Comparative study of low-pressure versus standard-pressure pneumoperitoneum in laparoscopic cholecystectomy

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Background

A pressure range of 12–14 mmHg is used in standard-pressure pneumoperitoneum during laparoscopic cholecystectomy. Utilizing low-pressure pneumoperitoneum, which ranges between 7 and 10 mmHg, has become widespread as a way to reduce the effects of pneumoperitoneum on human physiology while still allowing for sufficient working space.

Aim

This study's objective is to evaluate the outcome of laparoscopic cholecystectomy with low-pressure pneumoperitoneum against standard-pressure pneumoperitoneum.

Patients and methods

The study comprised 80 patients who underwent laparoscopic cholecystectomy and for symptomatic gallstone disease. The participants were divided into two groups of 40. During the procedure, 40 patients underwent standard-pressure pneumoperitoneum, while another 40 patients underwent low-pressure pneumoperitoneum. Operative time, intraoperative injuries or mortality, conversion to open surgery, alterations in blood pressure and heart rate during operation, incidence of postoperative shoulder tip pain, need for additional analgesia postoperatively, and incidence of postoperative nausea and vomiting were all recorded as outcome parameters.

Results

The mean time of operation in patients with low-pressure pneumoperitoneum was 65±10.6 min and with standard-pressure pneumoperitoneum was 61±9.7 min. Neither blood pressure nor heart rate changed in a way that was statistically significant when lower pressure pneumoperitoneum was used. Compared to the standard-pressure laparoscopic cholecystectomy group, the low-pressure group experienced statistically less postoperative shoulder pain ($P<0.05$). Nothing significantly different was seen in nausea and vomiting between the two groups ($P=0.767$).

Conclusion

While reduced intensity postoperative shoulder pain is a benefit of low-pressure pneumoperitoneum for the patient, it has no positive impact on intraoperative hemodynamics, operative time, intraoperative injuries, or mortality.

Keywords:
cholecystectomy, laparoscopic, pneumoperitoneum

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Introduction

For patients with symptomatic gallstone disease, laparoscopic cholecystectomy now has regarded the best therapy choice [1]. The most common way to produce pneumoperitoneum for laparoscopic cholecystectomy is to blow CO_2 into the peritoneal cavity and maintaining it at that pressure until the completion of the procedure, at which point it will be abolished and the ports will be removed [2].

Pneumoperitoneum is typically created at pressures ranging from 12 to 16 mmHg. Nevertheless, this may cause a variety of negative consequences, including disrupted blood gas values, compromised circulatory system performance, diminished pulmonary compliance, raised hepatic enzyme levels and kidney impairment, and even raised venous pressures of the abdomen [3]. Helmy *et al.* [4] analysis indicates that the liver cells underwent damage as a result of the induced pneumoperitoneum. It was clear from their study's histological findings that raising intraabdominal pressure causes some degree of hepatic architect inflammation. According to Helmy and colleagues, monitoring liver function is crucial for early identification of any anticipated impairment that may arise, especially in patients with compensated

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compromised liver, both during and after pneumoperitoneum release in any laparoscopic procedure [4]. As an alternative, low-pressure pneumoperitoneum has been founded [3,4].

Following a laparoscopic cholecystectomy, shoulder tip pain frequently develops, making the recovery period less comfortable. CO_2 insufflation is thought to be the reason for pain in the shoulder tip, which is so severe that regular analgesic administration is required. After laparoscopic cholecystectomy, shoulder tip pain has been observed to occur in 30–50% of cases [5].

Reducing the amount of CO_2 insufflation during a laparoscopy can benefit a patient who is already compromised, although there is little information available regarding the safety of achieving the procedure at peritoneal pressures lower than usual. Nonetheless, it would not be advantageous to use low-pressure pneumoperitoneum with inadequate visualization in a patient who is not compromised [6,7].

An increasing amount of evidence now advocates the use of the lowest peritoneal pressure that allows appropriate exposure of the surgical space over routine pressurization [8]. Pneumoperitoneum of low pressure is commonly described in the articles as an intraabdominal pressure of 6–10 mmHg [9–11].

The present research assessed the application of low-pressure pneumoperitoneum (described as <10 mmHg) versus high-pressure pneumoperitoneum (described as >14 mmHg) in individuals undergoing gallbladder removal with laparoscopic approach. The primary focus areas were the length of the operation, bile leakage, shoulder tip pain following the procedure, and postoperative nausea and vomiting. The objective was to evaluate if the low-pressure pneumoperitoneum could lower the laparoscopic cholecystectomy postoperative morbidity.

Patients and methods

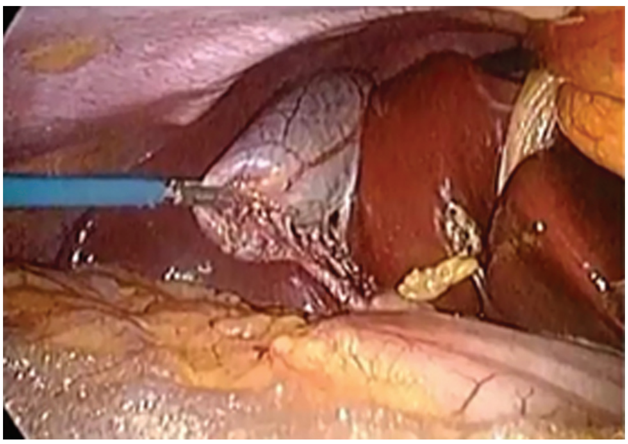
The General Surgery Department of Aswan University Hospital in Egypt conducted this randomized study from March 2023 to October 2023. It comprised 80 individuals who were scheduled for elective laparoscopic cholecystectomy after being diagnosed with symptomatic uncomplicated gallstone disease. Patients with abnormalities in liver studies, a history of hepatic disorder or a liver tumor, jaundice, morbid obesity, cardiopulmonary disturbance, biliary obstruction, choledocholithiasis, cholangitis, gallbladder tumor, an episode of acute pancreatitis or cholecystitis that occurred within the last 3 weeks, ongoing pregnancy, coagulopathy, or scarring from upper abdominal surgery were among the exclusion criteria.

The patients were randomly assigned to one of two groups: 40 patients underwent a standard-pressure pneumoperitoneum at 14 mmHg (SPLC) for a laparoscopic cholecystectomy, and 40 patients underwent a pneumoperitoneum with low pressure at 7–9 mmHg (LPLC) (Fig. 1).

The insufflation needle or trocar was inserted intraabdominally to begin the laparoscopic cholecystectomy. Next, the peritoneal cavity was inflated with CO_2 to a pressure of 12–16 mmHg. The initial port was set up at 14 mmHg of pressure. For the whole time of the surgery, the pressure of LPLC group was lowered to 8 mmHg, while the pressure of SPLC group was raised to 14 mmHg. After the four ports were introduced, patients were positioned in a reverse Trendelenburg position (30°) with 15° elevation of the right shoulder. Both groups received the same anesthetic approach. Blood pressure and pulse rate were recorded every 10 min in order to facilitate intraoperative monitoring.

Upon completion of the procedure all the port sites were closed. Diclofenac was given as postoperative analgesia once every 12 h, with extra doses as needed. Using a 0–10 pain scale, postsurgical pain was assessed at 6, 12, and 24 h. The need for further analgesia beyond the 12 hourly diclofenac, as well as the incidence of shoulder tip discomfort and

Figure 1



Under LPP, a work space with sufficient visibility was accomplished. LPP, low-pressure pneumoperitoneum.

postoperative nausea and vomiting, were all recognized.

Operational time, intraoperative injuries or mortality, conversion to open surgery, variations in heart rate, and mean arterial pressure during the procedure, occurrence of shoulder tip pain after surgery, requirement for additional analgesic medication after the procedure, and frequency of vomiting and nausea after surgery were the outcome parameters that were recorded.

The independent Student *t* test and the χ^2 were employed in statistical research. A statistically significant *P* value was defined as one less than 0.05.

Ethical approval and consent statement

This study follows all regulations of the ethical committee of Faculty of Medicine at Aswan University. All selected patients will sign a written informed consent after explaining the benefits and hazards of imaging techniques and laparoscopy.

Results

Age, sex, and BMI of the two groups were matched (Table 1).

Nine (11%) of the study's 80 participants were men, while 71 (89%) were women.

LPLC took 65±10.6 min on average, while SPLC took an average of 61±9.7 min ($P>0.05$).

After surgery, two (5%) patients from the 40 in the LPLC group and three (7.5%) patients from the 40 in the SPLC group required further analgesia ($P>0.05$) (Table 2).

Shoulder pain after operation was reported in three (7.5%) patients who underwent LPLC and 13 (32.5%) patients who underwent SPLC ($P<0.05$).

The LPLC group's average hospital stay is 1.56 days, whereas the SPLC group's average is 1.63 days. Both groups did not exhibit any notable intraoperative or postoperative complications. There was no conversion observed in this study (laparoscopy converted to open cholecystectomy) (Table 2).

After patients had fully awakened in the recovery room, nausea and vomiting were evaluated and the two groups did not exhibit any statistically significant differences ($P=0.767$) (Table 2).

In the two groups, the heart rate dropped considerably following induction and the establishment of pneumoperitoneum; with the maintenance of pneumoperitoneum, there was a modest rise. After induction, mean arterial pressure decreased in both groups, but it increased above baseline once pneumoperitoneum was established (Table 3).

Table 1 The baseline features of two groups

Characteristics	LPLC group (*N*=40)	SPLC group (*N*=40)	*P* value
Age (years) (mean±SD)	44.2±11.2	45.2±14.1	*P*=0.205ns
Sex			
Male	5	4	*P*=0.663ns
Female	35	36	
BMI (kg/m^2)	31.7±3.6	33.9±4.2	*P*=0.636ns

LPLC, low-pressure laparoscopic cholecystectomy; SPLC, standard-pressure laparoscopic cholecystectomy.

Table 2 Two groups' comparison of the outcome variables

Items	LPLC group (*N*=40)	SPLC group (*N*=40)	*P* value
Operative time (min) (mean±SD)	65±10.6	61±9.7	*P*=0.705ns
Conversion to open cholecystectomy	0	0	
Length of post-operative hospital stay (days)	1.56±0.74	1.63±0.61	*P*=0.665ns
Need for additional analgesia	2	3	*P*=0.861ns
Bile spillage	2	1	*P*=0.941ns
Visceral injury/vessel injury	0	0	
Postoperative shoulder tip pain	3	13	*P*<0.005
Nausea/vomiting	7	9	*P*=0.767ns
Mortality	0	0	

LPLC, low-pressure laparoscopic cholecystectomy; SPLC, standard-pressure laparoscopic cholecystectomy.

Table 3 Heart rate and mean arterial pressure variations in both groups during surgery

	LPLC group (*N*=40)		SPLC group (*N*=40)	
Items	Heart rate (bpm)	Mean arterial pressure (mmHg)	Heart rate (bpm)	Mean arterial pressure (mmHg)
Basal	86±8	93±12	85±9	94±13
Postinduction	81±10	88±14	83±16	91±10
10 min#	75±9	90±11	76±12	96±9
20 min#	78±12	92±13	76±11	93±11
30 min#	79±13	95±12	79±10	95±14
40 min#	81±9	96±13	80±12	94±9

The data are expressed as mean±SD. LPLC, low-pressure laparoscopic cholecystectomy; SPLC, standard-pressure laparoscopic cholecystectomy. #The defined period of time, expressed in minutes, after development of pneumoperitoneum.

Discussion

Enough abdominal room is needed for laparoscopic cholecystectomy in order to provide good exposure, which is necessary for both patient safety and satisfactory outcomes. Traditional techniques for establishing working space in the abdomen include pneumoperitoneum and abdominal wall raising techniques like the laparolift and laparotensor [12]. However, it has been demonstrated that there are particular side effects associated with laparoscopic cholecystectomy performed under standard-pressure pneumoperitoneum using carbon dioxide gas [12–14]. In a research conducted by Helmy *et al.* [14], elevated levels of transaminase were found 24 h after surgery in all patients who had laparoscopic cholecystectomy, whether with normal or compensated compromised liver. Their research established that an increase in intraabdominal pressure during laparoscopic cholecystectomy had a deleterious effect on liver function. Helmy *et al.* [14], suggested using gasless laparoscopy, low-pressure laparoscopy or taking precautions to safeguard the liver from the well-established negative consequences of increased intraabdominal pressure during laparoscopic cholecystectomy.

The idea of low-pressure laparoscopic cholecystectomy with carbon dioxide has been developed to lessen these particular disadvantages. Compared to laparoscopic cholecystectomy performed under standard pressure pneumoperitoneum, numerous studies have shown that laparoscopic cholecystectomy performed under low pressure pneumoperitoneum is associated with improved postoperative recovery, improved quality of life following surgery, and lowered surgery pain intensity [14–18].

In our study, the low pressure group had less postoperative shoulder pain, and the disparity was statistically significant. The results were consistent with previous researches [17–20]. Unlike our research, Sandhu *et al.* [21] study discovered that there was no statistically significant variation in the frequency of shoulder pain after surgery between the low-pressure and standard-pressure groups.

Laparoscopic surgery complications include nausea and vomiting. The gas used to inflate the peritoneal cavity may be the cause of the high risk of postoperative nausea and vomiting. This stresses the vagus nerve, which connects to the brain's center for nausea and vomiting. In our study, the incidence of postoperative nausea and vomiting after low and standard pneumoperitoneum was assessed. Although not statistically significant, this result is consistent with other studies that show no significant difference in the frequency of vomiting and nausea following surgery in standard-pressure and low-pressure laparoscopic procedures [22,23].

According to reports, low-pressure laparoscopic cholecystectomy causes less hemodynamic alterations in terms of heart rates, cardiac output, and blood pressure than standard pressure laparoscopic cholecystectomy [17,18]. Even though the predicted effects should be greater in the SPLC group, our investigation showed that hemodynamic changes are equivalent in both groups. One explanation could be that the 6 mmHg difference in intraperitoneal pressures between our standard-pressure pneumoperitoneum and low-pressure pneumoperitoneum groups was insufficient to impact hemodynamic state. Another possible explanation for the lack of statistical significance in hemodynamic changes is that our low-pressure pneumoperitoneum group kept intraperitoneal pressure at 8 mmHg, which is close to what some researchers define as standard pressure in their own investigations. According to one study, there was no difference that was statistically significant in the blood pressure and heart rate changes between the groups that underwent laparoscopic gallbladder removal under pneumoperitoneum with standard pressure (15 mmHg) and those that underwent it under pneumoperitoneum with low pressure (7 mmHg) [18]. Several studies show that cardiac output dropped to the same degree in both groups, however it recovered sooner in the laparoscopic cholecystectomy with low-pressure pneumoperitoneum group. In other investigations, mean arterial blood pressure and cardiac rate decreased following both low-pressure and standard-pressure laparoscopic cholecystectomy, although this was not statistically significant [24,25].

Our analysis revealed no significant intraoperative troubles or postoperative adverse effects. All patients had uneventful surgical recovery. The average time for SPLC in our study was 61±9.7 min, while the average time for LPLC was 65±10.6 min; however, this variation lacked statistical significance ($P>0.05$). That conclusion is compatible with previous researches by Goel and colleagues, Sandhu and colleagues, and Haribhakti and colleagues [25,26].

Two (5%) of the 40 patients in the LPLC group and three (7.5%) of the 40 patients in the SPLC group required additional postoperative analgesia. This difference did not achieve statistical significance ($P>0.05$). Our findings are in line with those of other research, such as Goel and colleagues, Sandhu *et al.* [21], and Joshipura and colleagues [25,26].

The majority of the patients in our research are between the ages of 40 and 50. Of the 80 cases, 71 (89%) were female (F>M). As can be observed, gallstone illnesses are more common among women. Similar age and sex distributions have been observed in other research such as Goel *et al.* [15] and Joshipura *et al.* [26].

Conclusion

This study shows that the low-pressure group experiences a considerable decrease of the frequency and severity of shoulder pain following surgery, as well as an early return of bowel activity, when the approach of lowering the pneumoperitoneum pressure to 10 mmHg or less is used. These findings support the widespread application of pneumoperitoneum with low pressure in laparoscopic gallbladder removal procedures.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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