

# Comparative Analysis of Hemodynamic Changes and Shoulder Tip Pain Under Standard Pressure Versus Low-pressure Pneumoperitoneum in Laparoscopic Cholecystectomy

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## ABSTRACT

**Background:** Laparoscopic cholecystectomy is the gold standard procedure for cholelithiasis. Pneumoperitoneum is created using carbon dioxide (CO<sub>2</sub>), which is usually maintained at a range of 12–14 mm Hg. An emerging trend has been the use of low-pressure pneumoperitoneum in the range of 7–10 mm Hg in an attempt to lower the impact of pneumoperitoneum on the human physiology while providing adequate working space. Our study proposes to compare the effects of low-pressure pneumoperitoneum with the use of standard pressure of pneumoperitoneum.

**Aims and objective:** To compare and analyze various factors like blood pressure, heart rate, end-tidal CO<sub>2</sub> and postoperative shoulder tip pain in cases undergoing laparoscopic cholecystectomy using standard pressure versus low pressure.

**Materials and methods:** This is a prospective randomized study carried out at Santosh Medical College and Hospitals, Ghaziabad from September 2017 to December 2018. This study included 60 patients of cholelithiasis which were divided into two groups of 30 patients each. Group I was offered laparoscopic cholecystectomy under standard pressure pneumoperitoneum and group II underwent laparoscopic cholecystectomy using low-pressure pneumoperitoneum. Patients in each group were evaluated for various intraoperative physiological changes and postoperative shoulder tip pain.

**Observations and results:** Cholelithiasis is commonly seen in middle-aged females. There is no significant difference in duration of surgery between the two groups. However, various factors like systolic blood pressure, heart rate, end-tidal CO<sub>2</sub> were significantly better in the low-pressure group. Postoperative shoulder tip pain (measured by VAS scoring system) was significantly less in the low-pressure group during the first 24 hours.

**Conclusion:** Laparoscopic cholecystectomy under low-pressure pneumoperitoneum causes minimal physiological changes and less postoperative shoulder tip pain.

**Keywords:** Cholelithiasis, Laparoscopic cholecystectomy, Low pressure, Pneumoperitoneum, Standard pressure.

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## INTRODUCTION

Laparoscopic cholecystectomy is the gold standard treatment for cholelithiasis. First human laparoscopic cholecystectomy was performed by Mouret in 1987.<sup>1-3</sup> Pneumoperitoneum is essential for any laparoscopic procedure. Pneumoperitoneum provides adequate working space and exposure during the surgery. Various agents have been tried so far for the creation of pneumoperitoneum like air, nitrogen, CO<sub>2</sub>, helium, argon, etc. However, there is no ideal agent, but CO<sub>2</sub> is now most commonly used gas for insufflation.<sup>4</sup> Usually intraperitoneal pressure is kept at 12–14 mm Hg during laparoscopic cholecystectomy. There are various side effects of CO<sub>2</sub> like cardiovascular changes, acid-base disorders, decrease pulmonary compliance and postoperative pain due to its prolonged use. These effects can be minimized by keeping low intraperitoneal pressure between 7 mm Hg and 10 mm Hg especially in elderly and patients with cardiovascular and respiratory comorbidities.<sup>4</sup> However, low pressures sometime may not provide adequate exposure and space during surgery leading to intraoperative complications and conversion to standard pressure.<sup>4-6</sup> In this study, we have compared various factors like blood pressure, pulse rate, end-tidal CO<sub>2</sub> and postoperative shoulder tip pain in patients undergoing laparoscopic cholecystectomy under standard pressure versus low pressure.

## AIMS AND OBJECTIVES

To compare and analyze various factors like blood pressure, heart rate, end-tidal CO<sub>2</sub> and postoperative shoulder tip pain in cases

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undergoing laparoscopic cholecystectomy using standard pressure versus low-pressure pneumoperitoneum.

## MATERIALS AND METHODS

This is a randomized controlled study carried out at Santosh Medical College and Hospitals, Ghaziabad from September 2017 to December 2018. This study included 60 patients of cholelithiasis which were divided into two groups of 30 patients each. Patients for each group were selected using a chit method. Group I was offered laparoscopic cholecystectomy under standard pressure pneumoperitoneum (12–14 mm Hg) and group II underwent laparoscopic cholecystectomy using low-pressure pneumoperitoneum (7–10 mm Hg). All patients of symptomatic cholelithiasis between 18 years and 65 years of age

were included in this study. Patients with severe cardiorespiratory comorbidities, renal failure, hepatic failure, morbid obesity, previous upper abdominal surgery, acute cholecystitis, malignancy, and bleeding disorders were excluded. The study was approved by the ethical committee of the institute and a prior informed consent was taken from patients. All patients underwent basic relevant investigations and a formal preanesthetic check-up. All cases were operated by senior surgeons having more than 10-year experience in laparoscopic surgery. All patients underwent standard four-port laparoscopic cholecystectomy under general anesthesia. Pneumoperitoneum was created by using a Veress needle and first port was inserted at a pressure of 12 mm Hg. In the standard pressure group, the pressure was taken up to 14 mm Hg whilst in the low pressure group the pressure was reduced to 10 mm Hg for the remaining duration of surgery. Cardiovascular parameters like heart rate, blood pressure (noninvasive), end-tidal CO<sub>2</sub> were noted before insufflation of CO<sub>2</sub>, at insufflation, during surgery, at exsufflation and before reversal of anesthesia were noted. Other factors such as surgical difficulty, duration of surgery and conversion to standard pressure were also considered.

Postoperative analgesia was administered in the form of injection sodium diclofenac 75 mg intramuscularly on demand. Postoperative pain and shoulder tip pain was assessed using VAS score (0–10) at 12, 24 and 48 hours, respectively. Patients were encouraged for early ambulation and were allowed oral liquids 12 hours after surgery as protocol patients were discharged 48 hours following surgery.

All patients were evaluated for various intraoperative factors and postoperative outcome and data was analyzed using the IBM statistical package for social sciences (SPSS) version 17.0. Chi-square test and student's t test were used for comparison of data between two groups. A *p* value of <.05 was considered significant.

## OBSERVATION AND RESULTS

Total 60 patients underwent laparoscopic cholecystectomy out of which 55 were female. Mean age of patients is 36.12 ± 3.1 years. In

low pressure group, three patients had operative difficulty, so two of them were converted to standard pressure and cholecystectomy was completed, but one patient was converted to open cholecystectomy. There were no complications like intraoperative bleeding or bile duct injury. Mean duration of surgery was similar in both the groups (Table 1).

There was no difference in heart rate before and during insufflation but after 15 minutes of insufflation of CO<sub>2</sub> and till exsufflation heart rate was significantly lower in the low-pressure group (Table 2).

Similarly, mean systolic and diastolic pressure was the same before and during insufflation, but pressures stayed significantly low during surgery until exsufflation in group II (Table 3).

It was also observed that the end-tidal CO<sub>2</sub> was significantly lower in group II after insufflation (Table 4).

Shoulder tip pain was less in the low pressure group for the first 24 hours postoperatively, but there was no significant difference in pain at 48 hours in both the groups (Table 5).

## DISCUSSION

Laparoscopic cholecystectomy is the gold standard procedure for symptomatic cholelithiasis. It is a novel technique which results in less pain, minimal scar and early recovery.<sup>1-3</sup> CO<sub>2</sub> is the most commonly used gas for creating pneumoperitoneum which can cause cardiorespiratory changes, acid-base disorders and decrease pulmonary compliance.<sup>4</sup> Pressure is kept at 12–14 mm Hg during surgery. In this study, we have analyzed and compare various cardiorespiratory factors while doing surgery under low pressure settings (7–10 mm Hg).

Cholelithiasis is commonly seen in middle aged females. This study also showed female predominance with a mean age of 36.12 ± 3.1 years. There was no significant difference in terms of complication like bleeding or bile duct injury and conversion to open cholecystectomy in both groups. There was no difference in

**Table 1:** Comparative analysis of laparoscopic cholecystectomy under standard pressure (14 mm Hg) with laparoscopic cholecystectomy under low pressure (10 mm Hg) on basis of various intraoperative factors

<i>Intraoperative factors</i>	<i>Laparoscopic cholecystectomy under standard pressure (group I)</i>	<i>Laparoscopic cholecystectomy under low pressure (group II)</i>	<i>p value</i>
Mean age (years)	35.5 ± 3	36.2 ± 2.5	0.89 (NS)
Mean duration of surgery (minutes)	60.45 ± 5.6	62.6 ± 4.5	0.78 (NS)
Intraoperative complications/difficulty	1	3	
Conversion to standard pressure	–	2	0.84 (NS)
Conversion to open cholecystectomy	1	1	

NS, non-significant; HS, highly significant

**Table 2:** Comparative analysis of laparoscopic cholecystectomy under standard pressure with laparoscopic cholecystectomy under low pressure on basis of mean heart rate

<i>Mean heart rate</i>	<i>Laparoscopic cholecystectomy under standard pressure (group I)</i>	<i>Laparoscopic cholecystectomy under low pressure (group II)</i>	<i>p value</i>
Before insufflation	86.65 ± 6.87	85.34 ± 7.13	0.77 (NS)
At insufflation	89.43 ± 6.89	88.73 ± 5.23	0.85 (NS)
During surgery (at 15 min)	89.53 ± 5.57	76.60 ± 5.30	0.01 (HS)
During surgery (at 30 min)	98.80 ± 5.10	79.37 ± 6.56	0.012 (HS)
At exsufflation	96.10 ± 9.16	78.20 ± 4.44	0.005 (HS)
After exsufflation (15 min)	93.73 ± 8.37	77.93 ± 5.37	0.015 (HS)

NS, non-significant; HS, highly significant

**Table 3:** Comparative analysis of laparoscopic cholecystectomy under standard pressure with laparoscopic cholecystectomy under low pressure on basis of blood pressure

	Laparoscopic cholecystectomy under standard pressure (Group I)	Laparoscopic cholecystectomy under low pressure (Group II)	p value
<i>Mean systolic blood pressure</i>			
Before insufflation	128.65 ± 6.34	127.54 ± 4.32	0.54 (NS)
At insufflation	132.73 ± 5.24	130.56 ± 5.42	0.67 (NS)
During surgery (at 15 min)	141.00 ± 4.03	119.53 ± 6.90	0.002 (HS)
During surgery (at 30 min)	142.27 ± 12.67	121.07 ± 8.51	<0.001 (HS)
At exsufflation	147.73 ± 7.48	119.87 ± 6.54	<0.001 (HS)
After exsufflation (15 min)	142.93 ± 7.44	127.13 ± 8.00	0.12 (HS)
<i>Mean Diastolic Blood pressure</i>			
Before insufflation	82.59 ± 3.67	80.96 ± 4.28	0.82 (NS)
At insufflation	87.77 ± 4.15	86.78 ± 3.48	0.79 (NS)
During surgery (at 15 min)	90.37 ± 5.73	76.10 ± 5.10	<0.001 (HS)
During surgery (at 30 min)	90.87 ± 7.18	80.87 ± 6.14	0.017 (HS)
At exsufflation	92.17 ± 4.49	78.10 ± 6.33	<0.001 (HS)
After exsufflation (15 min)	90.10 ± 2.26	83.43 ± 7.26	0.021 (HS)

NS, non-significant; HS, highly significant

**Table 4:** Comparative analysis of laparoscopic cholecystectomy under standard pressure with laparoscopic cholecystectomy under low pressure on basis of end tidal CO<sub>2</sub>

	Laparoscopic cholecystectomy under standard pressure (group I)	Laparoscopic cholecystectomy under low pressure (group II)	p value
<i>Mean end tidal CO<sub>2</sub></i>			
Before insufflation	28.45 ± 1.22	29.12 ± 1.67	0.89 (NS)
At insufflation	33.67 ± 1.49	30.33 ± 2.23	0.031 (HS)
During surgery (at 15 min)	34.13 ± 1.04	31.00 ± 1.39	0.045 (HS)
During surgery (at 30 min)	34.77 ± 3.93	30.57 ± 1.91	0.033 (HS)
At exsufflation	35.37 ± 2.25	30.20 ± 1.75	0.002 (HS)
After exsufflation (15 min)	33.87 ± 2.35	30.97 ± 1.45	0.011 (HS)

NS, non-significant; HS, highly significant

**Table 5:** Comparative analysis of postoperative shoulder tip pain using visual analog scoring (VAS) system

Time interval	Laparoscopic cholecystectomy under standard pressure (group I)	Laparoscopic cholecystectomy under low pressure (group II)	p value
12 hours (day 1)	2.12 ± 0.54	0.45 ± 0.30	0.002 (HS)
24 hours (day 1)	4.01 ± 0.87	2.67 ± 1.20	<0.001 (HS)
48 hours (day 2)	2.65 ± 1.53	2.14 ± 1.11	0.65 (NS)

NS, non-significant; HS, highly significant

mean duration of surgery in both the groups which is comparable with the results of previous studies.<sup>5-6</sup>

There was a significant decrease in mean heart rate, systolic blood pressure, diastolic blood pressure and end-tidal CO<sub>2</sub> post insufflation in the low pressure group (*p* value < 0.05). These findings were consistent with the results of previous studies.<sup>5-7</sup>

Shoulder tip pain was significantly reduced at 12 hours and 24 hours postoperatively in the low pressure group, but it was similar at 48 hours in both the groups. Various studies on shoulder tip pain post cholecystectomy under low pressure had shown similar results.<sup>7-10</sup> There were no long term complications.

## CONCLUSION

Laparoscopic cholecystectomy under low pressure settings (7–10 mm Hg) causes minimal cardiorespiratory changes and less post-

operative shoulder tip pain. Laparoscopic cholecystectomy under low pressure may be suitable for the elderly and patients with mild cardiorespiratory comorbidities.

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