ORIGINAL ARTICLE *Van Medical Journal*

Van Med J 31 (4): 249-254, 2024
DOI: [10.5505/vmj.2024. 83803](https://doi.org/10.5505/vmj.2024.83803)

The Effect of Intraoperative Recruitment Maneuver Application on the Postoperative Recovery?

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Abstract

Introduction: Anesthesia management, surgical techniques, and patient variables all affect postoperative recovery. After anesthesia and surgery, the Quality of Recovery-15 questionnaire is used to evaluate the quality of recovery. Pneumoperitoneum can affect respiratory mechanics and raise the risk of atelectasis during laparoscopic cholecystectomy. Protective mechanical ventilation techniques, such as recruitment maneuvers and positive end-expiratory pressure, may improve postoperative recovery by increasing oxygenation and lowering pulmonary problems. This study investigates the effects of different ventilation strategies during laparoscopic cholecystectomy on oxygenation, respiratory mechanics, hemodynamics, and postoperative recovery quality.

Materials and Methods: Two groups of sixty laparoscopic cholecystectomy patients were randomly assigned.

Control (Group C) receiving 5 cmH2O positive end-expiratory pressure and Recruitment (Group R) receiving the same positive end-expiratory pressure plus recruitment maneuvers. Hemodynamic parameters, blood gas values, and Quality of Recovery-15 scores were recorded and analyzed using statistical methods.

Results: The Recruitment group showed significantly higher partial pressure of oxygen (PO2) measurements at all intraoperative time points T1 (5 minutes after insufflation), T2 (5 minutes after desufflation), and T3 (1 hour postoperatively) compared to the Control group. The Recruitment group exhibited a higher peak airway pressure (Ppeak) at both T1 and T2. At fifteen minutes postoperatively, the mean arterial pressure in the recruitment group was considerably lower. Better postoperative recovery was shown by the Recruitment group's considerably higher Quality of Recovery-15 scores.

Conclusion: Recruitment maneuvers during laparoscopic cholecystectomy improve oxygenation and postoperative recovery quality, as evidenced by higher Quality of Recovery-15 scores. These findings suggest the potential benefits of integrating recruitment maneuvers into perioperative care plans to enhance patient outcomes.

Key words: intraoperative care; positive-pressure respiration; postoperative period; recovery of function

Introduction

Anesthesia management, surgical techniques, patient characteristics, and other factors all play a role in the complex process of postoperative recovery (1, 2). A pivotal indicator of successful postoperative recovery is the ability of patients to resume normal activities following surgery. The Quality of Recovery-15 (QoR-15) questionnaire provides a patient-reported outcome measure for assessing anesthesia and postoperative recovery quality(3-5). During laparoscopic cholecystectomy procedures, the insufflation of abdominal gas during pneumoperitoneum significantly impacts intraoperative respiratory mechanics (6,7). Diaphragmatic elevation leads to decreased lung volume, reduced functional (5) residual capacity, and diminished oxygen reserve. Decreased lung volume predisposes to collapse in compliant areas, promoting atelectasis formation during anesthesia. Furthermore, the Trendelenburg posture during surgery and the hypercarbic effect of CO_2 gas insufflation have a considerable impact on respiratory functioning. Depending on the patient's comorbidities, the extent of the surgery, and the type of procedure, up to 90% of patients undergoing laparoscopic surgery under general anesthesia may experience postoperative atelectasis (8). The lung condition known as atelectasis, which contributes to postoperative morbidity, is frequently linked to mechanical ventilation. Lower rates of atelectasis and lung problems are linked to protective mechanical ventilation. Although recruitment maneuvers (RMs) and positive end-expiratory pressure (PEEP) alone can improve oxygenation, their combination has the potential to improve oxygenation even more and lower the risk of pulmonary problems. As a result, using this combination intraoperatively may have similar beneficial effects on the lungs (2). Moreover, recent studies have demonstrated the utility of RM

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Received: 29.05.2024, Accepted: 11.07.2024

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during pneumoperitoneum and laparoscopic surgery in improving respiratory mechanics and oxygenation. A recruitment maneuver involves a continuous increase in airway pressure to open collapsed alveoli, followed by the application of adequate PEEP to keep the alveoli "open." Additionally, higher levels of PEEP result in improved alveolar stability and better homogeneity within the lungs. These objectives of recruitment maneuvers serve as part of lung protective strategies and aim to enhance oxygenation, thereby potentially facilitating faster and more effective postoperative recovery (2, 4, 9). This study aims to investigate the effects of different ventilation strategies during laparoscopic cholecystectomy on oxygenation, respiratory mechanics, and hemodynamics. Furthermore, it seeks to explore the impact of these ventilation strategies on postoperative recovery quality.

Materials and Methods

Study Design and Participants: Sixty patients aged 18- 65years with American Society of Anesthesiologists Classification (ASA) physical status I-III and a BMI < 35 kg/m² undergoing laparoscopic cholecystectomy were included in this study. Patients with decompensated heart failure or respiratory system diseases, renal and hepatic insufficiency, vertebral fractures, Raynaud's disease, Burger's disease, and hypotension were excluded. Patients were randomized into two groups using a closed-envelope method: Group C (Control) and Group R (Alveolar Recruitment).

Intervention: Group C received 5 cmH2O PEEP post-endotracheal intubation, while Group R received the same PEEP along with two recruitment maneuvers performed 5 minutes after CO2 insufflation and positioning, and 5 minutes after gas evacuation. The recruitment maneuver involved gradually increasing PEEP from 5 to 20 cmH_2O in increments of 5 cmH_2O, with ventilation maintained at a tidal volume of 8 mL kg/ml, respiratory rate of 10 breaths per minute, and 5 cmH_2O PEEP. Patients were ventilated 10 times per PEEP increment without exceeding the upper limits of plateau and peak pressures, which are 30 cmH2O and 40 cmH2O, respectively. During the operation, patients' Systolic Arterial Pressure (SAP), Diastolic Arterial Pressure (DAP), Mean Arterial Pressure (MAP), Heart Rate (HR), peripheral arterial oxygen saturation (SpO2), End-tidal CO2 (ETCO2), Peak and Plateau airway pressures were recorded at 5-minute intervals. Intraoperative blood gas values were recorded at T0 (5 minutes after intubation), T1 (5 minutes after insufflation), T2 (5 minutes after desufflation), and T3 (1 hour postoperatively).

Ethical approval: The Declaration of Helsinki carried out the study. Giresun Training and Research Hospital Education and Research Hospital local ethics committee granted authorization, with decision number E-53593568-7771-230018930 and date 0611.2023/06.

Statistical analysis: The statistical analyses were performed using the NCSS (Number Cruncher Statistical System) 2007 (Kaysville, Utah, USA) application. The study data were assessed using descriptive statistical techniques (mean, standard deviation, median, frequency, percentage, minimum, and maximum). Through the use of graphical analysis and the Shapiro-Wilk test, the conformance of the quantitative data to the normal distribution was examined. To compare two sets of normally distributed quantitative data, the student t-test was employed. Pairwise comparisons and intragroup follow-up of normally distributed variables were assessed using the General Linear Model and the Bonferroni test. For comparing qualitative data, the Pearson Chi-Square test was employed. Accepted criteria for statistical significance were $p<0.05$.

Results

Sixty patients, thirty of whom were in the recruitment group and thirty of whom were the control group, participated in the study at the Giresun Training and Research Hospital Hospital Anesthesiology and Reanimation Clinic. The sample's ages ranged from 18 to 65 years old (mean: 50.92±14.08 years), with 78.7% of the participants being female (n = 48) and 21.3% being male (n = 13). BMI range: 16.6 to 35 (mean kg/m²: 27.71±4.40). Age, gender, height, weight, and BMI did not differ statistically significantly across the groups ($p>0.05$). The partial pressure of oxygen (PO2) was assessed at four different time intervals in the study: T0 (baseline), T1, T2, and T3. At T0, the PO2 values of the Recruitment group were considerably lower than those of the Control group ($p=0.040$). At T1, T2, and T3, on the other hand, the PO2 values of the Recruitment group were considerably greater ($p<0.01$) than those of the Control group. Within both groups, there were substantial changes in PO2 from T0 to T3, with significant declines in measurements at each consecutive time point ($p<0.01$). When comparing the Recruitment group to the Control group, the decline in PO2 was less severe ($p=0.001$). Table 2.

Ppeak measurements: Peak airway pressure (Ppeak) measurements were taken at T0, T1, and

Table 1: Descriptive statistics and comparison results for the study characteristics

		Total (n=61)	Control group (n=30)	Recruitment group (n=31)	p
Age (years)	Mean±SD	51.00±14.00	48.07±13.85	54.26±10.84	[a]0.086
	Med (Min.-Max.)	54 (23-65)	48 (24-65)	57 (23-65)	
Gender; *n (%)*	Female	48 (78.7)	24 (80.0)	24 (77.4)	[b]0.806
	Male	13 (21.3)	6 (20.0)	7 (22.6)	
BMI (kg/m)[2]	Mean±SD	27.71±4.40	28.20±4.33	27.22±4.49	[a]0.387
	Med (Min.-Max.)	27.3 (16.6-34.2)	27.3 (21-36.7)	27.8 (16.6-37.2)	

[a]Student t Test [b]Pearson Chi-Square Test **BMI:** Body Mass Index, **SD:** Standard Deviation

Table 2: Descriptive statistics and comparison results for PO_2

		Total (n=61)	Control group (n=30)	Recruitment group (n=31)	*p*
PO_2 T0	Mean ± SD	261.80±54.72	276.33±57.88	247.74±48.32	[a]0.040*
	Med (Min.-Max.)	250 (175-419)	264 (186-419)	234 (175-375)	
PO_2 T1	Mean ± SD	208.39±70.01	171.30±43.68	244.29±72.46	[a]0.001**
	Med (Min.-Max.)	198 (104-502)	159.5 (104-270)	249 (120-502)	
PO_2 T2	Mean ± SD	206.31±76.63	173.50±49.66	238.06±85.10	[a]0.001**
	Med (Min.-Max.)	193 (106-459)	161.5 (106-273)	220 (117-459)	
PO_2 T3	Mean ± SD	99.09±20.02	87.45±13.19	110.35±19.15	[a]0.001**
	Med (Min.-Max.)	100 (64.9-193)	81.8 (64.9-108)	110 (84-193)	
	p	[c]0.001**	[c]0.001**	[c]0.001**	
	p(T0-T1)	[d]0.001**	[d]0.001**	[d]1.000	
	p(T0-T2)	[d]0.001**	[d]0.001**	[d]1.000	
	p(T0-T3)	[d]0.001**	[d]0.001**	[d]0.001**	
	p(T1-T2)	[d]1.000	[d]1.000	[d]1.000	
	p(T1-T3)	[d]0.001**	[d]0.001**	[d]0.001**	
	p(T2-T3)	[d]0.001**	[d]0.001**	[d]0.001**	
Difference (T3-T0)	Mean± SD	-162.71±61.65	-188.88±63.06	-137.39±49.10	[a]0.001**
	Med (Min.-Max.)	-146 (-354/-58)	-174.5 (-354/-91)	-124 (-275/-58)	

[a]Student T Test [c]General Linear Model [d]Bonferroni Test *p<0.05 **p<0.01 **T0** :5 minutes after intubation, **T1:**5 minutes after insufflation, **T2:**5 minutes after desufflation, **T3:**1 hour postoperatively.

Table 3: Descriptive statistics and comparison results for Ppeak

		Total (n=61)	Control group (n=30)	Recruitment group (n=31)	p
Ppeak T0	Mean ± SD	13.77±1.53	14.07±1.74	13.48±1.26	[a]0.139
	Med (Min.-Max.)	14 (12-18)	14 (12-18)	14 (12-16)	
Ppeak T1	Mean ± SD	27.03±4.34	24.13±2.75	29.84±3.72	[a]0.001**
	Med (Min.-Max.)	26 (17-36)	25 (17-28)	30 (22-36)	
Ppeak T2	Mean ± SD	24.51±3.35	22.57±2.70	26.39±2.82	[a]0.001**
	Med (Min.-Max.)	24 (16-32)	22 (16-27)	27 (20-32)	
	p	[c]0.001**	[c]0.001**	[c]0.001**	
	p(T0-T1)	[d]0,001**	[d]0,001**	[d]0,001**	
	p(T0-T2)	[d]0,001**	[d]0,001**	[d]0,001**	
	p(T1-T2)	[d]0,001**	[d]0,011*	[d]0,001**	

[a]Student T Test [c]General Linear Model [d]Bonferroni Test *p<0.05 **p<0.01
T0 :5 minutes after intubation, **T1:**5 minutes after insufflation, **T2:**5 minutes after desufflation

T2. No significant difference was observed between the groups at T0 (p=0.139). However, Ppeak values were significantly higher in the Recruitment group at T1 and T2 (p<0.01 for both). The changes in Ppeak from T0 to T2 were significant within both groups (p<0.01). The increase in Ppeak was greater in the Recruitment group compared to the Control group (p=0.001) Table 3 Mean Arterial Pressure (MAP) was measured preoperatively and at 5, 10, 15, and 30 minutes postoperatively. No significant differences were found at preop, 5 min, 10 min, or 30 min between the groups. A significant difference was found at 15 minutes, with lower MAP measurements in the Recruitment group compared to the Control group (p=0.049). There were no significant changes in MAP measurements over time within or between the groups. Significant difference between the groups in terms of the change in Ppeak measurements (p=0.001; p<0.01). The change (increase) in the Recruitment group was greater than the change in the Control group. Table 4 The study assessed Heart rate (HR) levels preoperatively and at 5, 10, 15, and 30 minutes postoperatively.

The Recruitment group had significantly higher preoperative HR levels than the Control group (p=0.046). At five, ten, fifteen, and thirty minutes, there were no discernible differences (p>0.05). From preop to 30 minutes, there was a substantial overall change in HR levels (p=0.001). There was a substantial (p<0.05) drop in HR at after 15 and 30 minutes as compared to 5 minutes. Quality of Recovery-15 (QoR-15T) scores were significantly higher in the Recruitment group compared to the Control group (p=0.001). The mean QoR-15T score was 109.00±11.77 for all patients, 101.00±8.25 for the Control group, and 116.74±9.23 for the Recruitment group, indicating better postoperative recovery in the Recruitment group. Table 5.

Table 4: Evaluation of MAP Measurements According to Groups

		Total (n=61)	Control group (n=30)	Recruitment group (n=30)	*p*
MAP Preop	Mean±SD	98.54±17.24	99.50±21.09	97.61±12.76	[a]*0.673*
	Med (Min.-Max.)	99 (11-150)	100 (11-150)	95 (78-134)	
MAP 5.min	Mean±SD	95.15±13.89	94.50±14.94	95.77±13.01	[a]*0.723*
	Med (Min.-Max.)	96 (57-130)	96 (57-118)	95 (69-130)	
MAP 10.min	Mean±SD	95.67±10.96	97.37±11.20	94.03±10.64	[a]*0.238*
	Med (Min.-Max.)	95 (74-127)	98 (74-127)	94 (75-120)	
MAP 15.min	Mean±SD	92.52±13.46	95.97±13.82	89.19±12.42	[a]*0.049**
	Med (Min.-Max.)	92 (67-124)	95 (70-124)	90 (67-120)	
MAP 30.min	Mean±SD	90.64±10.80	92.60±12.06	88.74±9.23	[a]*0.165*
	Med (Min.-Max.)	90 (61-123)	94 (69-123)	90 (61-107)	

MAP: Mean Arterial Pressure

Table 5: Evaluation of QoR 15 Scores by Groups

		Total (n=61)	Control group (n=30)	Recruitment group (n=31)	p
QoR 15T score	Mean±SD	109.00±11.77	101.00±8.25	116.74±9.23	[a]0.001**
	Med (Min.-Max.)	109 (86-132)	101 (86-118)	118 (97-132)	

[a]*Student T Test* ***p<0,01* **QoR-15 :** Quality of Recovery-15

Discussion

The overall group's mean QoR 15 score in this study was 109.00±11.77, whereas the control group's score was lower at 101.00±8.25 and the recruitment group's score was higher at 116.74±9.23. The statistical analysis reveals a significant difference (p=0.001) between the groups, indicating that the control and recruitment groups' recovery quality differed noticeably from one another. Better postoperative recovery is typically indicated by a higher QoR 15 score, which takes into account aspects such as pain management, physical comfort, emotional state, and general happiness with the surgical experience(10). Consequently, in this study, it seems that the recruitment group's recovery was of a higher caliber than that of the control group. The process of purposefully causing a brief increase in transpulmonary pressure to reopen non-aerated or inadequately aerated alveoli is known as a recruitment maneuver (RM). Improvements in respiratory system compliance and oxygenation are the initial benefits anticipated (2). At least a significant number of closed alveoli should have their critical opening pressure exceeded by the transpulmonary pressure during an RM. Because a larger lung capacity is reached during deflation at a specific pressure level, once these alveoli are reopened, less pressure is required to prevent re-collapse (2). This study's Quality of Recovery (QoR) 15 score provides information on patients' postoperative recovery quality. It is used as a gauge for evaluating patients' general state of recuperation and wellbeing after surgery. Compared to the longer and somewhat more sophisticated QoR-40, QoR-15 is readily printed on a single page, read, and completed fast, minimizing the time necessary to train individuals in its usage. This improves feasibility and lessens the workload for personnel, which is essential to keep clinical care and research execution safe (3, 10). During laparoscopic cholecystectomy, various strategies are employed to manage postoperative discomfort. Intraperitoneal saline irrigation, for instance, reduces discomfort but does not necessarily decrease the requirement for analgesics (11). Additional techniques including deep breathing after surgery, hemovac drainage from the trocar site, and intraperitoneal drainage also lessen the incidence and intensity of shoulder pain following laparoscopy in the early postoperative period. Gentle abdominal compression during trocar insertion also aids in the expulsion of residual intraperitoneal CO_2, contributing to a gradual decrease in postoperative pain scores over time (12-14). Although many factors enhance postoperative recovery and the quality of healing, recent research indicates that lung recruitment maneuvers (LRMs) significantly improve recovery outcomes following laparoscopic surgery and reduce postoperative discomfort. LRMs improve lung compliance, decrease residual pneumoperitoneum, and alleviate pain (15-17). Additional studies provide further evidence of the benefits of LRMs, highlighting improvements in pulmonary function, diaphragmatic mobility, arterial oxygenation, and the reduction of postoperative shoulder pain (18-20). Collectively, this body of research underscores the various advantages of LRMs in laparoscopic surgery, establishing them as a vital component of perioperative care plans. There is little data on how recruitment maneuvers, or LRMs, affect the quality of postoperative recovery following laparoscopic surgery. According to a study by Jo, Y. (2022), neither high-pressure alveolar recruitment maneuvers nor low-pressure ones improved the quality of recovery following laparoscopic sleeve gastrectomy in obese individuals, nor did they lessen postoperative shoulder or surgical site pain (21). Nonetheless, our analysis shows that the QoR 15 scores of the recruitment and control groups differ significantly. The observed disparity could perhaps arise from variations in patient demographics and the application of distinct scoring methodologies (QoR-15 in our study versus QoR-40 in Jo et al., 2022)(21).

Study limitations: This study's dependence on a single-center design is one of its limitations, which can limit how broadly applicable the results are to other patient populations. Furthermore, the results' statistical power and robustness may be compromised by the very small sample size, which may cause significant subtleties in the effects of recruiting strategies on postoperative recovery to go unnoticed. Moreover, even while the QoR-15 score offers insightful information on the overall quality of recovery, it might not fully capture the range of factors influencing patient recovery. In order to provide a more nuanced knowledge of postoperative recovery trajectories, future research endeavors should seek to address these limitations through multi-center studies with bigger and more diverse samples, augmented by comprehensive outcome measures and longitudinal evaluations. Furthermore, investigating plausible confounding variables and executing blinding protocols may improve the validity and dependability of the research outcomes.

Conclusion

This study concludes by highlighting the possible advantages of recruitment maneuvers in enhancing the quality of postoperative recovery following laparoscopic surgery. The significance of therapies targeted at improving lung function and decreasing residual pneumoperitoneum is highlighted by the notable discrepancy in QoR-15 scores between the recruitment and control groups.

Ethical approval: This study was approved by the Ethical Committee of Giresun Training and Research Hospital Education and Research Hospital with decision number E-53593568-7771-230018930 on 11 June 2023. Written informed consent was obtained from each patient.

Conflict of interest: The authors declare no competing interests.

Financial support: This study was conducted without any specific financial support from public, commercial, or non-profit funding agencies.

Authors contributions: Concept-Design: TA; Literature review: TA; Data collection: SÇ; Writing-review-revision: TA

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