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The Effect of Low Vs Standard Pneumoperitoneum Pressure during Laparoscopic Hysterectomy

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MI - Study design, data collection, data analysis and manuscript writing.
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ABSTRACT

Background: Laparoscopic hysterectomy, the minimally invasive procedure, relies heavily on pneumoperitoneum pressure for both surgical safety and vision. **Objective**: To compare the effects of low pneumoperitoneum pressure (12 mmHg) versus standard pressure (15 mmHg) during laparoscopic hysterectomy in terms of operative outcomes. **Methodology:** This randomized controlled trial was conducted at the Department of Gynaecology and Obstetrics, Patel Hospital, Karachi, from January to December 2024. The low-pressure (n=28) and standard-pressure (n=28) groups were randomly allocated to 56 women who were scheduled for laparoscopic hysterectomy for benign causes. Following established operating procedures, skilled laparoscopic gynecologists operated on both groups. The length of the procedure, the amount of CO_2 insufflated, the predicted blood loss, and the length of hospital stay were among the important intraoperative characteristics that were noted. SPSS version 20.0 was used to analyze the data using the proper statistical tests; $p<0.05$ was deemed significant. **Results:** The low-pressure group's median operation time was 95 minutes (IQR: 75–120), whereas the standard-pressure groups were 100 minutes (IQR: 75–120) (p=0.954). In the low-pressure group, the median amount of CO_2 insufflated was 335 liters (IQR: 279–535), whereas in the normal group, it was 410 liters (IQR: 290–520) (p=0.577). 26 patients (92.9%) in both groups had an estimated blood loss of less than 50 ml, whereas 2 patients (7.1%) in each group had an estimated blood loss of more than 50 ml (p=1.000). Both groups' median hospital stays lasted two days (IQR: two to three vs. two to two; p=0.195). In both groups, pelvic visualization was generally assessed as "good." **Conclusion:** Low pneumoperitoneum pressure (12 mmHg) is a safe and effective alternative to standard pressure in laparoscopic hysterectomy without compromising surgical outcomes.

INTRODUCTION

Laparoscopic hysterectomy, is a minimally invasive gynaecological surgery, which involves removal of the uterus with the use of laparoscope through small incisions in the abdomen [1]. Significant benefits include less postoperative discomfort, a shorter hospital stay, quicker healing, and higher patient satisfaction as compared to standard open surgery [2]. The development of a pneumoperitoneum (PNP), which offers the required working area for surgical instruments, is a crucial part of this strategy [3].

Using a Veress needle and the closed-entry approach, carbon dioxide (CO_2) is usually insufflated into the abdominal cavity to create pneumoperitoneum [4]. Because of its great solubility and quick removal, CO_2 is recommended. There is ongoing discussion over the optimal intra-abdominal pressure for PNP during laparoscopy [5,6]. Recent research has reclassified low pressure as 10–12 mmHg and standard as 15 mmHg, although formerly it was defined as 6–10 mmHg and standard as 12–15 mmHg [7, 8].

While higher insufflation pressure improves surgical visualization and reduced operating time, it comes at a cost increased intra-abdominal pressure can negatively impact the cardiovascular and respiratory systems. It raises central venous pressure, mean arterial pressure, and vascular resistance, potentially reducing visceral perfusion. Additionally, it can also lead to increased airway pressure and reduced pulmonary compliance, making anaesthesia management more challenging. [9,10,11]. Lower insufflation pressures, on the other hand, are linked to less respiratory and cardiovascular side effects, but they may also increase the risk of intraoperative hemorrhage, lengthen the process, and impair surgical exposure [12].

In light of these factors, we compared the effects of low (12 mmHg) and standard (15 mmHg) pneumoperitoneum pressure during laparoscopic hysterectomy in a randomized controlled study. We assessed factors such as intraoperative blood loss, length of operation, quantity of CO_2 utilized, and pelvic visualization quality. In order to

improve patient outcomes in minimally invasive gynecological surgery, this research attempts to ascertain if a lower insufflation pressure might provide a safer and effective substitute for the standard method.

Objective

To compare the effect of low pneumoperitoneum pressure (LPP; 12mmhg) vs standard pneumoperitoneum pressure (SPP; 15mmhg) during laparoscopic hysterectomy.

MATERIALS AND METHODS

Study Design and Setting

This was a prospective, randomized controlled trial conducted at the Gynaecology and Endoscopy Unit, Patel Hospital, Karachi, from January 2024 to December 2024, following approval from the Institutional Ethical Review Committee.

Study Population and Sampling

A non-probability consecutive sampling technique was used to enroll patients who were scheduled for laparoscopic hysterectomy. Using a balloting method, the patients were randomly assigned to two groups: Group A received low-pressure pneumoperitoneum (LPP; 12 mmHg), while Group B received standard-pressure pneumoperitoneum (SPP; 15 mmHg). With a power of 90%, a 95% confidence interval, and reference values from the body of existing literature demonstrating average surgery durations of 139.2 minutes for standard pressure and 147.3 minutes for low pressure, with a standard deviation of 5.7, the sample size was determined using the WHO sample size calculator. Based on case availability, a total of 56 patients (28 in each group) were recruited, even though the minimum needed sample size was 22 patients (11 in each group).

Inclusion and Exclusion Criteria

The research comprised patients who had no prior history of abdominal or pelvic procedures other than caesarean sections (C/S) and were scheduled for laparoscopic hysterectomy for benign uterine problems. Patients who presented with acute abdominal pain, uterine size more than 14 weeks, suspected pelvic adhesions such endometriosis, or complex uterine diseases like cancer were excluded. Furthermore, individuals who had intraoperative adhesions from previous C/S were also not included in the research.

Surgical Procedure and Pneumoperitoneum Protocol

Anaesthesia protocol was followed. A non-disposable verses needle inserted at the umbilicus or left upper quadrant (Palmer's point) with CO2 infused for peritoneal cavity distension. Keeping patient in Trendelenburg position under general endotracheal anaesthesia with muscle relaxant, intra-abdominal pressure of 15mmhg inserted for creating pneumoperitoneum, and then the pressures were maintained with LPP (12mmhg) labelled as group A and SPP (15mmhg) as group B, in a randomized manner. Laparoscopic hysterectomy proceeded, 10mm laparoscope to be inserted at supra-umbilicus position.

Under direct visualization two to three 5 mm ancillary ports inserted i.e. 1 above and parallel to laparoscope anat1 or 2 lateral to epigastric arteries. Intrauterine manipulator placed. CO2 insufflated at 20L/min at standard room temperature with 0% relative humidity.

Data Collection Parameters

Each patient's intraoperative parameters were documented, including the length of the procedure (measured in minutes), the volume of CO_2 insufflated (measured in liters), the estimated blood loss (measured in milliliters using a suction jar), and the surgeon's rating of the pelvic visualization quality (poor, fair, or good). A standardized questionnaire was used to gather all of the data in a methodical manner.

Statistical Analysis

SPSS version 20.0 was used to analyze the data. Depending on the distribution, quantitative factors including the length of the operation, the quantity of CO_2 inhaled, and the predicted blood loss were shown as either the median with interquartile range (IQR) or the mean with standard deviation. Frequencies and percentages were used to represent the qualitative factors. The Shapiro-Kolmogorov test was used to determine if the quantitative data was normal. For regularly distributed data, the independent t-test was used, and for non-normally distributed variables, the Mann-Whitney U test. P-values below 0.05 were regarded as statistically significant.

RESULTS

The patients in the standard-pressure (SPP) and low-pressure (LPP) groups had similar baseline demographics (table 1). The median age was 47 years (IQR: 43–56) in the SPP group and 46 years (IQR: 44–52) in the LPP group (p=0.84). The majority of patients were multiparous (89.3% in LPP vs. 78.6% in SPP; p=0.275), while the majority of married women were found in both groups (96.4% vs. 92.9%; p=0.553). The median uterine size was equal in both groups (12cm in LPP vs. 10cm in SPP; p=0.904), and the mean BMI was the same at 29.4 kg/m^2 (p=0.998). Since none of these variations were statistically significant, the groups were homogeneous at baseline.

Table 1

Demographic Characteristics of Patients Undergoing Laparoscopic Hysterectomy

Variable	Category	Low Pressure (N=28)	Standard Pressure (N=28)	P-Value
Age	Median (IQR)	46 (44-52)	47 (43-56)	0.84
Marital Status; n (%)	Married	27 (96.4%)	26 (92.9%)	0.553
	Unmarried	1 (3.6%)	2 (7.1%)	
Parity; n (%)	Nulliparous	3 (10.7%)	6 (21.4%)	0.275
	Multiparous	25 (89.3%)	22 (78.6%)	
BMI	Mean ± SD	29.4 ± 4.8	29.4 ± 5.6	0.998
Size of the Uterus; (cm)	Median (IQR)	12 (8-12)	10 (8-12)	0.904

Table 2 shows that there was no statistically significant difference (p=0.470) in the distribution of surgical reasons for laparoscopic hysterectomy between the two groups. The most prevalent indication in the LPP group was adenomyosis (35.7%), which was followed by thickened endometrium in the postmenopausal/perimenopausal phase (28.6%) and a fibroid uterus (32.1%). Adenomyosis (28.6%), fibroids (25%), and thickened endometrium (32.1%) were somewhat more prevalent in the SPP group. Cervical descent, irregular uterine hemorrhage, and unsuccessful medical therapy were less common signs, albeit they were all present in very modest amounts.

Table 2
Surgical Indications for Laparoscopic Hysterectomy

Indication	Low Pressure (N=28)	Standard Pressure (N=28)
Adenomyosis	10 (35.7%)	8 (28.6%)
Fibroid Uterus	8 (32.1%)	7 (25%)
Social Reason (CP Child)	0 (0%)	1 (3.6%)
Postmenopausal/Perimenopausal Thickened Endometrium	8 (28.6%)	9 (32.1%)
Cervical Descent	1 (3.6%)	0 (0%)
Abnormal Uterine Bleeding	0 (0%)	2 (7.1%)
AUB + Failed Medical Treatment	0 (0%)	1 (3.6%)
*P-value for indications of surgery = 0.470 (no significant difference)		

The two pressure groups' operational results were similar (table 3). The LPP group's median operation time was 95 minutes (IQR: 75–120), whereas the SPP group's was 100 minutes (IQR: 75–120) (p=0.954). Although not statistically significant (p=0.577), the LPP group's insufflation volume of CO_2 was marginally lower (median: 335 L; IQR: 279–535) than that of the SPP group (median: 410 L; IQR: 290–520). With 92.9% of patients in each group losing less than 50 ml of blood (p=1.000), the estimated blood loss was negligible in both groups. Both groups' median duration of hospital stay was two days, and the LPP group's IQR was somewhat broader (2–3 vs. 2–2; p=0.195). These results imply that low-pressure pneumoperitoneum has no detrimental effects on the safety or effectiveness of operations.

Table 3
Operative Outcomes Between Low and Standard Pneumoperitoneum Pressure Groups

Parameter	Category	Low Pressure (N=28)	Standard Pressure (N=28)	P-Value
Duration of Surgery (mins)	Median (IQR)	95 (75-120)	100 (75-120)	0.954
CO_2 Insufflated (liters)	Median (IQR)	335 (279-535)	410 (290-520)	0.577
Estimated Blood Loss (ml); n (%)	<50 ml	26 (92.9%)	26 (92.9%)	1.000
	>50 ml	2 (7.1%)	2 (7.1%)	
Length of Stay (days)	Median (IQR)	2 (2–3)	2 (2–2)	0.195

DISCUSSION

The intraoperative results of low-pressure pneumoperitoneum (12 mmHg) versus standard pressure (15 mmHg) during laparoscopic hysterectomy were compared in this randomized controlled trial, which concentrated on important operative parameters like surgical time, CO_2 insufflation volume, estimated blood loss, and length of hospital stay. Our results add to the continuing discussion on the ideal insufflation pressure for gynecologic laparoscopy.

There was no statistically significant difference in the median length of operation between the low-pressure group and the standard pressure group, with the low-pressure group's median duration being 95 minutes as opposed to 100 minutes (p=0.954). These results are in contrast to earlier research that found longer operating periods at lower pressures, which they attributed to decreased vision at insufflation pressures below 12 mmHg [13,14]. However, the surgical team's expertise and the use of 12 mmHg, the upper threshold of the "low pressure" category and probably enough for preserving surgical field exposure, may account for our constant operational time.

The low-pressure group's CO_2 consumption was somewhat lower (median: 335 L vs. 410 L; p=0.577), but this difference was not statistically significant either. This is consistent with earlier research showing lower CO_2 needs at lower intra-abdominal pressures, which enhanced surgical recovery and decreased systemic absorption of CO_2 [11,15]. Surgeons in our trial reported adequate pelvic vision in both groups despite the smaller gas volume, indicating that 12 mmHg could provide the best balance between patient safety and exposure.

In both groups, there was very little blood loss; 92.9% of patients lost less than 50 milliliters (p=1.000). These results are in line with earlier research that showed low-pressure laparoscopy during gynecological operations did not significantly increase intraoperative bleeding [16]. Even while our studies did not demonstrate a statistically significant improvement, the lower pressure may really lessen venous congestion and prevent bleeding.

Given that both groups' median duration of hospital stay at two days was the same (p=0.195), it seems that pressure level had no impact on early postoperative recovery. These results are consistent with earlier studies that found no discernible difference in recovery time between low and conventional pneumoperitoneum pressures after laparoscopic hysterectomy [17].

Overall, without sacrificing surgical parameters or patient outcomes, our research supports the viability and safety of conducting a laparoscopic hysterectomy at 12 mmHg.

Study Strengths and Limitations

This study's randomized controlled approach, which reduces selection bias and improves the validity of comparison results between low and conventional pneumoperitoneum pressures, is one of its main strengths. In order to ensure uniformity in surgical technique and data gathering, all procedures were carried out by skilled laparoscopic gynecologists following established guidelines. Furthermore, the prospective design made it possible for consistent result evaluation and real-time data accuracy. The research did reveal several drawbacks, however, such as a small sample size of 56 patients, which would have reduced the statistical ability to identify subtler changes. Additionally, findings may not be as generalizable to larger populations with different levels of surgical experience and institutional resources due to the single-center context. Additionally, even when done by skilled surgeons, subjective evaluation of pelvic visibility may bring observer bias into the assessment of surgical field quality.

CONCLUSION

This research shows that the operational time, CO_2 consumption, intraoperative blood loss, and length of hospital stay are similar for laparoscopic hysterectomy performed with low pneumoperitoneum pressure (12 mmHg) and standard pressure (15 mmHg). The lack of notable variations implies that low-pressure pneumoperitoneum is a secure and practical substitute that might lessen the physiological effects of high intra-

abdominal pressures without sacrificing patient outcomes or surgical effectiveness. These results lend credence to the idea that reduced insufflation pressures should be taken into account during regular laparoscopic gynecological procedures, especially for patients who are susceptible to cardiac problems.

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