

Effect of Pulmonary Recruitment Maneuver After Laparoscopic Cholecystectomy to Reduce Shoulder Tip Pain

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ABSTRACT

Objective: To compare the effectiveness of pulmonary recruitment maneuver (PRM) and passive release of pneumoperitoneum in terms of post-operative shoulder tip pain at 4, 8, 12, 24 and 48 hours in patients undergoing laparoscopic cholecystectomy (LC).

Study Design: Quasi-experimental study.

Place and Duration of Study: Department of General Surgery, Pakistan Institute of Medical Sciences, Islamabad, Pakistan from Oct 2021 to Sep 2022.

Methodology: For this comparative study, all patients who underwent elective LC were included using convenient sampling. The patients divided into two equal groups by lottery method on the day of surgery. One group received PRM and the other group had passive release of pneumoperitoneum at the end of surgery. Data was recorded in terms of shoulder tip pain using visual analogue scale (VAS) at 4, 8, 12, 24 and 48 hours of surgery, keeping pneumoperitoneum of 15mmHg as fixed variable. SPSS version 25 was used for statistical analysis.

Results: A total of 90 patients were included. There were 33 males (36.7%) and 57(63.3%) females with mean age of 47.49 ± 11.57 years (range from 21 to 75 years). The presence of shoulder tip pain was 67.3% in passive release group and 46.5% in PRM group. The VAS score in PRM group was statistically significant ($p=0.000$) at 4, 8, 12, 24 and 48 hours after LC.

Conclusion: The PRM reduces shoulder pain in patients after LC and is a better management plan as compared to the passive release of pneumoperitoneum.

Keywords: Laparoscopic Cholecystectomy, Pneumoperitoneum, Pulmonary recruitment maneuver, Shoulder tip pain

How to Cite This Article: Sakhizada F, Aqib M, Malik TAM, Akhtar F, Shah SA, Waqar SH. Effect of Pulmonary Recruitment Maneuver After Laparoscopic Cholecystectomy to Reduce Shoulder Tip Pain. Pak Armed Forces Med J 2025; 75(1): 177-181. DOI: <https://doi.org/10.51253/pafmj.v75i1.12581>

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INTRODUCTION

Laparoscopic cholecystectomy, a minimally invasive surgical procedure, is commonly used for gallbladder removal due to its advantages over open surgery.^{1,2} These include less pain, smaller incisions, reduced bleeding, shorter hospital stay, faster recovery, and early return to daily activities.³ However, postoperative pain, especially in the upper abdomen and shoulder tip, is most common complaint and it can lead to longer hospital stays and decreased patient satisfaction.⁴ This pain is strongly associated with residual gas volume i.e carbon dioxide in the abdomen from the procedure, which irritates phrenic nerve and diaphragm causing referred pain to shoulder tip.⁵

As the world is proceeding towards 'day-case surgeries', remarkable variations in analgesic protocols are necessary to provide standardized

interventions to reduce pain.⁶ A favorable strategy to reduce post-laparoscopic pain is the pulmonary recruitment maneuver, which is designed to open the respiratory tract and alveoli and indirectly increases intra-peritoneal pressure and thus helps in the removal of residual carbon dioxide.

Various efforts are in use to decrease this shoulder tip pain including non-steroidal anti-inflammatory drugs, intra-abdominal instillation of local anesthetics, low-pressure pneumoperitoneum, and slow insufflation. Another method is the use of intraperitoneal warmed normal saline infusion, CO₂ rises up and escapes through the port sites.⁷ Another new strategy evolving is active suctioning of residual gas by placing suction catheter in sub-diaphragmatic space just before the removal of trocars.

Because of limited local data available in our setting this study was planned to see the effects of pulmonary recruitment maneuver and passive release of pneumo-peritoneum in terms of shoulder tip pain at 4, 8, 12, 24 and 48 hours post-operatively in patients of laparoscopic cholecystectomy. The study aims to

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Received: 08 Aug 2024; revision received: 20 Jan 2025; accepted: 30 Jan 2025

determine the superior technique for patient benefit over specified time intervals.

METHODOLOGY

This quasi-experimental study was conducted for one year in Department of General Surgery, PIMS, Islamabad, after taking ethical approval from the institutional ethical review board (F.1-1/2015/ERB/SZABMU/858, dated 20.09.2021). Patients who were admitted in the Surgery ward for elective laparoscopic cholecystectomy were selected by non-probability consecutive sampling after informed consent for the study. Sample size was calculated with the help of WHO sample size calculator by keeping the anticipated population proportion (incidence of shoulder tip pain) in PRM group as 44% and in control group 63.4%. The total sample size turned out to be 102 patient. A detailed history was taken and complete clinical examination was done. Patients were divided into two equal groups. Group-A, the intervention group had pulmonary recruitment maneuver, while Group-B, the control group underwent the passive release of pneumoperitoneum.

Inclusion Criteria: Patients of either gender with age ranging from 19 to 80 years, admitted through the out patient department, for elective laparoscopic cholecystectomy with American Society of Anesthesiology (ASA) classification 1 and 2 were included in the study.

Exclusion Criteria: Pregnant females, patients with comorbidities, morbid obesity (BMI greater than 40), history of previous injury to shoulder joint, cervical vertebral disease and musculoskeletal disorders were excluded from the study. Patients who converted to open surgery and requirement of an abdominal insufflation pressure greater than 15 mm Hg at any time during the surgery were also excluded from the study.

A proforma designed for the study was used to collect the data regarding demographic variables, ASA class, duration of procedure, any complications and placement of drains. Visual analogue score (VAS) was used to record pain scores at 4, 8, 12, 24 and 48 hours of surgery.

Laparoscopic cholecystectomies were performed using standard technique. Carbon dioxide was used for pneumoperitoneum and all operations were done under general anaesthesia. Proper monitoring of the patients was done during the surgery. Randomization

was done at the end of the surgery before removing the ports. In Group-A, a pulmonary recruitment maneuver was performed by an Anaesthetist at the end of surgery while maintaining a pneumoperitoneum of 15mm Hg. Two manual inflations were given, each inflation was held for 5 seconds. In control Group-B, gas was released passively by keeping the ports open and abdomen was allowed to decompress by passive evacuation of residual gas. Data was collected through a designed proforma, filled by the principal investigator post-operatively for each patient. Routine postoperative care with analgesia was provided to all the patients regarding wound pain.(Figure)

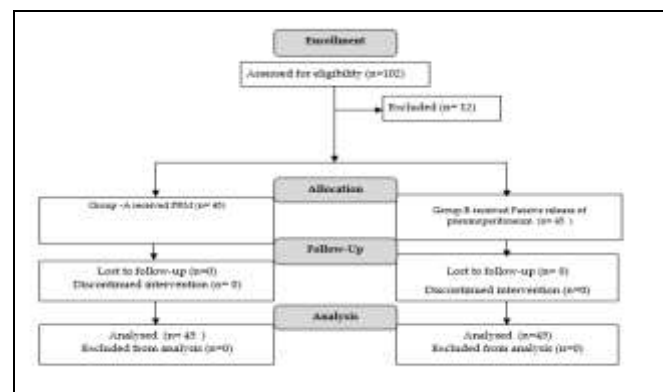


Figure: Patient Flow Diagram

Data was analyzed using Statistical Package for Social Science (SPSS v. 25). Frequency with percentage calculated for qualitative variables like gender. Mean with standard deviation was calculated for quantitative variables like age, operation duration and VAS score. For quantitative variables normality was assessed by using Kolmogorov-Smirnov test. The variables which were not following normal distribution were presented with the help of Median along with IQR and comparison of both groups were made using Mann Whitney U test. p -value ($p < 0.05$) was considered significant.

RESULTS

A total of 102 patients were enrolled for the study. Twelve patients were excluded for the reasons like not consented for the study, procedure was converted to open or anaesthetist could not performed PRM at the end of the operation. So 90 patients were studied. There were 33 male (36.7%) and 57(63.3%) female patients with Median age of 47.49(22.7) years (range from 21 years to 75 years). Both study groups

were same in terms of mean age, gender, BMI and duration of surgery.(Table I)

Pain scores, assessed using the Visual Analog Scale (VAS), were compared between the pulmonary recruitment maneuver group (Group-A) and the passive release group (Group-B) at various time intervals. Median (IQR) pain scores were significantly lower in Group A than in Group B at all time points: the 4th hour, 8th hour, 12th hour, 24th hour, and 48th hour (p -values<0.001). These findings suggest that the pulmonary recruitment manoeuvre was associated with reduced pain levels compared to passive release over time as shown in Table-II.

Table-I: Baseline Characteristics of Study Groups (n=90)

Characteristics	Pulmonary recruitment maneuver Group-A (n=45)	Passive release Group-B (n=45)	p -value
Age (years) Median (IQR)	47.00(23)	50.0(22)	0.577
Gender (n,%)			0.512
Male	18(40.0%)	15(33.3%)	
Female	27(60.0%)	30(66.7%)	
BMI (kg/m ²)	26.67±4.56	25.09±4.47	0.180
Duration of surgery (minutes)	25.0±1.45	26.98±1.41	< 0.001

Table-II: Comparison of Pain Scores among study groups (n=90)

Pain Visual Analogue Scale (VAS) score	Pulmonary recruitment maneuver Group-A (n=45) (Median (IQR))	Passive release of gas Group-B (n=45) (Median (IQR))	p -value
4th hour	6 (1)	6 (1)	< 0.001
8th hour	4 (1)	6 (1)	< 0.001
12th hour	3 (1)	4 (1)	< 0.001
24th hour	3 (0)	4 (1)	< 0.001
48th hour	1 (0)	2 (1)	< 0.001

* Mann Whitney U test was applied and difference is significant at 5% level of significance

DISCUSSION

This study reported that 67.3% of the control patients suffered from shoulder pain and 46.5% of the PRM group. According to the literature, shoulder tip discomfort is recorded in 35 to 80% of patients after laparoscopic cholecystectomy.^{8,9} Furthermore, there appears to be a positive relationship between the degree of subdiaphragmatic gas and shoulder discomfort intensity.^{10,11} According to recent research, PRM successfully removes subdiaphragmatic gas and

lessens shoulder tip pain following surgery.¹² Similar to previous research, this one found that PRM dramatically decreased the occurrence of shoulder tip discomfort throughout the 48-hour postoperative period.^{12,13} Phelps et al found that positional pain was reduced from 63 percent to 31 percent using PRM.¹⁴

In a recent randomized clinical study, the PRM group showed a substantial reduction in both the frequency and severity of shoulder pain at 12, 24, and 48 hours after surgery.¹⁵ Although our research also had comparable encouraging outcomes, the interpretation of data may be hampered by various surgical procedures and lengths of time.¹⁶

Arif et al investigated in the patients of laparoscopic cholecystectomy, the frequency and severity of pain at the shoulder tip following both active (gas suctioning) and passive pneumoperitoneum release. They found mean VAS pain score in intervention group at 16 hours was significantly lower than that of the control group (1.00±2.09 vs. 3.06±2.58; p <0.001). Additionally, it was shown that the most efficient way to get rid of gas from the abdomen is by active aspiration of CO₂. As a result, there will be a statistically significant reduction in postoperative discomfort, pain, and the requirement for rescue analgesics.¹⁷ This suggests that the intervention of removing residual carbon dioxide using the described technique led to reduced postoperative pain scores compared to the standard passive.

Another research conducted in 2013 in United Kingdom by Khanna A. et al found that the intervention group's overall postoperative pain scores were considerably lower (p =0001) than the control group. At both 12 and 24 hours, the intervention group's median (interquartile range) pain ratings were considerably lower than those of the control group (3.5 vs 5; p <0.010).¹⁸

Positive pressure ventilation, which raises intra-abdominal pressure and lowers the diaphragm in addition to inflating the lungs, is frequently used in conjunction with manual PRM after surgery. Elevated intraperitoneal pressure can be used to eliminate CO₂ gas that has accumulated in the abdominal cavity, which lessens irritation of the peritoneum or phrenic nerve and the accompanying shoulder pain. Our study demonstrated that PRM was a simple procedure to carry out and a useful way to lessen discomfort following a laparoscopic cholecystectomy. However, our study did not show an advantage for people with

mobility impairments by incision site and upper abdominal pain or PONV.

Reduced residual CO₂ gas in the abdominal cavity cannot relieve wound or epigastric pain, which is primarily caused by surgical wounds such as skin and tissue incisions. These wounds are typically prevented and treated with oral analgesics, local infiltration, nerve block, and analgesia pumps. Routine postoperative care with analgesia was provided to all patients in the study. It is worth noting that some other procedures, including oral analgesics, intraperitoneal saline instillation, drain placement, sodium bicarbonate membrane irrigation, intraperitoneal anesthetics and nerve blockers can also inhibit shoulder pain after laparoscopic cholecystectomy.¹⁹ Nevertheless, these procedures come with significant medical expenses in addition to the need for medications and equipment. PRM is more advantageous as it is simple to implement. However, it should be noted that the use of higher pressures can result in complications related to a person with impaired mobility, such as barotrauma and impairment of hemodynamics.²⁰ Ryu K *et al.*, conducted a randomized controlled trial that evaluated the efficacy and safety of a PRM using 40 cmH₂O and 60 cmH₂O maximal inspiratory pressures.¹¹ Results showed that low-pressure PRM was as effective as high-pressure PRM in reducing post-laparoscopy shoulder pain, minimizing risks.²¹ Yilmaz et al proposed that, when utilizing greater pressures, a lower maximum inspiratory pressure of 15 cm H₂O could be preferred to prevent potential issues in individuals with mobility difficulties.²² In our study, pneumoperitoneum at 15mm was maintained to avoid any complication. Because there is relatively little research on the use of low pressure in people with mobility impairments, we recommend further research on the optimal positive pressure in people with mobility disabilities that reduces the severity and incidence of side effects of post laparoscopy shoulder pain.

Tsai et al examined that how well PRM reduced shoulder discomfort caused by laparoscopy by eliminating post-laparoscopic carbon dioxide from abdominal cavity. They concluded that PRM significantly lessen pain after laparoscopic surgery and may be more beneficial for discomfort in upper abdomen and shoulder.²³ These results corroborated the findings of our investigation, which showed that the PRM group's mean VAS score at 4, 8, 12, 24, and 48

hours was significantly lower than that of the passive release group.

Shoulder tip pain following laparoscopic cholecystectomy remains a common complaint among patients, but it can be alleviated using pulmonary recruitment maneuvers. Understanding these mechanisms can improve patient care and outcomes. Further research is needed to establish standardized protocols and guidelines for the implementation of pulmonary recruitment maneuvers in laparoscopic cholecystectomy procedures.

LIMITATION OF STUDY

Certain patients may have abnormalities in their baseline features if they were hospitalized previously for an acute episode of cholecystitis. Despite the fact that the patients' appearances are comparable, we acknowledge that this is a study procedure limitation. Second, there was a lack of comprehensive standardization in the anesthetic management. However, there was no discernible difference between the groups. Thus, it should not have influenced our results that there were slight variations in the anesthetic therapy.

CONCLUSION

Study concludes that PRM reduces shoulder tip pain after laparoscopic cholecystectomy as it is safe and uncomplicated. Further PRM is a better management plan as compared to the passive release group for pneumoperitoneum, in terms of post-operative shoulder tip pain in patients of laparoscopic cholecystectomy.

Conflict of Interest: None.

Discolure: This article is based on the thesis of postgraduate student, for MS in General Surgery.

Funding Source: None.

Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

FS & MA: Data acquisition, data analysis, critical review, approval of the final version to be published.

TAMM & FA: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

SAS & SHW: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES

1. Mannam R, Sankara Narayanan R, Bansal A, Yanamaladoddi VR, Sarvepalli SS, Vemula SL et al. Laparoscopic Cholecystectomy Versus Open Cholecystectomy in Acute Cholecystitis: A Literature Review. *Cureus* 2023; 15(9): e45704. doi: 10.7759/cureus.45704

2. Hassler KR, Collins JT, Philip K, Jones MW. Laparoscopic Cholecystectomy. Treasure Island (FL): StatPearls Publishing; 2024.
3. Li XY, Tian M, Li AZ, Li KZ. The risk of shoulder pain after laparoscopic surgery for infertility is higher in thin patients. *Sci Rep* 2021; 11(1): 13421. <https://doi.org/10.1038/s41598-021-92762-3>
4. Naemi MF. Incidence of shoulder-tip pain in lap. cholecystectomy normal versus low-pressure pneumoperitoneum. *Biol Clin Sci Res J* 2023; 4(1): 486. <https://doi.org/10.54112/bcsrj.v2023i1.486>
5. Van Dijk JEW, Dedden S, Geomini P, Meijer P, van Hanegem N, Bongers M. Post laparoscopic Reduction of pain by combining intraperitoneal normal saline and the pulmonary Recruitment maneuver (POLAR BEAR trial). RCT to estimate reduction in pain after laparoscopic surgery when using a combination therapy of intraperitoneal normal saline and the pulmonary recruitment maneuver. *BMC Womens Health* 2017; 17(1): 42. <https://doi.org/10.1186/s12905-017-0397-8>
6. Abuelzein ML, Baghdadi MA, Abdelhady WA, Khairy MM. A prospective randomized controlled study on the role of restoring liver diaphragm surface tension and pain control at port sites in optimizing pain management following laparoscopic cholecystectomy. *Ann Gastroenterol Surg* 2023; 7(1): 131-137. <https://doi.org/10.1002/ags3.12602>
7. Artklar T, Erden S. The Effect of Breathing and Coughing Exercises and Oxygen Therapy on Shoulder Pain and Analgesic Consumption After Laparoscopic Cholecystectomy: A Randomized Controlled Study, *J PeriAnesth Nurs* 2024; 39(4): 540-546. <https://doi.org/10.1016/j.jopan.2023.10.008>
8. Sabzi Sarvestani A, Zamiri M. Residual Pneumoperitoneum Volume and Post laparoscopic Cholecystectomy Pain. *Anesthesiol Pain Med* 2014; 4(4): e17366. <https://doi.org/10.5812%2Faapm.17366>
9. Suginami R, Taniguchi F, Suginami H. Prevention of postlaparoscopic shoulder pain by forced evacuation of residual CO(2). *J Society Laparoscopic Robotic Surg*. 2009; 13(1): 56-59.
10. Kiyak H, Yilmaz G, Ay N. Semi-Fowler positioning in addition to the pulmonary recruitment manoeuvre reduces shoulder pain following gynaecologic laparoscopic surgery. *Wideochir Inne Tech Maloinwazyjne*. 2019; 14(4): 567-574. <https://doi.org/10.5114%2Fwiitm.2019.84384>
11. Ryu KH, Lee SH, Cho EA, Kim JA, Lim GE, Song T. Comparison of impacts of intraperitoneal saline instillation with and without pulmonary recruitment maneuver on post-laparoscopic shoulder pain prevention: a randomized controlled trial. *Surg Endosc* 2019; 33(3): 870-878. <https://doi.org/10.1186/s12871-023-02107-y>
12. Garteiz-Martínez D, Rodríguez-Ayala E, Weber-Sánchez A, Bravo-Torresblanca C, Carbó-Romano R. Pulmonary recruitment can reduce residual pneumo-peritoneum and shoulder pain in conventional laparoscopic procedures: results of a randomized controlled trial. *Surg Endosc* 2021; 35(8): 4143-4152. <https://doi.org/10.1007/s00464-020-07881-1>
13. Kihlstedt Pasquier E, Andersson E. Pulmonary Recruitment Maneuver Reduces Shoulder Pain and Nausea After Laparoscopic Cholecystectomy: A Randomized Controlled Trial. *World J Surg* 2021; 45(12): 3575-3583. <https://doi.org/10.1007/s00268-021-06262-6>
14. Phelps P, Cakmakaya OS, Apfel CC, Radke OC. A simple clinical maneuver to reduce laparoscopy-induced shoulder pain: a randomized controlled trial. *Obstet Gynecol* 2008; 111(5): 1155-1160. <https://doi.org/10.1097/aog.0b013e31816e34b4>
15. Sharami SH, Sharami MB, Abdollahzadeh M, Keyvan A. Randomised clinical trial of the influence of pulmonary recruitment manoeuvre on reducing shoulder pain after laparoscopy. *J Obstet Gynaecol* 2010; 30(5): 505-510. <https://doi.org/10.3109/01443611003802313>
16. Yazdimoghaddam H, Karimi F Z, NaviPour E. Evaluation of Interventions to Reduce Shoulder Pain Following Laparoscopic Surgery: A Systematic Review and Meta-Analysis. *J Adv Med Biomed Res* 2023; 31 (147) :294-315. <http://doi.org/10.30699/jambs.31.147.294>
17. Arif A, Nofal S, Khan M, Khan A, Bhatti A, Ishaq S. Shoulder Tip Pain in Laparoscopic Cholecystectomy with Active vs Passive Evacuation of Pneumoperitoneum. *Esculapio* 2021; 16(4): 116-119. <http://doi.org/10.51273/esc20.2516425>
18. Khanna A, Sezen E, Barlow A, Rayt H, Finch JG. Randomized clinical trial of a simple pulmonary recruitment manoeuvre to reduce pain after laparoscopy. *Br J Surg* 2013; 100(10): 1290-1294. <https://doi.org/10.1002/bjs.9202>
19. Deng X, Li H, Wan Y, Lin X. Pulmonary recruitment maneuver reduces the intensity of post-laparoscopic shoulder pain: a systematic review and meta-analysis. *BMC Anesthesiol* 2023; 155. <https://doi.org/10.1186/s12871-023-02107-y>
20. Lovas A, Szakmány T. Haemodynamic Effects of Lung Recruitment Manoeuvres. *Biomed Res Int* 2015; 2015: 478970. <https://doi.org/10.1155%2F2015%2F478970>
21. Ryu K, Choi W, Shim J, Song T. The impact of a pulmonary recruitment maneuver to reduce post-laparoscopic shoulder pain: A randomized controlled trial. *Eur J Obstet Gynecol Reprod Biol* 2017; 208: 55-60. <https://doi.org/10.1016/j.ejogrb.2016.11.014>
22. Yilmaz G, Kiyak H, Akca A, Salihoglu Z. Low-pressure pulmonary recruitment maneuver: equal to or worse than moderate-pressure pulmonary recruitment maneuver in preventing postlaparoscopic shoulder pain? A randomized controlled trial of 72 patients. *Wideochir Inne Tech Maloinwazyjne* 2020; 15: 519-525. <https://doi.org/10.5114/wiitm.2019.89831>
23. Tsai HW, Chen YJ, Ho CM, Hseu SS, Chao KC, Tsai SK, et al. Maneuvers to decrease laparoscopy-induced shoulder and upper abdominal pain: a randomized controlled study. *Arch Surg* 2011; 146(12): 1360-1366. <https://doi.org/10.1001/archsurg.2011.597>