

## Original article

# Impacts of General and spinal anesthesia on cognitive function

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**Abstract: Objective:** To investigate the impacts of general and spinal anesthesia on cognitive function in patients undergoing elective surgery. **Method:** A total of 106 patients undergoing elective surgery were selected and randomly divided into the general anesthesia group and spinal anesthesia. Mini-mental state examination (MMSE) was used to assess cognition of the two groups. **Results:** The preoperative MMSE scores of two groups had no significant differences,  $p > 0.05$ . The morbidity of POCD had no statistical significance between the two groups ( $p > 0.05$ ). The MMSE scores in spinal anesthesia group were lower than general anesthesia group in 24h, 48h after surgery,  $p < 0.05$ . The MMSE scores of two groups in 48h and 5 years were decreased when compared with in 24h after operation respectively,  $p < 0.05$ . **Conclusions:** The two anesthesia methods have no different effect on the occurrence of POCD. The effect of spinal anesthesia had more adverse influence on cognitive function of patients undergoing elective surgery than that of general anesthesia. Meanwhile, cognition impairment of general anesthesia and spinal anesthesia was a short-term effect and reversible, and there was no obvious damage to the long-term cognitive function.

**Key words:** General anesthesia; Spinal anesthesia; POCD; MMSE.

## Introduction

Postoperative cognitive dysfunction (POCD) is a common central nervous system complication during the perioperative period (Chung W, Park S, Hong J, et al. 2015), mainly manifests as postoperative delirium and deficits in the domains of attention, emotion and personality (Eckenhoff R, Maze M, Xie Z, et al 2020). These symptoms could disappear within a few years, but some may continue for several years or recur after improvement. Recent years, the changes in learning and memory, orientation, abstract thinking, attention and insight that occurred within 1 year of the perioperative period are collectively referred to as perioperative neurocognitive disorders (PND), POCD is a typical type of PND (Eckenhoff R, Maze M, Xie Z, et al 2020). Although the morbidity and mortality of POCD during the perioperative period have been greatly improved, these diseases still

have a great impact on the quality of life and overall health of patients after surgery. The pathogenesis of POCD is not clear at present, whether anesthesia has an impact in cognition remains obscure (Strøm C, Rasmussen L et al 2014).

Recent studies have found that anesthesia is an important risk factor for the occurrence of POCD (Mandal P et al 2016). It is widely accepted that general anesthesia has a negative effect on cognitive function. However, research found there was no difference in the incidence of POCD among patients undergoing general anesthesia or spinal anesthesia, and further observations had found that there was an increasing morbidity of POCD under spinal anesthesia (Squire L et al 1991). Thus, it's necessary to discuss whether different anesthesia methods have diverse effects on cognition. The aim of our study is to explore whether gener-

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al anesthesia and spinal anesthesia which as commonly used clinical anesthesia methods have any influence on cognition and have difference on POCD.

**Methods**

This study was done in the Department of Anesthesiology, Affiliated Hospital of Zunyi Medical University, Zunyi, Guizhou, China, from October 2015 to September 2016, A total of 106 elective surgery patients were selected as the research subjects. Inclusion criteria were patients aged from 18 to 65years of age, American Society of Anesthesiologists grade (ASA) I-III grade. Exclusion criteria were patients with neurological diseases, cognitive disorders, unable to communicate normally, history of have taken other experimental drugs or participated in other clinical trials in 3 months. The subject was approved by the medical ethics committee of hospital, and all patients have signed an informed consent. The 106 patients were divided into general anesthesia group and spinal anesthesia group in accordance with the random number table. Among them, 51 cases were in the general anesthesia group and 55 cases were in the spinal anesthesia group. After the two groups of patients entered the operating room, the peripheral venous channel was routinely opened, heart rates, blood pressure, electrocardiogram and pulse oxygen saturation were recorded every 5 minutes via monitor.

Mini-mental state examination (MMSE)(Mystakidou K, et al 2007) is a universally acknowledged tool to assess cognitive function, which has the characteristics of simplicity and high validity. It contains five sections: orientation, attention and calculation, memorization, language, and recall. It consists of 20 questions and a total of 30 points. When question answered correctly counted as 1 point, wrong or ignorant counted as 0 point. Patients who illiteracy (no education) less than 17 points, elementary school education (education ≤6 years) less than 20 points, middle school or above education (education ≥6 years) less than 24 points were judged as cognitive dysfunction. The scores measured by MMSE 24h after surgery, 48h after surgery and 5 years after surgery were compared with the scores of the patient 24h before sur-

gery. If the score differs by ≥2 points, considered the patient has POCD.

After inhaled oxygen by mask, general anesthesia group through intravenous drop midazolam 0.05-0.075mg/kg, Eto-midate 0.15-0.3mg/kg, fentanyl 0.4g/kg, and Rocuronium 0.6mg/kg by turn, then, mechanical ventilation after tracheal intubation, maintain the depth of anesthesia by intravenous injection of propofol and remifentanyl. During the operation, the muscle relaxant was added intermittently according to the operation situation, and sevoflurane was given occasionally when needed. Anesthesiologist removed the tracheal tube after assessing whether the patient has reached the extubation indications after surgery. Anesthesia ventilation respiratory parameters were tidal volume of 6-8 ml/kg, respiratory quotient 1:2, and oxygen flow at 1 L/min. Puncture was performed on the intervertebral space of the L2-3 or the L3-4 of spinal anesthesia, then 8-12mg bupivacaine was injected, if necessary supplemented by 0.25% lidocaine for anesthesia, adjust the level of anesthesia to meet the needs of surgery.

SPSS 17.0 statistical software was used for data analysis. Measurement data were expressed as mean ± standard deviation. The independent samples t-test was used for comparison between the two groups. Count data were expressed as frequencies with percentages and x2 test was used to compare the count data for multi-group measurement data. A difference with a p-value less than 0.05 was considered statistically significant.

**Results**

There was no difference in age, weight, ASA physical status, gender distribution and previous anesthesia history between general anesthesia group and spinal anesthesia group (p > 0.05 )(Table 1).

Postoperative delirium was present in 9 patients (17.65%) for the general anesthesia group and in 8 patients (14.55%) for the spinal anesthesia group in 24h after surgery. In 48h after surgery, the number of patients who experienced cognitive decline in the two groups was 5 (9.80%) and 1 (1.82%). Results of follow-up 5 years later indicated that POCD oc-

**Table 1.** Patients’ characteristics data in patients receiving elective surgery of general anesthesia group and spiral anesthesia group.

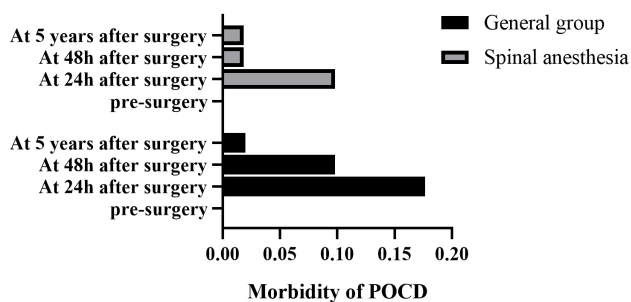
	<b>General group (n=51)</b>	<b>Spinal group (n=55)</b>
Age	45.84±11.43	46.60±11.25
Weight	36.60±0.22	36.01±4.45
ASA (I/ II/ III)	8/ 42/ 1	7/ 47/ 1
Gender (M/ F)	24/ 27	33/ 22
Anesthesia history	18/ 51	25/ 55

Data were mean ± standard or the number of patients.

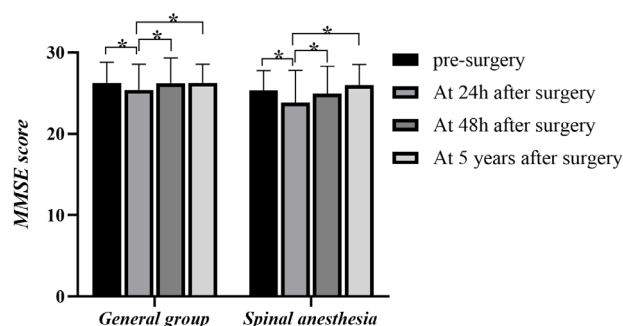
**Table 2.** The MMSE score of patients at pre-surgery, 24h after surgery, 48h after surgery and 5 years after surgery.

Groups	n	pre-surgery		At 24h after surgery		At 48h after surgery		At 5years after surgery	
		Mean ±SD	p-value	Mean ±SD	p-value	Mean ±SD	p-value	Mean ±SD	p-value
General group	51	26.25±2.56	$p > 0.05$	25.41±3.16	$p < 0.05$	26.22±3.13	$p < 0.05$	26.25±2.30	$p > 0.05$
Spinal group	55	25.35±2.40		23.84±3.94		24.93±3.39		26.02±2.52	

Data were mean ± standard or the number of patients.



**Figure 1.** The morbidity of POCD in two groups at different time.



**Figure 2.** The MMSE score of patients at pre-surgery, 24h after surgery, 48h after surgery and 5 years after surgery, \* $p < 0.05$ .

occurred in 1 patient (1.96%, 1.82%) of both the two groups respectively. However, the difference in the incidence of postoperative delirium between groups did not reach statistical significance ( $p > 0.05$ ) (Figure 1).

The MMSE score of spinal anesthesia group was decreased compared with general anesthesia in 24h and 48h after operation ( $p < 0.05$ ) (Table 2). In both groups, cognitive impairment was observed after surgery in 24h (a decrease in MMSE score  $\geq 2$  points from pre-operation), and this impairment had improved in 48h and 5 years after surgery ( $p < 0.05$ ) (Figure 2). Meanwhile, the MMSE score had no difference among pre-operation, 48h and 5 years after operation ( $p < 0.05$ ) (Figure 2).

**Discussions**

In this study, we compared MMSE scores of general anesthesia and spinal anesthesia in patients undergoing elective surgery, in order to investigate whether the type of anesthesia contributes to the development of cognitive impairment. Our research indicates that general anesthesia and spinal anesthesia had no difference in morbidity of POCD. Also, impairments of anesthesia on cognition is a short-term and reversible.

The postoperative cognitive impairment affects the quality of life of patients seriously, increase the mortality rate, prolong the patient’s recovery time and even cause other complications in the clinic (Nakao S, et al 2019). Permanent cognitive impairment could bring serious mental and economic burdens to patients and their families (Steinmetz J, et al 2009). At present, the pathogenesis of POCD is not completely

clear, studies believe that it is closely related to anesthesia, surgery and age (Berger M, et al 2019; Olotu CJ, et al 2020). Meanwhile, there is no specific diagnostic standard for POCD. The Montreal Cognitive Assessment Scale (MoCA), Wechsler Adult Intelligence Scale (WAIS) Mini-mental State Examination (MMSE) and other neuropsychological tests are common selected for preliminary evaluation of POCD internationally, iconography, electrophysiology, biochemical indicators and other clinical examination are used to diagnosis as supplementary means (Borchers F, et al 2021). We used MMSE to evaluate cognitive function, which has high credibility and effectiveness, and is simple and easy to operate, can well reflect a patient’s mental status and cognitive function. Its specificity is 87%, and the sensitivity is 82%, mainly for the measurement of brain cognitive function, and reducing the interference caused by other reasons (Çebi M, et al 2020).

General anesthesia (Moody O, Zhang E, Vincent K, et al 2021) is through intravenous drugs to satisfy sedation, analgesia, and muscle relaxation, or use inhaled anesthetic gas to inhibit the central nervous system temporarily, make patients consciousness loss, pain disappeared and skeletal muscles relaxed, to meet the surgical needs. Spinal anesthesia (Zhang X, Xu T, Jia L, et al 2021) is a method of injecting drugs into the spinal to block nerve conduction to achieve anesthesia effect. General anesthesia can significantly affect the signal transmission among neurons by acting on different targets of central nervous system, regulate the protein expression, trigger apoptosis, and reduce cerebral blood flow. Compared with general anesthesia, spinal anesthesia can reduce the use

of anesthetics, promote postoperative recovery, and reduce nerve damage. Studies showed that postoperative complications and hospital stay in patients with spinal anesthesia are reduced compared with general anesthesia (Havas F, et al 2013). Now, there still has been controversy over whether anesthesia will affect the cognitive function of patients, at the meantime, people often conceive that general anesthesia will cause stupidity. Therefore, conduct a prospective and long-term follow-up clinical study is needful.

In this study, a general anesthesia group and a spinal anesthesia group were set up to evaluate the cognitive function of patients per-operation, 24h after surgery, 48h after surgery, and 5 years after surgery, compared the long-term and short-term effects of general anesthesia and spinal anesthesia on patients' cognitive function. The results found that the MMSE scores of patients in the spinal anesthesia group at 24h and 48h after surgery are lower than general anesthesia group, indicating that spinal anesthesia had a poorer impact on cognitive function than general anesthesia group. And results have shown that two groups of patients experienced a short-term reversible cognitive decline after surgery, may be related to the metabolism of anesthetics. The regulate of cognitive function is related to multiple factors, but there is no significant difference in preoperative MMSE scores and clinical characteristics between the two groups of patients with different anesthesia methods in this study. It can be considered that the physical fitness of the two groups of patients is at the same baseline level before operation.

The limitations of our study are that general anesthesia has not been further refined into intravenous general anesthesia and inhalation general anesthesia. There are many types of anesthetics involved in the experiment, and it is not clear which drug has a greater impact on cognitive function, and our tool to assess whether a patient occurred cognitive impairment is relatively single, there may be some one-sidedness.

### Conclusions

In summary, compared with general anesthesia, spinal anesthesia had a greater impact on the cognition of patients undergoing elective surgery. At the same time, the two methods of anesthesia had a short-term and reversible damage to cognitive function. The function has no obvious effect on long-term cognition.

### Acknowledgements

Not applicable.

### Conflict of interest

There is no conflict of interest in this study.

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## 全身麻醉和腰麻对认知功能的影响

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[摘要]: 目的: 探讨全麻和腰麻对择期手术患者认知功能的影响。方法: 选择择期手术患者 106 例, 随机分为全麻组和腰麻组。采用简易精神状态检查 (MMSE) 对两组患者进行认知功能评定。结果: 两组术前 MMSE 评分比较差异无统计学意义,  $p>0.05$ 。两组 POCD 病患率比较, 差异无统计学意义 ( $p>0.05$ )。术后 24h、48h, 腰麻组 MMSE 评分低于全麻组,  $p<0.05$ 。两组术后 48h、5 年 MMSE 评分分别较术后 24h 下降,  $p<0.05$ 。结论: 两种麻醉方法对 POCD 病的发生无不同影响。与全身麻醉相比, 腰麻对择期手术患者认知功能的不良影响更大。同时, 全麻与腰麻联合应用的认知功能损害为短期效应, 可逆, 对远期认知功能无明显损害。

[关键词]: 全身麻醉; 腰麻; POCD; MMSE

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