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**Research Article,**

# Investigating the Different Depth of Anesthesia Effects on Postoperative Cognitive Functions

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**Abstract:**

**Objectives:** The cognitive level of anesthesia and recovery time after surgery is multifactorial and can vary according to the type of surgery, the type of anesthesia used and patient characteristics. We aimed to investigate the effect of deep and light anesthesia levels monitorisation on postoperative neurocognitive function.

**Methods**: The study included 42 patients who underwent thoracic surgery. The patients were divided into two groups as Light group (n=21) and Deep group (n=21). Patients were maintained with Desfluran with the levels of entropy in the form of 40±5 in the deep group and 60±5 in the light group. Blood samples for S100β and neuron specific enolase (NSE) were taken, preoperatively, 1 hour postoperatively and on the 7th day postoperatively. Mini mental test was performed one day before and 7th day postoperatively.

**Results:** There was no difference between the groups in terms of the mini mental scores evaluated preoperatively and on the 7th postoperative day (p=0.116, p=0.198). Comparisons of S100β and NSE between the groups measured were similar. When compared within the groups; In the light group, the postoperative values of S100β and NSE were lower than preoperative values, whereas in Group D, the postoperative values showed an increase compared to the preoperative values. All these were not statistically different.

**Conclusion:** It was concluded that light anesthesia may have a positive effect on cognitive functions in patients with one lung ventilation.

**Key words:** entropy, anesthesia depth, thoracic surgery, cognitive dysfunction

## Introduction:

Cognitive function is the memory and mental process of obtaining individual information, solving problems and planning the future. Cognitive dysfunction is a reduction in these processes [1]. Brain functions can be changed rapidly after anesthesia and surgery, and this change may manifest itself in the form of consciousness, depression, and attention-memory impairment. The time of cognitive recovery from anesthesia and surgery is multifactorial and may vary depending on the type of anesthesia used, the type of surgery and individual patient characteristics. Anesthetics and their doses are among the many factors of importance for recovery [2]. The concept of postoperative disturbance in cognition has often been referred to as postoperative cognitive dysfunction (POCD), and considered as a kind of functional disorder in nervous system. It has been reported that inflammatory responses and abnormal oxygen metabolism in brain are closely associated with the pathophysiological processes of POCD. Meanwhile, anesthetic depth may also affect POCD [3].

Many clinical tests and biomarkers are used to determine postoperative neurological outcomes. The Mini Mental Status test (MMDT) is one of the neurophysiological tests that is often preferred because of the clinical ease of application. It is a short, convenient, and standardized method that can be used to detect global cognitive level, with limited specificity for the separation of clinical syndromes. In addition to clinical tests, biochemical assays are frequently used to detect POCD. For this purpose, many biomarkers are being investigated and the most commonly analyzed biomarkers for post-operative cognitive dysfunction are serum S100β and neuron specific enolase (NSE) [4]. Previous studies in literature have investigated the effects of anesthesia at different depths on perioperative stres response [5,6], but to the best of our knowledge, there is no study in literature evaluating the effects of different anesthetic depths on cognitive function in thoracic surgery. In the current study, it was planned to investigate the effects of deep and superficial anesthesia levels using entropy monitorization on postoperative neurocognitive functions and s100β and NSE values in patients undergoing thoracic surgery.

## Materials and Methods:

The study included 42 patients of American Society of Anesthesiologists (ASA) physiological status I-II and aged 18-65 years who were scheduled to undergo one-lung ventilation in thoracic surgery. Approval for the study was granted by the Local Ethics Committee (approval no: 2016/55, code:2011-KAEK-2) and informed consent was obtained from all the patients. Any patients with neurocognitive impairment, those who underwent intensive intubation postoperatively and those who were illiterate were excluded from the study.

In the operating room, the patients were monitored with entropy and surgical pleth index (SPI) monitoring in addition to standard anesthesia monitorization (electrocardiogram, heart rate, blood pressure, oxygen saturation, end-tidal carbon dioxide) using the Carescape monitor (GE Healthcare F1-00510 Helsinki Finland). For the assessment of entropy, 3 self-adhesive electrodes were placed on the patient's forehead to demonstrate the irregularity of EEG signals as a method of measurement of anaeasthesia depth. As the anesthetic dose increases, the EEG becomes more regular and the entropy value approaches zero. The working principle of entropy is based on the calculation of spectral entropy of the raw electroencephalographic and frontal electromyography data. The EEG signal can be interpreted as 2 numerical values, defined as the response entropy which measures the state and muscle activity. The recommended depth of anesthesia with entropy is 40-60 [7].

All patients were induced by Arrhythmal 1 mg/kg, Midazolam 0.08-0.1 mg/kg, Propofol 1-2 mg/kg, Fentanyl 2 mcg/kg, and tracheal intubation was facilitated with Rocuronium 0.5-0.6 mg/kg. In the course of the anesthesia management, the patients were randomly assigned to one of two groups; Light group (L, n = 21) and Deep group (D, n = 21. Anaesthesia was maintained with Desfluran with the levels of entropy in the form of 40 ± 5 in the deep group, and 60 ± 5 in the light group with a 50% air-oxygen mixture. The Remifentanil infusion was started at 0.25 mcg/kg/min for all patients, and was continued to maintain the Surgical Pleth Index (SPI) values between 35-50. When the SPI value increased above 50, the Remifentanil rate was increased by 0.05 mcg/kg/min. SPI monitors surgical stress reactions and performs appropriate analgesic management during anesthesia using Pulse Photo-Plethysmographic Aperture and pulse rate data in pulse oximetry measurements [8]. SPI values range from 0 to 100 and higher scores indicate higher stress levels. Rocuronium 0.1 mg/kg per hour was given for maintenance of muscle relaxation. Midazolam 1mg was added per hour to all patients. Volume-control ventilation was adopted during anesthesia with tidal volume (VT) of 8 ml/kg and a PEEP of 5 $cmH_2O$. During one-lung ventilation (OLV), VT was kept at 6-8 ml/kg by adjusting the respiratory rate to maintain end tidal carbon dioxide ($EtCO_2$) between 35 and 45 mmHg, oxygen saturation at>95%, and peak airway pressure at <30 $cmH_2O$. At the end of the surgery, 1 g paracetamol and 1 mg/kg tramadol were given to all patients.

The perioperative heart rate (HR), mean arterial pressure (MAP), peripheral oxygen saturation, and entropy-SPI levels of all patients were measured before anesthesia induction (T1), 5 min after intubation (T2), 10 min after intubation (T3), 30 min after intubation (T4), 60 min after intubation (T5), 90 min after intubation (T6), 120 min after intubation (T7), 180 min after intubation (T8) and 5 min after extubation (T9). In addition, blood gases were analyzed and recorded 5 min after intubation (T1), at the15th minute of one lung ventilation (T2), and 5 min after extubation (T3). The demographic data of the patients, such as age, gender, body mass index, and extent of surgical resection (e.g. lobectomy, cystectomy, wedge resection) were recorded, together with the duration of one lung ventilation, the duration of the operation, remifentanil consumption, and blood usage during the case. After the patients were extubated, they were brought to the post-anesthesia care unit (PACU) and assessed with the Ramsey sedation scale (1= anxious and agitated, 2 = co-operative, oriented and calm, 3 = sleepy but rapid response to instructions, 4 = asleep but able to be awakened, 5 = sluggish response to calls, 6= deep sleep or anesthetic, and no response to calls ). In order to evaluate S100β and NSE, 5 cc blood samples were taken preoperatively (T1), at 1 hour postoperatively (T2) and on the 7th day postoperatively (T3) The S100 β measurement was performed with the SunRed brand Human S100β Elisa kit (Jufengyuan Road, Baoshan District, Shanghai, China). Absorbance readings were made with a ChemWell 2910 brand ELISA reader (Awareness Technology, Inc. Martin Hwy, Palm City, USA) and the results are given as ng / L. Serum NSE measurements were performed with SunRed brand Human NSE Elisa kit (Jufengyuan Road, Baoshan District, Shanghai, China).

Absorbance readings were made with the ChemWell 2910 brand ELISA reader. (Awareness Technology, Inc. Martin Hwy, Palm City, USA) and the results are given as ng / ml. In order to evaluate cognitive functions, the Mini mental status test was administered to the patients one day before surgery and on the 7th day postoperatively.

**Statistical analysis:**

Power analysis was conducted using G*Power 3.1.9.2 package program to determine the number of observations. The size of the sample required for the three replicate measurements was determined as 42, with effect size=0.5 (medium), α=0.05, power=80%. Statistical analyses of the study data were made using Statistical Package for Social Sciences (SPSS) for Windows 20.0 software. The Shapiro Wilk test was used to verify normal data distribution. Data were expressed as mean±standard deviation (SD), median (min-max) and percentages. Continuous variables were analyzed using the Student's t test or the Mann-Whitney U test for parametric and non parametric data, respectively. Categorical variables were analyzed using the Chi-Square test or Fisher Exact test. When comparing data within groups, the Friedman test was used as a non-parametric test and the Paired-samples test as a parametric test. The results were evaluated in a confidence interval of 95% and at a significance level of p <0.05.

**Results:**

The study included 42 patients (Group Light = 21, Group Deep = 21). One patient from each group was excluded from the study because they were admitted to intensive care postoperatively. Thus, the evaluations were completed with 40 patients (Group L = 20, Group D = 20). Demographic characteristics (age, gender, body mass index, education status) and smoking cessation were similar in both groups (Table 1). Although there was no significant difference in terms of gender between the two groups, the ratio of male gender was higher in both groups (p=0.185, Table 1). Although the distribution of surgeries performed was similar in both groups, the most commonly performed surgical type was wedge resection (Group L=45% of patients, Group D=55% patients), respectively (p=0.228, Table 1).

**Table 1. Demographic characteristics of patients and distribution of surgeries performed.**

| | Group L (n=20) | Group D (n=20) | p |
|---|---|---|---|
| Gender (F/M), n | May-15 | 09-Nov | 0.185* |
| Age (year) | 58 (19-65) | 48 (18-65) | 0.063# |
| BMI | 26.84 ± 4.28 | 24.72 ± 3.78 | 0.105& |
| Comorbidities (yes/no) | Apr-16 | Mar-17 | 0.677* |
| Smoking (yes/no) | May-15 | Jul-13 | 0.337* |
| Anesthesia history (yes/no)Education level | Jul-13 | 10-Oct | 0.337* |
| Primary education | 15 | 10 | 0.208* |
| High school | 5 | 9 | |
| university Surgical procedure | 0 | 1 | |
| Lobectomy | 4 (%20) | 1 (%5) | 0.228* |
| Diaphragmatichernia repair Bulla excision | 0 | 1 (%5) | |
| Wedge resection | 3 (%15) | 4 (%20) | |
| Tm exision | 9 (%45) | 11 (%55) | |
| Pleurodesis | 1 (%5) | 1 (%5) | |
| Hydatid cystectomy | 3 (%15) | 0 | |
| | 0 | 2 (%10) | |

Abbreviations: Group L; group light, Group D; group deep, F/M; female/male, BMI; body mass index,

Note: Data expressed as mean ± SD, median (minimum-maximum).

*Data expressed as Chi-square test.

#Data expressed as Mann–Whitney U-test.

& Data expressed as Student T test.

There were no differences between the groups in terms of intraoperative mean arterial pressure, heart rate, SPI and end-tidal CO2 values (Table 2, Table 3).

**Table 2. Comparison between the groups of mean arterial pressure and heart rate values of patients**

| | Group L (n=20) | Group D (n=20) | p |
|---|---|---|---|
| MAP T1, mmHg | 93 (86-108) | 89 (55-101) | 0.903# |
| MAP T2, mmHg | 81.80 ± 14.39 | 80.70 ± 13.53 | 0.805& |
| MAP T3, mmHg | 77.60 ± 21.77 | 79.90 ± 14.34 | 0.695& |
| MAP T4, mmHg | 78.15 ± 13.86 | 81.95 ± 12.50 | 0.359& |
| MAP T5, mmHg | 77.15 ± 12.97 | 79.15 ± 16.39 | 0.671& |
| MAP T6, mmHg | 72.64 ± 8.21 | 78.38 ± 13.10 | 0.211& |
| MAP T7, mmHg | 75.44 ± 11.98 | 77.45 ± 13.65 | 0.734& |
| MAP T8, mmHg | 72.83 ± 14.74 | 78.80 ± 14.00 | 0.512& |
| MAP T9, mmHg | 83.50 ± 11.11 | 80.30 ± 14.07 | 0.430& |
| HR T1, beat/min | 90 (78-109) | 77 (74-89) | 0.144# |
| HR T2, beat/min | 90.15 ± 14.11 | 88.35 ± 16.10 | 0.709& |
| HR T3, beat/min | 85.30 ± 12.83 | 84.10 ± 12.88 | 0.769& |
| HR T4, beat/min | 82.75 ± 13.42 | 81.70 ± 14.55 | 0.814& |
| HR T5, beat/min | 81.45 ± 11.52 | 81.70 ± 14.55 | 0.941& |
| HR T6, beat/min | 82.00 ± 9.61 | 77.13 ± 10.11 | 0.209& |
| HR T7, beat/min | 74.78 ± 11.11 | 79.91 ± 8.53 | 0.258& |
| HR T8, beat/min | 77.33±12.35 | 77.60±13.83 | 0.974& |
| HR T9, beat/min | 84.60±12.49 | 81.80±10.41 | 0.446& |

Abbreviations: Group L; group light, Group D; group deep, MAP; mean arterial pressure, HR; heart rate. T1; before anesthesia induction ,T2; 5 min after intubation, T3; 10 min after intubation, T4; 30 min after intubation , T5; 60 min after intubation ,T6; 90 min after intubation, T7; 120 min after intubation, T8; 180 min after intubation, T9; 5 min after extubation .

Note: Data expressed as mean ± SD, median (minimum-maximum).

#Data expressed as Mann–Whitney U-test.

& Data expressed as Student T test

**Table 3. Comparison between the groups of surgical pleth index and end-tidal carbon dioxide values of patients**

| | Group L | Group D | p |
|---|---|---|---|
| SPI T1 | 66.95 ± 12.84 | 65.60 ± 15.77 | 0.768& |
| SPI T2 | 41.70 ± 9.09 | 38.00 ± 11.42 | 0.264& |
| SPI T3 | 37.75 ± 10.40 | 35.30 ± 12.67 | 0.508& |
| SPI T4 | 38.80 ± 11.19 | 37.20 ± 11.31 | 0.655& |
| SPI T5 | 42.65 ± 11.60 | 38.65 ± 5.61 | 0.173& |
| SPI T6 | 47.00 ± 11.67 | 44.00 ± 7.89 | 0.428& |
| SPI T7 | 38.56 ± 10.19 | 46.90 ± 9.80 | 0.087& |
| SPI T8 | 45.50 ± 3.08 | 48.33 ± 5.20 | 0.278& |
| SPI T9 | 63.45 ± 15.76 | 65.55 ± 12.19 | 0.323& |
| $ETCO_2$ T2 | 35.10 ± 4.52 | 33.70 ± 4.31 | 0.272& |
| $ETCO_2$ T3 | 35.80 ± 4.45 | 34.25 ± 4.33 | 0.154& |
| $ETCO_2$ T4 | 38.00 ± 5.47 | 35.65 ± 4.71 | 0.136& |
| $ETCO_2$ T5 | 39.00 ± 6.00 | 36.20 ± 5.60 | 0.767& |
| $ETCO_2$ T6 | 38.58 ± 5.72 | 37.94 ± 5.56 | 0.380& |
| $ETCO_2$ T7 | 37.67 ± 7.00 | 40.27 ± 5.95 | 0.369& |
| $ETCO_2$ T8 | 40 (34-50) | 36 (32-38) | 0.640# |

Abbreviations: Group L; group light, Group D; group deep, SPI: surgical pleth index, ETCO2:end-tidal carbon dioxide, mmHg

T1; before anesthesia induction,T2; 5 min after intubation, T3; 10 min after intubation, T4; 30 min after intubation, T5; 60 min after intubation,T6; 90

min after intubation, T7; 120 min after intubation, T8; 180 min after intubation, T9; 5 min after extubation .

Note: Data expressed as mean ± SD, median (minimum-maximum).

#Data expressed as Mann–Whitney U-test.

& Data expressed as Student T test.

The duration of surgery, and duration of one lung ventilation were similar were similar in the two groups (Table 4). There was no difference in remifentanil consumption between the groups (p=0.164, Table 4). Blood transfusions were similar in both groups (p = 1.000, Table 4).

**Table 4. Operation characteristics, remifentanyl consumption, and blood usage in the groups.**

| | Group L (n=20) | Group D (n=20) | p |
|---|---|---|---|
| Duration of anesthesia (min) | 110 (65-250) | 122.50 (63-280) | 0.694# |
| Duration of surgery (min) | 77.50 (45-230) | 105 (45-240) | 0.935# |
| Duration of OLV (min) | 44 (20-180) | 70 (20-180) | 0.267# |
| Remifentanyl consumptionı (cc) | 59 (34-153) | 52.50 (23-123) | 0.164# |
| Blood usage (yes/no, n) | Mar-17 | Apr-16 | 1.000α |

Abbreviations: Group L; group light, Group D; group deep, OLV; one lung ventilation

Note: Remifentanyl 1cc=40 mcg,

Data expressed as mean ± SD, median (minimum-maximum).

#Data expressed as Mann–Whitney U-test, αFisher exact test.

The Ramsey scores at entrance and exit of the recovery room were similar in both groups (p=0.122 and p=0.419, Table 5). The Mini mental test results measured preoperatively and on the postoperative 7th day were similar in both groups and within each group (Table 5).

**Table5.** Ramsey scores and mini mental test levels of patients in both groups.

| | Group L (n=20) | Group D (n=20) | p |
|---|---|---|---|
| Ramsey PACU entrance | 2.00 ± 1.07 | 2.55 ± 0.88 | 0.122 & |
| Ramsey PACU exit | 2.15 ± 0.36 | 2.05 ± 0.39 | 0.419 & |
| Minimental test preoperative | 23.00 ± 4.92 | 25.20 ± 3.63 | 0.116 & |
| Mini mental test 7thday | 22.55 ± 4.61 | 24.30 ± 3.79 | 0.198 & |
| Mini mental test, p within group | 0.498β | 0.286β | |

Abbreviations: Group L; group light, Group D; group deep, PACU: post-anesthesia care unit

Note: Data expressed as mean ± SD

β Data expressed as paired samples test

& Data expressed as Student T test

No difference was determined between the groups in respect of the perioperative blood gas analyses of the patients (Table 6).

**Table 6. Comparison between the groups of arterial blood gases analysis of patients.**

| | Group L (n=20) | Group D (n=20) | P |
|---|---|---|---|
| PH T1 | 7.41 (7.33-7.51) | 7.41 (7.35-7.51) | 0.281# |
| PH T2 | 7.29 ± 0.08 | 7.31 ± 0.07 | 0.485& |
| PH T3 | 7.35 ± 0.07 | 7.35 ± 0.05 | 0.941& |
| $PO_2$ T1 | 167.05 ± 32.09 | 158.60 ± 31.94 | 0.409& |
| $PO_2$ T2 | 104 (59.80-201) | 93 (59.40-241) | 0.745# |
| $PO_2$ T3 | 116.12 ± 31.85 | 121.03 ± 35.16 | 0.646& |
| $PCO_2$ T1 | 36.90 (33.30-50.70) | 36.00 (32.80-49.10) | 0.337# |
| $PCO_2$ T2 | 49.80 ± 9.58 | 47.43 ± 9.74 | 0.444& |
| $PCO_2$ T3 | 43.97 ± 7.49 | 42.09 ± 6.77 | 0.410& |
| $HCO_3$ T1 | 24.05 (20.10-29.30) | 23 (21.20-27.20) | 0.211# |
| $HCO_3$ T2 | 22.67 ± 3.24 | 22.42 ± 1.91 | 0.769& |
| $HCO_3$ T3 | 23.20 (18.30-34.60) | 22.30 (19.00-25.00) | 0.110# |
| Lactat T1 | 10 (5-20) | 9 (4-14) | 0.086# |
| Lactat T2 | 12.90 ± 4.65 | 11.45 ± 2.25 | 0.215& |
| Lactat T3 | 10.50 (5-24) | 11.50 (7-16) | 0.320# |

Abbreviations: Group L; group light, Group D; group deep

T1; 5 min after intubation, T2; 15th minute of one lung ventilation T3; 5 min after extubation,

Note: Data expressed as mean ± SD, median (minimum-maximum).

#Data expressed as Mann–Whitney U-test.

&Data expressed as Student T test

**The entropy levels of the patients during surgery are shown in Figure 1.**

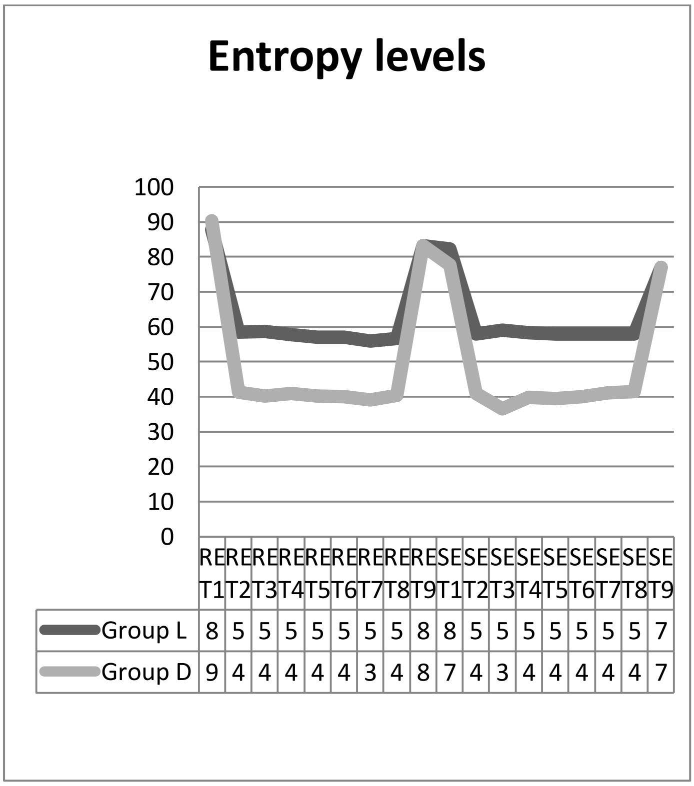



**Fig. 1** Intraoperative entropy levels of patients,

Abbreviations: Group L; group light, Group D; group deep, RE; response entropy, SE; state entropy

T1; before anesthesia induction ,T2; 5 min after intubation, T3; 10 min after intubation, T4; 30 min after intubation , T5; 60min after intubation ,T6; 90 min after intubation, T7; 120 min after intubation, T8; 180 min after intubation, T9; 5 min after extubation .

The comparisons between the groups of S100 β preoperatively, 1 hour postoperatively and 7th day postoperatively were similar. In the light group, the preop values of S100β decreased gradually in the postoperative 1st hour and on the postoperative 7th day, whereas in Group D, the postoperative values showed an increase compared to the preoperative values, but these changes were not statistically different (Figure 2).

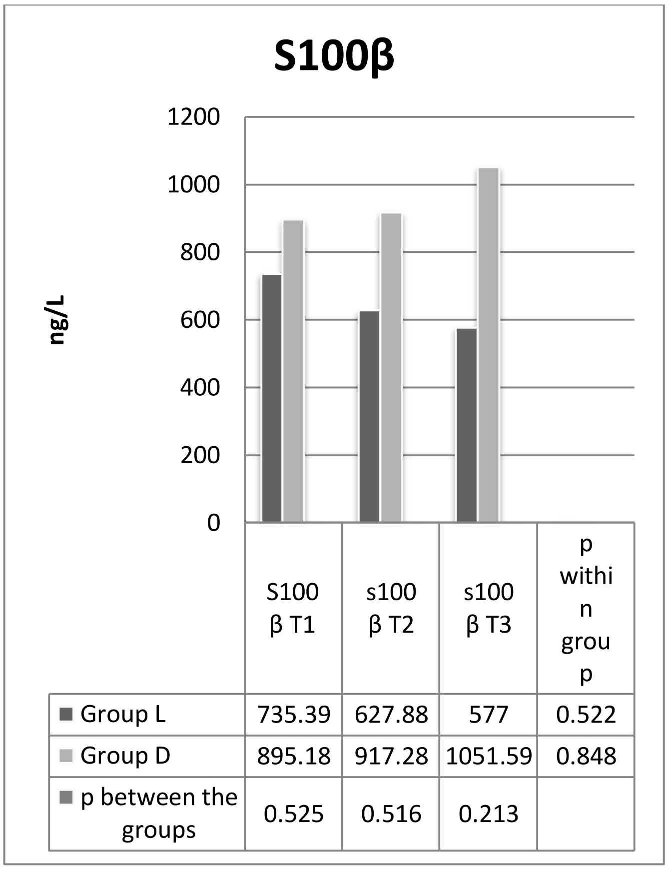


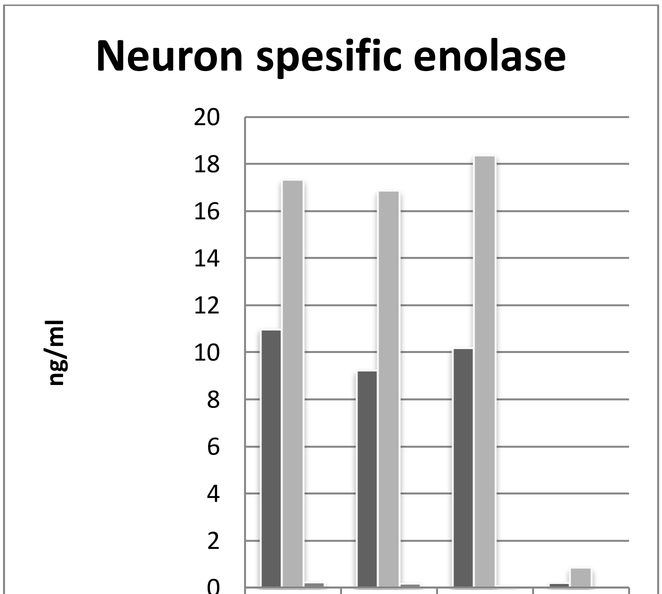

**Fig. 2** Comparison of S100β levels between and within the groups

Abbreviations: Group L; group light, Group D; group deep

T1; preoperatively, T2; 1 hour postoperatively, T3; 7th day postoperatively.

No difference was determined between the groups in respect of the NSE values measured at all the time points. In the comparisons made within the groups, the postoperative NSE values in the light group were lower than the preoperative values and in the deep group; the NSE value was higher than the preoperative value on the postoperative 7th day.

**These changes were not at a statistically significant level (Figure 3).**




| | NSE T1 | NSE T2 | NSE T3 | p within group |
|---|---|---|---|---|
| Group L | 10.99 | 9.24 | 10.2 | 0.212 |
| Group D | 17.33 | 16.87 | 18.39 | 0.861 |
| p between the groups | 0.231 | 0.183 | 0.076 | |

**Fig. 3** Comparison of neuron specific enolase within and between the groups

Abbreviations: Group L; group light, Group D; group deep, NSE; neuron specific enolase

T1; preoperatively, T2; 1 hour postoperatively, T3; 7th day postoperatively

**Discussion:**

In this study investigating the effects of different levels of anesthesia on postoperative cognitive functions, patients were evaluated with the mini-mental test preoperatively and on the postoperative 7th day and S100β and NSE values were assessed preoperatively, at 1hr postoperatively and on the 7th day. The results were seen to be simialr in both groups. In the light group, the preoperative values of S100β decreased gradually in the postoperative 1st hour and on the postoperative 7th day, whereas in Group D, the postoperative values showed an increase compared to the preoperative values, but these changes were not statistically different. No difference was determined between the groups in respect of the NSE values measured at all the time points. In the comparisons made within the groups, the postoperative NSE values in the light group were lower than the preoperative values and in the deep group, the NSE value was higher than the preoperative value on the postoperative 7th day, but these changes were not at a statistically significant level. Perioperative blood gas values and hemodynamic variables, remifentanil consumption, Ramsey scores in PACU were not different between the groups.

Numerous clinical and experimental studies have been carried out in recent years regarding POCD, which is one of the most serious postoperative complications of anesthesia. Age, preoperative cognitive dysfunction, preoperative drug use (such as anticholinergic drugs), and adverse reactions (hypoxia, hypotension, etc.) encountered during surgery are among the risk factors of POCD [9, 10]. However, the pathogenesis is still not fully understood [11]. In thoracic surgery under one lung ventilation (OLV), there is an additional risk for POCD because of the potential hypoxemia associated with OLV [12]. Li et al found that POCD occurred in 28% of patients with one lung ventilation which was compatible with other findings in literature [13]. Therefore, in the current study, it was aimed to improve cognitive function by differentiating the depth of anesthesia in this high-risk group.

To determine postoperative neurological outcomes, many clinical tests and biomarkers are used, with the mini mental status test as a clinical test and the biomarkers of serum S100β and NSE among the most preferred. When these tests are repeated during the postoperative period and compared with preoperative values, the decrease in scores indicates postoperative dysfunction. The time of application of the tests in the postoperative period has been reported ranging from four days to eight years [4].

The calcium-binding acidic protein S100 (molecular weight 21 kDa) is found in different forms depending on the configuration of the alpha or beta unit and the beta subunit is specific to the brain [14]. Experimental studies have shown that the extracellular S100 protein may play a role in learning and memory, although the essential function of many of the S100 proteins that are thought to be functional (neuronal and glial growth, proliferation and activation) is not fully understood yet [15, 16]. Neuron-specific enolase (NSE), which is found in the cytoplasm of neurons, is the second most commonly studied biomarker for neurocognitive dysfunction [17]. Gu et al. [18] reported that both serum S100β and serum NSE levels were sensitive to early diagnosis of brain damage after CPB. Johnsson et al. [19] concluded that both biomarkers are associated with neurological complications. However, Ishida et al. [20] suggested that in cardiovascular surgery, a large portion of the increase in S100β and NSE levels during CPB is due to surgical contamination not to neuronal damage. Ramlawi et al. [21] showed that the incidence of early neurocognitive dysfunction was 40% in patients undergoing CABG or valve surgery, and that postoperative cognitive dysfunction was more associated with NSE and tau protein and there was no relationship between S100β and postoperative cognitive dysfunction. In a comparison of S100β and NSE, Rasmussen et al. [22] showed that there was no association between postoperative cognitive dysfunction and these two biomarkers in non-cardiac surgery. However, the same researchersm also showed that NSE is associated with early postoperative cognitive dysfunction in patients undergoing cardiac surgery, but that neither NSE nor S100β is associated with late postoperative cognitive dysfunction [23]. Herrmann et al. [24] concluded that post-operative serum S100β and NSE values were superior in predicting early neurophysiological outcome in patients undergoing cardiac surgery (CABG or valve replacement surgery). In contrast to these studies, Basile et al. [25] determined that both S100β and NSE were associated with postoperative cognitive dysfunction in the late phase (6 months). However, in that study, this significant association between S100β and postoperative cognitive dysfunction was lost when the patients were classified according to age (younger or older than 69 years). In the current study, there was no difference between the groups in respect of the S100β and NSE values preoperatively and in the postoperative 1st hour and on the 7th day. Although not at a statistically significant level, the postoperative values of S100β in the light group decreased slightly whereas the postoperative values increased in the deep group compared to the preoperative values. Likewise, postoperative NSE values were lower than preoperative values in the light group and higher in the deep group. The lack of significance in this difference could be attributed to the age range of 18-65 years of the patients included in the study. If more elderly patients were included, a meaningful difference might emerge so there is a need for new studies with the inclusion of patients over 65 years of age.

By monitoring the depth of anesthesia, the perioperative autonomic and adrenergic response of surgical stress is avoided, postoperative healing is accelerated, and there is a faster reduction of anesthesia [26, 27]. Entropy is one of the methods used to measure the depth of anesthesia, and the recommended depth of anesthesia is 40-60 [7]. Jiange et al. [28] evaluated the effect of different anesthesia methods on laparoscopic radical gastrectomies by applying entropy monitorization, keeping the entropy levels between 45-60 during those studies. In the current study, entropy levels were maintained at an average of 58 in the deep group and 40 in the light group. The awakening of the patients in the light group and the subsequent recollections were the greatest concerns. To prevent this, midazolam was applied to all patients during the procedure. No case of intraoperative awareness occurred during this study. Moreover, Remifentanil infusion was performed with SPI monitorization for more effective analgesia during the operation and SPI levels were kept between 35 and 50 in both groups. Bergmann et al reported that in a randomized trial of 170 shoulder arthroscopy patients, consumption of both propofol and remifentanil was reduced by adjusting the remifentanil dose according to SPI values, and there was no difference between the SPI and control groups in the postoperative pain severity [29]. In another study of 45 children who underwent elective adenotonillectomy, fentanyl consumption was lower in the SPI-guided analgesia group than in the conventional analgesia group, but hypertension developed more frequently during the operation and caused more agitation and pain scores in the recovery room in the SPI-guided group [30]. In the current study, remifentanil consumption was lower in the deep group than in the light group, but there was no statistically significant difference (p=0.164). This was thought to have been possibly associated with the higher level of Desfluran maintained in the deep group, but Desfluran consumption was not measured, which caan be considered a limtation of the study. The hemodynamic parameters (mean arterial pressure, pulse), and blood gas levels were stable in both groups, and the Ramsey sedation scales in the recovery room were similar in both groups. All these results indicate that a stable level of anesthesia was provided in both groups. It can be concluded that light anesthesia has a positive effect on postoperative cognitive function. Nevertheless, there is a need for further studies, especially of elderly patients, to confirm these findings.

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