Middle-East Journal of Scientific Research 13 (4): 459-463, 2013
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2013.13.4.7218

Aerobic Exercise Training and Incentive Spirometry Can Control Postoperative Pulmonary Complications after Laparoscopic Cholecystectomy

Ashraf A. El-Marakby, Ashraf Darwiesh, Ehab Anwar,
Ahmed Mostafa , Salwa R. El-Gendy , Riziq Allah Gaowgzeh and Ahmed Jad

Department of Physical Therapy, Faculty of Applied Medical Sciences,
King Abdulaziz University, Saudi Arabia

Abstract: The revolution in laparoscopic surgery has began three decades ago when laparoscopic cholecystectomy (LC) was introduced. The aim of the present study was to detect the beneficial effect of aerobic exercise training and incentive spirometry in controlling postoperative pulmonary complications after laparoscopic cholecystectomy. Twelve patients who had undergone laparoscopic cholecystectomy were participated in the present study. Their ages ranged from 29 to 50 years. Patients were divided into two experimental groups: - (A) Aerobic walking training and incentive spirometry in addition to the traditional physical therapy, where (B) was traditional physical therapy group.The results obtained in the present investigation indicated that, there was a significant reduction in values of HR and a significant decrease in SaO_2 and IC of both groups. There were significant differences between both groups at the end of the study. Conclusion: Association of aerobic exercise to incentive spirometry helped in controlling postoperative pulmonary complications after laparoscopic cholecystectomy.

Key words: Aerobic Exercise % Incentive Spirometry % Postoperative Pulmonary Complications % Laparoscopic Cholecystectomy

INTRODUCTION

The gall bladder is the second, only to the appendix, as the intra-abdominal organ most commonly requiring surgical intervention. In 1990, laparoscopic cholecystectomy (LC) has replaced open surgery as the standard treatment for symptomatic gallbladder diseases and stones [1].

Since its introduction, laparoscopic cholecystectomy (L.C.) has become the treatment of choice for symptomatic gall bladder disease. Rapid recovery after L.C and increasing experience with its postoperative course has led to progressively shorter postoperative hospital stay [2].

Laparoscopic cholecystectomy has replaced open cholecystectomy (OC) as the preferred therapeutic modality in the treatment of symptomatic cholelitheasis. Because of perceived difficulties in dissection and the premise of unacceptably high complication rates, the presence of acute cholecystitis was once considered an absolute contraindication to the performance of L.C. [3].

One of the most important putative advantages of Laparoscopic surgery is the reduction of the extent of surgical trauma, postoperative metabolic, inflammatory and immunologic changes are proportional to the degree of surgical trauma, elimination or reduction of these changes has been shown to decrease the incidence of postoperative complications and improve survival [4].

Pulmonary complications are common after abdominal surgery and result in increased patient morbidity, prolonged hospital stay and greater cost. Strategies aimed at reducing the incidence of postoperative pulmonary complications depend largely upon the aggressive application of preventative measures to high - risk patients [5]. Pulmonary complications (reduced lung volumes, chest infection and hypoxia) are most frequently occurring after upper abdominal surgery, with reported occurrence frequencies of up to 75 % of all patients. Pulmonary complications continue to be an important

Corresponding Author: Ashraf A. El-Marakby, Department of Physical Therapy, Faculty of Applied Medical Sciences, King Abdulaziz University, P.O. Box: 80324, Jeddah, 21589, Saudi Arabia. E-mail:profshehab@live.com

cause of postoperative morbidity and mortality [6].

Pulmonary function is commonly altered after surgery, particularly in patients who have had chest or upper abdominal surgery. The physiological changes are directly related to anesthesia (general or regional) and to the type of incision and surgical technique employed and are reflected by decreases in total pulmonary capacities and volumes [7]. Impairment of pulmonary function is one of the most significant postoperative complications of upper abdominal surgery (UAS) [8, 9].

The main purpose of this study was to detect the beneficial effect of aerobic exercise training and incentive spirometry in controlling postoperative pulmonary complications after laparoscopic cholecystectomy.

MATERIALS AND METHODS

Subjects: Twelve patients who had undergone laparoscopic cholecystectomy participated in the present study. These patients were selected randomly from General Surgery Department, King Abdulaziz Teaching University Hospitals. Their ages ranged from 29 to 50 years. A brief medical history of each participant was obtained to ensure that non had previous cardiopulmonary or musculoskeletal complications that might restrict their activity and influence the results. Patients were divided into two experimental groups: (A) received free-paced walking exercise training, incentive spirometry in addition to the traditional postoperative chest physical therapy and (B) received the traditional postoperative chest physical therapy.

This study was approved by the Scientific Research Ethical Committee, Faculty of Applied Medical Sciences at King Abdulaziz University. All participants were free to withdraw from the study at any time. If any adverse effects had occurred, the experiment will be terminated and the Human Subjects Review Board would be informed. However, no adverse effects occurred and so the data of all the participants were available for analysis.

Equipments and Measurements: *Pulse oximeter* (Model8500, Nonin Medical): an earlobe sensor was used to measure heart rate (HR) and arterial oxygen saturation (SaO2) noninvasively.

Incentive spirometry (Voldyne Volumetric manufactured by Sherwood Medical Company U.S.A.): It is a respiratory therapy device that provides visual feedback in term of volumetric success as a patient performs a deep breath. Incentive spirometry is consider as a guideline for progression of treatment. Also incentive spirometer was used in measurement of inspiratory capacity (IC).

Procedures of the Study

Routine Chest Physiotherapy Program for Patients after Laparoscopic Cholecystectomy: Patients of the two groups received the routine chest physiotherapy program for patients after laparoscopic cholecystectomy which was started on the morning of the first post operative day, a physiotherapist supervised and assisted the treatment twice a day in the first two post operative days and once a day from the third to the tenth days. During any session, the patients performed three to five deep breaths interspersed with periods of quiet breathing followed by two or three coughs or huffs (with wound support by a pillow or his/her hands). This maneuver was carried out at least 10 times over a 15 minutes period. Additional techniques such as positioning and chest wall percussion were applied if breathing and coughing exercises alone were not effective in clearing excessive or retained pulmonary secretions. Patients were instructed to perform breathing and coughing exercise independently every hour [10].

Breathing Exercise with Incentive Spirometry: Patients of group (A) received breathing exercise training with IS (Voldyne Volumetric manufactured by Sherwood Medical Company U.S.A.) in addition to the routine chest physiotherapy program for patients after CABG up to the tenth post operative day. Application of breathing training with incentive spirometry was applied for five minutes, five times a day [11,12].

Walking Training Procedure: Warming up phase consisted of active range of motion exercises, pelvic tilting exercises and isometric quadriceps exercises for 15 minutes daily and before each training.

Exercise Phase Started at the Third Day as the Following:

- - 3rd - 5th day, 3 minutes free paced walking,
- - 6th - 7th day, 6 minutes free paced walking,
- -8th - 9th day, 9 minutes free paced walking,
- -10th - 12th day, 12 minutes free paced walking,
- -13th - 14th day, 15 minutes free paced walking.

Group (A): Six patients who had laparoscopic cholecystectomy and received free-paced walking exercise training, incentive spirometry in addition to the traditional postoperative chest physical therapy.

Group (B): Six patients who had laparoscopic cholecystectomy and received the traditional postoperative chest physical therapy.

Statistical Analysis: Paired -t-test was used to compare between pre-test and post-test values of the investigated parameters in both groups. While the unpaired -t-test was used to compare between results of both groups ($p<0.05$).

RESULTS

The results obtained in the present investigation indicated that, there was a significant reduction in values of HR and a significant decrease in SaO2 and IC of both groups. There were significant differences between both groups at the end of the study ($P <0.05$) (Tables 1, 2 and 3).

DISCUSSION

The main purpose of this study was to detect the beneficial effect of aerobic exercise training and incentive spirometry in controlling postoperative pulmonary complications after laparoscopic cholecystectomy. The results obtained in this study indicated that, there was a significant reduction in values of HR and a significant decrease in SaO2 and IC of both groups. There were significant differences between both groups at the end of the study. These results were approved and confirmed by many previous studies.

Incentive spirometry (IS) is currently used in the postoperative period of CABG to prevent postoperative pulmonary complications. It involves deep breathing through a device with visual feedback, can be used independently by patients and motivation. It provides low level resistive training while minimizing the potential of fatigue to the diaphragm which is useful for patients who are resistant or unable to co-operate fully with maximal inspiratory efforts [14].

Incentive spirometry (IS) is proposed on the theoretical basis of encouraging patients to breathe to total lung capacity, to sustain that inflation and by opening collapsed alveoli to prevent atelectasis; postoperative hypoxemia may be reduced with this technique. It is characterized by active recruitment of the diaphragm and other inspiratory muscles. Also, it reported better elimination of pulmonary secretions and decreased risk of chest infection [14, 15].

Incentive spirometry is widely used clinically as an adjunct to chest physiotherapy that provides the patient with visual feedback of the volume of air inspired during a deep breath. It provides low -level resistive training while minimizing the potential of fatigue to the diaphragm. It has been used to enhance lung expansion and inspiratory muscle strength [14].

Respiratory muscle training by incentive spirometry increases production of surfactant which leads to reducing surface tension, increasing lung compliance, decreasing the work of breathing and opening of collapsed alveoli to prevent atelectasis. The improvement

Table 1: Mean and significance of the pre and post values of heart rate, inspiratory capacity and arterial oxygen saturation in group (A).

	Mean ± SD			
	Pre	Post	t-value	Significance
HR (Beat/Min.)	103.67±3.981	75.85±3.792	-4.176	P < 0.05
SaO2(%)	86.32±3.651	98.15±2.815	3.45	P < 0.05
IC(L.)	415.83±68.34	1759.83±160.25	4.63	P < 0.05

HR = Heart rate SaO2 = Arterial oxygen saturation IC = Inspiratory capacity

Table 2: Mean and significance of the pre and post values heart rate, inspiratory capacity and arterial oxygen saturation in group (B).

	Mean ± SD			
	Pre	Post	t-value	Significance
HR (Beat/Min.)	103.58±4.152	81.23±3.975	-3.428	P < 0.05
SaO2(%)	85.89±3.370	94.14±3.115	2.88	P < 0.05
IC(L.)	422.45±72.641	1545.72±138.52	3.827	P < 0.05

HR = Heart rate SaO2 = Arterial oxygen saturation IC = Inspiratory capacity

Table 3: Mean and significance of the post values of heart rate, inspiratory capacity and arterial oxygen saturation in group (A) and group (B).

	Mean ± SD			
	Group (A)	Group (B)	t-value	Significance
HR (Beat/Min.)	75.85±3.792	81.23±3.975	2.597	P < 0.05
SaO2(%)	98.35±2.815	94.14±3.115	2.245	P < 0.05
IC(L.)	1759.83±160.25	1545.72±138.52	2.266	P < 0.05

HR = Heart rate SaO2 = Arterial oxygen saturation IC = Inspiratory capacity

of total lung and thoracic compliance may be contributed to increase arterial oxygen saturation (SaO2) [16].

Application of treadmill walking exercise three times weekly for 8 weeks resulted in increased exercise endurance, less dyspnea, improved vital capacity (V.C), maximum voluntary ventilation (MVV) and twelve minute walking test. Improvements may be due to one or more of the following factors: improved aerobic capacity, or muscle strength or both, increased motivation and improved ventilatory muscle function [17].

After exercise training an older individual is able to show some improvement in the pulmonary response to exercise. Most of the improved pulmonary function results from greater efficiency of ventilatory and skeletal muscle performance. This is evidence by the decreased production of lactate and carbon dioxide when undertaking a given workload. The individual is able to work at a lower percentage of maximal voluntary ventilation and has an increased ventilatory response for a given oxygen uptake and less perceived dyspnea. Ventilatory muscle training in addition to lower extremity exercise training resulted in reduction in dyspnea, improved respiratory muscle strength and endurance, increased exercise ability and improved health related quality of life [18].

CONCLUSION

Association of aerobic exercise to incentive spirometry helped in controlling postoperative pulmonary complications after laparoscopic cholecystectomy.

ACKNOWLEDGMENT

Authors are deeply appreciative of the participants in the study.

REFERENCES

1. Blum, C. and D. Adams, 2001. Who did the first laparoscopic cholecystectomy? J. Minim. Access Surg., 7: 165-168.
2. Litwin, D. and M. Cahan, 2008. Laparoscopic cholecystectomy. Surg. Clin. North Am., 88(6): 1295-313.
3. Tucker, O., P. Fajnwaks, S. Szomstein and R. Rosenthal, 2008. Is concomitant cholecystectomy necessary in obese patients undergoing laparoscopic gastric bypass surgery? Surg. Endosc., 22: 2450-2454.
4. Zaliekas, J. and J. Munson, 2008. Complications of gallstones: the Mirizzi syndrome, gallstone ileus, gallstone pancreatitis, complications of "lost" gallstones. Surg. Clin. North. Am., 88(6): 1345-68.
5. Elwood, D., 2008. Cholecystitis.2008. Surg Clin North Am., 88(6): 1241-52.
6. Kuy, S., S. Roman and J. Sosa, 2009. Outcomes Following Cholecystectomy in Pregnant and Non-Pregnant Women in the United States. Journal of Surgical Research. 151: 235-6.
7. Sanabria, A., L. Dominguez, E. Valdivieso and G. Gomez, 2010. Antibiotic prophylaxis for patients undergoing elective laparoscopic cholecystectomy. Cochrane Database Syst. Rev., 12: CD005265.
8. Gurusamy, K., S. Junnarkar, M. Farouk and B. Davidson, 2008. Meta-analysis of randomized controlled trials on the safety and effectiveness of day-case laparoscopic cholecystectomy. Br J. Surg.. 95(2): 161-8.
9. Csikesz, N., R. Ricciardi, J. Tseng and S. Shah, 2008. Current status of surgical management of acute cholecystitis in the United States. World J. Surg., 32(10): 2230-6.
10. Agostini ,P. and S. Singh, 2009. Incentive spirometry following thoracic surgery: what should we be doing?. Physiotherapy. 95: 76-82.
11. Gosselink, R., S. Katleen, C. Philippe, W. Hilde, T. Thierry, L. Antoon, D. Georges and D. Mare, 2010. Incentive spirometry does not enhance recovery after thoracic surgery. Crit. Care Med., 28: 679-683.
12. Weindler, J. and R. Kiefer, 2007. The efficacy of postoperative incentive spirometry is influenced by the device specific imposed work of breathing. Chest., 119: 1858-1864.

13. Haeffener, M., G. Ferreira, S. Barreto, A. Ross and P. Dall'Ago, 2008. Incentive spirometry with expiratory positive airway pressure reduces pulmonary complications, improves pulmonary function and 6-minute walk distance in patients undergoing coronary artery bypass graft surgery. American Heart Journal. 156: 900.e1-900.e8.
14. Weindler, J. and R. Thomas, 2009. The efficacy of postoperative incentive spirometry is influnced by the device- specific imposed work of breathing. Chest., 119: 1858-1864.
15. Overend, I., C. Anderson, S. Lucy, C. Bhatia, B. Jonsson and C. Timmermans, 2008. The effect of incentive spirometry on postoperative pulmonary complications: A systematic review. Chest., 120: 971-978.
16. Weiner, P., A. Man and M. Weiner, 2007. The effect of incentive spirometer and inspiratory muscle training on pulmonary function after lung resection. Journal of Thoracic and Cardiothoratic Surgery. 113: 552-557.
17. Normandin, E., C. Mccusker and M. Conners, 2006. An evaluation of two approaches to exercise conditioning in pulmonary rehabilitation. Chest., 121: 1085-1091.
18. Weiner, P., R. Magadle and N. Yauay, 2005. The cumulative effect of long acting branchodilators, exercise and inspiratory muscle training on the perception of dyspnea in patients with advanced chronic obstructive pulmonary disease. Chest., 118: 672-678.