Turkish Journal of Geriatrics
DOI: 10.29400/tjgeri.2024.377
2024; 27(1):42–51

- Ekin Anıl ÜNAL[1]
- Mehmet Selim ÇÖMEZ[2]
- Hilmi DEMİRKIRAN[3]
- Onur KOYUNCU[2]
- Sedat HAKİMOĞLU[2]
- Senem URFALI[2]

CORRESPONDANCE

[3]Hilmi DEMİRKIRAN

Phone : +905336676188
e-mail : h.dkiran@hotmail.com

Received : Jan 09, 2024
Accepted : Feb 14, 2024

[1] Sanliurfa Training and Research Hospital, Anesthesiology and Reanimation Clinic, Sanliurfa, Turkey

[2] Hatay Mustafa Kemal University, Department of Anesthesiology and Reanimation, Hatay, Turkey

[3] Van Yuzuncu Yil University, Department of Anesthesiology and Reanimation, Van, Turkey

ORIGINAL ARTICLE

THE EFFECT OF LOW-FLOW VERSUS HIGH-FLOW ANESTHESIA ON POSTOPERATIVE COGNITIVE FUNCTIONS IN GERIATRIC PATIENTS UNDERGOING TUR-P SURGERY

Abstract

Introduction: This paper investigates the effect of low-flow anesthesia applications on postoperative cognitive function in geriatric age group (≥65 years old) patients who underwent elective transurethral resection of the prostate surgery.

Materials and Method: A total of 98 patients aged 65 and over who underwent elective transurethral resection of the prostate surgery under general anesthesia between December 2021 and November 2022 in Hatay Mustafa Kemal University Research Hospital's Department of Anesthesiology and Reanimation were included in the study. The patients were subjected to a mini mental test the day before the operation and postoperatively at six hours, one day, three days, and seven days. Visual analogue scale scores were evaluated at 3, 6, 12, 24, 48, and 72 hours. The data obtained were compared between the patient groups who underwent low-flow (1 L/min, n: 49) and high flow (4 L/min, n: 49) anesthesia. P< 0.05 was considered statistically significant.

Results: A comparison between the postoperative 6thhour, 1st day, 2nd day, 3rd day, and 7th day mini mental testing scores of the low-flow anesthesia and high flow anesthesia groups did not exhibit any notable variations (p: 0.668, 0.785, 0.745, 0.705, respectively). The visual analogue scale scores of the cases at 3, 6, 12, 24, 48, and 72 hours did not differ statistically according to the type of flow applied (p: 0.316, 0.925, 0.651, 0.548, 0.624, 0.466, respectively).

Conclusion: It is thought that low-flow anesthesia can be applied safely, but it does not have a significant effect on cognitive functions compared to high flow anesthesia.

Keywords: Anesthesia, General; Sevoflurane; Cognitive Dysfunction; Geriatrics.

INTRODUCTION

The purpose of general anesthesia (GA) in surgery is to provide appropriate surgical conditions by ensuring early recovery without side effects. With advancing age, brain volume decreases, especially in gray matter, current neurotransmitter levels, receptor numbers, afferent transmission pathways, and speed decrease; moreover, blood-brain barrier permeability increases and cerebral blood flow decreases (1). Therefore, cognitive functions such as orientation, attention, memory, concentration, as well as motor, sensory, and autonomic functions are affected (2). Cognitive dysfunction in patients undergoing general anesthesia may delay healing and prolong hospital stay.

The volatile anesthetics, which are rapidly eliminated with minimal metabolic extinction, may reduce cognitive dysfunction and provide faster recovery in patients in the postoperative period. There are various potential advantages of low flow anesthesia (LFA). It improves the flow dynamics of inspired air, raises mucociliary clearance, keeps body temperature, decreases fluid loss, preserves up to 75%, and diminishes greenhouse gas emissions and costs (3, 4). Some studies have examined the degradation products of low-flow (LF) sevoflurane anesthesia and its effect on organ toxicity (5). It is uncertain how postoperative cognitive dysfunction (POCD) and recovery are affected by low flow sevoflurane anesthesia, and – to our knowledge – very few studies have been undertaken on this topic. In this study, we investigated whether the fresh gas flow (FGF) level affects cognitive functions after LFA with sevoflurane. Although LFA is widely used in clinical practice, our study is one of the few that compare the effects of LF and high-flow (HF) sevoflurane anesthesia on cognitive function in elderly patients. The primary objective, therefore, of this randomized, prospective study was to compare the effect of LF sevoflurane anesthesia and HF sevoflurane anesthesia on cognitive function in elderly patients who underwent elective transurethral resection of the prostate (TUR-P) surgery under general anesthesia. The secondary objective was to identify the factors associated with POCD.

MATERIALS AND METHOD

The study was approved by a decision of the Hatay Mustafa Kemal University Clinical Research Ethics Committee, dated 21.12.2021, with the number 2021/180. The purpose of the study was explained to patients who were taking part in the study and the method to be used, and their written consent was obtained. The prospective, randomized, double-blind study was conducted between December 2021 and November 2022 at Hatay Mustafa Kemal University Health Research and Application Hospital in accordance with the Universal Code of Ethics contained in the Declaration of Helsinki.

American Society of Anesthesiologists (ASA) I–III patients aged 65 and over who were scheduled for elective TUR-P surgery under GA were included in the study. Conditions that cause major bleeding during the operation and increase tissue oxygen consumption (septicemia, thyrotoxicosis, hyperthermic cases, etc.), uncontrolled diabetes, alcoholism, active substance use or withdrawal symptoms, allergy to anesthetic agents to be used, cognitive dysfunction (such as Alzheimer's disease, dementia, delirium, etc.), illiterate patients, and those who did not accept the study were excluded from the study.

In a similar study, the effect size value calculated according to the statistical findings of the study comparing high and low flow by obtaining the difference between the postoperative sixth-hour mini mental test (MMT) values and the preoperative MMT values was 0.407. According to this result, the minimum number of patients to be recruited with 80% power was 96 (6). Using the closed-envelope method, patients who met the inclusion criteria were randomized, and 98 patients completed the study. In the preoperative period, patients' age, body mass index (BMI) and ASA classification were recorded and MMT was applied. The next day, electrocardiography, peripheral oxygen saturation (SpO_2), noninvasive blood pressure (NIBP), and end-tidal carbon dioxide ($EtCO_2$) monitoring were performed on all patients admitted to the operating room. Following the opening of the intravenous (IV) route, 0.9% NaCl infusion was administered in all patients. GA was subsequently induced with 0.03 mg/kg midazolam, 1 mcg/kg fentanyl, 2–2.5 mg/kg propofol, and 0.6–1 mg/kg rocuronium, and the patients received orotracheal intubation. After intubation, 40% O_2 + 60% air + 2.5% sevoflurane mixed FGF was adjusted to 6 L/min, and mechanical ventilation was started. When the minimum alveolar concentration (MAC) of sevoflurane reached a value between 0.8 and 1.2, anesthesia was maintained by adjusting the flow to 1 L/min in patients with LF and 4 L/min in patients with HF. Remifentanil infusion for intraoperative analgesia was administered by titration to 0.05–0.2 µcg/kg/min so that the heart rate (HR) was ± 20% of the preoperative value. During the operation, inspiratory O_2 concentrations (FiO_2) were monitored and were not allowed to fall below 35%. In the case of a decrease, the applied O_2 concentration was increased by 10%. During the operation, NIKB, SpO_2, HR, FiO_2, MAC and $EtCO_2$ values were checked and recorded every 10 minutes. In the intraoperative period, body temperature was measured and recorded with the help of an esophageal temperature probe at 30-minute intervals following the induction. Eye-opening time was defined as the time to eye opening after discontinuation of the volatile agent. In the LFA group, the sevoflurane was turned off 15–20 minutes before the end of the surgery. At the end of the surgery, the FGF was raised to 6 L/min and the FiO_2 was 100%. In the HFA group, after the sevoflurane was turned off, the FGF was raised to 6 L/min and the FiO_2 to 100%. Rocuronium was antagonized with 2 mg/kg sugammadex. When the extubation criteria were met, the patients were extubated and eye-opening times were recorded. The cognitive functions of the patients were re-evaluated and recorded by the anesthesiologist at the sixth hour, and on the first, third, and seventh day postoperatively via MMT. In addition, postoperative visual analogue scale (VAS) scores were recorded after 3, 6, 12, 24, 48, and 72 hours. Diclofenac sodium 2x1 IM was administered to the patients for two days in the treatment of postoperative pain. Moreover, 15 mg/kg paracetamol IV was administered to patients with VAS ≥4. The data obtained for the LFA and HFA groups were compared.

Statistical analysis was performed via the SPSS 22 (Statistical Package for the Social Sciences, IBM, USA) program. Pearson chi-square test was applied to compare the percentages of qualitative data. The suitability of quantitative data for normal distribution was confirmed with the Kolmogorov-Smirnov test. The Mann-Whitney U test was applied in the comparison between two groups of quantitative variables that did not exhibit normal distribution. The Student's t test was used to compare two groups with normally distributed quantitative variables, and the one-way ANOVA test was used to compare more than two groups. The least significant difference test was used to make a pairwise comparison after ANOVA. The correlations of quantitative variables were evaluated using Spearman's correlation analysis. Statistical significance was accepted as $p<0.05$.

RESULTS

The study was conducted with 98 patients who underwent elective TURP surgery under GA, 50% (n=49) of whom received HFA and 50% (n=49) LFA.

When comparing the age, BMI, ASA classification, and operation time of the patients according to the type of flow, no statistically remarkable results were found between the LFA and HFA groups ($p>0.05$; Table 1).

When comparing mean arterial pressure (MAP), mean pulse, and eye-opening times according to flow type, no statistically remarkable results were found between the LFA and HFA groups (p>0.05; Table 1).

In the comparison of MMT scores according to flow type, the preoperative and postoperative sixth-hour, first-, third-, and seventh-day MMT scores of the various cases did not reveal any statistically remarkable result (p>0.05; Table 2).

No statistically remarkable result was found in the comparison of the difference between MMT scores according to flow type in all time periods (p>0.05; Table 3).

When the VAS scores of the cases after 3, 6, 12, 24, 48, and 72 hours were compared according to the flow type, no statistically remarkable result was identified (p>0.05).

Although the initial temperature values were higher than the 30-, 60-, and 90-minute temperature values in both flow types, there was no statistical difference according to the flow type (p>0.05). However, in all other time periods (30, 60, and 90 minutes), a statistically remarkable result was found in the temperature values according to the flow type (p<0.001). Although the temperature values in both groups decreased compared to the baseline, this decrease was greater in the HFA group.

In analyses involving all cases, a strong positive correlation (at the level of 0.781) between age and

Table 1. Age, ASA Scores, BMI, Mean Arterial Pressures (MAP), Mean Heart Rates (MHR), Eye Opening Time and Operation Time (min) Distribution of the Cases by Flow Type

		Total	Flow Type		p
			LFA (n=49)	HFA (n=49)	
Age (year)	Min-Max (Median)	65-92 (74)	65-92 (74)	65-87 (74)	Z= -0,203
	Mean±SD	74,58±6,97	75,00±7,76	74,16±6,13	p=0,839*
ASA n (%)	ASA I	15 (15,3)	7 (14,3)	8 (16,3)	χ^2: 0,378
	ASA II	57 (58,2)	30 (61,2)	27 (55,1)	p=0,828**
	ASA III	26 (26,5)	12 (24,5)	14 (28,6)	
BMI	Min-Max (Median)	20,5-29,7(25,25)	20,5-29,7(25,3)	20,5-29,7(25,2)	T=0,109
	Mean±SD	25,20±2,53	25,23±2,52	25,17±2,56	p=0,913***
Operation Time (min)	Min-Max (Median)	68-98(90)	68-98(90)	68-98(88)	Z= -0,071
	Mean±SD	87,75±7,46	87,71±7,78	87,79±7,22	p=0,943*
MAP (mmHg)	Min-Max (Median)	71-93(78)	71-93(78)	71-90(78)	Z=-0,898
	Mean±SD	79,05±5,04	79,46±5,16	78,63±4,93	p=0,369*
MHR	Min-Max (Median)	58,90-72,10 (66,70)	62,30-72,10 (66,60)	58,90-71,40 (67,00)	T=-0,646
	Mean±SD	66,77±2,27	66,62±2,19	66,92±2,36	p=0,520**
Eye Opening Time (min)	Min-Max (Median)	7-13(10)	7-13(10)	7-13(10)	Z=-0,954
	Mean±SD	9,85±1,54	9,69±1,45	10,02±1,63	p=0,340*

*Mann Whitney U Test ** Pearson Chi-Square Test (χ^2) ***Student T Test (T) Z: Z score P< 0.05 was considered statistically significant.

Table 2. Comparison of MMT scores by flow type

		Flow Type		p
		LFA (n=49)	HFA (n=49)	
Preop. MMT	Min-Max (Median)	21,00-29,00(25,00)	19,00-29,00(25,00)	F=-0,488
	Mean±SD	24,85±2,09	25,06±2,04	*0,626
6th hr MMT	Min-Max (Median)	18,00-29,00(23,00)	16,00-27,00(24,00)	F=-0,430
	Mean±SD	23,22±2,71	23,44±2,44	*0,668
1st day MMT	Min-Max (Median)	20,00-29,00(24,00)	19,00-28,00(24,00)	F=-0,273
	Mean±SD	24,10±2,33	24,22±2,09	*0,785
3rd day MMT	Min-Max (Median)	21,00-29,00(25,00)	19,00-29,00(25,00)	F=-0,326
	Mean±SD	24,73±2,21	24,87±2,11	*0,745
7th day MMT	Min-Max (Median)	21,00-29,00(25,00)	19,00-29,00(25,00)	F=-0,380
	Mean±SD	24,81±2,15	24,97±2,09	*0,705

*Student T Test, F: F test, P< 0.05 was considered statistically significant.

Table 3. Comparison of the difference between MMT scores according to flow type

MMT score difference	LFA	HFA	P*	Z value
	Mean±SD	Mean±SD		
Preop- 6th hr difference in MMT score	1,63±0,97	1,61±0,95	1,0	0,00
Preop- 1st day difference in MMT score	0,75±0,63	0,83±0,58	0,474	-0,716
Preop- 3rd day difference in MMT score	0,12±0,33	0,18±0,39	0,402	-0,837
Preop- 7th day difference in MMT score	0,04±0,19	0,08±0,27	0,402	-0,838

*Mann-Whitney U Test, Z: Z score, P< 0.05 was considered statistically significant.

Tablo 4. Correlation between age and MMT scores

Difference		Age		
		Total	LFA (n=49)	HFA (n=49)
Preop-6th hr	R	0,781	0,848	0,707
	p*	<0,001	<0,001	<0,001
Preop-24th hr	R	0,375	0,435	0,293
	p*	<0,001	0,002	0,041
Preop-3rd day	R	0,185	0,282	0,084
	p*	0,068	0,049	0,566
Preop-7th day	R	0,084	0,234	-0,042
	p*	0,413	0,106	0,773

*Sperman Korelasyon, R: korelasyon, P< 0.05 was considered statistically significant.

Tablo 5. Comparison of MMT scores according to ASA PS Classification

		ASA PS Classification			Test value	Making the difference
		ASA I (n=15)	ASA II (n=57)	ASA III (n=26)	p	
Preop. MMT	Min-Max (Median)	22-29(27)	22-29(25)	19-27(23,5)	F=11,400	ASA III
	Mean±SD	26,13±1,95	25,29±1,83	23,53±1,90	**<0,001	
6th hr MMT	Min-Max (Median)	21-28(26)	20-29(24)	16-25(21)	F=29,357	ASA III
	Mean±SD	25,4±1,80	23,92±2,05	20,84±2,14	**<0,001	
1st day MMT	Min-Max (Median)	21-28(26)	21-29(24)	19-26(22,5)	χ^2: 0,378	ASA III
	Mean±SD	25,46±1,72	24,63±1,96	22,38±1,96	* <0,001	
3rd day MMT	Min-Max (Median)	21-29(27)	22-29(25)	19-26(23)	F=12,985	ASA III
	Mean±SD	26,06±2,12	25,19±1,86	23,23±1,96	**<0,001	
7th day MMT	Min-Max (Median)	21-29(27)	22-29(25)	19-27(23,5)	F=10,873	ASA III
	Mean±SD	26,06±2,12	25,24±1,85	23,46±1,98	**<0,001	

*Kruskal-Wallis **Anova test, F: F test, χ^2: Chi-Square Test

changes in sixth-hour MMT scores according to preoperative scores was found to be statistically remarkable (p<0.001). There was a weak positive correlation (at the level of 0.375) between age and the changes in the first-day MMT scores according to the preoperative scores, and it was found to be statistically remarkable (p<0.001). Although a very weak positive correlation was identified between age and the changes in the third- and seventh-day MMT scores according to the preoperative scores, it was not found to be statistically remarkable (p>0.05; Table 4).

In the LFA group, a strong positive correlation (at the level of 0.848) was identified between age and the changes in the sixth-hour MMT scores according to the preoperative scores, which was statistically remarkable (p<0.001). A weak positive correlation (at the level of 0.435) was identified between age and the changes in the first-day MMT scores according to the preoperative scores, which was statistically remarkable (p=0.002). A weak positive correlation (at the level of 0.282) was identified between age and the changes in the third-day MMT scores according to the preoperative scores, which was statistically remarkable (p=0.049). Although a very weak positive correlation was found between age and the changes in the seventh-day MMT scores according to the preoperative scores, it was not statistically remarkable (p>0.05; Table 4).

In the HFA group, a strong positive correlation (at the level of 0.707) was found between age and the changes in the sixth-hour MMT scores according to the preoperative scores, which was statistically remarkable (p<0.001). A weak positive correlation (at the level of 0.293) was found between age and the changes in the first-day MMT scores according to the preoperative scores, which was statistically remarkable (p=0.041). Although there were very weak positive correlations between age and the changes in the third-day and seventh-day MMT scores according to the preoperative scores, they were not found to be statistically remarkable (p>0.05; Table 4).

When MMT scores were compared according to the ASA classification, it was seen that the difference in MMT scores preoperatively, 24th hour, 3rd day and 7th day time periods was between ASA II and III and ASA I and III, while there was a difference in all groups in the case of the sixth-hour scores. When the change in MMT scores according to the ASA classification (MMT score of two or more changes) was compared, the most notable change was identified in the ASA III classification (Table 5).

DISCUSSION

There are several studies examining the effects of GA and spinal anesthesia on postoperative cognitive functions in urological surgeries (7). However, there are a limited number of studies investigating the effects of LFA and HFA on cognitive functions, and these studies indicate different results regarding cognitive functions. The objective of this study was to identify the effects of LFA and HFA on cognitive functions in elderly patients by standardizing the factors that may cause POCD. In our study, it was observed that LFA was not superior to HFA in the case of postoperative cognitive functions in patients aged 65 years and older who underwent elective TUR-P surgery under GA. According to the type of flow, the preoperative and postoperative sixth-hour, and first-, third-, and seventh-day MMT scores of the various cases did not exhibit any statistically significant differences. When the change (decrease) in the postoperative sixth-hour and first-, third-, and seventh-day MMT scores according to the preoperative scores in the HFA group was compared with the change in the LFA group, it was not found to be statistically significant. However, preoperative MMT scores and seventh-day MMT scores were found to be similar in the LFA group. When the temperature changes were compared, it was seen that there were temperature drops in both groups, yet fewer in the LFA group than in the HFA group. The temperature was maintained better in the LFA group than in the HFA group.

As mentioned above, there are a limited number of studies on cognitive function change in relation to LFA and HFA. In a study by Sandeep et al, which included 60 patients, no notable difference was found between LF and HF sevoflurane anesthesia in terms of cognitive dysfunction (8). In our study, the decrease and change in the sixth-hour, twenty-fourth-hour, and third-, and seventh-day MMT scores according to the preoperative MMT scores were similar in both groups. However, MMT scores in the LFA group were similar in the preoperative period and on the seventh day.

Age-related decline in organ function can affect the metabolism and excretion of anesthetic drugs, change the clinical effects of anesthesia, and prolong recovery after anesthesia. The International Study of Postoperative Cognitive Dysfunction (ISPOCD-1) is the first major study on postoperative cognitive impairment. The ISPOCD-1 applied neurocognitive testing at regular intervals postoperatively to patients older than 60 who had major non-cardiac surgery and had an operation lasting >2 hours. Cognitive dysfunction was found in 25.8% of the patients one week after the operation and 9.9% of the patients three months later. Moreover, in follow-ups that lasted between one and two years it was determined that 10% of these patients continued to experience cognitive disorders (9). This study revealed the importance of postoperative cognitive functions in the geriatric population. The incidence of POCD in different age groups has been shown to vary. In the study by Monk TG et al., which included 117 young, 112 middle-aged and 138 elderly patients, the incidence of POCD was found to be 36.6% for those aged 18–39, 30.4% for those aged 40–59, and 41.4% for those over the age of 60. All of these patients had undergone major non-cardiac surgery, and after three months, the rate was 5.7% in the young group, 5.6% in the middle-aged group, and 12.7% in the group aged over 60 (10).

In a study conducted by Tuman et al., it was stated that the incidence of POCD in patients undergoing coronary artery surgery with cardiopulmonary bypass was 0.9% in people <65 years of age, 3.6% in patients aged 65–74, and 8.9% in people aged >75 years (11). According to the review by Luo et al., advanced age is considered an independent risk factor for POCD. Increasing evidence has demonstrated that neuroinflammation plays a serious role in POCD. The findings of the abovementioned review indicate that the neuroinflammatory pathogenesis of POCD is age dependent (12). All the cases in the present study revealed a strong positive correlation between age and changes in sixth-hour MMT scores according to preoperative scores; moreover, a weak positive correlation was found between age and the changes in the first-day MMT scores according to the preoperative scores, which was statistically significant. Although a very weak positive correlation was found between age and the changes in the third- and seventh-day MMT scores according to the preoperative scores, it was not statistically significant. These findings are similar to those found in the literature and emphasize that there is a linear relationship between advancing age and POCD.

Elderly population are vulnerable to hypothermia due to impared thermoregulation ability (13). Postoperative hypothermia may cause masking of hypovolemia, delayed recovery, cardiac ischemia, arrhythmia, coagulopathy, wound infection, increased blood loss, decreased drug metabolism, negative nitrogen balance, and prolonged hospitalization. As a result of shivering following hypothermia, oxygen consumption may increase by 400% to 500%, which may result in hypoxia. It has been demonstrated that cardiac morbidity can be reduced by 55% due to normothermia. Prevention of hypothermia is therefore of vital importance in elderly patients (14). In the study by Gua-Liang Gong et al., using the logistic regression of 70 patients, hypothermia was considered a risk factor for POCD (15). In the study by Yu Cui et al., which included 249 neonatal patients, hypothermia was observed less frequently in the group using fresh low gas flow than in the control group (16). In our study, although there was a decrease in other time periods compared to preoperative temperature scores in both types of flow, the decrease was greater in the HFA group. Temperature is better preserved in the LFA group.

Findings in the literature demonstrate that ASA risk classification is also effective in relation to cognitive functions. In a study conducted with 118 patients over the age of 75 who underwent major abdominal surgery, postoperative delirium and cognitive dysfunction were observed in 28 patients (24%). In this study, ASA III–IV group was stated as one of the risk factors (17). In the review by S Bala Bhaskar et al., it was observed that increased comorbidity increased the incidence of POCD (18). In our study, there was no notable change between the two groups in terms of quantity, since the ASA classification was homogeneously distributed. When MMT scores were compared according to the ASA classification, it was seen that the difference in the preoperative, twenty-fourth hour, third-day, and seventh-day MMT scores was between ASA II and III and ASA I and III, while there was a difference in all groups at the sixth hour. When the change in MMT scores (MMT score of 2 and/or more changes) according to the ASA classification was compared, the greatest change was observed in the ASA III group.

Prolonged anesthesia and hypotension/hypertension during surgery have been implicated as risk factors for POCD (19). In a study by Lukasz et al. involving 7,000 patients, hypotension and hypertension were considered as risk factors for POCD (20). Yocum GT et al. included 21 normotensive and 24 hypertensive elderly patients who underwent lumbar laminectomy or microdiscectomy in a study on cognitive function. Preoperative and postoperative first-day and first-month neurocognitive tests were applied to the patient groups. It was found that the low mean arterial pressure values observed in the hypertensive patient group were associated with poor cognitive functions observed on the postoperative first day and first month (21). In our study, there was no notable change in mean arterial pressure changes between the two groups. Prolonged anesthesia duration (>2 hours) may lead to POCD by increasing anesthetic uptake and accumulation and creating a tendency to hypothermia in non-cardiac surgeries. POCD may be more common and severe after serious and long operations (22). In our study, the duration of anesthesia did not exceed two hours and there was no notable change between the two groups.

Although postoperative pain levels vary, the pain can be extremely severe in certain patients. Postoperative pain can be severe at levels of extensive surgical trauma, which can cause mental stress and sleep disturbances and increase the risk of POCD (23). In a study involving 225 elderly patients, J jiang et al. found that postoperative pain and analgesia were associated with the occurrence and development of POCD (24). In the present study, no notable change was detected between the two groups in terms of VAS scores.

Observing and comparing the change in cognitive functions during a single type of surgical intervention can be regarded as one of the positive aspects of the present study. It is therefore predicted that the relative anesthesia duration, estimated VAS scores, and surgical stress levels are more easily standardized. The fact that ASA scores, age, BMI, mean HR, mean arterial blood pressure, and VAS scores were not notably different between the two groups is thought to support our comparison of the effect of LF and HF sevoflurane anesthesia on cognitive functions, which was the primary objective of the study.

The limitations of this study include the use of only one test to evaluate cognitive functions and the fact that the groups were not compared according to education levels.

CONCLUSION

In the presence of the necessary equipment – and with its advantages in relation to reducing costs, preventing environmental pollution, minimizing heat loss, and respiratory physiology – LFA can be safely applied in geriatric patients. However, LFA is not thought to have a significant effect on cognitive functions compared to HFA. Nevertheless, investigating its effect in long-term follow-ups may contribute to the literature.

REFERENCES

1. Alvis BD, Hughes Cgjac. Physiology considerations in geriatric patients. Anesthesiology clinics 2015;33(3):447-56. (DOI: 10.1016/j.anclin.2015.05.003).
2. Meco BC, Gumus G. Perioperatıve Neurocognitive Disorders In Geriatric Patients: A Review of Neuronal Pathophysiology. Turkish Journal of Geriatrics 2022;25(2):339-346 (DOI: 10.31086/tjgeri.2022.292)
3. Hönemann C, Hagemann O, Doll D. Inhalational anaesthesia with low fresh gas flow. Indian J Anaesth 2013;57(4):345-50.(DOI: 10.4103/0019-5049.118569).
4. Aldrete JA, Cubillos P, Sherrill D. Humidity and temperature changes during low flow and closed system anaesthesia. Acta Anaesthesiol Scand 1981;25(4):312-14.(DOI: 10.1111/j.1399-6576.1981.tb01657.x).
5. Frink EJ Jr, Malan TP, Morgan SE, et al. Quantification of the degradation products of sevoflurane in two CO2 absorbants during low-flow anesthesia in surgical patients. Anesthesiology 1992;77(6):1064-69.(DOI: 10.1097/00000542-199212000-00003).
6. Kadam P, Bhalerao S. Sample size calculation. Int J Ayurveda Res 2010;1(1):55-7. (DOI: 10.4103/0974-7788.59946).
7. Kurt N. The Impact of Anesthesia Method on Postoperative Cognitive Functions in Urological Surgeries: A Prospective Randomized Single-Blind Study. Van Medical Journal 2023;30(4):390-95. (DOI: 10.5505/vtd.2023.87522).
8. Sandeep C. To compare the effects of sevoflurane under low-flow and medium-flow anaesthesia on cognitive function and recovery in patients undergoing elective laparoscopic cholecystectomy under general anaesthesia. J Cardiovasc Dis Res 2023;14(4):2010-2017. (DOI: 10.31838/jcdr.2023.14.04.241).

9. Biedler A, Juckenhöfel S, Larsen R, et al. Postoperative cognition disorders in elderly patients. The results of the" International Study of Postoperative Cognitive Dysfunction" ISPOCD 1. Der Anaesthesist 1999;48(12):884-95. (DOI: 10.1007/s001010050802).

10. Monk TG, Weldon BC, Garvan CW, et al. Predictors of cognitive dysfunction after major noncardiac surgery. The Journal of the American Society of Anesthesiologists 2008;108(1):18-30. (DOI: 10.1097/01.anes.0000296071.19434.1e).

11. Tuman KJ, McCarthy RJ, Najafi H, Ivankovich AD. Differential effects of advanced age on neurologic and cardiac risks of coronary artery operations. The Journal of thoracic and cardiovascular surgery 1992;104(6):1510-17.(DOI: 10.1016/S0022-5223(19)33877-2).

12. Luo A, Yan J, Tang X, et al. Postoperative cognitive dysfunction in the aged: the collision of neuroinflammaging with perioperative neuroinflammation. Inflammopharmacology 2019;27(1):27-37. (DOI: 10.1007/s10787-018-00559-0).

13. Cho SA, Yoon S, Lee SJ, et al. Clinical efficacy of short-term prewarming in elderly and adult patients: A prospective observational study. Int J Med Sci 2022;19(10):1548-1556.(DOI: 10.7150/ijms.77578).

14. Kim D. Postoperative hypothermia. Acute and Critical Care 2019;34(1):79-80 (DOI:10.4266/acc.2018.00395.

15. Gong G-L, Liu B, Wu J-X, et al. Postoperative cognitive dysfunction induced by different surgical methods and its risk factors. The American Surgeon 2018;84(9):1531-7. (DOI: 10.1177/000313481808400963).

16. Cui Y, Wang Y, Cao R, Li G, et al. The low fresh gas flow anesthesia and hypothermia in neonates undergoing digestive surgeries: a retrospective before-after study. BMC anesthesiology 2020;20(1):1-8. (DOI: 10.1186/s12871-020-01140-5).

17. Brouquet A, Cudennec T, Benoist S, et al. Impaired mobility, ASA status and administration of tramadol are risk factors for postoperative delirium in patients aged 75 years or more after major abdominal surgery. Annals of surgery 2010;251(4):759-65.(DOI: 10.1097/SLA.0b013e3181c1cfc9).

18. Bhaskar SB, Bajwa SJS. From pre-operative co-morbidities to post-operative cognitive dysfunction: The challenging face of geriatric anaesthesia. Indian Journal of Anaesthesia 2014;58(3):248. (DOI: 10.4103/0019-5049.135024).

19. Zhang Y, Bao H-G, Lv Y-L, et al. Risk factors for early postoperative cognitive dysfunction after colorectal surgery. BMC anesthesiology 2019;19(1):1-6.(DOI: 10.1186/s12871-018-0676-4).

20. Krzych ŁJ, Pluta MP, Putowski Z, Czok M. Investigating association between intraoperative hypotension and postoperative neurocognitive disorders in non-cardiac surgery: a comprehensive review. Journal of Clinical Medicine 2020;9(10):3183.(DOI: 10.3390/jcm9103183).

21. Yocum GT, Gaudet JG, Teverbaugh, et al. Neurocognitive Performance in Hypertensive Patients after Spine Surgery. Anesthesiology 2009;110:254–261 (DOI: 10.1097/ALN.0b013e3181942c7a)

22. Rundshagen I. Postoperative cognitive dysfunction. Deutsches Ärzteblatt International 2014;111(8):119. (DOI: 10.3238/arztebl.2014.0119).

23. Xiao QX, Liu Q, Deng R, Gao ZW, Zhang Y. Postoperative cognitive dysfunction in elderly patients undergoing hip arthroplasty. Psychogeriatrics 2020;20(4):501-9.(DOI: 10.1111/psyg.12516).

24. Jiang J, Lv X, Liang B, Jiang H. Circulating TNF-α levels increased and correlated negatively with IGF-I in postoperative cognitive dysfunction. Neurological Sciences 2017;38(8):1391-92.(DOI: 10.1007/s10072-017-2962-1).