<tr>
<td>SKT- immediate recall</td>
<td>Pre</td>
<td>5.63</td>
<td>1.61</td>
<td>82</td>
<td>-0.41</td>
<td>1.74</td>
<td>-2.16</td>
<td>81</td>
<td>0.033</td>
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<td></td>
<td>Post</td>
<td>6.05</td>
<td>1.34</td>
<td>82</td>
<td>-0.41</td>
<td>1.74</td>
<td>-2.16</td>
<td>81</td>
<td>0.033</td>
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<tr>
<td>SKT- delayed recall</td>
<td>Pre</td>
<td>6.64</td>
<td>1.65</td>
<td>82</td>
<td>-0.57</td>
<td>1.69</td>
<td>-3.07</td>
<td>81</td>
<td>0.003</td>
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<td></td>
<td>Post</td>
<td>7.22</td>
<td>1.47</td>
<td>82</td>
<td>-0.57</td>
<td>1.69</td>
<td>-3.07</td>
<td>81</td>
<td>0.003</td>
<td>Yes</td>
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<tr>
<td>SKT-recognition</td>
<td>Pre</td>
<td>1.13</td>
<td>1.27</td>
<td>82</td>
<td>-0.79</td>
<td>1.84</td>
<td>-3.91</td>
<td>81</td>
<td>0.001</td>
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<tr>
<td></td>
<td>Post</td>
<td>1.93</td>
<td>1.61</td>
<td>82</td>
<td>-0.79</td>
<td>1.84</td>
<td>-3.91</td>
<td>81</td>
<td>0.001</td>
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<td>Non-verbal learning</td>
<td>Pre</td>
<td>12.72</td>
<td>3.30</td>
<td>82</td>
<td>1.99</td>
<td>5.09</td>
<td>3.53</td>
<td>81</td>
<td>0.000</td>
<td>Yes</td>
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<tr>
<td></td>
<td>Post</td>
<td>10.73</td>
<td>3.62</td>
<td>82</td>
<td>1.99</td>
<td>5.09</td>
<td>3.53</td>
<td>81</td>
<td>0.000</td>
<td>Yes</td>
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<tr>
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<td>1.76</td>
<td>4.24</td>
<td>3.75</td>
<td>81</td>
<td>&lt;0.001</td>
<td>Yes</td>
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<tr>
<td></td>
<td>Post</td>
<td>15.03</td>
<td>5.58</td>
<td>82</td>
<td>1.76</td>
<td>4.24</td>
<td>3.75</td>
<td>81</td>
<td>&lt;0.001</td>
<td>Yes</td>
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<tr>
<td>Word fluency</td>
<td>Pre</td>
<td>9.82</td>
<td>3.76</td>
<td>82</td>
<td>-0.23</td>
<td>5.13</td>
<td>-0.39</td>
<td>79</td>
<td>0.696</td>
<td>No</td>
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<td></td>
<td>Post</td>
<td>10.22</td>
<td>4.31</td>
<td>82</td>
<td>-0.23</td>
<td>5.13</td>
<td>-0.39</td>
<td>79</td>
<td>0.696</td>
<td>No</td>
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</table>

‘Change to worse?’ indicates statistical difference to baseline with worse postoperative performance.

SD: standard deviation; mean diff.: mean of difference; SD diff.: standard deviation of difference; df: degrees of freedom.

aMean scores represent mistakes.

bMean scores represent correct answers.
cMean scores represent mistakes.

dMean scores represent performance time.
POCD following cardiac surgery is a well-known phenomenon. It occurs mostly in memory domains, and the Rey Auditory Verbal Learning test or similar memory instruments belong to the most sensitive measures to detect subtle postoperative decline. In analogy with our previous studies [2, 12, 13], a postoperative cognitive decline was observed in the declarative memory domains in this observational study again. In all tests that had been applied to assess memory functions, the mean performance dropped clearly from baseline. Is the objective decline in neuropsychological test performance reflected by subjective measures? It seems that most of the patients did not realize any new memory difficulties in daily living. The self-reported CFQ did not differ between baseline and postoperative assessment. However, in practice, clinicians are often confronted with complaints of close relatives, such as spouses, who report subtle impairments. This observation is supported by the study results: the assessment by others was worse in the f-CFQ after surgery. Thus, relatives observed more mistakes related to memory and attention failures. Correlations with neuropsychological tests indicate that the subjective view by spouses is associated with objective POCD.

The strength of this study is that it incorporates the spouses’ view. Many studies reported subjective cognitive or memory failures just in the eyes of patients, however, the reliability self-reported deficits remain questionable. One study [14] using the s-CFQ reported even more cognitive failures in the healthy control group than in the CABG group 1 year after surgery. The article discusses a variety of possible explanations. As stated by the authors, it is possible ‘that subjective self-ratings could not reflect absolute levels of everyday competence, but only the relative success of individuals’ adaption to specific environments’. Healthy subjects might be more likely to function in demanding environments and are thus more likely to be confronted with their cognitive weaknesses. Furthermore, CABG patients who recently endured a major cardiac surgery in which a serious, life-threatening disease was treated might value their life and functioning different when faced with only minimal memory impairment. A factor involved could be also the fact that individuals with cognitive—and especially memory—impairment tend to not realize their weaknesses properly or just ‘forget what they forgot’ [14].

In the pertinent literature, the assumption was raised whether subjective—or objective—POCD symptoms just reflect underlying anxiety or depression. Our results do not support this idea. In fact, associations were seen between perceived subjective cognitive failures and depression/anxiety scores. However, it is not reasonable to portray this association as a valid major reason for objective or subjective cognitive decline. As seen in this and all our previous studies, depression and anxiety scores improved significantly after surgery, whereas cognitive decline was verified in all memory tests. Correlations between depression and cognitive tests were not found. Furthermore, the effect of worse postoperative assessment by others in the f-CFQ remained clearly significant after controlling for HADS scores. These results support previous findings. McKhann et al. [6] compared measures of subjective memory complaints in 220 CABG patients with 92 non-surgical cardiac patients at 3 months, 1, 3 and 6 years. CABG patients showed increased memory complaints over the years, except for the 6-year time point—the frequency of memory complaints in both groups was equalizing over time, decreased depression over time, and objective worsening in memory tests that correlated with subjective memory complaints. As seen in our results, also in their study, the authors found that the reported effects remained significant when controlled for depression. In summary, it can be safely assumed that depression or related psychiatric symptoms do not explain, neither objective nor subjective POCD in cardiac patients as a whole.

As conclusions of our study, we point out: POCD after on-pump cardiac surgeries is often perceived by close relatives,
like spouses. The result demonstrates that cognitive side-effects could have a perceivable impact on daily living functions. However, according to our results, slight deficits are more realized by others than by the patients themselves. Although some studies reported increased self-stated memory complaints after heart surgeries and correlations with cognitive tests, in this study we found only increased memory complaints by relatives and correlations between their ratings and psychometric cognitive measures. This indicates that assessment by others is more reliable than self-assessment. Furthermore, we cannot explain subjective or objective POCD by psychiatric pathology such as depression, but we assume POCD to represent a cerebral side-effect of the major heart surgical intervention.

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