ORIGINAL ARTICLE

CONTENTS

The dynamics of recovery of external breathing function in patients after laparoscopic cholecystectomy in the acute period under the influence of the rehabilitation program

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ABSTRACT

Aim: To determine the dynamics of renewal of the function of external respiration in patients after laparoscopic cholecystectomy at the acute stage of rehabilitation under the influence of a rehabilitation program.

Materials and Methods: The study is randomized, simple with blinded assessors. The forced vital capacity (FVC, l), forced expiratory volume in the first second (FEV1, l) and peak expiratory flow rate (PEFR, l/s) were assessed. Spirometry was performed 120 patients on the first day of admission of patients to the surgical department for surgical intervention, on the second day and on the day of discharge. Methods of mathematical statistics: arithmetic mean (M) and standard error of the mean (±m), Student's t-test were calculated, differences at $p<0,05$ were considered statistically significant.

Results: It has been established that laparoscopic cholecystectomy leads to a statistically significant decrease in the parameters of respiratory function in all age categories. More pronounced positive dynamics of respiratory function in the group of respiratory therapy. It was established that without respiratory therapy on the day of discharge there was no restoration ($p<0.05$) in groups of elderly patients of group of FVC l, FEV1 l, PEFR l/s; in middle-aged patients did no restoration FEV1, l, PEFR, l/s; in younger patients there was no recovery of FEV1, l.

Conclusions: The results of the study indicate the effectiveness of the introduction of diaphragmatic breathing exercises in combination with early mobilization at the acute and subacute stages of rehabilitation in patients after laparoscopic cholecystectomy in order to restore the function of the respiratory system.

KEY WORDS: cholecystectomy, physical therapy, breathing exercises

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INTRODUCTION

Laparoscopic cholecystectomy (LCH) has long been the gold standard for the surgical treatment of calculus cholecystitis. However, it should be understood that there is an operative-anesthetic risk that increases with age and may be responsible for the high rate of postoperative complications. Thanks to the improvement of surgical tactics of treatment, a decrease in postoperative mortality in acute cholecystitis has been achieved, which currently amounts to 0,3-2,9 % [1, 2].

As is known, the acute postoperative period for patients after surgical intervention on the abdominal organs (AO) is the period when those changes in the activity of organs and systems that are a direct consequence of surgical trauma and anesthesia are most pronounced. First of all, in the immediate period after the operation, the patient feels the effects of artificial lung ventilation (ALV) during the intervention. Last but not least is the new pain in the wound. As a rule, patients instinctively avoid straining and using the muscles of the anterior abdominal wall. When breathing, patients begin to avoid the diaphragmatic type of breathing, which in turn requires additional participation in breathing of the intercostals muscles, and, as a result, the type of breathing changes from diaphragmatic to chest. A significant impact on the decrease in respiratory function has a restriction of the activity of patients, which leads to a decrease in the function of external respiration. Reducing the number of days spent in the surgical department for such patients does not eliminate the problem of incomplete recovery of patients after surgery. The patient at home continues to avoid the correct type of breathing and spares the muscles of the anterior abdominal wall due to pain, respectively,

physical performance remains at a low level. Instead of relief, patients cannot return to the activities that they had before surgery for a long time. Therefore, one of the main tasks of rehabilitation in the acute and sub-acute period should be the prevention of congestive pneumonia and the restoration of the function of external respiration with the inclusion of the muscles of the diaphragm and the anterior abdominal wall.

AIM

To determine the dynamics of renewal of the function of external respiration in patients after laparoscopic cholecystectomy at the acute stage of rehabilitation under the influence of the rehabilitation program.

MATERIALS AND METHODS

Determined the dynamics of recovery of external breathing function in patients after laparoscopic cholecystectomy at the acute stage of rehabilitation under the influence of a rehabilitation program. Research design: The study is randomized, simple with blinded assessors. The forced vital capacity (FVC, l), forced expiratory volume in the first second (FEV 1, l), in liters, and peak expiratory flow rate (PEF, l/s) were assessed. Spirometry was performed on the first day of admission of patients to the surgical department for surgical intervention, on the second day and on the day of discharge using a SPIROBANK II BASIC 7882 spirometer [3,4]. The days of discharge (M±m) in the groups were different: A1 3,75 ± 0,25; A2 3,90 ± 0,20; B1 4,65 ± 0,40; B2 4,85 ± 0,41; C1 6,20 ± 0,58; C2 6,10 ± 0,60. Patients were divided into age categories: group A – young patients aged 18 to 44 years (n=40), including men (n=7) and women (n=33); group B – patients of middle age from 45 to 59 years (n=40), including men (n=7) and women (n=33); group C – elderly patients from 60 to 74 years old (n=40), of which men (n=9) and women (n=31) Each age category of patients upon admission to the surgical department was divided by randomization by a simple random selection method with lottery in the control groups (A1, B1, C1) and groups that underwent rehabilitation intervention according to our method of the group (A2, B2, C2).

Inclusion criteria: patients with chronic calculous cholecystitis (CCC), who underwent laparoscopic cholecystectomy in the surgical department of the Ivano-Frankivsk Central City Clinical Hospital in 2019-2020. Exclusion criteria: the presence of neuropsychiatric pathology in patients; refusal of patients to participate in the study. Methods of mathematical statistics: statistical processing of research results was performed using the standard Microsoft Excel program package (Microsoft 365 for enterprises, owner nholod@ifnmu.edu.ua). The Kolmogorov-Smirnov consistency criterion was used to test the null hypothesis H0 that the studied sample obeys the normal distribution law. Arithmetic mean (M) and standard error of the mean (±m) were calculated. The probability of differences was assessed using the Student's paired t-test for dependent samples. Differences were considered statistically significant at $p<0.05$ (95% significance level). FDD was assessed in accordance with the recommendations of the European Respiratory Society/American Thoracic Society. The best value from the three tests was taken into account. There was no withdrawal from the study. The used methods of the conducted research correspond to the principles of the Declaration of Helsinki, approved by the ethics commission Ivano-Frankivsk National Medical University (IFNMU).

RESULTS

Demographic indicators of patients and the length of days spent in the department by group are presented in Table 1.

Group A1 patients aged 35,80 ± 1,41 years were in the surgical department for 3,75 ± 0,25 days; group A2 patients aged 36,30 ± 1,44 years were in the department for 3,90 ± 0,20 days. Group B1 patients aged 52,35 ± 0,99 years were in the surgical department for 4,65 ± 0,40 days; group B2 patients aged 52,15 ± 0,94 years were in the department for 4,85 ± 0,41 days. Group C1 patients aged 65,75 ± 1,00 years were in the surgical department for 6,20 ± 0,58 days; group C2 patients aged 65,60 ± 0,89 years were in the department for 6,10 ± 0,60 days. Statistical difference between age and number of days of stay between groups of each age category A1 and A2; B1 and B2; C1 and C2 were absent ($p> 0.05$).

Comparison of FVC parameters is presented in Table 2. Comparison of indicators before surgery and the first day after surgery (P0 before P1) showed a statistically significant decrease in ($p<0,05$) FVC in all groups (M±m): A1 from 2,68 ± 0,81 to 2,09 ± 0,78; A2 from 2,74 ± 0,84 to 2,04 ± 0,75; B1 from 2,49 ± 0,76 to 1,83 ± 0,69; B2 from 2,51 ± 0,67 to 1,80 ± 0,68; C1 from 2,28 ± 0,68 to 1,61 ± 0,63; C2 from 2,31 ± 0,64 to 1,57 ± 0,60. Comparing FVC indices between the first postoperative day and the day of discharge (P1 before P2), a statistically significant increase in ($p<0,05$) indices was found in groups A2 from 2,04 ± 0,75 to 2,52 ± 0,70; B2 from 1,80 ± 0,68 to 2,23 ± 0,65; C2 from 1,57 ± 0,60 to 1,97 ± 0,61, which, along with early mobilization, performed diaphragmatic exercises. Comparison

Table 1. Demographics of patients by groups

Group	Total number of persons	Including women	Including men	Age (M±m), years	Number of bed days, (M±m) days
Group A1	20	16	4	35,80 ± 1,41	3,75 ± 0,25
Group A2	20	17	3	36,30 ± 1,44	3,90 ± 0,20
Group B1	20	17	3	52,35 ± 0,99	4,65 ± 0,40
Group B2	20	16	4	52,15 ± 0,94	4,85 ± 0,41
Group C1	20	16	4	65,75 ± 1,00	6,20 ± 0,58
Group C2	20	15	5	65,60 ± 0,89	6,10 ± 0,60

Table 2. Indicators of FVC, l

Group	Indication before operative intervention, (M±m), P_0	Indicator on the first day after surgery, (M±m), P_1	Indicator on the day of discharge, (M±m), P_2	p P_1 before P_0	p P_2 before P_1	p P_2 before P_0
Group A1	2,23 ± 0,49	1,73 ± 0,43	1,88 ± 0,48	< 0,05	> 0,05	< 0,05
Group A2	2,26 ± 0,47	1,71 ± 0,42	1,99 ± 0,42	< 0,05	< 0,05	> 0,05
Group B1	2,01 ± 0,46	1,48 ± 0,38	1,63 ± 0,49	< 0,05	> 0,05	< 0,05
Group B2	1,98 ± 0,45	1,46 ± 0,38	1,71 ± 0,39	< 0,05	< 0,05	> 0,05
Group C1	1,86 ± 0,54	1,29 ± 0,53	1,51 ± 0,52	< 0,05	> 0,05	< 0,05
Group C2	1,83 ± 0,52	1,26 ± 0,51	1,60 ± 0,53	< 0,05	< 0,05	> 0,05

Table 3. Indicators of forced expiratory volume in one second of FEV 1, l

Group	Indication before operative intervention, (M±m), P_0	Indicator on the first day after surgery, (M±m), P_1	Indicator on the day of discharge, (M±m), P_2	p P_1 before P_0	p P_2 before P_1	p P_2 before P_0
Group A1	2,68 ± 0,81	2,09 ± 0,78	2,30 ± 0,85	< 0,05	> 0,05	> 0,05
Group A2	2,74 ± 0,84	2,04 ± 0,75	2,52 ± 0,70	< 0,05	< 0,05	> 0,05
Group B1	2,49 ± 0,76	1,83 ± 0,69	2,10 ± 0,73	< 0,05	> 0,05	> 0,05
Group B2	2,51 ± 0,67	1,80 ± 0,68	2,23 ± 0,65	< 0,05	< 0,05	> 0,05
Group C1	2,28 ± 0,68	1,61 ± 0,63	1,86 ± 0,62	< 0,05	> 0,05	< 0,05
Group C2	2,31 ± 0,64	1,57 ± 0,60	1,97 ± 0,61	< 0,05	< 0,05	> 0,05

Differences were considered statistically significant at $p<0.05$.

of FVC parameters on the day of discharge and before surgery (P2 before P0) found that in all patients, except for group C1 (old people), who did not engage in diaphragmatic breathing exercises, the parameters did not differ statistically.

Comparison of FEV1 parameters is presented in Table 3. Comparison of indicators before surgery and the first day after surgery (P0 before P1) also established a statistically significant decrease (p<0,05) in FEV1 in all groups (M±m): A1 from 2,23 ± 0,49 to 1,73 ± 0,43; A2 from 2,26 ± 0,47 to 1,71 ± 0,42; B1 from 2,01 ± 0,46 to 1,48 ± 0,38; B2 from 1,98 ± 0,45 to 1,46 ± 0,38; C1 1,86 ± 0,54 from to 1,29 ± 0,53; C2 from 1,83 ± 0,52 to 1,26 ± 0,51. Comparing the FEV1 indices between the first postoperative day and the day of discharge (P1 before P2), a statistically significant increase in indices (p<0,05) was found in groups A2 from 1,71 ± 0,42 to 1,99 ± 0,4; B2 from 1,46 ± 0,38 to 1,71 ± 0,39; C2 from 1,26 ± 0,51 to 1,60 ± 0,53, which performed diaphragmatic exercises with early mobilization. Comparison of FEV1 values on the day of discharge and surgery (P2 before P0) found that all patients of groups A1, B1, C1, who did not engage in diaphragmatic breathing exercises, had a statistically significant decrease (p<0,05) in of FEV1, there was no restoration to the preoperative level.

Comparison of PEFR parameters is presented in Table 4 Comparison of indicators before surgery and the first day after surgery (P0 before P1) showed a statistically significant decrease (p<0,05) in PEFR in all groups (M±m): A1 from 5,69 ± 2,04 to 3,61 ± 1,76; A2 from 5,72 ± 2,10 to 3,62 ± 1,77; B1 from 5,40 ± 1,76 to 3,46 ± 1,51; B2 from 5,42 ± 1,84

Table 4. Indicators of the peak speed of exhalation of PEFR, l/s

Group	Indication before operative intervention, (M±m), P_0	Indicator on the first day after surgery, (M±m), P_1	Indicator on the day of discharge, (M±m), P_2	p P_1 before P_0	p P_2 before P_1	p P_2 before P_0
Group A1	5,69 ± 2,04	3,61 ± 1,76	4,49 ± 1,82	< 0,05	> 0,05	> 0,05
Group A2	5,72 ± 2,10	3,62 ± 1,77	4,76 ± 1,74	< 0,05	< 0,05	> 0,05
Group B1	5,40 ± 1,76	3,46 ± 1,51	4,29 ± 1,69	< 0,05	> 0,05	< 0,05
Group B2	5,42 ± 1,84	3,40 ± 1,51	4,38 ± 1,52	< 0,05	< 0,05	> 0,05
Group C1	4,89 ± 2,09	2,73 ± 1,49	3,69 ± 1,51	< 0,05	> 0,05	< 0,05
Group C2	4,87 ± 2,09	2,69 ± 1,48	3,90 ± 1,50	< 0,05	< 0,05	> 0,05

to 3,40 ± 1,51; C1 from 4,89 ± 2,09 to 2,73 ± 1,49; C2 from 4,87 ± 2,09 to 2,69 ± 1,48. Comparing the PEFR indices between the first postoperative day and the day of discharge (P1 before P2), a statistically significant ($p<0,05$) increase in indices was found in groups A2 from 3,62 ± 1,77 to 4,76 ± 1,74; B2 from 3,40 ± 1,51 to 4,38 ± 1,52 ; C2 from 2,69 ± 1,48 to 3,90 ± 1,50, which, along with early mobilization, performed diaphragmatic exercises. Comparison of PEFR, (l/s) values on the day of discharge and before surgery (P2 before P0) revealed that in all patients of groups elderly and middle-aged C1, B1 who did not engage in diaphragmatic breathing exercises, a statistically significant decrease was observed ($p<0,05$), i.e., there was no recovery of PEFR to the preoperative level.

DISCUSSION

In developing a rehabilitation intervention, we took into account the experience of scientists [5]. Before surgery, patients of groups A2, B2, C2 underwent some training, where there was an explanation to patients about the importance of increasing physical activity and restoring respiratory function. Patients were taught proper diaphragmatic positive expiratory pressure breathing techniques and the exercises they would do after surgery for faster recovery. They taught the technique of moving from the starting position (SP) lying in the SP while sitting and standing, the technique of correct coughing.

In most cases, in all patients of groups A2, B2, C2, the goals of physical therapy were: prevention of postoperative complications, peripheral circulatory disorders, thromboembolic complications, hypostatic pneumonia, disorders of the gastrointestinal tract, complications from the postoperative wound; increased activity of the abdominal muscles, prevention of hernias, activation of intestinal motility, restoration of tolerance to physical activity, restoration of physical qualities, etc. One of the goals was to restore the function of external respiration of patients (improvement of bronchial patency and drainage function of the bronchi, restoration of lung capacity) and the correct breathing pattern. An important part of rehabilitation in groups A2, B2, C2 was the application of the principles of individualization, consciousness and activity of the patient. The next day after surgery, early mobilization of patients was performed. Performed breathing and therapeutic exercises to stretch the intercostals muscles, breathing exercises with diaphragmatic breathing, namely with positive expiratory pressure, since this technique helps to remove sputum from the main bronchi in patients with hypersecretion after upper abdominal airway surgery and improved lung function [6]. Performed therapeutic exercises in the initial positions lying, sitting, standing. Categorically avoided exercises that lead to an increase in intra-abdominal pressure. The ratio of respiratory and therapeutic exercises was 1:2. The duration of the first lesson did not exceed 10 minutes. Each patient performed the exercises 2 times a day (morning and afternoon) under the guidance of a physical therapist. A significant problem in the implementation of rehabilitation measures was that the pain in the area of the surgical wound was exacerbated by movement. As a result, patients tried to reduce the amount of physical activity as much as possible.

The presence of pain syndrome contributes to a decrease in the productivity and effectiveness of coughing, as a result, a violation of the mechanism of sputum evacuation from the tracheobronchial tree of the lungs. When developing a physical therapy program for elderly patients, we took into account the fact that physiological changes with aging

occur in all systems and organs of the body, including respiration. As a rule, elderly people experience deformity of the chest, atrophy of the intercostals muscles and diaphragm [8]. The size of the lung decreases and the structure of the alveoli changes, the elasticity of the elastic fibers' decreases, due to which the intra alveolar membranes disappear and the alveolar passages expand. There is a decrease in the gas exchange surface and a decrease in the vital capacity of the lungs, the reserve volume of inhalation and exhalation, tidal volume, and the respiratory rate increases. As a result, there is a decrease in the functional capabilities of the respiratory organs with an increase in hypoxia and hypercapnia, which is especially evident during physical activity. Elderly patients usually have bronchial obstruction with irregular lung ventilation [8-10].

When implementing a rehabilitation program for patients after LCH, special attention was paid to elderly patients, because they have a higher risk of developing congestive pneumonia. Therefore, the use of breathing exercises in elderly patients is vital [8].

Early mobilization of patients occurred in all groups, because it is important for the prevention of postoperative deep vein thrombosis and pulmonary thrombosis, the most common cause of in-hospital death. Scientists have found that pneumoperitoneum and the Trendelenburg position lead to a decrease in the volumetric blood flow velocity, prevent total femoral venous blood flow and increase venous stasis [11,12]. The control groups were trained in correct coughing and early mobilization of patients on the first day. Early mobilization in all groups included: sitting on the edge of the bed with legs down, coughing, standing, walking in place, walking in the ward, walking along the corridor and stairs. When performing early mobilization, the age, condition of the patient, etc. were taken into account.

CONCLUSIONS

1. It has been established that laparoscopic cholecystectomy leads to a statistically significant decrease in the parameters of forced vital capacity, forced expiratory volume per second and peak expiratory flow in all age categories.
2. It was established that without respiratory therapy in groups of elderly patients of group C1 there was no restoration ($p<0,05$) of FVC, l before surgery (P0) 2,28 ± 0,68, on the day of discharge (P2) 1,86 ± 0,62, FEV 1.l (P0) 1,86 ± 0,54, (P2) 1,51 ± 0,52 PEFR l/s (P0) 4,89 ± 2,09, (P2) 3,69 ± 1,51; middle-aged patients of group B2 did not recover ($p<0,05$) FEV1, l (P0) 2,01 ± 0,46, (P2) 1,63 ± 0,49, PEFR, l/s (P0) 5,40 ± 1,76, (P2) 4,29 ± 1,69; in younger patients there was no recovery ($p<0,05$) of FEV1, l (P0) 2,23 ± 0,49, (P2) 1,88 ± 0.48.
3. The use of diaphragmatic breathing exercises in combination with early mobilization leads to a statistically significant increase in the parameters of the forced vital capacity of the lungs in groups A2 from 2,04 ± 0,75 to 2,52 ± 0,70; B2 from 1,80 ± 0,68 to 2,23 ± 0,65; C2 from 1,57 ± 0,60 to 1,97 ± 0,61, the volume of forced exhalation in one second in groups A2 from 1,71 ± 0,42 to 1,99 ± 0,4; B2 from 1,46 ± 0,38 to 1,71 ± 0,39; C2 from 1,26 ± 0,51 to 1,60 ± 0,53 and the peak expiratory velocity in groups A2 from 3,62 ± 1,77 to 4,76 ± 1,74; B2 from 3,40 ± 1,51 to 4,38 ± 1,52 ; C2 from 2,69 ± 1,48 to 3,90 ± 1,50 in comparison with the indicators on the day of discharge and on the first day after surgery.
4. The results of the study indicate the effectiveness of the introduction of diaphragmatic breathing exercises in combination with early mobilization at the acute and subacute stages of rehabilitation in patients after laparoscopic cholecystectomy in order to restore the function of the respiratory system.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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