ORIGINAL ARTICLE

A Prospective Comparative Trial of Post -Operative Pulmonary Function: Laparascopic versus Open Cholecystectomy

Sandeep Bhat, A Katoch, L Kalsotra*, R K Chrungoo

Abstract

Gall stone disease is the most common biliary pathology and has plagued the mankind for over 2000 years. Since the National Institutes of Health Consensus Conference, in 1993, laparoscopic cholecystectomy has replaced open cholecystectomy as the gold standard in the treatment of patients with symptomatic gall stone disease. The present prospective study was conducted to evaluate and compare post- operative pulmonary dysfunction following laparoscopic and open cholecytectomy. A total of 60 patients, 30 each in laparoscopic and open cholecystectomy groups, respectively, were studied. Pulmonary function tests of the patients were determined by computerized spirometer, Medspiror, pre-operatively and post operatively on day 1 and day 6. Forced vital capacity (FVC), Forced expiratory volume in one second (FEV1), Peak expiratory flow rate (PEFR) and Mid-expiratory flow(FEF-25-75%) were determined The ultimate outcome showed a gratifying trend towards laparoscopic cholecystectomy which is discussed in detail in the article. Laparoscopic cholecystectomy causes significantly less impairment of post-operative pulmonary function.

Key words

Laparoscopic Cholecystectomy; Open Cholecystectomy; Medspiror; Pulmonary function test;

Introduction

Gall stone disease is the most common biliary pathology and has plagued the mankind for over 2000 years (1). Approximately one-tenth of the adult population in United States harbours gall stones (2). The vast majority of subjects (more than 85%) are asymptomatic, and when such patients are followed, between 1 to 4 per cent per year will develop biliary symptoms.

Today, cholecystectomy i.e., complete removal of gall bladder remains the most effective and the only curative modality of treatment which can be performed either by open method or laparoscopically. Since the National Institutes of Health Consensus Conference, in 1993, laparoscopic cholecystectomy has replaced open cholecystectomy as the "gold standard" in the treatment of patients with symptomatic gall stone disease . It has been estimated that 85 per cent of all cholecystectomies performed in United States in 1993 were done laparoscopically (3).

Laparoscopic cholecystectomy is known to reduce the post-operative pulmonary dysfunction and pain by limiting the trauma to the abdominal musculature (4). It also improves cosmesis, hastens recovery and reduces hospital stay and post-operative complications.

In the present scenario, laparoscopic cholecystectomy has become a safe and acceptable procedure to the patient. The present study was conducted to evaluate and compare the post-operative pulmonary dysfunction following laparoscopic and open cholecystectomy.

Material and Methods

The study was conducted in the Department of General Surgery and Physiology, Govt. Medical College, Jammu

From the Post Graduate Departments of Surgery and *Physiology, Govt. Medical College, Jammu (J&K)
Correspondence to : Dr Sandeep Bhat, H.No. 21, Lane No. 1 A Roop Nagar, Enclave, Jammu (J&K)

and a total of 60 patients, 30 each in laparoscopic and open cholecystectomy group were enrolled in study design.

Eligibility Criteria

Symptomatic gall stone disease, ellective surgery, normal common bile duct (on pre-operative Ultrasonography), no history of previous chronic obstructive or restrictive airway disease, normal pre operative PFT, ASA class I and II, BMI < 30.

Pulmonary function tests of the patients were determined by computerized spirometer, Medspiror (Med Systems (P) Ltd. Chandigarh), pre-operatively and post-operatively on day 1 and day 6 in sitting position.

Medspiror was used to calculate the following test results:

(i) Forced vital capacity (FVC)

(ii) Forced expiratory volume in one second (FEV1)

(iii) Peak expiratory flow rate (PEFR)

(iv)Mean forced expiratory flow during middle half of the FVC (FEF - 25 - 75%)

(v) FEV1 / FVC :

The mean percentage change in each variable, on post-operative day 1 and day 6, was evaluated and compared with pre-operative values, both in laparoscopic cholecystectomy and open cholecystectomy group, respectively. Intragroup and intergroup comparisons of these variables was made using paired and unpaired t-test, respectively.

Open cholecystectomy was performed using classical right subcostal incision. Laparoscopic cholecystectomy was performed using four conventional ports, Pneumoperitonium was created by insufflation of CO2 with the help of Verees needle, through the umblical port, at a pressure of 12-15 mmHg.

Results

The prospective comparative trial was conducted in the Department of Surgery, Government Medical College, Jammu. All surgeries were performed under general anaesthesia and all the patients tolerated the surgical procedure well with no intra-operative complication in either group. There was no significant difference in patient demographics. The comparative assessment of risk factors was done and was found to be statistically non-significant.

The mean operating time in laparoscopic cholecystectomy was 59.33 minutes and open cholecystectomy was 45.33 minutes. The difference was found to be statistically highly significant ($p < 0.00001$). The mean post-operative hospital stay in laparoscopic cholecystectomy was 1.73 days and in open cholecystectomy was 3.4 days. The difference was found to be statistically highly significant ($p < 0.00001$).

Intra group comparison

Table 1 : Mean percentage change in pulmonary function after Open Cholecystectomy

PFT	FVC	FEV_1	FEV1/FVC	FEF - 25-75%	PEFR
Post-operative day 1	46.61	50.23	5.2	47.88	43.16
p-value	0.000	0.000	0.021	0.000	0.000
Post-operative day 6	19.52	21.12	0.35	20.84	19.18
p-value	0.000	0.000	0.84	0.000	0.000

After open cholecystectomy a significant decrease occurred in all the variables studied compared to pre-operative values. FVC, FEV1, FEF - 25-75%, PEFR decreased significantly both on day 1 and day 6. The FEV1/FVC decreased significantly on post-operative day 1. FEV1/FVC returned to near normal on post-operative day 6 (Table1).

Similarly,in laparoscopic cholecystectomy group, the mean percentage decrease in pulmonary function variables namely, FVC, FEV1, FEV1/FVC, FEF - 25-75% and PEFR on post-operative day 1 and day 6 were statistically significant, except for decrease in FEV1/FVC on post-operative day 6 which was statistically non-significant(Table 2).

Table 2 : Mean percentage change in pulmonary function after Laparoscopic Cholecystectomy

PFT	FVC	FEV1	FEV1/FVC	FEF - 25-75%	PEFR
Post-operative day 1	25.49	28.6	3.2	24.5	21.3
p-value	0.000	0.000	0.019	0.000	0.000
Post-operative day 6	5.57	6.5	0.1	5.05	5.9
p-value	0.000	0.000	0.91	0.0003	0.0009

Intergroup comparison

The pulmonary function variables (FVC, FEV1, FEV1/FVC, FEF - 25-75%, PEFR) in the two groups were

analyzed using unpaired t-test. There was statistically significant difference in FVC, FEV1, FEF - 25-75% and PEFR in the two groups on post-operative day 1 and day 6 with laparoscopic cholecystectomy group showing better preservation of pulmonary function. The FEV1/ FVC did not show any statistically significant difference on post-operative day 1 and day 6 although the fall in open cholecystectomy was more than laparoscopic cholecystectomy group (Table 3)

Table 3 : Intergroup comparison of mean reduction in pulmonary function variables

POD	Group	FVC	FEV1	FEV1/ FVC	FEF - 25-75%	PEFR
Day 1	Open Cholecystectomy	46.61	50.23	5.2	47.88	43.16
	Laparoscopic Cholecystectomy	25.49	28.6	3.3	24.5	21.3
	p-value	0.000	0.000	0.44	0.000	0.000
Day 6	Open Cholecystectomy	19.52	21.12	0.35	20.84	19.18
	Laparoscopic Cholecystectomy	5.57	6.5	0.1	5.05	5.9
	p-value	0.007	0.005	0.90	0.009	0.01

The analgesic requirement was more with open cholecystectomy patients than with laparoscopic cholecystectomy patients. The open cholecystectomy patients required parenteral analgesics for a minimum period of 2 days, while as most of the laparoscopic cholecystectomy patients were discharged by then. The open cholecystectomy patients continued with the oral analgesics till the first follow-up (one week after discharge) in OPD. The laparoscopic cholecystectomy patients continued analgesics for an average period of 5 days post-operatively. The hospital stay was significantly less with laparoscopic cholecystectomy group.

Discussion

The pulmonary effects of surgery and general anaesthesia have been well documented (5,6). Upper abdominal surgery can produce dysfunctional pulmonary mechanics independent of effects of general anaesthesia. Although the etiology of the pulmonary dysfunction after upper abdominal surgery has not been completely elucidated, post-operative pain and diaphragmatic dysfunction are considered to be major contributory factors (7). Incisional pain limits inspiratory capacity and impairs cough reflex thereby producing a pattern of shallow inspiration leading to alveolar collapse. Upper abdominal surgery also decreases diaphragmatic excursion and may lead to paradoxical motion of diaphragm which further leads to increased demand on intercostals muscle contribution to respiration, thereby decreasing functional residual capacity (8)

Post-operative pulmonary dysfunction has been considered a restrictive process (4). The ratio of FEV1/ FVC helps to distinguish between airflow limitations and restrictive abnormalities. In patients with airflow limitations the FEV1/FVC is reduced, but in patients with restrictive disease, the ratio is normal or increased. In the present study, the FEV1/FVC decreased both after open (5.2%) and laparoscopic (3.2%) cholecystectomy, but the decrease was more in open cholecystectomy than in laparoscopic cholecystectomy group. This suggests that a reduction in airflow limitations (i.e. bronchoconstriction) may play a beneficial role in reducing pulmonary compromise in patients after laparoscopic cholecystectomy. Decreased analgesic requirement in the present study suggests that laparoscopic cholecystectomy was accompanied by less post-operative pain as compared to open cholecystectomy. Pain undoubtedly contributes to the cascade of events, resulting in chest wall splinting, reduced FRC, tachypnea and shallow breathing which ultimately lead to atelectasis, the forerunner of pulmonary complications.

Diaphragmatic dysfunction after laparoscopic cholecystectomy should also be considered. Respiratory changes during laparoscopy occur because of trendelenburg position and intraperitoneal insufflation of carbon dioxide. There is also small but sustained alteration in control of breathing and mechanics.(9)Diaphragmatic elevation resulting from insufflation of CO2 decreases FRC which increases ventilation/perfusion mismatch and alveolar space. However, there is no significant change in PaO2, possibly because of an increase in cardiac output which occurs after insufflation of CO2 and continues even after deflation (10). This, plausibly, explains for better oxygenation following laparoscopic cholecystectomy. There is also reflex inhibition of diaphragmatic inspiratory activity after laparoscopic cholecystectomy (11,12) However, impaired diaphragmatic function early after laparoscopic cholecystectomy is gradually restored over a period of 24 hours which is also documented by

direct diaphragmatic electromyography (13).

The results of this study indicated that considerable impairment of pulmonary function occurred after laparoscopic cholecystectomy in otherwise healthy patients The patterns of post-operative alterations were qualitatively similar but quantitatively less than those after open cholecystectomy. The patterns and magnitude of the changes in pulmonary function after laparoscopic or open cholecystectomy observed in this study are in agreement with other studies (4, 14, 16). The discrepancies may possibly be attributed to differences in patient selection criteria, duration of anaesthesia and surgery and measurement at different post-operative times.

Laparoscopic cholecystectomy appears to be superior to the open form of the procedure because less post-operative pulmonary dysfunction occurs.(14-16). By minimizing injury to the abdominal wall skin and musculature, the procedure of laparoscopic cholecystectomy minimizes the adverse alterations in post-operative ventilatory mechanics and reduces impairment of post-operative oxygenetion, which ultimately results in decreased incidence of pulmonary complications. The benefits may be offset by the diaphragmatic dysfunction induced by the pneumoperitonium, reflex inhibition of the diaphragmatic inspiratory activity, and longer operating and anaesthetic time. However, the magnitude of the changes is significantly less when compared to open cholecystectomy.

Conclusion

In the present study, pulmonary function variables (FVC, FEV1, PEFR, FEF - 25-75%) were significantly less impaired after laparoscopic cholecystectomy when compared to open cholecystectomy on post-operative day 1. The values returned to near normal on post-operative day 6 in laparoscopic cholecystectomy group, which was highly significant when compared to open cholecystectomy. Laparoscopic cholecystectomy was associated with less requirement of analgesia and shorter post-operative hospital stay when compared to open cholecystectomy.

Thus, we conclude that the laparoscopic cholecystectomy causes significantly less impairment of post-operative pulmonary function. These benefits should also be transferable to other major abdominal procedures. Access to the abdominal cavity with the laparoscopic method should be considered a significant therapeutic advance towards the goal of eliminating the post-operative pulmonary complications in patients undergoing major abdominal procedures.

References

1. Shahedi WH. The biliary system through the ages. *Int Surgery* 1979; 64 : 63.
2. NIH Consensus Conference. Gall stones and laparoscopic cholecystectomy. *JAMA* 1993; 269 : 1018-24.
3. Soper NJ, Brunt LM, Kerbl K *et al*. Laparoscopic general surgery. *N Engl J Med* 1994; 330:409-19.
4. Frazee RC, Roberts JW, Okeson GC *et al*. Open versus laparoscopic cholecystectomy. A comparison of post-operative pulmonary function. *Ann Surg* 1991; 213 : 651-54.
5. Latimer RG, Kickman M, Day WC *et al*. Ventilatory pattern and post-operative complications after abdominal surgery determined by pre-operative and post-operative computerized spirometry and blood gas analysis. *Am J Surg* 1971; 122 : 622-32.
6. Meyer JR, Lembeck L, Kave HO *et al*. Changes in functional residual capacity of lung after operation. *Arch Surg* 1975;110 :576-83
7. Simonneau G, Vivean A, Sartene R *et al*. Diaphragm dysfunction induced by upper abdominal surgery. *Am Rev Resp Dis* 1983; 128 (5) : 899-903.
8. Ford GT, Whitelaw WA, Rosenal TW *et al.* Diaphragm dysfunction after upper abdominal surgery in humans. *Am Rev Resp Dis* 1983; 127 : 431-436.
9. Bablekos GD, Michaelides SA, Roussou T, Chralabotoulos KA. *Arch Surg* 2006; 141(1): 16-22.
10. Puri GD and Singh H. Ventilatory effects of laparoscopy under general anaesthesia. *Br J Anaesthesia* 1992; 68 : 211-13.
11. Erice F, Fox GS, Salib YM et al. Diaphragmatic function before and after laparoscopic cholecystectomy. *Anesthesiology* 1993; 79 : 966-75.
12. Shulman SM, Choter T, Weissman C *et al*. Dynamic respiratory patterns after laparoscopic cholecystectomy. *Chest* 1993; 103 (4) : 1173-77.
13. Sharma R, Clergue F, Jansson E, Reiz S. Diaphragmatic function after laparoscopic choleystectomy. *Br J. Anaesthesia* 1994;72:34.
14. Hasukie S, Mesic D. Post-operative pulmonary changes after laparoscopic cholecystectomy. *Med Arh* 2001; 55 : 91-93.
15. Bablekos GD, Roussou T, Rasmussen T *et al*. Post-operative changes in pulmonary function after laparoscopic and open cholecystectomy. *Hepatogastroenterology* 2003; 50 (53) : 193-200.
16. Ravimohan SM, Kaman L, Jindal R, Singh R, Jindal SK. Post-operative pulmonary function in laparoscopic versus open cholecystectomy : Prospective, comparative study. *Ind J Gastroenterol* 2005; 24 (1) : 6-8.