Panacea Journal of Medical Sciences 2021;11(3):395–400

Content available at: https://www.ipinnovative.com/open-access-journals

Panacea Journal of Medical Sciences

Journal homepage: http://www.pjms.in/

Original Research Article

Alterations in pulmonary function following laparoscopic cholecystectomy

Malaya Kumar Patel[1], Sheela Ekka[1], Mahendra Ekka[1,*], Pujarini Beuria[2], Sapan Kumar Jena[1]

[1]*Dept. of Anaesthesiology, Veer Surendra Sai Institute of Medical Sciences and Research, Burla, Odisha, India*
[2]*Dept. of Anaesthesiology, S.C.B. Medical College and Hospital, Cuttack, Odisha, India*

A R T I C L E I N F O

Article history:
Received 12-01-2021
Accepted 13-03-2021
Available online 24-11-2021

Keywords:
Lungphysiology
Pulmonary function tests
Laparoscopic
Cholecystectomy

A B S T R A C T

Background: In laparoscopic cholecystectomy, inflammation of the punctured abdominal wall or gall bladder bed, carbon dioxide pneumo-peritoneum and intraoperative patient position has significant effect in the pathogenesis of pulmonary dysfunction. The objective of this study is to detect any changes in pulmonary functions following laparoscopic cholecystectomy using bedside spirometry and to detect degree of impairment of pulmonary function, their complications and the time taken for recovery of post-operative spirometry measurements to the preoperative (baseline) values.
Materials and Methods: This was a prospective observational study in which the preoperative and postoperative spirometry of 70 patients undergoing laparoscopic cholecystectomy under general anaesthesia was compared. Pre-operative spirometry was performed to record the baseline values. Patients who had normal FVC, FEV_1, PEFR values were included in the study. Those who were not able to perform acceptable maneuver were excluded from the study. Pulmonary function testing was done twice following surgery on postoperative day one and on postoperative day three. Adequate pain relief was given to attain a VAS score of less than 40. Spirometry values were compared using paired *t*-test. P-value of <0.05 was considered statistically significant.
Results: Significant differences were found for the Forced Vital Capacity variable (p=0.001), Forced Expiratory Volume in the first second (p=0.020) and peak expiratory flow rate (p=0.000) between the pre- and immediate postoperative periods, indicating restrictive ventilator dysfunction.
Conclusion: Light restrictive respiratory disturbances were observed after laparoscopic cholecystectomy, wih rapid recovery of pulmonary function, which may lower postoperative pulmonary morbidity and mortality.

1. Introduction

Changes in pulmonary function account for significant morbidity andmortality following surgery.[1] Abdominal surgery results in the greatest depression in pulmonary function which has been reported to be as high as 70%[2] and micro atelectasis is regarded as a uniform occurrence. The most common post-operative complicationsare atelectasis, pulmonary edema, pneumonia, pulmonary thromboembolism and acute exacerbation of COPD. They increase mortality, morbidity, length of hospital stay& overall medical cost.

Although laparoscopic cholecystectomy results in postoperative pulmonary complication, but there is faster recovery of postoperative pulmonary function and less atelectasis and hypoxemia than open cholecystectomy.

Inflammation of the punctured abdominal wall or gall bladder bed, or both, carbon dioxide pneumo-peritoneum

* *Corresponding author*.
E-mail address: mekka15071976@gmail.com (M. Ekka).

https://doi.org/10.18231/j.pjms.2021.079

or intraoperative patient position has significant effect in the pathogenesis of this pulmonary dysfunction.[3] The impact of upper abdominal surgery on respiratory function parameters, including lung volumes, flow rates, arterial blood gases and diaphragmatic function, was investigated in several studies.[4,5]

The aim of my study is to detect degree of impairment of pulmonary functions and complications after laparoscopic cholecystectomy using bedside spirometry, so that early diagnosis and interventions may decrease post-operative morbidity and mortality.

2. Materials and Methods

1. Spirometer for pulmonary function testing (Easy One)
2. Pulse oximeter for measuring SPO2

2.1. Spirometry specifications

1. Easy One$^{(TM)}$ DIAGNOSTIC 6.5$^{(c)}$ ndd 2000-2010
2. Product of ndd Medical technologies

2.2. Test specifications

1. Value selection- Best trial
2. System interpretation- GOLD 2008 / HARDIE
3. Predicted- KNUDSON 83
4. Paediatric predicted- POLGAR

2.3. Methodology

After obtaining institutional ethical approval, this prospective observational study was carried out on a total of 70 patients of either sex between 20-60 years of age, BMI between 18.5-29.9 kg/m^2, belonging to ASA physical status I and II, scheduled for elective laparoscopic cholecystectomy under general anaesthesia. Written informed consent was obtained from all the patients before the surgery. The patients were subjected to detailed clinical examination and routine investigations to exclude any systemic disorder. Emergency surgery, patients with cardio-respiratory diseases, pregnant women, patients with smoking history, duration of surgery exceeding 60 minutes were the exclusions.

Based on previous studies,[6] a sample size of 53 was required considering an error margin of 5% and a power of 80%. Considering a dropout rate of more than 10%, a total of 70 patients were enrolled in the study.

Patients have been explained about the study procedure, benefits, importance of post-op lung function and the need to do spirometry in the immediate postoperative period. Then the pre-op spirometry was performed to record the baseline values. Patients who had normal FVC, FEV1, PEFR values only were included in the study. Patients who were unable to perform acceptable maneuver excluded from the study. Following a standardized anesthetic protocol, all the cases were done under general anaesthesia with inj. Glycopyrrolate 0.04mg/kg, inj. Midazolam 0.05mg/kg and inj. Nalbuphine 0.1mg/kg as premedication. Inj. Diclofenac 1.5mg/kg was given as additional intra-op analgesia. Induction was done with inj. Propofol 2mg/kg and inj. Succinylcholine 1.5mg/kg. Endotracheal intubation was done with appropriate size cuffed endotracheal tube. Adequate plane of anaesthesia was maintained with sevoflurane (1%-2%) and N2O in a 50% mixture with O_2. Adequate muscle relaxation attained by using inj. vecuronium in standard prescribed dosage. ETCO2 monitoring was done for all patients to ensure adequate ventilation and CO2 elimination. The beginning of surgery corresponded to the moment of the skin incision and the end, the last stitch of the skin suture.

The patients were all operated on by the same surgeon using the similar surgical technique. Incision was given at the upper edge of the umbilical scar in supine position. Intra-abdominal pressure was maintained at a pressure ≤ 12 mmHg throughout the laparoscopic procedure. At the end of procedure, abdomen was compressed to release the residual gas from peritoneum.

The patients underwent serial Spiro metric measurements. The first test was carried out pre-operatively. The second test was within the first 24 post-operative hours. And third test was undertaken on post-operative day3. Most patients were discharged from hospital on postoperative day 3, so we could not perform spirometry after day 3. The spirometry was always conducted by the same professional – a respiratory function technician – with the same equipment: Easy One^{TM} DIAGNOSTIC 6.5 software pc based portable spirometer, which can measure pulmonary flow and volume parameters and is validated by the American Thoracic Society (ATS). The device, in addition to generating flow-volume and volume-time curves, discriminated 12 spirometric variables and the results were printed out automatically. The parameters were analyzed based on Knudson's regression equation. Preparation for each spirometry session included calibrating the spirometer through an appropriate calibration syringe, adjusted to ambient temperature (25ºC to 40ºC) and atmospheric pressure.

The individual variables height (in cm), weight (in kg), gender and date of birth were recorded and stored in the spirometer. After 10 minutes of rest in a calm environment, each patient underwent three valid and reproducible tests. The spirometry reports were always provided and interpreted by the same person, a specialist in lung function tests, blinded to the patients' clinical history. The variables FVC, FEV_1 and PEFR were analyzed individually, pre- and postoperatively, up to the point when their values normalized (80 % of the pre-calculated theoretical value for FVC, FEV_1 and PEFR). The hypothesis that means between groups were equal before and after surgery was tested through paired *t*-test. The value of $P<0.05$ was considered statistically significant.

Inj. tramadol at a dose of 1mg/kg intramuscular was given for postoperative analgesia. Patients were followed up to post-op ward where first post-op spirometry was done within first 24hrs after assessing the pain scale. VAS (visual analogue scale from 0-100) was used to assess the pain score. VAS score less than 40 was taken as acceptable score since it indicates minimal pain which won't affect the performance of spirometry. When pain scores were more than 40, intravenous paracetamol was given at a dose of 15 mg/kg body weight over 20 min as infusion. Once pain score is within acceptable limits post-op spirometry was performed at the bedside. Those patients whose pain score was more than 40 excluded from the study.

3. Results

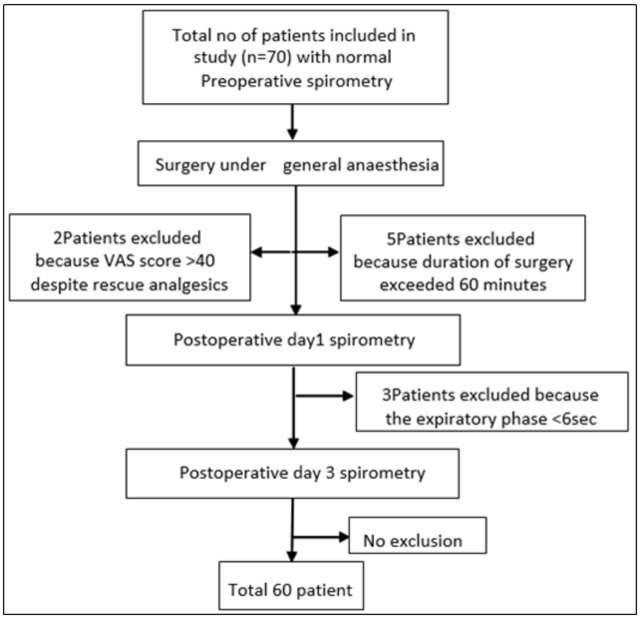

Fig. 1: CONSORT Diagram

A total of 60 patients were analyzed after exclusion due to various reasons. Data were collected in a prescribed format and tabulated in Microsoft excel 2016 and analyzed using SPSS version 23. Normality assumption was examined by the Shapiro-wilk W test. According to normality testing, the variables used in analysis were expressed in mean ± SD. Descriptive statistics were presented in the form of frequency, percentages, mean ± SD, minimum maximum, the difference between mean of three PFT parameters (FEV1, FVC, PEFR) of the same study group at different time (i.e. pre operatively, on postoperative day1 and on postoperative day3) were evaluated using one way repeated measure ANOVA after fulfilling the parametric tests prerequisites. Statistical significance was set at $P<0.05$.

The percentage of participants in 20-30yrs, 30-40yrs, 40-50 years, 50-60 years age group are 31.7%,35.0%, 26.7%, 6.7% respectively with a mean age of 36.3 years and the range was 21-58yrs.

Majority of the patients in this study group belonged to the female gender group (n=38, 63.3%). Male gender was only 36.7%.

Majority of the patients in this study group belonged to the 51-60kgs weight, class interval (n=21, 35%) with a mean weight of 57.6kgs.Minimum weight of the patient was 42kg and maximum was 85kg. Height of the patients in this study group was between 142 to 170 cm with maximum percentage in 151-160cms height (n=24, 40%) & mean height of157.1cms. BMI range of the patients was 19-29 kg/m^2 with a mean of 23.3 ± 2.9 kg/m^2.

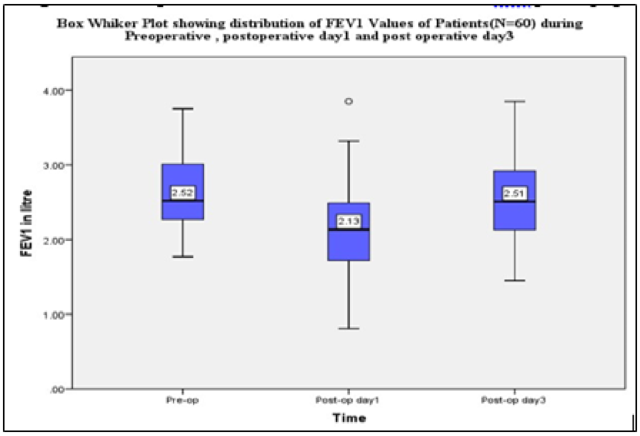

Fig. 2: Comparison of mean of FEV1 in PREOP. and post op. period

Mean FEV1 values preoperatively, post operatively on day 1 and post operatively on day 3 are 2.63 L, 2.16L & 2.54L respectively. The results of ANOVA indicated a significant effect of time on FEV1 values, F value=79.271, P value<0.05. It means that there is significant change in FEV1 value of patient before and after operation.

Follow up comparisons indicated that each pair wise difference was significant, i.e. $P<0.05$. There is a significant decrease in FEV1 value on day 1 following lap cholecystectomy as well as on day 3 following operation. But FEV1 on day 3 post op is significantly higher compared to day 1 post op. Pre- operative FEV1.>Post op day 3 FEV1 (96.4%)> post op day 1 FEV1 (81.9%).

3.1. Distributionof FVC values during PRE OP,

One way repeated measure ANOVA test was used to compare the mean FVC values of total 60 patients before operation, on day 1 and day 3 following operation. The test shows a statistically significant difference in mean FVC

Table 1:

Mean Value	Preoperative	Post-operative day 1	Post-operative day 3
FEV1	2.635	2.160(81.9%)	2.541(96.4%)
FVC	3.029	2.487(75.6%)	2.885(95.2%)
PEFR	6.509	5.393 (82.8%)	6.159 (92.6%)

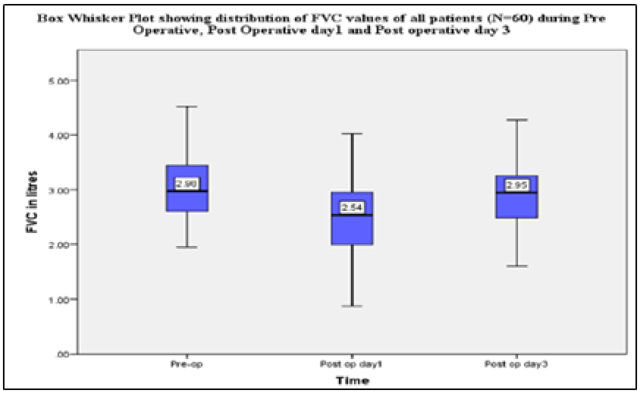

Fig. 3: Comparison of mean of FVC values during pre op, post op day 1 and post op day 3

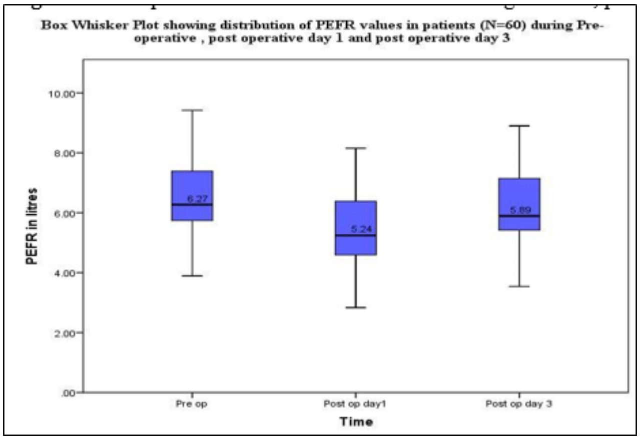

Fig. 4: Comparison of mean of PEFR values during PREOP, post op day 1 and post op day 3

values when compared at three different time periods with F value= 74.05, P value < 0.05 and eta^2= 0.719.

Further pair wise comparison was done between each possible pair. It is clearly evident from the above table that mean FVC value in preoperative period is more than mean FVC in postoperative day 1 and day 3 and the difference in the mean values are significant.

However, the mean FVC value during post op day 1 is lower as compared to post op day 3 and the difference in is also significant.(P value<0.05) So, the conclusion is there is a significant change in FVC values after lap cholecystectomy. However, FVC parameter gradually improves on day 3 following operation. Pre-op FVC> Post op day 3(75.6%)> Post op day 1(95.2%)

One way repeated measure ANOVA test was used to compare the mean PEFR values of total 60 patients before operation, on day 1 and day 3 following operation. The test shows a statistically significant difference in mean PEFR values when compared at three different time periods with F value=118.14, P value < 0.05.

Here difference of mean of PEFR between each group was compared, where 1=preoperative, 2= postoperative day 1, 3= postoperative day 3 and I time is the reference group to which other group (J time) are compared

Based on estimated marginal means

1. The mean difference is significant at the 0.05 level.
2. Adjustment for multiple comparisons: Bonferroni.

Further pair wise comparison was done between each possible pair. It is clear from the above table that mean PEFR value in preoperative period is more than mean PEFR in postoperative day 1 and day 3 and the difference in the mean values are significant.

However, the mean PEFR value during post op day 1 is lower as compared to post op day 3 and the difference in is also significant.(P value<0.05).

So, the conclusion is there is a significant change in PEFR values after lap cholecystectomy. However, FVC parameter gradually improves on day 3 following operation.

Pre-op PEFR> Post op day 3 PEFR (94.6%)> Post op day 1 PEFR (82.8%).

Statistically significant differences occurred in all the three variables when preoperative and postoperative values were compared (P=0.001for FVC, P=0.020 for FEV1, P=0.000 for PEFR). Follow up comparisons indicated that each pair wise difference was significant, i.e. P< 0.05. There is a significant decrease in FEV1 and FVC value on day 1 following lap cholecystectomy. But FEV1 on day 3 post op is significantly higher compared to day 1 post op. (Pre.>Post day3> post day 1).

4. Discussion

Laparoscopic surgery has been a revolutionary alternative to many open surgical procedures. For the anaesthetists, “minimally invasive” surgery requires maximally attentive anaesthesia. Pneumoperitoneum in conjunction with extreme patient positioning induces transient, but significant, multiorgan derangements that require short-term manipulation of physiology to minimize

Table 2: Pairwise comparisons of mean fev1, VC & PEFR values during pre-operative, postop day1 and post op day 3

(I) Time	(J) Time	Mean Difference FEV1 (I-J)	FEV1 Sig.	Mean Difference FVC(I-J)	FVC Sig.	Mean Difference PEFR (I-J)	PEFR Sig.
1	2	.475*	.000	.542*	.000	1.116*	.000
	3	.093*	.020	.144*	.000	.350*	.000
2	1	-.475*	.000	-.542*	.000	-1.116*	.000
	3	-.381*	.000	-.398*	.000	-.766*	.000
3	1	-.093*	.020	-.144*	.000	-.350*	.000
	2	.381*	.000	.398*	.000	.766*	.000

complications. Subjectively there is no doubt that patients recover more quickly from laparoscopic procedure, and one of the reasons for this smoother recovery may be this procedure's diminished effect on postoperative pulmonary function compared with previously standard open procedure. Laparoscopic cholecystectomy does not damage the abdominal muscles and diaphragmatic function is significantly less affected compared to the open method. This procedure is accompanied by a lower impact on respiratory function and better oxygenation.

Post operatively all the patients had a significant fall in FVC values measured on postoperative day 1. The reduction was significantly more, from mean pre-op FVC 3.029 L to post-op FVC 2.487 with a reduction of 24.4 %. The second post-op FVC done on postoperative day3 revealed improvement in capacities. The FVC recovered to 2.885 L which is just 4.8% less compared to pre-op values. Hence FVC measurements after lap-cholecystectomy were found to be significantly low both during first and third post-operative day, this is similar to the findings published by Hasukic S et al, S.M.Ravimohan et al.[7,8]

Post operatively all the patients had a significant fall in FEV1 values. The pre-op mean FEV1 value of 2.635 L was reduced to 2.160 L on postoperative day1, with a reduction of 18.1% which later improved significantly to 2.541 L on postoperative day3,is again a reduction of 3.6 % compared with the pre-op value. The mean FEV1 values after laparoscopic cholecystectomy were significantly reduced both on first and third postoperative day, this is like the findings reported by Hasukic S et al. and Suter M. et al.[7]

PEFR value in mean was of 6.5 L/min in preop which decreased to 5.39 L/min with a reduction of 17.2% on postoperative day1. It later recovered well at 6.16 L/min measured on postoperative day 3 which was still 5.4% less compared with pre-op values. The PEFR values were significantly reduced in laparoscopic cholecystectomy both during first and third postoperative day. This is like the findings reported by Hasukic S et al.[7]

In the present study, mild restrictive ventilatory defects were observed, with FVC, FEV_1 and PEFR reduction, when these three variables were compared pre- and postoperatively, and the decrease in FVC is more than that of FEV_1. Therefore, it can be concluded that laparoscopic cholecystectomy also results in postoperative spirometric changes, an observation that agrees with several other scientific journals. However, in the present study, the more pronounced decreases in FVC, FEV_1 and PEFR were 24.4%, 18.4% and 17.2% respectively on postoperative day 1, in relation to the baseline values.

But on postoperative day 3, the more pronounced decrease in FVC, FEV1 and PEFR are 4.8%, 3.6% and 5.4% respectively. This implies that postoperative day3 spirometric values are comparable to normal tests when compared with the predicted values. Reports were found of scientific observations like those made in the present study. More marked alterations are usually found, even in laparoscopies, with decreases between 20% and 30%[9] in all the variables or even more expressive reductions, greater than 40%.

Several studies[10,11] showed that for patients who underwent upper abdominal surgery, compared with the abdominal cavity, the thoracic wall provided major postoperative contributions in respiratory movement. Showing that after upper abdominal surgery, (1) the artificial stimulation of phrenic nerves produced normal trans-diaphragmatic pressure; and (2) diaphragmatic pressures developed during inspiration were shown to be decreased. As for why general anaesthesia and analgesia had no effects, the diaphragmatic activity is not affected by perceptible postoperative pain. However, a reflex inhibition regarding diaphragmatic motility seems to occur with the aid of the abdominal region nerves being activated during the operation.

Thus, in the present study, reduced diaphragm dysfunction a characteristic of laparoscopic procedures, along with shorter anaesthetic and surgical time, were the main determinants for minimally altered postoperative spirometric values in relation to the preoperative values. Thus, the spirometric variables decreased in the immediate postoperative period when compared with the preoperative values, and in the following measurement (third postoperative day), values were already equivalent to those of the preoperative period. Several studies pointed to the recovery of pulmonary function after laparoscopic cholecystectomy between 8 to 10 days[12,13] which finds no support in the present study. The difference is likely explained by the reduced operative time involving less tissue injury and diaphragm dysfunction.

5. Conclusion

From the above study, we concluded that there is mild restrictive pulmonary dysfunction after laparoscopic cholecystectomy, which manifested as significant decrease in FVC, FEV1 and PEFR in postoperative day1 and day3 in comparison with preoperative (baseline) values. But there was a faster recovery of pulmonary functions, which was evident by the rapid improvement of FVC, FEV1 and PEFR as seen in postoperative day 3.

6. Conflict of Interest

The authors declare that there are no conflicts of interest in this paper.

7. Source of Funding

None.

References

1. Ali J, Weisel RD, Layug AB, Kripke BJ, Hechtman HB. Consequences of postoperative alterations in respiratory mechanics. *Am J Surg*. 1974;128(3):376–46.
2. Churchill ED, Mcneil D. The reduction in vital capacity following operation. *Surg Gynecol Obstet*. 1927;44(6):483–8.
3. Beecher HK. The measured effect of laparotomy on the respiration. *J Clin Investig*. 1933;12(4):639–50.
4. Wightman JA. A prospective survey of the incidence of postoperative pulmonary complications. *Br J Surg*. 1968;55(2):85–91.
5. Latimer RG, Dickman M, Day WC, Gunn ML, Schmidt CD. Ventilatory patterns and pulmonary complications after upper abdominal surgery determined by preoperative and postoperative computerized spirometry and blood gas analysis. *Am J Surg*. 1971;122(5):622–32.
6. Ramos GC, Pereira E, Neto SG, and ECO. Pulmonary function after laparoscopic cholecystectomy and abbreviated anesthetic-surgical time. *Revista do Colegio Bras Cirurgioes*. 2009;36(4):307–11.
7. Hasukic S, Mesic D, Dizdarevic E, Keser D, Hadiselimovic S, Bazardanovic M. Pulmonary function after laparoscopic and open cholecystectomy. *Surg Endosc Ultrasound Interv Techn*. 2002;16(1):163–9.
8. Ravimohan SM, Kaman L, Jindal R, Singh R, Jindal SK. Postoperative pulmonary function in laparoscopic versus open cholecystectomy: prospective, comparative study. *Indian J Gastroenterol: Official J Indian Soc Gastroenterol*. 2005;24(1):6–8.
9. Erice F, Fox GS, Salib YM, Romano E, Meakins JL, Magder SA, et al. Diaphragmatic function before and after laparoscopic cholecystectomy. *Anesth: J Am Soc Anesthesiologists*. 1993;79(5):966–75.
10. Osman Y, Fusun A, Serpil A, Umit T, Ebru M, Bulent U, et al. The comparison of pulmonary functions in open versus laparoscopic cholecystectomy. *J Pak Med Assoc*. 2009;59(4):201–4.
11. Tiefenthaler W, Pehboeck D, Hammerle E, Kavakebi P, Benzer A. Lung function after total intravenous anaesthesia or balanced anaesthesia with sevoflurane. *Br J Anaesth*. 2011;106(2):272–6.
12. Trianthiroussou MD, Vassiliou MP, Behrakis PK. Postoperative changes on pulmonary function after laparoscopic and open cholecystectomy. *Hepatogastroenterology*. 2003;50(53):1193–200.
13. Wong DH, Weber EC, Schell MJ, Wong AB, Anderson CT, Barker SJ, et al. Factors associated with postoperative pulmonary complications in patients with severe chronic obstructive pulmonary disease. *Anesth Analgesia*. 1995;80(2):276–84.

Author biography

Malaya Kumar Patel, Associate Professor

Sheela Ekka, Assistant Professor

Mahendra Ekka, Assistant Professor

Pujarini Beuria, Senior Resident

Sapan Kumar Jena, Senior Resident

Cite this article: Patel MK, Ekka S, Ekka M, Beuria P, Jena SK. Alterations in pulmonary function following laparoscopic cholecystectomy. *Panacea J Med Sci* 2021;11(3):395-400.