

Comparison of standard and low-pressure pneumoperitoneum; reduction in frequency and intensity of post-operative shoulder pain

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A B S T R A C T

Background: Laparoscopic cholecystectomy is now gold standard and depends on good exposure of the peritoneal cavity. It is achieved by insufflation of the abdominal cavity with CO₂. Operating at lower intraabdominal pressure (<12 - 15mmHg) has been associated with fewer pulmonary and hemodynamic complications and lesser postoperative pain.

Objective: To ascertain the advantages of low-pressure pneumoperitoneum over standard pressure pneumoperitoneum. Our study focused on assessing postoperative pain frequency and intensity. None of the other parameters of low-pressure pneumoperitoneum were evaluated in this study.

Methodology: Our study was quasi experimental study conducted at Department of surgery, KRL Hospital over period of 4 years from 2013 to 2016. SPSS version 20 was used to calculate p value. A p value of less than 0.05 was taken as significant.

Results: A total of 456 patients with symptomatic gallstones were equally divided in two groups assigned to undergo low pressure (7-8mm of Hg) pneumoperitoneum or standard pressure (12-14mm of Hg) pneumoperitoneum laparoscopic cholecystectomy. The average age of patients was 46.2+/-13.6yrs in group A compared to 43.5 +/- 12.9 in group B. There were 60 (26.3%) male and 168 (73.7%) female patients in group A compared to 53 (23.2% and 175 (76.85) in group B respectively. It was found that group A 14 (6.1%) had no postoperative pain, 26 (11.4%) had VAS (visual analogue score 1 – 10) between 1– 7 and 188 (82.5%) had VAS of 8 – 10 where as in group B, 164 (72.6%) patients reported no shoulder tip pain postoperatively, 42 (18.6%) had VAS of 1 – 7 and 20 (8.8%) had VAS of 8 – 10. The difference was statistically significant (p-value = <0.001).

Conclusion: It is concluded that reducing the pressure of pneumoperitoneum to 7 – 8 mm of Hg tends to produce lower incidence of postoperative shoulder tip pain.

Keywords: Laparoscopy, pain syndrome, cholecystectomy, pneumoperitoneum

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Introduction

Laparoscopic cholecystectomy depends on good exposure of the peritoneal cavity. It is achieved by insufflation of the abdominal cavity with CO₂.¹ Laparoscopic cholecystectomy has become standard procedure for gall stone disease because it achieves

greater exposure with smaller incisions averting upper abdominal incision. In addition, advantages of laparoscopic cholecystectomy include decreased post-operative pain and early mobilization and return to routine life.² Despite its many advantages laparoscopic

cholecystectomy is associated with some degree of distress and pain. Although patients undergoing laparoscopic cholecystectomy do not suffer from wound pain as much as patients undergoing open cholecystectomy but they do infrequently complain of abdominal pain and shoulder tip pain postoperatively³. The exact pathophysiology of post laparoscopy pain is still under debate. The exact mechanism of pain related to pneumoperitoneum has not been clarified. Many etiological factors have been postulated to contribute to post cholecystectomy pain syndrome, with CO₂ absorption from the peritoneum, diaphragmatic irritation by high intra-abdominal pressure caused by pneumoperitoneum, the raw area created after removal of gall bladder on liver and pain coming from the incision sites⁴. Multiple researchers have observed that with low-pressure pneumoperitoneum there was a significant reduction in frequency and severity of postoperative pain syndrome (abdominal pain and shoulder tip pain).^{3,4,5}

Operating at lower intraabdominal pressure (<12 - 15mmHg) has been associated with fewer pulmonary and hemodynamic complications and lesser postoperative pain.^{6,7} Intraoperative safety of the procedure in decreased surgical space in low pressure laparoscopic cholecystectomy is not well recognized and is still debatable.⁸ In either general or regional anesthesia, there were no problems of visibility of operative field using low-pressure pneumoperitoneum. Surgeons while using four ports for standard dissection of clot's triangle for cholecystectomy, did not experience any additional difficulty in low pressure pneumoperitoneum when compared to standard or high-pressure pneumoperitoneum.^{9,10,11}

In recent years a lot of focus has been given to improve surgical techniques to reduce frequency and intensity of post-laparoscopy pain in general surgery as well as gynecological surgeries. Several techniques have been introduced to improve post-operative pain. Intra-peritoneal local anesthetic instillation, removal of residual CO₂ before closure, peritoneal washout with saline, ultrasound guided transverse abdominis plane block with local anesthetic agents like lidocaine and Bupivacaine are some of the techniques that have been investigated.^{9,11}

It is assumed that shoulder tip pain is caused by over stretching of diaphragmatic muscle fibers due to high

pressure pneumoperitoneum.⁷ Slow insufflation with CO₂ (1-2 L) at the beginning of procedure and complete evacuation of pneumoperitoneum at the end of surgery can decrease the occurrence of postoperative shoulder tip pain. There is no consensus amongst researchers regarding use of low or standard pressure pneumoperitoneum in terms of procedure safety and postoperative pain. However, most studies support low pressure but locally, there is almost no literature comparing the two said interventions. The advantages of low-pressure pneumoperitoneum over standard pressure pneumoperitoneum have yet to be ascertained in our local settings. This study was planned with thought that it would provide evidence-based results.

Methodology

This Quasi experimental study was conducted at department of surgery Kahuta Research Laboratories hospital Islamabad over period of 3 years from 2013 to 2016. A total of 456 patients were selected by non-randomized convenience sampling technique. Sample size was calculated using Slovin's formula. It is computed as $n = N / (1 + Ne^2)$. Whereas: n = no. of samples, N = total population, e = error margin / margin of error. All patients more than 18 years of age, of either gender, ASA physical status grade 1 and 2, undergoing elective laparoscopic cholecystectomy were included. The patients having gall stones but, clinically diagnosed and confirmed by ultrasound and CT scan of having acute cholecystitis, cholangitis, empyema gall bladder, acute pancreatitis, obstructive jaundice, or suspicion of malignancy were excluded. Patients with history of previous abdominal surgery, bleeding disorders and those with ASA Physical grade 3 or above were also excluded.

The study was started after obtaining approval from hospital ethical committee. Informed consent was obtained from all patients prior to inclusion in the study. All findings were recorded on a study proforma. We assigned patients to two groups either A or B. Group A patients had standard pressure i.e 12 – 14mm of Hg pneumoperitoneum cholecystectomy and Group B patients had low pressure i.e. 7 – 8 mm of Hg pneumoperitoneum cholecystectomy. Post-operative shoulder tip pain presenting within first 24 hours of surgery was assessed according to VAS (1 – 10) and

then defined as 0 = no pain, 1 = mild to moderate pain but does not require analgesia and 2 = severe pain that requires intravenous analgesia (VAS 8 – 10). These were recorded on proforma. Appropriate analgesia was instituted according to severity and patients were discharged accordingly.

Statistics analysis: Data was collected and analyzed on SPSS version 23 Descriptive statistics were used for demographic variables. Quantitative data including variables as age, VAS, frequency and percentage was analyzed for mean and standard deviation. Frequencies were calculated for qualitative variables as drug used for analgesia. The effect modified as age, gender and diagnosis of patient ASA 1 and 2 were controlled by stratification. A p-value of less than 0.05 was taken as significant.

Results

A total of 456 patients were included in the study. Standard pressure pneumoperitoneum Group A had 228 patients and low-pressure pneumoperitoneum Group B also had 228. Tables 1 mention age details of patients in the two groups. Mean age in group A was 46.2 ± 13.6 and in group B it was 43.5 ± 12 . In group A 60 (26.3%) were males and 53 (23.2%) males were in group B. Among females 168 (73.7%) were in group A and 175 (76.8%) were in group B. Table 2 shows patients' presentations. Comparison of postoperative shoulder tip pain among study groups is shown in table 3. Out of 228 patients in group A 96 were of ASA grade 1 and 132 were grade 2. Among group B 153 were of ASA grade 1 and 75 were ASA grade 2. The post-operative shoulder tip pain was significantly associated with standard pressure group whereas low pressure group was statistically significantly associated with no pain (p value = < 0.001).

Table 1: Age of Patients in Two Study Groups

Age (Years)	Group A (n=228)	Group B (n=228)
Up to 20	3 (1.3%)	9 (3.9%)
21 to 30	29 (12.7%)	28 (12.3%)
31 to 40	51 (22.4%)	63 (27.2%)
41 to 50	60 (26.3%)	62 (27.2%)
51 to 60	45 (19.7%)	45 (19.7%)
61 or above	40 (17.5%)	21 (9.2%)
Mean ± SD	46.2±13.6	43.5 ± 12.9

Table 2: Diagnosis of Patients in Two Study Groups

Diagnosis	Group A (n=228)	Group B (n=228)
Symptomatic Cholelithiasis	227 (99.6%)	225 (98.7%)
Acute Cholecystitis (on laparoscopy)	1 (0.4%)	2(0.8%)
Interval Cholecystectomy	0 (0%)	1 (0.4%)

Table 3: Comparison of postoperative shoulder tip pain among study groups

Shoulder tip pain (VAS)	Group A (n=228)	Group B (n=228)
0 (no pain)	14 (6.1%)	164 (72.6%)
1 (VAS 1 – 7)	26 (11.4%)	42 (18.6%)
2 (VAS 8 – 10)	188 (82.5%)	20 (8.8%)

Discussion

Laparoscopic cholecystectomy has replaced open cholecystectomy as the main surgical technique for cholelithiasis¹². Superiority of laparoscopic procedures over open procedures has been established on the basis of lesser hemorrhage, better cosmetic results, less postoperative pain, shorter hospital stay and quick recovery and return to routine life.¹² Laparoscopic procedure depends on insufflation of peritoneal cavity with CO₂ to improve visibility. This results in increased intraabdominal pressure that has adverse effects of on cardiac output and pulmonary system during laparoscopic procedures. High intraperitoneal pressures during laparoscopic cholecystectomies cause postoperative pain.^{13,14} Most surgeons perform laparoscopic surgery at a pressure level of 12 mmHg with upper limit set at 15mmHg. Pressure exceeding 15mm Hg is considered as a high pressure and is strictly contraindicated.¹³ Increased intraabdominal pressure created by CO₂ gas insufflation produces changes in regional blood flow to intraperitoneal viscera. There is a risk of splanchnic ischemia at high intraabdominal pressure. Reports of disturbances in hepatic, splanchnic and renal blood flow from high intraabdominal pressure have been mentioned in

literature.¹⁵ Systematic reviews by Gurusamy et al and Behnaz F et al established that low pressure laparoscopic cholecystectomy can be completed successfully using low pressure in approximately 90% of patients.^{8,12} In comparison to a study done by Sandhu et al comparing low pressure pneumoperitoneum and standard pressure pneumoperitoneum laparoscopic cholecystectomy, where the average age of patients was 54 and 55.2 respectively while our patients' average ages in group A and B were 46.2 and 43.5 respectively.⁷ In a similar study by Goyal et al the age of patients varied between 21 and 75 years.¹⁶ Nabi S et al compared low and standard pressure laparoscopic cholecystectomy.¹⁷ In their study Nabi S et al described statistically significant difference (p value < 0.05) in occurrence of shoulder tip pain between SPLC and LPLC.

Shoulder tip pain was noted in 15 (37.5%) of patients in SPLC group whereas in LPLC group only 5 (12.5%) patients complained of shoulder tip pain.¹⁷ Our study results are comparable to results of these systematic reviews, post-operative shoulder tip pain in our study was significantly associated with standard pressure group (82.5% had it between 8 – 10) whereas low pressure group was statistically significantly associated with no pain between VAS 8 – 10 (p value = < 0.001). Clinically significant difference in pain score ranging from 1.0 to 1.5 points on a 0–10 pain scale has been mentioned in literature in LPLCs.^{18,19} Effects of low-pressure pneumoperitoneum were evaluated in four blinded clinical trials.¹⁹ Comparison of intensity of pain on first post-operative day between SPLC and LPLC showed clinically significant difference between the two groups. Warlé et al has published the only blinded study comparing postoperative pain beyond 24 hours after surgery and observed a difference of 0.8 in overall pain score on a 0–10 scale up to 4th postoperative day.²⁰ Out of two studies assessing shoulder pain one revealed a difference of approximately two points up to postoperative day one.¹⁸ While in the other study mean pain scores of 0.7 and 0.9 were observed.^{18,20,21} Randomized controlled trials describing comparison between standard and low pressure non-cholecystectomy procedures (i.e., laparoscopic donor nephrectomy and laparoscopic gynecologic procedures) also showed that low-pressure pneumoperitoneum is associated with less postoperative

pain.^{18, 22} Most of the studies have shown that keeping low pressure pneumoperitoneum during laparoscopic cholecystectomy significantly reduces post-operative shoulder pain.^{23,24} The results of Singh R et al also show a significant reduction in frequency and intensity of post-operative pain after laparoscopic cholecystectomy.²³ The Mean VAS score came down to 0.08 at 24 hours in low pressure group, whereas it was 1.00 in standard pressure Group. The results from our study are similar to the observations from different studies present in systemic review and meta-analysis by Hua et al in 2014.^{23,25} In their results Singh R et al and Donatsky et al established that pain score decreased at almost all intervals 0-6 hours, 7-12 hours and 13-24 hours in low pressure pneumoperitoneum cholecystectomy patients.^{21,23}

The limitations of this study were that we used non-probability convenience sampling technique for data collection, there was no blinding and we studied only one outcome i.e. shoulder tip pain. The perioperative details in terms of operative time and post-operative stay in hospital were not documented. Further studies should be conducted to compare all these parameters.

Conclusion

It is concluded that decreasing the pressure of pneumoperitoneum to 7 – 8 mmHg results in significantly lower frequency and intensity of post-operative shoulder tip pain. There is need to conduct further experimental studies using rigorous research methods with large randomized samples.

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