Spirometric indices of patients following laparotomic or laparoscopic cholecystectomy: A Comparison Study

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Abstract: Cholecystectomy, due to acute cholecystitis or biliary colic pain, is one of the most common general surgical operations. Pulmonary complications occur in 20-60% of patients who are undergoing abdominal surgery. Lung is the organ most at risk of postoperative complications. The purpose of this study is the comparison of spirometric parameters in patients following laparoscopic or laparotomic cholecystectomy. this descriptive-analytic study done on 60 patients referred to hospital for cholecystectomy. Patients randomly divided into two groups: laparoscopic cholecystectomy (n=30) and laparotomic cholecystectomy (n=30). Spirometric indices were collected before and 24 hours after operations. Data were analyzed using SPSS software. Data considered significant at the level of $p<0.05$. the mean of spirometric indices including FEV1, FVC and PEF25-75% of both groups were decreased after surgery in comparison to amounts before surgery which were significant only in laparoscopic group ($P<0.05$). Several mechanisms cause reduced pulmonary function after upper abdominal surgery. Reductions in spirometric indices were significantly lower in laparoscopic group and patient's pulmonary function was better after laparoscopic cholecystectomy.

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Introduction:

Cholecystitis is the inflammation of gallbladder, which commonly occurs due to stone-induced bile duct obstruction (1, 2). Cholecystectomy due to acute cholecystitis or biliary colic pain is one the most common operations done by general surgeons (2, 3). Pulmonary complications rate following abdominal; surgery is 20-60% and pulmonary function tests decrease apparently after upper abdominal surgery (3-7). Laparotomic cholecystectomy leads to inefficiency of pulmonary function, which increases the risk of pneumonia and atelectasis. Laparoscopic cholecystectomy is the method of choice for treatment of symptomatic cholecystitis, in which the patient tolerates less pain and duration of hospital stay, smaller skin incisions and faster recovery in comparison to laparotomic cholecystectomy. On the other hand, administration of carbon dioxide (CO_2) gas in laparoscopy may increase the abdominal pressure, which may finally lead to impairment of pulmonary function. So, this method is not recommended in patients with impaired pulmonary function (1). So, as both of the the so-called surgical methods may lead to some extents of pulmonary function impairment, we designed this study to compare spirometric indices of patients following laparotomic or laparoscopic cholecystectomy.

Material & Methods:

In our descriptive-analytic study, we studied 60 patients referred to Ali-Ebne-Abitaleb hospital for cholecystectomy during years 2008-2010. Spirometry was done before and 24-hours after surgery and data

were collected. We explained the aim of study for each patient by clarification of benefits and side effects of two surgical methods (laparotomy and laparoscopy) for cholecystectomy. We explained for the patients that the selection of surgical method would be based on randomization. After signing out the written informed consent, surgical operation was done.

Based on randomly selected quaternary block sizes method, patients were randomly divided into two groups: 1. laparoscopy (n=30) and 2. Laparotomy (n=30). Sex and age matching was done for both groups.

Data were analyzed using SPSS software V.17. Student T-test used for determination of relation between two variables. Descriptive data were expressed as mean ± SD. The statistical significance level considered as $P<0.05$.

Spirometric indices that were considered in our study including FEV1=Forced expiratory volume in one second ،FVC= Forced vital capacity ، PEF=Peak expiratory flow rate and FEF25-75%= Forced expiratory flow at 25% to 75%. Spirometry performed by someone who was not aware of its objectives. Standard general anesthesia was done for both groups and then, laparotomy or laparoscopy was done. Laparoscopic cholecystectomy started with an incision beneath the umbilicus, then a trocar inserted into peritoneum cavity and carbone dioxide gas injected in order to increase the abdominal pressure to 14 mmHg.

Then port No.10 and laparoscope camera inserted, and then three 1 cm length incisions created on the right costal margin for insertion of laparoscope trocars. At the end of cholecystectomy, all trocars brought out, CO2 gas evacuated, and then the abdominal wall incisions were closed. In laparotomy method, cholecystectomy done through a 10-12 cm length abdominal incision under right costal margin (Kocher incision) and then the incision was sutured. 24 hour after surgery, spirometry was done for all patients and data inserted into SPSS software V.17 for further analysis.

We included the patients aged 30 years and older with symptoms of cholecystitis which was approved by sonography and candidated for elective cholecystectomy to our study. Exclusion criteria were: age of 65 years or older and less than 30 years, Body Mass Index (BMI) more than 30, past medical history of cardiopulmonary diseases, abnormal PFT (<75% proportionate to age, sex and weight) and smoking of more than 10 cigarettes per day.

Results:

From 60 patients' candidate of cholecystectomy, 30 were tolerated laparoscopy and 30 were tolerated laparotomy. The mean change of FEV1 in laparoscopic method was significantly less than laparotomy (0.66±0.28 versus 1.9±0.39 respectively) ($P<0.05$) (Table.1). The mean change of FVC parameter in laparotomy-tolerated patients was significantly more than changes of this parameter in patients tolerated laparoscopy (1.16±0.11 versus 0.83±0.2 respectively) ($P<0.05$) (Table.2).

We also found that the mean change of FEF 25-75% in laparotomy method is significantly more than laparoscopy method (0.75±0.28 versus 0.39±0.11 respectively) ($p<0.001$) (Table.3). About the mean change of PEF, it was significantly higher in patients after laparotomy (1.84±0.86) in comparison to laparoscopy method (1.28±0.08) ($P<0.001$) (Table.4). The mean changes of FEV1/FVC in laparoscopy was 0.06±0.01 which was significantly less than this amount in laparotomy group (0.1±0.08) ($P<0.001$) (Table.5).

Discussion:

In the study of Sandeep and colleagues in 2007, 60 patients were tolerated cholecystectomy equally divided into two groups: laparoscopy and laparotomy. PFT with spirometer before and after surgery revealed better function of lung in laparoscopy method in comparison to laparotomy (3). In another study, Ravimohan and colleagues in 2005, compared PFT, chest x-ray (CXR) and arterial blood gas (ABG) of 40 patients tolerated laparoscopic cholecystectomy with 15 laparotomic ones. The result of their study recommended that the above-mentioned tests had better values in patients tolerated laparoscopic cholecystectomy (4).

A study in 2006 by Bablekos and colleagues conducted a clinical trial of 28 patients tolerated cholecystectomy, 18 with laparoscopy method and 10 with laparotomy method. Comparison of PFT 24 hours after surgery revealed a decrease in both groups while these changes were apparent only in laparotomy group after 8 days post-surgery (5). In another similar study, Hasukić and colleagues in 2002 conducted a clinical trial with 60 patients candidate of cholecystectomy who were equally divided into two groups of laparoscopy and laparotomy. PFT, CXR and ABG done for both groups and their values comparison revealed a significantly better FEV1 and FVC in patients tolerated laparoscopy (6).

In another clinical trial in 2000, Mimica and colleagues found that PFT and ABG of the patients tolerated laparoscopic cholecystectomy (n=50) were significantly better than patients tolerated laparotomic method (7).

In the clinical trial of Hendolin and colleagues in 2000, 47 patients tolerated cholecystectomy divided into laparoscopy (n=22) and laparotomy (n=25). They found that post-surgical pain and length of hospital stay were significantly less in laparoscopy group in comparison to laparotomy group while patients tolerated laparoscopic cholecystectomy had better pulmonary function after surgery (8). Similarly, Coskun and colleagues in 2000 in a clinical trial on 53 patients found that laparoscopic

cholecystectomy leads to better pulmonary function after surgery in comparison to laparotomic cholecystectomy (9).
Upper abdominal surgery apparently changes the pulmonary function that could be attributed to general anesthesia or the surgical process.
Due to decreasing lung volume, developing a pulmonary shunt and changing of lung mechanics, general anesthesia can lead to changes in respiratory gas exchange. Although, result of recent studies revealed that this effect is temporarily and would be fade during the 24 hours after surgical process. But upper abdominal surgery has more apparent and prolonged effect on pulmonary function which may prolongs even for 10 days after surgery (10).

Conclusion:
In this study, the mean changes in FEV1-FVC-PEF25-75% of all patients 24 hours post-surgery in both laparoscopy and laparotomy groups were reduced in comparison to the amounts of before surgery. However, the mean changes in all these parameters were significantly lower in laparoscopy group. This is consistent with previous studies.
Several mechanisms can cause pulmonary function to diminish apparently after upper abdominal surgery including surgical incisions and post-operative pain. During the surgical incision of right costal margin for cholecystectomy, abdominal wall muscles are cut. Since the abdominal muscles have an effective role in deep breathing and effective cough, cut off these muscles could be one of the leading causes of changes in pulmonary function tests after surgery. Naturally, the difference in length of surgical incision in laparoscopy method in comparison to laparotomy may lead to a significant better pulmonary function in patients of laparoscopy group. Instead of a large incision, surgeons create only four small incisions forb laparoscopy. Therefore, the abdominal wall muscle dysfunction and pain after laparoscopic surgery is the least. Another reason for these changes is diaphragmatic dysfunction. Diaphragmatic dysfunction could be due to pain, increased tonicity of abdominal wall or manipulation of phrenic nerve during cholecystectomy, which is more apparent in laparotomy method.
the mean changes of FEV1/FVC ratio decreased in both group but in laparoscopy group, it was significantly less than laparotomy group ($p<0.001$). FEV_1/FVC ratio is helpful in differentiation of obstructive from restrictive lung diseases. This ratio is decreased in obstructive lung diseases while is normal or increased in restrictive ones (6, 10).
In our studied population, mean PEF variation decreased compared to before surgery in both groups of patients, but this change in the laparoscopic group was significantly lower ($p<0.001$). PEF decrease could be explained by impairment in cough mechanism. Among the laparotomy group patients, this dysfunction is more pronounced due to impaired abdominal muscle dysfunction and larger incisions' induced pain, which could lead to a significant different pulmonary function among laparotomy and laparoscopy groups.

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Table 1. Comparison of FEV_1 in laparoscopic versus laparotomic cholecystectomy

Type of surgery	Before surgery (mean±SD)	After surgery (mean±SD)	Mean changes (mean±SD)
Laparoscopy	3.06±0.42	2.30±0.54	**0.66±0.28** [a]
Laparotomy	3.03±0.41	1.13±0.38	**1.9±0.39** [b]

All data are represented mean±SD. [a,b] Data considered significant at the level of $p<0.05$.

Table 2. Comparison of FVC in laparoscopic versus laparotomic cholecystectomy

Type of surgery	Before surgery (mean±SD)	After surgery (mean±SD)	Mean changes (mean±SD)
Laparoscopy	3.52±0.65	2.64±0.60	**0.83±0.20** [a]
Laparotomy	3.73±0.50	2.56±0.52	**1.16±0.11** [b]

All data are represented mean±SD. [a,b] Data considered significant at the level of $p<0.05$.

Table 3. Comparison of $FEF_{25-75\%}$ in laparoscopic versus laparotomic cholecystectomy

Type of surgery	Before surgery (mean±SD)	After surgery (mean±SD)	Mean changes (mean±SD)
Laparoscopy	1.87±0.56	1.47±0.51	**0.39±0.11** [a]
Laparotomy	1.76±0.30	1.00±0.30	**0.75±0.28** [b]

All data are represented mean±SD. [a,b] Data considered significant at the level of $p<0.05$.

Table 4. Comparison of PEF in laparoscopic versus laparotomic cholecystectomy

Type of surgery	Before surgery (mean±SD)	After surgery (mean±SD)	Mean changes (mean±SD)
Laparoscopy	5.44±01.26	4.15±1.23	**1.8±0.08** [a]
Laparotomy	5.58±0.94	3.74±1.22	**1.84±0.86** [b]

All data are represented mean±SD. [a,b] Data considered significant at the level of $p<0.05$.

Table 5. Comparison of FEV1/FVC ratio in laparoscopic versus laparotomic cholecystectomy

Type of surgery	Before surgery (mean±SD)	After surgery (mean±SD)	Mean changes (mean±SD)
Laparoscopy	0.86±0.01	0.8±0.01	**0.06±0.01** [a]
Laparotomy	0.84±0.03	0.74±0.1	**0.1±0.08** [b]

All data are represented mean±SD. [a,b] Data considered significant at the level of $p<0.05$.