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RESEARCH ARTICLE

Difference of Surfactant Protein-D in Laparoscopy and Laparotomy Gynecology Surgery

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ABSTRACT

Laparoscopy is a commonly utilized surgical technique because of its numerous benefits, including minimally invasive treatments, improved cosmetic outcomes, and reduced hospitalization durations. Throughout laparoscopy, the use of pneumoperitoneum and the Trendelenburg position can cause atelectasis, particularly in the lower parts of the lungs. This can also increase mechanical strain on the lung tissue, resulting in substantial pulmonary dysfunction throughout the perioperative period. This study is observational analytical research aimed at evaluating the variations in serum SP-D levels in patients who are undergoing laparoscopic and laparotomy gynecological surgery. The samples that fulfill the specified criteria will be categorized into two groups: the laparoscopy group and the laparotomy group. Both groups will receive general anesthesia. Both groups underwent examination for levels of surfactant protein-D after induction and were subjected to statistical testing after 2 hours of operation. Statistical analysis revealed a significant difference in surfactant protein-D levels before and after laparoscopic surgery (before surgery: 133.27 ± 34.93 ng/mL, after surgery: 154.80 ± 37.27 ng/mL; p = 0.021). The levels of surfactant protein-D before and after laparotomy surgery were measured (before surgery: 156.84 ± 34.93 ng/mL, after surgery: 143.28 ± 37.27 ng/mL). Statistical analysis showed that there was no significant difference between the two groups (p = 0.287). Moreover, the levels of surfactant protein-D differed between laparoscopic and laparotomy procedures (21.53 ng/mL in laparoscopic surgery and -13.56 ng/mL in laparotomy surgery). Statistically, the two groups exhibited a significant difference (p = 0.025). After two hours, the pneumoperitoneum level of SP-D increased. There were no significant disparities in SP-D levels before and after gynecological laparotomy surgery. SP-D levels increased during laparoscopy but dropped after laparotomy.

INTRODUCTION

Laparoscopy is extensively utilized in surgical interventions owing to its benefits, including minimally invasive techniques, improved aesthetic outcomes, and reduced hospitalization durations. Laparoscopy can cause atelectasis, particularly in the lower regions of the lungs, due to pneumoperitoneum and the Trendelenburg posture. This can also increase mechanical strain on the lung tissue, resulting in considerable pulmonary dysfunction throughout the postoperative period (Nguyen et al., 2021). Inadequate mechanical ventilation parameters during general anesthesia may exacerbate and potentially initiate pulmonary damage in people with healthy lungs, resulting in ventilator-induced lung injury (VILI)

(Liu et al., 2020).

CO_2 insufflation within the abdominal cavity induces the diaphragm to exert pressure towards the lungs. This condition increases intrathoracic pressure, lowering compliance in the respiratory system associated with hypoxemia, atelectasis, oedema, and barotrauma. Recruitment maneuvers aimed at reducing the extent of atelectasis result in an increase in pulmonary pressure. This could potentially lead to postoperative pulmonary dysfunction. Elevated intra-abdominal pressure leads to an increased occurrence of lung damage, resulting in the generation of inflammatory cytokines and reactive oxygen species (ROS) (Brandao et al., 2019).

Researchers have identified surfactant protein-D (SP-D) serum as a lung-specific biomarker for acute lung illness. The reference is from Murata et al. (2016). SP-D circulating in the blood is a potential biomarker of pulmonary inflammation, causing damage to the alveolar epithelium and consequently increasing the permeability of the alveolar epithelial barrier (Sakamoto et al., 2012).

There have been no studies conducted to investigate the impact of laparoscopy, namely pneumoperitoneum and laparotomy, on lung biomarkers. Given the provided background information, the author intends to investigate variations in SP-D serum levels as a potential biomarker for lung damage in laparoscopic surgery and gynecological laparotomy.

LITERATURE REVIEW

Laparoscopy is a surgical technique that enables a physician to examine the belly, pelvis, or chest by making small incisions in the skin (Pizzol et al., 2021). Laparoscopic surgery is a technique that uses a laparoscope in the abdominal cavity to monitor and guide surgery from outside the abdomen to solve problems with diseased tissue, hemostasis, electrocoagulation, suturing, and other operations. Laparoscopic surgery is commonly employed because of its little blood loss, low postoperative pain, rapid recovery, and short hospitalization duration (Sun et al., 2023).

Based on research by Imaralu et al. (2022), laparoscopy accounts for 13.5% of gynecological operations (Imaralu et al., 2022). Loring et al. (2015) reported that there has been a significant shift in gynecological surgical departments towards the use of laparoscopic procedures. According to their study, over 72% of hysterectomies are now performed using laparoscopy, and more than 93% of these surgeries are done using minimallyinvasive techniques. This transformation has occurred in less than 8 years. Laparoscopy is a significant diagnostic tool, especially in cases of chronic pelvic pain of unknown cause (Loring et al., 2015).

Argentino et al. stated that laparoscopy contributed to the diagnosis in 59.6% of cases of infertility ($p > 0.05$), in 93.7% of chronic pelvic pain of unknown cause ($p < 0.01$), and conclusively explained the diagnosis of acute abdominal and exclude tubo-ovarian abscess ($p < 0.05$). Laparoscopy also increased the diagnosis of pelvic-abdominal adhesions by 76.7% ($p > 0.05$) (Argentino et al., 2019).

The pressure effects of the gas introduced into the closed cavity, the systemic effects of the gas, the almost universal introduction of CO_2 (either absorbed or embolized), the patient's position during surgery, the anesthetic used, and the cardiopulmonary system all contribute to the physiological changes associated with laparoscopy, patient status (Banerjee et al., 2021).

Pneumoperitoneum causes an increase in intra-abdominal pressure, resulting in elevation of the diaphragm. This makes the lung basal tissue fall apart, which leads to a drop in its functional residual capacity (FRC), a mismatch in the ventilation perfusion ratio (V/Q), and more blood shunts inside the lungs. These things all lead to low oxygen levels and a rise in the alveolar-arterial oxygen gradient [(A-a)DO_2]. These consequences can be overcome by increasing the frequency of mechanical ventilation with positive end-expiratory pressure (PEEP) and also by increasing the fraction of inspired oxygen (FiO_2)

during laparoscopic surgery. Various studies support the idea that PEEP (5 cm H2O) should be considered essential during laparoscopic surgery to reduce intraoperative atelectasis caused by pneumoperitoneum. This mechanism can increase FRC, resulting in increased gas exchange and oxygenation (Srivastava & Niranjan, 2010).

The mechanical effect of pneumoperitoneum is compression of the inferior vena cava, which causes a decrease in venous return, a decrease in cardiac output, and an increase in central venous pressure, thereby increasing vascular resistance in the arterial circulation (Srivastava & Niranjan, 2010).

ARDS patients have implemented lung protection strategies to minimize potential damage from mechanical ventilation. The lung recruitment maneuver, which is part of the open lung approach, is an adjunct to mechanical ventilation. Lung recruitment maneuvers are a temporary and sustained method of reopening collapsed alveoli through increasing transpulmonary pressure. The primary goal of lung recruitment maneuvers as part of lung-protective ventilation is to improve oxygenation (Semedi et al., 2021). The patient undergoes a laparoscopic procedure in either the Trendelenburg or reverse Trendelenburg position. These positions have an impact on cardiopulmonary function. In the Trendelenburg position, the preload increases due to increased venous return from the lower extremities. This position results in a cranial shift of the viscera, which increases pressure on the diaphragm. In the reverse Trendelenburg position, lung function tends to improve because the internal organs shift caudally, which increases tidal volume by reducing pressure on the diaphragm. This position also reduces the heart's preload and causes a decrease in venous return, which causes hypotension. Blood pooling in the lower extremities increases stasis and is predisposing to deep vein thrombosis (DVT) (Srivastava and Niranjan, 2010).

The head-up position further reduces venous return, cardiac output, and mean arterial pressure while increasing peripheral and pulmonary vascular resistance. Respiratory system damage is considered to be most affected in the reverse Trendelenburg position, but this also depends on the duration of the pneumoperitoneum (Bajwa & Kulshrestha, 2016).

SP-D is a biomarker of lung epithelial injury that is made by type II alveolar cells. It is very important for keeping the alveolar-capillary interface intact (Agustama et al., 2022). Type II pneumocytes release the surfactant that covers the surface of the pulmonary alveoli. This surfactant provides beneficial gas exchange by reducing alveolar surface tension and preventing the upper alveoli collapse (Kurt et al., 2016).

Several factors can cause rate changes in SP-D. Smoking causes a significant decrease in the rate of bronchoalveolar lavage of SP-D compared to the non-smoking population. This is caused by cleaning. SP-D showed a significant increase in surface tension (Honda et al., 1996). SP-D serum levels studied were higher in populations with diabetes mellitus compared to those without diabetes mellitus. The influencing factors are not yet widely known. However, insulin resistance, chronic low-grade inflammation, microvascular damage, and defects in bronchoalveolar surfactants are considered to be influencing factors (López-Cano et al., 2017).

When the air-blood barrier breaks down, proteins that are secreted by the lungs leak out of the blood vessels and into the interstitium and air spaces. Concentration gradient SP-D possible SP-D synthesized in the respiratory tract leaks into the bloodstream in acute and chronic lung injury. Thus, in some circumstances, including acute cigarette smoke exposure, SP-D may decrease on BAL while increasing in serum. Examples include variation investigations of SP-D in COPD and asthma. Studies on rabbits and humans have shown that proteins are cleared from the air spaces in the lungs depending on their molecular size. However, it confirms that LMW SP-D can move from the lungs to the blood more easily than HMW SP-D , which was a big surprise (Sorensen, 2018). Early detection of lung injury can help doctors monitor the patient's condition and provide prompt treatment to reduce further morbidity (Rizka et al., 2024).

RESEARCH METHOD

This research is an observational analytical study to assess changes in serum SP-D levels in patients undergoing laparoscopy and gynecological laparotomy. Samples that meet the inclusion criteria will be divided into two groups, the laparoscopy and laparotomy groups, both of which will be under general anesthesia. Both groups statistically tested the levels of the surfactant protein-D after induction and two hours after surgery.

Inclusion criterias are, patients aged 18 to 64 years old, American Society of Anesthesiologists (ASA) I-II, patients or family members are willing to sign an informed consent to participate in the study, here is no history of lung disease or disorder, no significant heart, liver, or kidney disorder, no diabetes mellitus, no smoking. And exclusion criterias are instable hemodynamic condition during perioperative, changes in intraoperative surgery plan, patients underwent surgery for less than two hours.

RESULT AND DISCUSSION

Table 1. Demographic Characteristic

Subject Characteristics		Group		Total	p value
		Laparascopy (Mean ± SD) (n = 18)	**Laparotomy (Mean ± SD) (n = 18)**		
Age (years)		38.72 ± 7.88	42.78 ± 9.24	40.75 ± 8.71	0.16[a]
Body weight (kg)		57.83 ± 8.93	53.78 ± 10.35	55.81 ± 9.74	0.21[a]
Height (cm)		153.83 ± 4.43	153.72 ± 3.8	153.78 ± 4.1	0.93[a]
BMI (kg/m2)		23.59 ± 2.72	22.67 ± 3.94	23.13 ± 3.37	0.42[a]
PS ASA	1	4 (22.2%)	2 (11.1%)		0.658[b]
	2	14 (77.8%)	16 (88.9%)		
a independent T test					
b uji Chi-Square (Fisher's Exact)					

The age variables, body weight, height, and BMI have p values > 0.05 in the independent T test, which indicates that the demographic characteristics of both groups are homogeneous.

Table 2. Differences in Surfactant Protein-D Levels Before and After Laparoscopic Surgery

Group	Mean ± SD (ng/ml)	N	Mean Differences	P value
Before laparoscopy	133.27 ± 34.93	18	21.53	0.021
After laparoscopy	154.80 ± 37.27	18		

Different tests for surfactant protein-D levels before and after laparoscopic surgery using paired t tests.

Table 2 above analyzes the differences in surfactant protein-D levels before and after laparoscopic surgery using a paired T-test. The levels of surfactant protein-D prior and after laparoscopic surgery varied, with 133.27 ng/mL before surgery and 154.80 ng/ml after operation, with an average difference of 21.53 pg/ml in both groups. Statistically, the two groups had significant differences (p = 0.021).

Table 3. Comparison of Surfactant Protein-D Levels Before and After Surgery in The Laparotomy Group

Group	Mean ± SD (ng/ml)	N	Mean Differences	P value
Before laparotomy	156.84 ± 34.93	18	13.56	0.287
After laparotomy	143.28 ± 37.27	18		

Different tests for surfactant protein-D levels before and after laparotomy surgery using paired t tests.

Table 3 above analyzes the differences in surfactant protein-D levels before and after surgery in the laparotomy group using the paired T-test. The levels of surfactant protein-D prior to and following surgery showed no differences; before surgery, it was 156.84 ng/mL, and the control group was 143.28 ng/ml, with an average difference of 13.56 pg/ml between the two groups. Statistically, both groups had insignificant differences (p = 0.287).

Table 4. Comparison Of Changes in Surfactant Protein D Levels in Laparoscopy and Laparotomy

Group	**Mean ± SD (ng/ml)**	**N**	**Mean Differences**	**P value**
Laparoscopy SP-D Changes	21.53 ± 35.79	18	35.09	0.026
Laparotomy SP-D Changes	-13.56 ± 52.29	18		

Different tests for changes in the level of surfactant protein-D in laparoscopy and laparotomy using independent t tests.

Table 4 above analyzes the differences in surfactant protein-D levels before and after surgery in the laparotomy group using independent samples and a t-test. The rate of change in the level of surfactant protein-D in laparoscopy and laperotomy showed different rates; in laparoscopy surgery, there was a change of 21.53 ng/mL, and in laparotomy surgery, there was a difference of -13.56 ng/mL. Statistically, the two groups have significant differences (p = 0.026).

Laparoscopic surgery has an effect on the respiratory function of postoperative patients. It shows significant changes in respiratory mechanisms in patients undergoing the procedure, in particular increased respiratory pressure and decreased lung compliance. These changes coincide with high-risk factors for ventilator-related lung injury, such as increased respiratory pressure and high tidal volume. Xue et al. (2024) observed significant disruptions in the diaphragm's movement following surgery, an inability to return to the stage of re-formation in the short term, and a notable rise in lung injury serum markers (Xue et al., 2024).

In this study, the mean difference between SP-D before and after laparoscopy surgery was 21.53. This indicates an injury to the lungs. Laparoscopy injuries affect a variety of organs. Lung injury often occurs postoperatively and can lead to a decrease in vital capacity as well as an increase in the number of postoperative respiratory complications (e.g., pneumonia, atelectasis) (Chandler et al., 2020).

There is a link between laparoscopic surgery and local and systemic inflammation, which can lead to an increase in SP-D levels. Several factors, including pressure, duration, temperature, and humidity during surgery, influence this inflamation (Tajima et al., 2020).

Other studies found significant changes in serum markers of pulmonary injury, such as surface protein D (SP-D) and cell secretory protein Clara 16 (CC16). Disruption of alveolar-capillary barrier function led to an increase in serum concentrations of SP-D and CC16. There is a clear correlation between the severity of lung injury and the serum concentrations of CC16 and SP-D (Xue et al., 2024).

In laparoscopic surgery, the intraoperative pneumoperitoneum and the Trendelenburg position increase the likelihood of atelectasis by shifting the diaphragm to the cranial region. This lowers lung coherence and causes the small airways and alveoli to collapse. In addition, PEEP keeps the alveoli open and prevents open alveoles and repeated collapse, which over long periods of ventilation can lead to lung injury. However, high levels of PEEP use during intraoperative treatment raise significant concerns about barotrauma in normal lungs and therefore may be associated with lung injuries (Nguyen et al., 2021). SP-D levels can affect recovery time after surgery. Although elective surgery does not change SP-D levels, cardiac surgery and laparoscopy can. (Xue et al., 2024).

CONCLUSION

After 2 hours of pneumoperitoneum, the SP-D levels increased from their initial levels. We found no significant difference in the SP-D levels before and after gynecological laparotomy surgery.

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