Cognitive aging and the effect of coronary artery bypass graft (CABG)

Chapter 14

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ABSTRACT

The present study assesses postoperative cognitive dysfunctions in middle aged and elderly patients who have undergone coronary artery bypass surgery (CABG). A Word Learning test, the Stroop test, and a Reaction Time test were used on four occasions, two times before and two times after surgery. In addition, the patients were compared to individually matched healthy controls at the first test session. The results indicate that CABG patients had an inferior memory performance compared to controls before the operation and that they were slower than controls. Short-term cognitive impairments were found in patient groups ten days but not six weeks after the operation. The elderly group (mean age 67) had a disproportionately impaired performance on a learning task compared to younger patients (mean age 53) ten days after the operation. The results support the notion that age has a role in susceptibility to short-term but not in long-term postoperative cognitive dysfunction.

INTRODUCTION

Both clinical observations and controlled studies have provided evidence that operations under general anaesthesia can give rise to postoperative cognitive dysfunction (POCD; Hole, Terjesen, & Breivik, 1980). However, the literature is not unequivocal as to the nature and extent of these dysfunctions and their epidemiology. Apart from differences between the studies with regard to psychometric and patient characteristics, the factor age also appears to be important (Smith, Roberts, Rogers, & Bennett, 1986; Nadstawek, Hausmann, Bartsch, Födisch, & Stoeckel, 1989; Townes, Bashein, Hornbein, Coppel, Goldstein, Davis, et al., 1989). Older subjects have a higher risk of POCD than younger subjects. It is interesting in this respect that Houx and Jolles have obtained evidence that general anaesthesia can reduce cognitive performance of otherwise healthy individuals (Houx, Vreeling & Jolles, 1991; Houx & Jolles, 1993). This performance decrement was found especially in subjects aged 60 years and over, and the differences involved became steadily greater with increasing age. Operation under general anaesthesia can in this respect be considered a 'Biological Life Event' (BLE) which may influence the normal cognitive aging process. Houx and Jolles (1993) hypothesized that such a BLE may interact with age and shift the age-related cognitive decline to a younger age.

Because studies suggest that age is an important factor in determining the outcome of a coronary artery bypass graft (CABG) operation 8 days after surgery (Newman, Smith, Treasure, Joseph, Ell, & Harrison, 1987; Smith, Roberts, Rodgers, & Bennett, 1988), the present study was devised in order to investigate POCD in relation to age in CABG patients. Specifically, the possible effect of age on POCD was tested by comparing the neurocognitive performance of middle aged and old CABG patients 8 days and 6 weeks after the operation. It was hypothesized that the older group would be compromised more by both short-term and long-term cognitive residual effects (CRE).

Short-term CRE are defined as memory problems, slower processing of information, and inability to concentrate properly for any length of time, in association with reduced brain activity for up to a week at the most following an operation. Long-term CRE are defined as the same symptoms which might, however, occur for up to 6 months after an operation, and sometimes for even longer (Sotaniemi, Mononen, & Hokkanen, 1986). The chance of long-term CRE increases with age. The cause of short-term CRE is thought to lie primarily in the effects of the psychoactive medication given during and after operation, in combination with stress and fatigue (Riis, 1983). The development of long-term CRE is mainly ascribed to the effects of general anaesthesia, which can easily lead to intraoperative and postoperative hypoxia (Rosenberg & Kehlet, 1992).

METHODS

Subjects

Male patients (N=41; ages 41–78 years) who underwent elective CABG in the St. Antonius Hospital in Nieuwegein participated in the study. Patients were assigned to two groups, middle aged (≤60 years, N=21; mean age 53) and old (>60 years, N=20; mean age 67). A control groups was drawn from a larger population of subjects who were normal and healthy according to all criteria used in gerontological research. The controls were matched to the patients in age, education, and socio-economic status. The mean age of the middle-aged and elderly controls was 53 and 69 years, respectively.

Procedure and neurocognitive evaluation

Patients were given several tests to assess cognitive functions twice preoperatively (6 weeks and 2 days before the operation; measurements 1 and 2, respectively) and twice postoperatively (10 days and 6 weeks after the operation; measurements 3 and 4, respectively).
Among several other tests, the following three tests were administered: the Visual Verbal Learning Test (Brand & Jolles, 1985) involves five presentations with free recall of a 15-word list and delayed recall and recognition of this list after 20 minutes. The score is the number of items correctly recalled at each trial. The Motor Choice Reaction test (Houx & Jolles, 1993) was used in order to investigate complex reaction time in the incompatible-choice condition. Finally, the Stroop Color Word Test (Lezak, 1995) was used to measure interference susceptibility.
A distinction was made between short-term CRE and long-term CRE. Short-term CRE were defined as the change in performance from measurement 2 to measurement 3 and long-term CRE as the change occurring from measurement 2 to measurement 4. The performance of the CABG patients on measurement 1 was compared with the performance of the controls to see whether the CABG patients performed systematically poorer.

RESULTS

With respect to memory measures, the immediate recall score over five trials and the delayed recall were taken as measures of learning performance and retrieval from memory. Effects of group and age was found with ANOVA ($F(1,78)=28.1$, $p<0.001$ and $F(1,78)=11.8$, $p<0.001$, respectively), indicating that the patients had an inferior memory performance before the operation compared with controls. A differential effect of the operation was evident in old versus middle-aged patients in that the immediate recall was compromised after 10 days (age by time of measurement interaction effect $F(1,39)=7.7$, $p<0.01$). After 6 weeks, both middle-aged and elderly patients showed an improvement of their performance (Fig. 14.1a). No differential age effects were found on the delayed recall score whereas a significant increase in performance was found after 6 weeks for both age groups (main effect of operation $F(1,39)=20.4$, $p<0.001$, and $F(1,38)=10.25$, $p<0.05$, in immediate and delayed recall, respectively) (Fig. 14.1b).

With respect to the complex speed parameters (Stroop test and Motor Choice Reaction Time), a two way ANOVA yielded a significant group difference before the operation for simple movement speed only. The patient were slower than the controls ($F(1,78)=4.3$, $p<0.05$), with movement speeds of 122.2±42.8 and 127.1±55.0 milliseconds for middle-

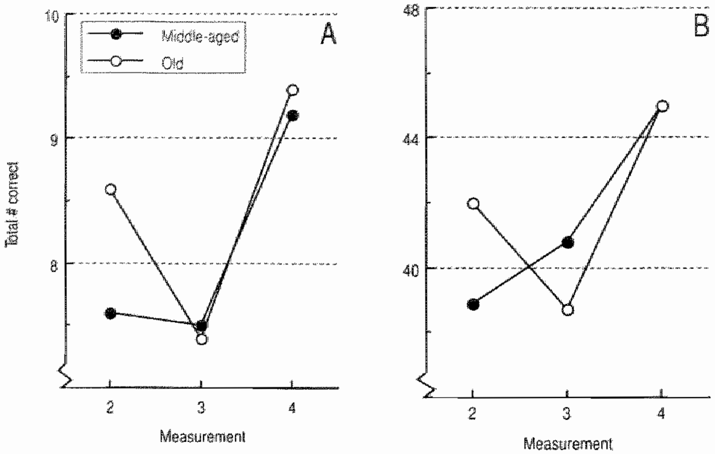

Fig. 14.1.
Performance of middle-aged and old patients in the immediate recall (a), and delayed recall (b) of the memory test. Scores were obtained two days before operation (measurement 2), ten days (measurement 3) and six weeks (measurement 4) after the operation.

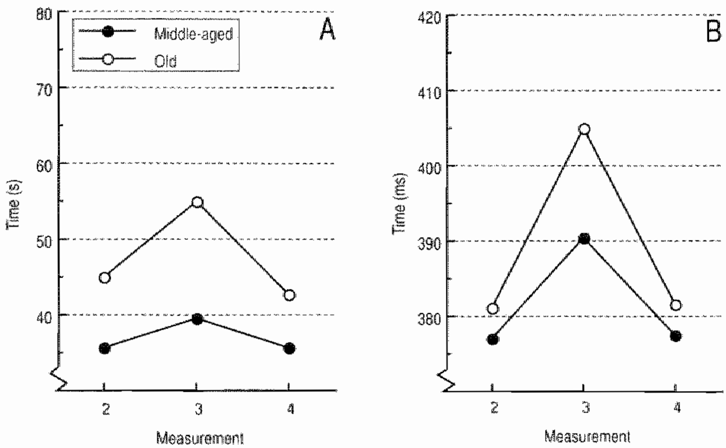

Fig. 14.2.
Performance of middle-aged and old patients in the Stroop Color Word Test (a) and complex reaction time task (b) of the cognitive speed tests. Scores were obtained two days before operation (measurement 2), ten days (measurement 3) and six weeks (measurement 4) after the operation.

aged and old controls, and 148.3±37.9 and 141.9±39.7 milliseconds for middle-aged and old patients. Significant age effects were found for the Stroop Interference scores ($F(1,76)=16.8$, $p<0.001$), which is in agreement with earlier findings. A short-term effect of the operation was found on the Stroop Interference score ($F(1,38)=9.1$, $p<0.01$). The elderly group performed disproportionately worse at 10 days after the operation, but there was not a significant interaction of group by age. The patients showed a decline in performance from immediately before to 10 days after the operation. At 6 weeks after the operation, the patients had reverted to the pre-operation performance (see Figure 14.2a). Similar findings were made for the 'incompatible choice' condition of the motor performance task. There was an operation effect ($F(1,39)=6.2$, $p<0.05$); the patients showed a deterioration of performance immediately after the operation, but after 6 weeks they had reverted to baseline level (see Figure 14.2b).

DISCUSSION

The results showed that elderly and middle-aged patients have a similar pattern of cognitive recovery after CABG. Both groups were slower 10 days after the operation, but their performance speed returned to the baseline level after 6 weeks. Unlike the middle-aged subjects, however, the elderly subjects showed a short-term decline in memory performance. The elderly subjects showed a relatively better long-term recovery. Accordingly, the elderly subjects did not have an appreciably greater mental deterioration in the long-term than the middle-aged patients. A second finding pertains to the cognitive impairment which was found 10 days after the operation and immediately before the patients were discharged from the hospital. These short-term POCD were evident for the majority of the neurocognitive variables used. In contrast to these short-term effects, no long-term POCD were found after 6 weeks. Bed-rest, sleep deprivation, sedation, and general illness have all been thought of as possible causes of postoperative fatigue and impairment in memory and psychomotor skills. These factors could affect all patients equally. However, the present data do provide some evidence that the older age group was somewhat more vulnerable to the effects of the operation, as the older group had a disproportionately impaired immediate recall performance 10 days after the operation. These findings, generally, are in line with earlier research which demonstrated that age is an important factor in determining the cognitive performance of CABG patients 8 days after the operation (Newman, 1987; Smith, 1988).

The relevance of the present findings is that impairments of both memory and complex speed parameters were seen at a time when the patient was judged fit to be discharged from the hospital. As by far the majority of the subjects were characterized by a neuropsychological dysfunction, care should be taken to warn patients that some impairment of memory, concentration, and reaction time can be expected for several weeks to months after the operation. It may be the case that the lack of such a warning may provide a causal factor for the development of cognitive complaints and worries in the postoperative months. It can be expected that those patients who are somatically, psychosocially, or socially in poor condition may be at greater risk of developing long-term distress. Further research should be performed to evaluate this notion.

A problem with CABG patients is that they suffer from a narrowing of the coronary arteries due to atherosclerosis. Therefore, they have a decreased or total blockage of blood flow to the myocardium. This causes a decreased capacity of the heart to pump blood to the brain, and this can affect the brain by interrupting the continuous flow of arterial blood

(Stanton, 1988). Thus heart disease as such can be a risk factor or vulnerability factor for cognitive or brain dysfunction. In this respect, the present data provide support for the ideas of Houx and Jolles about the BLE effect: heart disease can be a BLE, as evidenced by the decreased cognitive performance scores of the CABG patients even before the operation. Anxiety can be discarded as a causative factor for this decreased performance (Dijkstra, Houx, & Jolles, subm.). A similar study with different kinds of surgery is planned. In a multi-centre study involving 1,800 elderly patients (over 60 years of age), cognitive functions before and after operations under general anaesthesia will be measured. An additional question posed in follow-up research which is in progress relates to the epidemiology of cognitive complaints and disorders after anaesthesia. How often does this occur? This question is being investigated in the context of the Maastricht Aging Study (MAAS). BLE and psychosocial factors will be identified, and, in particular, operations carried out under general anaesthesia will be analysed in detail in relation to the existence of complaints and cognitive disorders.

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