The Effect of Pneumoperitoneum Duration on Serum S100B Level Alterations During Laparoscopic Surgery in the Operating Theater of Universitas Airlangga Hospital

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KEYWORDS

Laparoscopy, Pneumoperitoneum, S100B, Duration, CO_2

ABSTRACT:

Background: Laparoscopic surgery is more recommended due to its advantages over conventional surgery, particularly its faster recovery time. However, laparoscopic surgery also has short-term and long-term disadvantages, one of which is the occurrence of Postoperative Cognitive Disorder (POCD). This condition can occur because laparoscopic procedures utilize CO_2 gas to facilitate the surgeon visualization of the surgical field. The pneumoperitoneum condition results in increased intra-abdominal pressure (IAP). Elevated IAP can lead to a reduction in cerebral perfusion pressure (CPP), causing cerebral edema. S100B can serve as a biomarker for brain injury, as it originates from astrocytes and glial cells. This study aims to analyze the effect of pneumoperitoneum duration on changes in S100B levels during laparoscopic surgery.

Methods: This study used a cross-sectional analytic observational study, using a time- and number-limited consecutive sampling method. A total of 30 samples were drawn from the study population, which included adult patients with ASA physical status 1-2 undergoing laparoscopic surgery in the digestive or gynecological department at the Operating Theatre of Universitas Airlangga Hospital, Surabaya.

Results: The study results demonstrated an increase in postoperative S100B levels. Comparative analysis of preoperative and postoperative S100B levels using the Wilcoxon Signed Rank test yielded a p-value of 0,049 ($p < 0,05$), indicating a significant difference between pre-laparoscopic and post-laparoscopic surgery S100B levels. Further analysis of the correlation between pneumoperitoneum duration and changes in S100B levels using the Spearman test resulted in a p-value of 0,870 ($p > 0,05$), indicating no significant correlation between pneumoperitoneum duration and alterations in S100B levels.

Conclusion: There was an increase in S100B levels between preoperative and postoperative periods in laparoscopic surgery; however, the duration of the laparoscopy did not affect changes in S100B levels. Other factors influencing changes in S100B levels include conditions during laparoscopy, such as hypoperfusion and hypoxemia.

1. Introduction

Laparoscopic procedures differ from open surgery. Laparoscopy is performed using insufflation with carbon dioxide (CO_2) gas to create space and provide visibility for the surgeon. It is recommended due to its faster recovery time compared to other surgical methods and is considered as safe as conventional open surgery. However, depending on the type of surgery, laparoscopy carries certain risks. Bowel surgery, for instance, is associated with specific risks related to anesthesia, bleeding, or infection complications. Postoperative risks also depend on the patient's overall health condition (Kotekar et al., 2018).

Several short-term and long-term postoperative effects may be experienced. One study found that postoperative cognitive dysfunction (POCD) occurred in 55% of colorectal laparoscopic surgery patients on the first postoperative day, with 32% experiencing it in the long-term follow-up group. The study suggested a relationship between laparoscopy and POCD due to increased intra-abdominal pressure (12–15 mmHg), which leads to elevated central venous pressure (CVP) and decreased cerebral perfusion pressure (CPP). These changes result in increased hydrostatic and oncotic pressure, which can cause cerebral edema and ultimately lead to POCD (Vitish-Sharma et al., 2020). Additionally, the Trendelenburg position commonly used during laparoscopic surgery can further increase CVP, reducing venous blood flow to the brain. This condition raises hydrostatic pressure, potentially leading to cerebral edema, increased cerebrovascular resistance, and decreased cerebral perfusion (Vitish-Sharma et al., 2020).

S100B protein belongs to the calcium-mediated S100 protein family, consisting of 24 different types with similar structures and functions. S100B is specifically localized in neural tissues, with the highest expression in astroglial and Schwann cells. Under normal conditions, serum S100B levels remain very low. Serum biomarkers for blood-brain barrier (BBB) dysfunction serve as essential additional tests to predict complications related to prior BBB impairment, such as symptomatic intracranial hemorrhage (sICH) and symptomatic brain edema (sBE) (Honegger et al., 2023). Serum S100B levels increase in conditions involving neuronal damage, leading to greater BBB permeability (Tomaszewski, 2015).

A study conducted by Schmidt and Carmona provided new insights into the relationship between POCD and increased S100B levels in patients undergoing Robotic-Assisted Laparoscopic Radical Prostatectomy (RALRP). Among 82 patients who underwent RALRP, 30% experienced POCD seven days postoperatively, while 10% had POCD three months postoperatively. Serum S100B levels significantly increased at 30 minutes and 24 hours post-surgery in patients exhibiting POCD symptoms (Schmidt & Carmona, 2020). These studies suggest that laparoscopy is associated with POCD, and S100B biomarker analysis can be used to detect this condition. The authors have investigated the effect of laparoscopic surgery duration on changes in S100B levels.

Based on the aforementioned background, this study aims to analyze the differences between preoperative and postoperative serum S100B levels. Additionally, it seeks to examine the impact of pneumoperitoneum duration on changes in serum S100B levels during laparoscopic surgery at the Central Surgical Installation of Universitas Airlangga Hospital.

2. Literature Review

The Relationship Between S100B and POCD incidence

The association between serum S100B levels and postoperative cognitive dysfunction (POCD) in previous studies has shown contradictory results. Serum S100B levels were found to be unrelated to cognitive function following cardiac surgery; however, high S100B levels were observed in non-cardiac surgery patients who developed POCD. An increase in S100B levels was also noted in patients with delirium compared to those without delirium (van Munster et al., 2009). Another study found that S100B release was associated with short-term POCD but not with persistent POCD (Gerriets et al., 2010).

In previous research, a significant increase in S100B levels was observed in patients with POCD. Several other studies have also demonstrated a relationship between S100B levels and cognitive dysfunction in patients who underwent resuscitation after a stroke, suffered severe head trauma, or underwent cardiac, vascular, and abdominal surgeries. However, in urological surgery, no difference in S100B levels was found between patients with and without POCD. In contrast, nearly all patients undergoing hip and knee arthroplasty experienced an increase in S100B levels. It is assumed that S100B is only released from cerebral tissue; therefore, its elevation is suspected to be caused by cerebral ischemia, head injury, or cerebral embolism related to cardiopulmonary bypass (Linstedt et al., 2002).

The concentration of S100B in blood or cerebrospinal fluid samples can be measured. In the blood, S100B levels are typically less than or equal to 0.12 ng/ml, while in cerebrospinal fluid, its concentration is usually 100 times higher (Linstedt et al., 2002). Previous studies have demonstrated that S100B is associated with brain tissue hypoxia (Iriz et al., 2005), which can result from acute or chronic hypoxia. A key advantage of S100B is that it is undetectable in the blood under normal conditions. S100B levels increase in cases of brain trauma, stroke, and cerebrovascular perfusion (CBP) disorders due to blood-brain barrier (BBB) damage (Iriz et al., 2005). Prior research has also shown a correlation between serum S100B and neurocognitive dysfunction (Berger et al., 2002). Elevated S100B can be detected in cerebrospinal fluid and secondarily in the blood due to BBB leakage.

Studies indicate that nerve damage is one of the causes of POCD, as S100B levels, a marker of neural injury, increase after cardiac surgery (Baktiar et al., 2020). S100B is known as a damage-associated molecular pattern (DAMP) protein, which is released by damaged neurons or activated by stress (Hajduková et al., 2015). This protein also plays a role in inflammation. Although the normal range of S100B remains unclear in the literature, a cut-off value of 0.10 µg is commonly referenced. As a prognostic factor, changes in S100B concentration or trends over time are more meaningful than absolute S100B levels (Tomaszewski, 2015).

Conceptual Framework

Laparoscopic procedures require carbon dioxide (CO_2) insufflation to achieve pneumoperitoneum, which increases the working space and enhances surgical visualization (Yang et al., 2021). The administration of CO_2 gas can lead to an increase in intra-abdominal pressure (IAP) (Umano et al., 2021). Several factors influence the rise in IAP, including patient positioning, hemodynamics, duration, and ventilation. The increase in pneumoperitoneum pressure leads to an elevation in central venous pressure (CVP), which subsequently reduces venous blood flow from the brain. This process results in increased hydrostatic and oncotic pressure in the brain, ultimately causing cerebral edema (Vitish-Sharma et al., 2020).

S100B is a calcium-binding protein produced by astrocytes and found both intra- and extracellularly in brain tissue. The physiological function of S100B is to enhance interactions between neurons and glial cells. S100B serves as an important biochemical marker for POCD, as it is typically excreted into the bloodstream due to brain injury caused by blood-brain barrier (BBB) permeability disturbances (Ozturk et al., 2020).

Hypothesis

There is an effect of pneumoperitoneum duration on changes in serum S100B levels during laparoscopic surgery at Universitas Airlangga Hospital.

3. Methods

Research Design

This study employs an analytical observational cross-sectional study to assess serum S100B levels during laparoscopic surgery based on CO_2 insufflation duration.

Study Population

The study population consists of patients undergoing elective laparoscopic surgery at the Central Surgical Unit of Universitas Airlangga Hospital. The study sample includes individuals from the population who meet the inclusion and exclusion criteria. The minimum sample size is determined using a correlation formula.

Previous studies analyzing S100B levels in laparoscopic surgery have found that serum S100B levels increased by 1.2 with an SD of 0.4 at 30 minutes post-surgery (Ozturk et al., 2020)

$$n = \left\{ \frac{1{,}96 - 0{,}84}{\frac{1}{2}\log\frac{(1+0{,}5)}{(1-0{,}5)}} \right\}^2 + 3$$

Therefore, the minimum sample size to be used in the study is 30 people. The sampling technique used in the study was time-limited consecutive sampling and the number of minimum samples that had been calculated.

Inclusion and Exclusion Criteria

Inclusion Criteria

This study requires samples that meet the following inclusion criteria: Young adult patients aged 18–59 years; American Society of Anesthesiologists (ASA) physical status classification I–II; and patients with no history of craniotomy.

Exclusion Criteria

The selected samples must not meet the following exclusion criteria: Blood loss exceeding 20% of the estimated blood volume (EBV); refractory desaturation lasting more than 3 minutes; patients converted to open laparotomy; patients with a history of stroke; and patients with a history of previous cardiac surgery.

Research Variable

Table 1
Operational Definition of Variables

No	Variable	Definition	Tools and Measurement Methods	Unit	Scale
1.	Pneumoperitoneum Duration	Duration from gas start-up to shutdown	Measured in minutes using a stopwatch or similar timer	minute	Ratio
2.	S100B	Blood samples taken 30 minutes before induction and 30 minutes after surgery	Utilized ELISA	ng/mL	Ratio
3.	Laparoscopy	A minimally invasive surgical procedure performed by insufflating CO_2 into the abdominal cavity.			

Data Collection Method

Patients who were planned to undergo elective surgery with laparoscopic techniques at the Central Surgical Installation of Universitas Airlangga Hospital under general anesthesia who met the inclusion criteria were taken as samples. S100B examination was performed before induction and 30 minutes after surgery was completed.

Data Processing and Analysis Techniques

The collected data will be recorded in the data collection sheet (DFS) and processed using SPSS version 23.0 software. All demographic characteristics data will be summarized descriptively. All measurement data will be presented as mean ± standard deviation or median (range) as well as minimum and maximum data and then attached in a table or graph. Data on changes in S100B levels will be tested for normality with the Saphiro-Wilk test. Then it will be correlated clinically using statistical tests. If the data is normally distributed, the statistical test is performed with the Pearson correlation test. If the data is not normally distributed, the statistical test is performed with Spearman correlation test.

Operational Framework

Patients who are planned to undergo elective surgery with laparoscopic techniques will be included in the study sample if they meet the inclusion criteria. Preoperative sampling was performed before induction as a baseline value. Induction of general anesthesia was performed by administering fentanyl 1-2 μg/kgBW intravenously, propofol 1-2 mg/kgBW intravenously, rockuronium 0.6-1.2 mg/kgBW intravenously, and preoxygenation of fraction of inspired oxygen (FiO2) 100%.

During surgery, mean arterial pressure (MAP) and hemodynamic status were monitored for shock or hypotension (exclusion criteria). The patient was anesthetized with intraoperative analgesic fentanyl 1 μg/kgBW intermittently intravenously. Isoflurane inhalation gas 1.2 vol% with FiO_2 50% and flow 2 lpm, tidal volume 6 ml/kgBW, frequency 16 x/min with target end-tidal carbon dioxide ($EtCO_2$) 35-45 mmHg and target oxygen saturation (SpO_2) >95%. Blood samples were taken the night before induction and 30 minutes after surgery.

Research Ethics

The research ethics have been approved by the Research Ethics Committee of Universitas Airlangga Hospital with approval number: 187/KEP/2024.

4. Results

Descriptive Research Demographics

The study was conducted at the Central Surgical Installation of Universitas Airlangga Hospital during the period August to October 2024. The selected samples have been selected and based on the minimum formula, the subjects for the sample were obtained as many as 30 data. The following is a description of the demographics of the subjects in this study where for category data is presented in the form of frequency, percentage while for score data is presented in the form of median range, mean ± standard deviation:

Table 2
Distribution of Demographic Characteristics

Demography	n (%)
Gender	
Male	5 (16,7%)
Female	25 (83,3%)
Education	
Elementary School	2 (6,7%)
Junior High School (SMP)	17 (56,7%)
Senior High School (SMA/SMK)	9 (30,0%)
Bachelor (S1)	2 (6,7%)
Comorbid	
Exist	25 (83,3%)
None	5 (16,7%)
Type of Surgery	
Digestive Surgery	16 (53,3%)
Gynecological Surgery	12 (46,7%)
PS ASA	
1	5 (16,7%)
2	25 (83,3%)
Surgery History	
Yes	12 (40%)
No	18 (60%)

Based on the results of table 2, the distribution of general demographics based on 30 research samples, on the demographics of the amount of bleeding obtained an average of 205.0 ml. A total of 1 sample had bleeding of more than 40% EBV. In the demographics of the length of surgery, the average was 139 minutes with 1 sample undergoing surgery for 335 minutes. The highest postoperative S100B value was found to be 121.662 ng/mL, and was found in samples who experienced bleeding of more than 1000 ml.

Table 3
Demographics and Data Normality Test

Demography	n (%)	Range (Median)	Mean±SD	Normality p value
Age (years)	30 (100%)	24 – 65 (39,0)	40,77 ± 13,41	0,011
BMI (kg/m^2)	30 (100%)	16,6 – 33,3 (23,30)	23,76 ± 4,08	0,506
Duration of Surgery (minutes)	30 (100%)	60 – 335 (117,5)	139,0 ± 66,56	0,000
Lowest MAP (mmHg)	30 (100%)	55 – 86 (67,0)	69,07 ± 7,35	0,189
Highest MAP (mmHg)	30 (100%)	87 – 120 (98,0)	101,67 ± 8,33	0,051
Bleeding (mL)	30 (100%)	100 – 1300 (175,0)	205,0 ± 214,69	<0,001
IAP (mmHg)	30 (100%)	12 – 15 (14,0)	13,67 ± 1,09	<0,001
$EtCO_2$ (cmH_2O)	30 (100%)	30 – 45 (36,0)	36,3 ± 3,65	0,242

*declared normal if the p value of normality > 0,05

Pneumoperitoneum Duration

Pneumoperitoneum duration is the duration from CO_2 insufflation into the peritoneal cavity until it is turned off, the data is measured by recording in minutes from the beginning of insufflation to deflation using a timer. Because the pneumoperitoneum duration data is in numerical form, it is necessary to perform a normality test to see whether the distribution of pneumoperitoneum duration data is normally distributed or not. The normality test used is the Shapiro-Wilk test because the amount of data < 50 samples, the normality test serves to determine the next test where if the data is declared normal then for the next stage test using parametric methods while if it is not normal then using non-parametric methods.

Table 4
Pneumoperitoneum duration descriptive and normality test

	n	Range (Median)	Mean±SD	Normality p value
Pneumoperitoneum Duration	30	45 – 315 (117,5)	126,67± 69,29	< 0,001

*declared normal if the p value of normality > 0,05

Based on the results of table 4 for the duration of pneumoperitoneum from 30 samples in the range of 45 to 315 minutes with a median value of 117.5 and a mean ± standard deviation of 126.67 ± 69.29 minutes. Based on the results of the normality test using Shapiro-Wilk, the p value is 0.001 where the value is <0.05, meaning that the distribution of pneumoperitoneum duration data is not normally distributed.

S100B

Data on S100B levels are taken based on 2 observations, namely at the time of pre and post-surgery, because the S100B level data is in the form of ratios / values, it is necessary to do a normality test to see whether the distribution of S100B data is normally distributed or not, the normality test used is the Shapiro-Wilk test because the amount of data < 50 samples, the normality test serves to determine the next test where if the data is declared normal then for the next stage test using parametric methods while if it is not normal then using non-parametric methods. The following is a descriptive table of S100B and the results of the normality test:

Table 5
S100B Normality Test

S100B	n	Range (Median)	Mean±SD	Normality p value
Before surgery	30	5,503 – 113,311 (31,678)	35,739 ± 20,184	<0,001
After surgery	30	11,507 – 121,662 (34,235)	38,693 ± 20,763	<0,001
Deviation	30	-8,551 – 23,815 (3,140)	2,953 ± 7,332	0,242

*declared normal if the p value of normality > 0,05

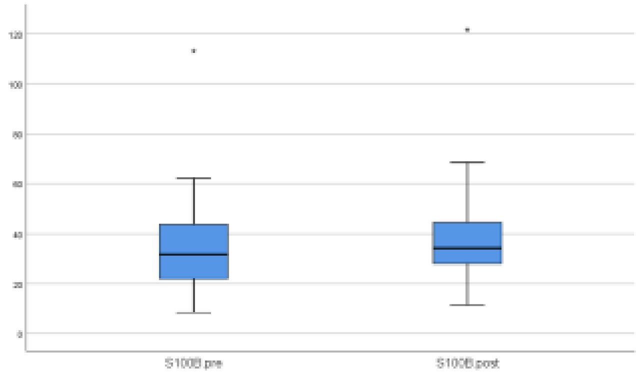
Based on the results in table 5, from a total of 30 samples, the preoperative S100B levels ranged from 5.503 to 113.311, with a median value of 31.678 and a mean ± standard deviation of 35.739 ± 20.184. The postoperative S100B levels ranged from 11.507 to 121.662, with a median value of 34.235 and a mean ± standard deviation of 38.693 ± 20.763. The change in S100B levels ranged from -8.551 to 23.815, with a median value of 3.140 and a mean ± standard deviation of 2.953 ± 7.332.

Further, based on the results in Table 5, the normality test using Shapiro-Wilk showed a p-value of 0.001 for both preoperative and postoperative S100B levels, which is <0.05, indicating that the preoperative and postoperative S100B levels follow a normal distribution. However, the p-value for the change in S100B levels was 0.242, which is >0.05, meaning that the distribution of changes in S100B levels is considered non-normal.

S100B Comparison Test

S100B comparison test analysis is testing pre S100B levels with post laparoscopic surgery S100B levels to see if there is a difference in changes in pre S100B levels with post laparoscopic surgery. The difference test used the Wilcoxon Signed Rank test because the pre and postoperative S100B data were not normally distributed. The following is a graph of the comparison test of pre S100B levels with post laparoscopic surgery S100B levels:

Figure 1
Box Plot of Preoperative S100B Levels and Postoperative S100B Levels After Laparoscopic Surgery



For the analysis of the comparison test of pre S100B levels with post laparoscopic surgery S100B levels using the Wilcoxon Signed Rank test, the p value is 0.049 which is <0.05, which means that there is a significant or meaningful difference in pre S100B levels with post laparoscopic surgery S100B levels, where based on the median value and mean ± standard deviation for pre S100B levels 31,678 and 35,739 ± 20,184 while postoperative S100B levels are 34,235 and 38,693 ± 20,763 which means that postoperative laparoscopic S100B levels are higher than preoperative S100B levels, which means there is an increase in preoperative S100B levels with postoperative laparoscopic S100B levels.

Test of the Effect of Pneumoperitoneum Duration on S100B Changes

A test was conducted to determine whether pneumoperitoneum duration influences changes in S100B levels. The effect was analyzed using regression testing. The following table presents the regression test results on the effect of pneumoperitoneum duration on changes in S100B levels:

Table 6
Regression Test on the Effect of Pneumoperitoneum Duration on Changes in S100B Levels

	n	r_s	p *value*	Description
Pneumoperitoneum Duration with S100B Levels	30	0,02	0,947	Insignificant effect

Based on the results of table 6 for the test results of the effect of pneumoperitoneum duration with changes in S100B levels using the Spearman test, the p value is 0.947 which is >0.05, which means that the duration of pneumoperitoneum has no effect on changes in S100B levels.

Demographic Test with S100B Changes

Both general and clinical demographic characteristics will be tested against changes in S100B levels to see if demographic characteristics are associated with changes in S100B levels and also to ensure that demographics are not a confounder for changes in S100B levels. The following table shows the test results of demographic characteristics with changes in S100B levels:

Table 7
Demographic Test with Changes in S100B Levels

Demography	n	S100B Changes Mean±SD	p value
Gender			
Male	5 (16,7%)	7,753 ± 10,512	0,232[a]
Female	25 (83,3%)	1,993 ± 6,385	
Age	30 (100%)	-	0,962[c]
BMI	30 (100%)	-	0,993[c]
Education			
Elementary School	2 (6,7%)	15,448 ± 11,832	0,143[b]
Junior High School	17 (56,7%)	1,637 ± 6,983	
Senior High School	9 (30,0%)	1,244 ± 4,191	
Bachelor	2 (6,7%)	9,333 ± 6,979	
Comorbid			
Exist	25 (83,3%)	2,367 ± 6,530	0,487[a]
None	5 (16,7%)	5,883 ± 10,999	
Type of Surgery			
Digestive Surgery	16 (53,3%)	3,667 ± 8,215	0,836[b]
Gynecological Surgery	13 (43,3%)	1,974 ± 6,609	
Obstetric Surgery	1 (3,3%)	4,258 ± 0,000	
PS ASA			
1	5 (16,7%)	5,883 ± 10,999	0,487[a]

2	25 (83,3%)	2,367 ± 6,530	
Surgery History			
Yes	12 (40%)	2,097 ± 6,641	
No	18 (60%)	3,523 ± 7,893	0,832[a]
Duration of Surgery	30 (100%)	-	0,948[c]
Lowest MAP (mmHg)	30 (100%)	-	0,296[c]
Highest MAP (mmHg)	30 (100%)	-	0,429[c]
Bleeding	30 (100%)	-	0,427[c]
IAP	30 (100%)	-	0,279[c]
$EtCO_2$	30 (100%)	-	0,158[c]

[a] Mann Whitney, [b] Kruskal Wallis, [c] Spearman where it is significant if the p value <0.05

Based on the results of table 7 test analysis of general demographic characteristics with changes in S100B levels, the p value for gender p=0.232, age p=0.962, BMI p=0.993, education p=0.143, comorbid p=0.487, type of surgery p=0.836, PS ASA p=0.487, history of surgery p=0.832 and length of surgery p=0.948 where the value is> 0.05 which means that the general demographic characteristics of gender, age, BMI, education, comorbidities, type of surgery, PS ASA, history of surgery, and length of surgery with changes in S100B levels are declared insignificant or not statistically significant which means that the general demographic characteristics of gender, age, BMI, education, comorbidities, type of surgery, PS ASA, history of surgery and length of surgery are not a confounder for changes in S100B levels.

Further, based on the results of table 7 test analysis of objective demographic characteristics with changes in S100B levels, the p value for the lowest MAP p=0.296, the highest MAP p=0.429 the amount of bleeding p=0.427, IAP p=0.279 and $EtCO_2$ p=0.158 where the value is> 0.05 which means that the demographic characteristics of the lowest MAP objective data, The lowest MAP, the highest MAP, the amount of bleeding, IAP and $EtCO_2$ with changes in S100B levels were declared insignificant or not statistically significant, which means that the laboratory demographic characteristics of the lowest MAP, the highest MAP, the amount of bleeding, IAP and $EtCO_2$ are not a confounder for changes in S100B levels.

5. Discussion

Clinical Characteristics of Research Subjects

This study aimed to analyze the effect of pneumoperitoneum duration on laparoscopic surgery involving 30 patients with uniform characteristics. BMI demographic data of 30 samples were obtained, the BMI range was 16.6 - 33.3 with a median of 23.3 and a mean standard deviation of 23.76 ± 4.08. Several studies have shown that people with obesity (high BMI) tend to have higher levels of S100B. This could be due to higher systemic inflammation in obese people. This inflammation can affect brain function and lead to increased levels of S100B, signaling stress or damage to glia cells (Steiner et al., 2010).

In the results of this study, the general demographic distribution on gender of 30 samples was obtained for 5 (16.7%) men and 25 (83.3%) women. For age demographics, the age range is 24 - 65 years with a median value of 39.0 and a mean ± standard deviation of age of 40.77 ± 13.41. Age distribution in this study, age was not normally distributed because the p value was <0.05. This is in accordance with research that has been conducted, that gender factors, and concomitant systemic diseases such as DM, hypertension and dyslipidemia have no influence on S100B levels (Selcuk et al., 2005).

In this study, a sample of 30 patients was obtained with an educational background of elementary school as much as 2 (6.7%), junior high school as much as 17 (56.7%), high school / vocational school as much as 9 (30.0%), and S1 as much as 1 (3.3%). Test of demographic characteristics obtained p = 0.143 (p> 0.05). This indicates that education is not a confounder for changes in S100B. Previous research states that although there are indications that educational status may influence health outcomes in general, specific research regarding the direct relationship between educational status and serum S100B levels in the context of surgery is limited. S100B levels seem to be more influenced by clinical conditions and other factors such as age and type of surgery compared to the patient's education level. Further research is needed to explore this relationship in more depth and to understand how other demographic factors may interact with biomarkers such as S100B in the context of postoperative health.

Correlation analysis in this study did not show a significant association between the duration of pneumoperitoneum and changes in serum S100B levels. However, other factors may also influence changes in serum S100B levels in the postoperative period. Other studies have shown that other factors such as conditions during surgery (hypoperfusion and hypoxemia) are associated with changes in serum S100B levels. Increased levels of S100B were found in patients who experienced heavy bleeding. Increased levels of S100B may be due to decreased oxygen supply in the brain, which, due to bleeding, can cause brain cell damage (Stamataki et al., 2013). After hemodynamic decompensation occurs, cerebral perfusion pressure will decrease, and S100B levels increase significantly (Pelinka et al., 2003)

In this study, it was found that the duration of laparoscopy was not shown to have a significant effect on changes in S100B levels, which is known as a biomarker for brain injury and neurodegenerative conditions. S100B protein is often used as an indicator of metabolic or inflammatory stress in various pathological conditions, including head trauma and other neurological disorders. However, in the context of laparoscopic surgery, the intra-abdominal pressure generated during the procedure is not sufficient to trigger a clinically meaningful increase in S100B levels. This suggests that the duration of laparoscopic surgery does not affect the risk of S100B-related neurological complications. Examination of S100B levels may help identify potential tissue damage that is not clinically detectable, allowing early intervention to prevent further complications. The use of this biomarker may complement clinical and radiological evaluations in ensuring the safety of laparoscopic procedures. Thus, integration of S100B screening in laparoscopic protocols may improve the overall quality of patient care.

From the results of the study, there was no effect of pneumoperitoneum duration on S100B changes. This may be due to the less variable duration and amount of bleeding. As such, further research can be conducted with a larger scale, a more diverse sample, and a more varied duration and amount of bleeding.

6. Conclusion

Based on the results and discussion mentioned, it can be concluded that there is no significant influence between the duration of laparoscopic surgery and changes in S100B levels. Future studies are expected to consider other factors such as the amount of bleeding and hemodynamic conditions during surgery that could potentially affect changes in S100B levels. Further research by considering MAP, IAP, and $EtCO_2$ during surgery is expected to be a factor that affects changes in S100B levels.

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