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Case Report

Case Studies of Postoperative Cognitive Dysfunction in Elderly Patients

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ABSTRACT

Background and Objective: Postoperative cognitive dysfunction (POCD) involves decline in several cognitive domains after surgery and is particularly common after cardiac surgery. Given the potential effects of such cognitive dysfunction on quality of life, it is important to study it in multiple populations in order to limit its occurrence. Recent advances in surgical technology may assist in achieving this goal.

Methods: We present the long-term neuropsychological outcome of two elderly patients, one of whom had off pump heart surgery and the other oncological surgery. We administered a series of neuropsychological tests assessing attention, complex scanning, verbal working memory, executive functioning, short-term and long-term memory, and visuospatial perception before surgery, prior to discharge, at 3-month follow-up and 6 years after surgery. We compared the performance of these two patients to normative datasets.

Results: Despite equivalent levels of pre-surgery performance between the two patients, the oncology patient exceeded his preoperative neurocognitive levels, suggesting less postoperative cognitive dysfunction in the heart patient overall, on all neuropsychological domains at 6-year follow-up, except short-term retention. In contrast, the heart patient showed no improvement, and, instead, showed some cognitive decline which remained consistent over time.

Conclusion: Our findings highlight the critical role of the type of surgery utilized in the development of POCD and have implications for clinical management and patients' quality of life in the very long term.

Key Points

- Postoperative cognitive dysfunction assessing cognitive domains with neuropsychological tests is necessary in heart surgery and breast cancer for optimal quality of life.
- The research highlights the critical role of the type of surgery utilized in the development of POCD and have implications for clinical management and patients' quality of life in the very long term.

Introduction

Postoperative cognitive dysfunction (POCD) refers to impairment in one or more cognitive domains after surgery. This may include decrements in attention, orientation, memory, and learning and may improve to baseline levels by three months after surgery [1, 2]. The severity of POCD covers a broad range, varying from mild cognitive decline to severe dementia and postoperative delirium [2]. Researchers suggest that approximately a quarter of elderly patients who undergo major surgery suffer from cognition dysfunction and 50% of these patients will experience a permanent dysfunction [3]. While present after various types of surgery, it is most common after cardiac surgery employing cardiopulmonary bypass [4]. The reason of cognitive decline after anaesthesia and surgery remains unclear, but research indicates that this could be a result from the anaesthesia, the surgery, the patient, or their combination. The temporal relationship to anaesthesia and surgery that identified, does not imply causation. Although poor cerebral oxygenation can lead to poor cerebral and cognitive outcomes, cognitive decline after surgery in the elderly can be developed in the absence of cerebral hypoxemia [5].

Heart surgery often leads to cognitive impairment, in spite of life-saving potential. Extracorporeal circulation (ECC) often causes side effects varying from mild to severe vascular cerebral stroke, as well as renal and pulmonary complications, and systemic inflammatory response [2]. The extensive influence of ECC, not surprisingly, may have an adverse

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impact on cognitive functions. A comprehensive neuropsychological assessment is necessary for the detection and specification of POCD, as it is sometimes quite subtle and may elude detection [6]. The incidence of postoperative cognitive decline among cardiac surgery patients is far from trivial. Specifically, studies have reported rates ranging from 11% to 80%, and it persists in as many as 42% of patients up to 3-5 years later, referred to as long-term POCD [7, 8]. In contrast, the incidence of POCD after non-cardiac surgery appears to be much lower, showing substantial improvement over time; the prevalence rate one week after surgery is 25.8%, at 3 months it is 9.9 % and at 2 years it is 1% [4].

Cancer survivors are exposed to several risk factors for cognitive dysfunction, such as general anaesthesia, surgical trauma, among others. Sekiguchi *et al.* (2016) examined patients with breast cancer who underwent surgery, 1 week and 6 months after surgery and showed attentional dysfunction and thalamic volume reduction immediately after surgery [9, 10]. This is considered due to changes in brain structure, particularly in the thalamus, that occurs immediately after surgery. Patients would develop clinical POCD are those with risk factors of POCD, such as the severity of surgery, the occurrence of complications, and pre-existing cognitive impairments [10]. PCCI caused by chemotherapeutic drugs that are cytotoxic affecting both normal and cancer cells, they contribute to cognitive impairment following chemotherapy treatment. Cognitive dysfunction is common following other anticancer treatments such as radiation therapy, hormonal therapy, surgery, or in patients with noncentral nervous system cancer, and has important effects on brain functioning.

In addition, several studies suggest that clinical manifestations of cognitive dysfunction may occur in cancer patients, prior to chemotherapy or in patients who are not treated with cancer therapies. Because of the above, some researchers suggest that it should be more correct if we use the term cancer-related cognitive dysfunction [11]. In addition, Megari (2020) have found that breast cancer patients who received chemotherapy, performed worse compared to patients with prostate, colorectal and thyroid cancer in cognitive tasks including attention, memory, executive functions and language [12]. Moreover, breast cancer patients had significantly greater difficulty in performing IADL compared to patients with other types of cancer [13]. Several investigators have speculated regarding the possible mechanisms of POCD suggesting intraoperative cerebral ischaemia and cerebral oxygen desaturation, caused by hypoperfusion, arrhythmias, rapid rewarming and inflammation, either local or global, as potential risk factors [14, 15].

As regards the etiologic role of cardiopulmonary bypass and anaesthesia in the development of POCD, the main fact is that it remains quite controversial [2]. Among potential contributory factors that have not been well established, is the subtle blood pressure change during coronary artery bypass surgery that can cause watershed strokes, as well as the drugs associated with anaesthesia [16, 17]. In addition, it has been hypothesized that nonspecific effects of surgery, such as postoperative pain, medications, and sleep disturbance, may also be contributing factors for POCD [18]. Demographic and clinical factors that are correlated with postoperative cognitive dysfunction include the patient’s age, educational level, preoperative cognitive performance and comorbidity [19]. Older patients, with limited education and comorbid cerebrovascular disease are the most likely to show POCD [2, 20]. Thus, the pathogenesis of postoperative cognitive decline remains unclear, as it may be a multifactorial phenomenon.

POCD may have additional sequelae. It has been found to be associated with increased morbidity and mortality, prolonged hospitalization, and increased health care costs, and may have an adverse impact on social functioning and health-related quality of life [21]. Most critically, it has important social implications for patients as well as their caregivers, as it can limit patients’ social functioning, independent living and autonomy [2]. Therefore, it would be important to assess all patients post-surgically for this condition. Perhaps due to the multifactorial nature of the pathogenesis of POCD, there does not appear to be a single intervention that might provide adequate protection of the brain during surgery [14]. Prevention is the best treatment for many diseases and in case of POCD, early recognition and management of potential perioperative risk factors can lead to optimal outcome of patients who undergo surgical procedures. Long-term follow-up of POCD is essential in understanding the factors related to its development and treatment. Most long-term follow-up assessments have been conducted as early as one month and as late as five years post-surgery [22]. In the present study, we investigated two patients at four time points: at baseline (pre-surgery), before discharge (7-10 days post-surgery), three months post-surgery and 6 years post-surgery.

Table 1: Patients’ demographic and clinical characteristics.

Characteristic	Case 1	Case 2
Type of surgery	Heart	Oncology
Age (yrs)	76	75
Education (yrs)	12	10
Gender	Male	Female
Surgery time (min)	88	93
Length of ICU stay (days)	2	1

Methods

I Participants

Participants in this study were two patients. One suffering from CAD scheduled for elective off-pump coronary artery bypass grafting and the other patient with breast cancer scheduled for mastectomy. The two study patients were matched regarding their demographic and clinical characteristics, as seen in (Table 1). Exclusion criteria for the original neuropsychological study were a pre-existing psychiatric or neurological disorder, inability to cooperate with a neuropsychological assessment, as judged by the experimenter, carotid artery stenosis greater than 60%, as assessed with duplex ultrasonography, a history of substance and alcohol abuse, and cancer patients receiving chemotherapy or radiation therapy. A description of the two patients follows:

i Case Report I

B.C is a 76-year-old man with 12 years of education, who had worked as an administrator in an office. He is married and has two adult children. Other than his CAD, he had a negative medical history. He underwent off pump cardiac surgery and received neuropsychological testing before surgery, prior to discharge (7-10 days after surgery), at three-months postoperatively, and 6 years after surgery.

ii Case Report II

P.H. is a 75-year-old woman with 10 years of education, who had worked as a nurse. She is married and has three adult children. She, too, had a negative medical history other than her cancer problem, and underwent surgical mastectomy. A neuropsychological assessment was conducted before surgery, prior to discharge (7-10 days after surgery), at three-month follow-up, as well as 6 years postoperatively.

II Procedure

We administered a battery of neuropsychological tests and assessed all major cognitive domains (visual-spatial perception, executive functions, complex scanning and visual tracking, attention, verbal working memory, and short- and long-term memory). The battery included tests with multiple versions or tests that could be adapted to multiple administrations in order to avoid potential practice effects in follow-up testing. Also included were scales measuring anxiety, depression, and positive and negative mood, as neuropsychological performance may be influenced by a patient's mood state (Table 2). This assessment required approximately 60 minutes for each patient to complete and was blind to patient management. We investigated cognitive changes prior to discharge, three months and six years after surgery, in each patient by comparing their follow up scores to pre-surgery baseline scores on each test as well as normative data. The criterion of change that we chose to apply was that of 20% decrease. We defined cognitive dysfunction as a postoperative 20% decrease, relative to pre-surgery performance, on 20% of neuropsychological tests at each follow up time point [7].

Table 2: Raw scores of neuropsychological performance and mood ratings of two patients at four time points.

Test	Time-point	Case 1	Case 2
Stroop Word	*T1*	57	60
	T2	36‡	59
	T3	38‡	69
	T4	38‡	69
Color	*T1*	45	49
	T2	38	47
	T3	40	55
	T4	38	54
Color-Word	*T1*	25	26
	T2	12‡	23
	T3	23	28
	T4	21	38
Fuld Object Memory Test ***Storage***	*T1*	42	40
	T2	31‡	44
	T3	32‡	46
	T4	35	47
Retrieval	*T1*	30	32
	T2	31	33
	T3	29	36
	T4	31	36
Repeated retrieval	*T1*	23	23
	T2	17	23
	T3	18	27
	T4	17	27
Long-term recall	*T1*	8	8
	T2	6	7
	T3	7	10
	T4	7	10
Long-term recognition	*T1*	2	2
	T2	4	3
	T3	3	0
	T4	3	0

Ineffective reminders	*T1*	5	4
	T2	5	2
	T3	6	1
	T4	6	0
Symbol Digit Modalities Test	*T1*	51	55
	T2	38	51
	T3	41	57
	T4	41	57
Judgment of Line Orientation	*T1*	7	7
	T2	5	7
	T3	6	8
	T4	6	8
Digit Span ***Forward***	*T1*	6	6
	T2	4	6
	T3	4	10
	T4	4	10
Backward	*T1*	4	4
	T2	2‡	4
	T3	3	5
	T4	3	5
Scale			
PANAS ***Positive Affect***	*T1*	40	41
	T2	37	41
	T3	38	41
	T4	35	34
Negative Affect	*T1*	16	19
	T2	16	16
	T3	15	13
	T4	18	12
Geriatric Depression Scale	*T1*	1	1
	T2	3	0
	T3	2	0
	T4	4	2
State-Trait Anxiety Inventory	*T1*	35	37
	T2	32	31
	T3	30	28
	T4	28	22

‡ This mark indicates cognitive decline relative to normative data and according to the 20% decrease criterion.

Results

The two patients did not differ from each other, nor from the normative datasets, on their neuropsychological performance preoperatively. Yet post-surgery, the two patients' cognitive performance diverged (Table 2). Specifically, according to the 1 SD criterion, Case 1 had cognitive decline on attention at the 3-month follow-up time point, on executive functions immediately postoperatively and on short-term memory at two follow up time points. In contrast, Case 2 had increased performance at three-month and at six-year follow-up after surgery, compared to his preoperative performance, with no cognitive decline. With respect to mood measures, neither patient had elevated scores on depression, anxiety, or positive and negative mood scales, nor did they show significant change over time.

Discussion

Our findings indicated different patterns of change postoperatively, despite equivalent levels of cognitive abilities preoperatively. Specifically, the cancer patient had no cognitive decline postoperatively, and, in fact, showed increased performance on attention, executive functioning, short-term and long-term memory, verbal working memory, complex scanning and visual-spatial perception across the four time points. In contrast, the heart patient showed some cognitive decline, specifically on attention, executive functions, verbal working memory and short-term memory, which remained consistent over time, and never reached his pre-surgery baseline neurocognitive levels. Both cases showed consistency at six years after surgery, relative to the three-month follow-up, indicating that their cognitive status remained stable over time, and that any spontaneous recovery had ceased by three months postoperatively. In conclusion, the present findings suggest long term improvement of cancer patient and failure to reach preoperative levels after heart surgery. This improvement of cognitive functioning among cancer patients has implications for resuming social and occupational roles, as well as for quality of life after surgery. In contrast, heart operations are associated with an increased risk of cognitive decline three months after surgery that appears not to improve over the course of a six-year follow-up, with implications for reduced daily functioning.

Some limitations of the present study should be considered, with respect to the generalizability of our findings. Long term outcome was available only for two patients. Future investigations should include more comparison groups, such as non-surgical patients with coronary artery disease who are treated medically, or patients undergoing other major non-cardiac surgery with general anaesthesia. These comparison groups could help to clarify the respective roles of surgical procedures in developing POCD. Future research is necessary to study the role of variables such as age and degree of pre-existing cerebrovascular disease, peripheral vascular disease, or diabetes and personality factors such as Type D personality -- the so-called distressed personality (with negative mood state and social inhibition) -- as predictors of cognitive outcomes after CABG. Thus, the present findings suggest the influence of the type of surgery (heart or oncology) on cognitive functioning and a partial etiologic role of cardiopulmonary bypass on POCD. The clinical implications are substantial as POCD can have an adverse impact on quality of life and social functioning [23]. In addition, it is a multifactorial problem that may have a serious social and economic impact on society. Any surgery-related technique or procedure with the potential of reducing POCD following surgery may be of great benefit to the patient and his/her family.

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