Original Article

Short-term memory impairment in patients undergoing general anesthesia and its contributing factors

ABSTRACT

Background: Short-term memory disorder following surgery and anesthesia is a common complication of anesthesia and a common complaint of the patients.

Aims: This study was designed to assess memory impairment in patients undergoing elective surgery, investigate the effect of general anesthesia (GA) on memory, and identify the factors contributing to it, as well as the specific effect of anesthesia on each of the memory domains.

Setting and Design: This cross-sectional study was performed in a university hospital.

Methods and Materials: Patients with the American Society of Anesthesiologists (ASA) Class I, II, and III who were candidates for elective abdominal surgery were enrolled. Patients answered several questions based on the Wechsler Memory Scale–Revised V (WMS-R-V), a standardized questionnaire, minutes before entering the operating room (OR) and again after 24 h postoperation, and the differences were recorded.

Statistical Analysis: Analysis was performed using T-independent and Chi-square tests with Pearson's coefficient and Fischer's exact test and Man–Whitney test. Data were analyzed using the Statistical Package for the Social Sciences (SPSS) software.

Results: Four hundred patients (198 females and 202 males) with a mean age of 50.75 years were enrolled in our study. Our study results showed that short-term memory after GA was significantly decreased compared with preanesthesia ($P < 0.05$). There was no significant relationship between memory disorder following GA and gender ($P = 0.18$) or comorbidities ($P = 0.138$). However, older age was found to be a contributing factor to memory loss following GA ($P < 0.001$). The highest and lowest effect of GA were found on the number repeat (45.2%) and personal information (16.2%) domain of the memory.

Conclusion: GA significantly reduces the patient's short-term memory after the surgery.

Key words: Amnesia; general anesthesia; memory disorders; preoperative period; short-term memory

Introduction

Modern anesthesia has increasingly made it possible to perform complex surgeries and diagnostic procedures for patients with confidence and led to significant advances in the medical field. For a long time, it was believed that general anesthesia (GA) exerted a temporary, reversible effect on the central nervous system (CNS), returning to its original state

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once it was discontinued.[1] Today, we know that the long-term effects, including cellular signal changes and their effects, after exposure to anesthesia are abundant,[2] and these effects may be favorable or undesirable.[3] Anesthesia medications received during surgery are associated with cerebral dysfunction in young and old people.[4] Recent studies have also consistently reinforced the belief that anesthetics can cause morphological changes and long-term functional impairment.[5] Postoperative cognitive dysfunction (POCD) leads to cognitive and memory impairment following surgery.[6] In addition, anesthesia is referred to as a temporary memory disorder.[7] Previous studies have shown that the incidence of POCD 1 week after noncardiac major surgery is 40% in elderly patients and it remains at about 10% even after 3 months of surgery.[8] Memory impairment and impaired learning ability are the most common clinical manifestation of POCD.[6] Despite the lack of evidence for the pathogenesis and molecular mechanism of POCD, studies indicate that POCD is a neurological disorder that results from a combination of factors, including surgery, anesthesia, etc.[9] Neurodegenerative diseases, inflammatory diseases, and CNS disorders have also been implicated in the mainstream of the POCD pathogenesis hypothesis.[6] Recent studies suggest that GA can have long-term effects on memory and perception. So far, researchers have found evidence of increased risk of cognitive and memory impairment in elderly patients following anesthesia;[10] however, more recent studies have shown evidence of anesthesia in middle-aged patients' memory impairment.[11] Anesthesia and its complications despite being used for more than a century still remain a mystery to the physicians. POCD is a common complication of anesthesia and can occur up to 80% after cardiac surgery and 26% after noncardiac major surgeries,[12] as well as a possible association between POCD and increased risk of Alzheimer's disease (AD). According to recent studies,[13] identifying the causes, understanding its precise mechanism, and trying to prevent it from occurring is an important priority in public health.[14]

Surgery and anesthesia bring significant degrees of stress to the patient, and the use of anesthetic drugs and hemodynamic fluctuations and other operating room (OR) events can affect the patient's memory status and, therefore, lead to patients' dissatisfaction.[15] This has led to extensive researches in patients undergoing nonneurologic surgeries.[16] Memory and learning are among the most complex and important behavioral processes, and as the spectrum of anesthetic worldwide use is expanding, knowledge about the effects of these drugs on the memory process is of particular importance. So far, no direct effect of anesthesia on any domain of the short-term memory has been investigated. Therefore, we designed this study to obtain more needed information about the effects of anesthesia on memory and examine each of the memory domains more closely. The aim of this study was to investigate the factors affecting memory impairment caused by GA and the anterograde and retrograde effects of anesthesia on the memory process.

Subjects and Methods

This cross-sectional study was performed on patients who were ASA Class I, II, or III and had undergone GA and elective abdominal surgery. Patients younger than 18 or older than 80 years old, abusive drug users, patients with a history of brain damage, seizures or other mental or psychiatric disorders, patients who took any neurological or psychological drug, and patients who did not consent to participate in the study were excluded. Random sampling was performed. The variables studied in this study consist of age; gender; and comorbidities (nonneurological diseases), including diabetes, hypertension, etc.

All the patient information was kept confidential, and this study was performed based on the declaration of Helsinki. Written informed consent was obtained from the patients before entering the study.

In this study, the Wechsler Memory Scale–Revised V (WMS-R-V) questionnaire was used to measure recent memory. Due to cultural and environmental effects, the WMS-R V questionnaire was modified and standardized in Persian.

Patients responded to a specified number of questions minutes before entering the OR, and the questions were asked again 24 h after the surgery, and their differences were recorded. In addition to determining the total score, which is the total state of memory, this test has five subtests, each of which determines the status of separate parts of memory. These five subtests include personal information, orientation to time and place, mental control, logical memory, and number repeat.

Data were analyzed by the Statistical Package for the Social Sciences (SPSS) software, version 22 and Excel 2016 statistical software. The analysis was performed using T-independent and Chi-square tests with Pearson's coefficient and Fischer's exact test and Man–Whitney test with $P < 0.05$ was considered significant.

Results

Four hundred patients belonging to ASA Class I–III who were candidates for elective abdominal surgery and GA were enrolled in this study. Our study population consisted of

198 (49.5%) females and 202 (50.5%) males between the age of 18 and 78 years, with the mean age of 50.75 years. We categorized our study population based on sex, the presence of comorbidity (diabetes, hypertension, previous surgical history, etc.), and age to measure their effect on short-term memory impairment after GA. The results showed that 166 patients (41.5%) had no comorbidity and 234 (58.5%) had one or more comorbidities. Of the 198 female patients, 88 had no comorbidities and 110 had comorbidities. In men, out of the 202 patients, 78 had no comorbidities and 124 had comorbidities. The results of the Chi-square test showed that there was no significant difference between the two groups in terms of male and female comorbidities ($P > 0.237$). Based on the mean age of our participants, we divided the patients into two groups of older (≥50 years) and younger (<50 years), including 170 (42.5%) and 230 (57.5%) patients, respectively.

The effect of GA on each domain of short-term memory is shown in Table 1.

Our results showed that there are statistically significant differences between pre and postanesthesia in terms of the mean scores for short-term memory domains. For the total score, the mean scores before and after anesthesia were 34.37 and 29.49, respectively. According to Table 1, there is a significant difference between the level of short-term memory not only in the total scores but also in every other five domains of our study.

Table 2 summarizes the effect of anesthesia on different domains of short-term memory divided by gender, comorbidity, and age with respect to the magnitude of the effect. The results showed that GA influenced the total score of 29.6%, However, it had the highest effect on number repeat (45.2%) and the least effect on personal information (16.2%). No significant correlation between gender or comorbidity and short-term memory impairment was found ($P = 0.18$, $P = 0.138$, respectively). However, there has been a significant correlation between age and short-term memory impairment ($P < 0.001$).

Table 1: Pre and postanesthesia mean score differences

Variable	Mean difference	*P*
Personal information	0.29	<0.001
Orientation	0.39	<0.001
Mental control	0.67	<0.001
Logical memory	1.43	<0.001
Number repeat	2.20	<0.001
Total Score	4.88	<0.001

Discussion

Given the impact of anesthetics on the function of memory and the increasing use of these drugs, it is important to know the extent of these changes and how they are affected. Accordingly, various studies have been conducted around the world to understand the effect of GA on memory and how it is used. Previous studies have confirmed the definitive effect of anesthesia on short-term memory, but its precise mechanism has not been determined, and in most previous studies, there has been no clear association between anesthesia and long-term POCD. Most studies have found that there is no significant relationship between anesthesia and long-term memory impairment.[17,18] According to the results of previous studies showing that anesthetics temporarily affect patients' memory and given the importance of other uncertain and unproven content in this area, we did a study that identifies the effect of GA on different areas of the memory. In this study, we also examined the variables of sex, comorbidity and age, and their relationship with postanesthesia memory impairment.

Researchers at the University of Toronto[19,20] investigated the effects of anesthetics on memory loss receptors of the brain. According to their study, even after the disappearance of anesthetics, these receptors remain active for some time and affect the memory. A 2008 study by Rasenberg *et al*., consisting of 1064 patients over 18 years of age at the Florida Hospital,[21,22] found factors, such as older age, lower education level, history of vascular problems, and previous POCD, are associated with cognitive impairment in the first 3 months after the surgery. We also examined the age and concluded that older age acts as a risk factor for memory dysfunction in all different domains of memory. However, we did not examine the education level as a variable. In the

Table 2: The effect of gender, comorbidity, and sex on postoperative memory impairment

Variable	All	Gender			Comorbidity			Age		
		Male	Female	*P*	+	−	*P*	Older	Younger	*P*
Personal information	16.2%	16.5%	15.8%	0.74	23.6%	22.6%	0.81	35.9%	14.4%	0.001
Orientation	25.7%	26.5%	25.0%	0.72	27.7%	28.2%	0.82	37.5%	22.3%	0.001
Mental control	23.8%	24.3%	23.4%	0.70	29.6%	28.7%	0.76	41.5%	16.1%	0.001
Logical memory	18.9%	18.4%	19.5%	0.62	22.0%	21.6%	0.74	29.4%	14.5%	0.001
Number repeat	45.2%	42.2%	48.6%	0.14	52.7%	52.8%	0.90	69.6%	38.9%	0.001
Total Score	29.6%	27.0%	32.5%	0.18	35.8%	38.8%	0.13	54.9%	23.2%	0.001

study by Johnson *et al*.,[23,24] the prevalence of POCD in the first week was reported to be 19.2% compared to 4.4% in the control subjects. The prevalence of cognitive impairment after 3 months was 6.2%, which was not significantly higher than the control group (4.1%) and was unable to prove evidence of POCD after three months of surgery. In this study, we assessed patients' short-term memory during the first 24 h after anesthesia, which confirmed the results of previous studies but did not investigate the long-term outcome. William *et al*.[25] found that GA increases the risk of POCD more than local anesthesia, which we did not compare. A study by the Department of Anaesthesia of Denmark and many other studies found that there was no significant relationship between anesthesia and long-term POCD.[17,18]

In this study, we examined each of the memory domains more closely which had not been performed in previous studies. As in previous studies,[26,27] we found a significant relationship between the effect of GA on short-term memory of patients and as we showed a more memory impairment in the area of number repeat which corresponded to working memory, and fewer memory changes in the field of personal information which corresponded to reference memory. As a result, we found that anesthesia affects working memory more, confirming previous studies.

We also found that GA had the highest effect on the repetition of cultivars (45.2%) and the least on personal and public information of patients (16.2%), which is consistent with the results of previous studies. So, the working memory section is more affected by GA than reference memory.

In conclusion, we found that GA affects the short-term memory, and its most impact is on number repeat, while its least impact is on personal information. There has been no correlation between patients' gender or comorbidity and postanesthesia, short-term memory impairment. However, we found that older age is a risk factor for the decrease in the level of memory 24 h postanesthesia.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published, and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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