Impact of incentive spirometer on tip shoulder and right hypochondrial pain post laparoscopic cholecystectomy

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Abstract

Background: Laparoscopic cholecystectomy (LC) continues to be more evolving. Pain remains the main annoying symptom postoperative.

Objectives: This study aimed to proof if using incentive spirometry (IS) after LC will alleviate tip shoulder and right hypochondrial pain.

Patients and Methods: On 90 patients undergoing LC at Kasr Al ainy hospitals and National Hepatology and Tropical Medicine Research Institute (NHTMRI) who were identified as having chronic calcular cholecystitis clinically and radiographically by ultrasonography, a prospective randomized controlled research was conducted. Two groups are formed. Group I (n = 45) receiving IS (consisting of 20 slow, deep breaths with a spirometry while sitting or semi sitting every 2 hours beginning at 2 hours postoperative) . There will be no respiratory over activity in Group II (n = 45). The "Visual Analogue Scale" (VAS) score used to further analyses shoulder and right hypochondrial pain.

Results: Group I average pain score was significantly lower than Group II average pain score at 2 hours, 4 hours, and 6 hours (p-value 0.001), as well as at 8 hours (p-value =0.007). However, there were no significant differences between the study group and the control group on the second postoperative day (p-value = 0.900). In comparison to the control group, the study group receives a significantly lower dose of an analgesic (p-value 0.001).

Conclusion: IS can be used routinely post LC at first day postoperative alleviating shoulder and right hypochondrial pain also decreasing analgesics requirement postoperative.

Keywords: Incentive spirometry; Tip shoulder; Right hypochondrial pain; laparoscopic cholecystectomy; Pain Management**.**

DOI: 10. 21608/svuijm.2023.207046.1573

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Received: 22 April, 2023.

Revised: 30 April, 2023.

Accepted: 5 May, 2023.

Published: 7 May, 2023

Cite this article as: Ayat Ahmad Mohamed Bakr, Amr Mohamed AbdelFattah Ayad, Amr Abdelraouf , Amir K. Abosayed. (2023). Impact of incentive spirometer on tip shoulder and right hypochondrial pain post laparoscopic **cholecystectomy**. *SVU-International Journal of Medical Sciences*. Vol.6, Issue 2, pp: 266-278.

Introduction

The most effective method of treating symptomatic chronic calculer cholecystitis is laparoscopic cholecystectomy **(Bangash et al.,2018)**. LC has many advantages less postoperative agonizing pain , much better surgical scars, lessens the postoperative recovery duration **(Cianci et al.,2020)** reduced pulmonary problems, and shorter hospital stays for patients **(Rubert et al.,2016)**.

In spite of several blessings of laparoscopic surgical treatment, Few symptoms following surgery, specifically right hypochondrium and shoulder discomfort that leads to about 35% to 80% decrease in patients satisfaction **(Park et al.,2020)**.

Shoulder and right hypochondrial pain are considered one of early post laparoscopic symptoms that caused by carbon dioxide (CO2), that stays inside the abdominal cavity for some times irritating the surroundings. As a result, incentive spirometry considers a newly approach that relieve the irritating pain after laparoscopic surgery **(Saremirad et al.,2021)**.

Tip Shoulder and right hypochondrial pain had been maximum at 24 h and gradually reduced thereafter. Saremirad et al. study the duration of the operation and the pressure inside the abdominal cavity were the factors has no relations with tip shoulder pain after surgery.The occurrence of tip shoulder and right hypochondrial not common while doing open cholecystectomy surgery and known early during gynecological laparoscopic surgery **(Wazir et al.,2022)**.

Due to various factors including surgical trauma at entry by ports, peritoneal irritation by CO2, and abdominal distension , pain following a laparoscopic cholecystectomy is vary. Pain etiology post laparoscopic cholecystectomy is multifactorial. Incision site (somatic pain) , intraabdominal pain (visceral pain) and pain at the shoulder site (somatic referred pain) .early pain after surgery usually discomfort related to visceral pain and it differs from shoulder pain **(Dixon et al.,2005)**.

At same day of surgery visceral pain is upmost that declined on the next day after surgery while shoulder pain take the upper hand. Although large variants between patients of pain perception post abdominal surgery **(Alam et al.,2009)**.

For reduction of pain at shoulder the surgical treatment with low-co2 pressure insufflation, warmed co2, anti-inflammatory drugs intake before surgery, intrabdominal local anesthetic irrigation and drains insertions .Unfortunately, multiple studies are conflicting about the above mentioned interventions varient studies showed that shoulder pain is less if the initial pressure of CO2 pressure is maintained below normal levels however this has to be supported **(Agostini et al.,2009)**.

With the same approach, respiratory physiotherapy using incentive spirometry (IS) may have an impact on the mechanical movement of the chest wall and diaphragm. Multiple studies shows and report the dynamic movements of diaphragm and chest wall by cine magnetic resonance image **(Kotani et al.,2015)**.

The Triflow tool, a float-oriented incentive spirometer, has 3 chambers connected in series, each of which has a ball. The ball rises inside the chamber when the patient's attempt creates a sub atmosphere pressure above it. The 1st ball must be elevated with an inspiratory flow of 600 mL/s, the 1st and 2d balls must be elevated with an inspiratory flow of 900 mL/s, and all 3 balls must be elevated with an inspiratory flow of 1200 mL/s. The tiny, 4000 mL extent-oriented incentive spirometer contains a one-way valve to prevent exhalation into the device. A sliding pointer displays the recommended amount of inspiration, and an inspiratory flow guide instructs the user to breathe slowly (**Restrepo et al.,2011**).

Studies shows a physiologically effective distinction in the effects of the volume and flow-orientated incentive spirometer. Triflow tool implement greater efforts of respiratory muscles and chest expansion. Volume-orientated devices (Coach 2 tool) implement much less efforts of breathing and enhance diaphragmatic movement **(do Nascimento et al.,2014)**.

The volumetric incentive spirometer is preferred for cardiac and thoracic surgical procedures , according to earlier studies, since it provides the accepted feedback for slow, maintained inspiration and volume .Researches display that sluggish maintained inspirations are very useful in lung expansion than speedy inspirations. Studies additionally display that diaphragmatic respiratory exercising encourages greater diaphragmatic motion **(Grams et al.,2012)**.

By stretching the alveoli and chest, incentive spirometry (IS) increases the diaphragm's movements and stimulates it to contract downward. As a result, less CO2 is accumulated inside the abdominal cavity and result in the removal of CO2 **(Guimarães et al.,2009)**. This study aimed to research whether using IS after LC can be used to alleviate tip shoulder and right hypochondrial pain.

Patients and methods

Randomized controlled trial that was conducted prospectively in 90 patients collected from Kasr Al ainy hospitals and National Hepatology and Tropical Medicine Research Institute (NHTMRI) Who clinically and radiologically by ultrasound diagnosed to have chronic calcular cholecystitis, and candidate for LC during the study period from November 2022 to April 2023. Randomization occurs using a computer-generated randomization schedule and sealed opaque envelope technique .Patients with associated other abdominal surgery procedures like adhesiolysis, previous lung surgery, previous shoulder pain chronicity, pregnant patients, ,chronic disease (except diabetes mellitus and hypertension),surgery converted from laparoscopic to open surgery, prolonged operation of more than two hours and psychiatric disorders were excluded from the study. . The Research Ethics Committee (REC) obtained its permission before the research could begin, in accordance with the Helsinki Declaration. The patients that were involved provided written informed consent.

Two groups are formed. Group I (n = 45) receiving IS (consisting of 20 slow, deep breaths with a spirometry while sitting or semi sitting every 2 hours beginning at 2 hours postoperative)(**Hristara et al .,2008**). There will be no respiratory over activity in Group II (n = 45). The "Visual Analogue Scale" (VAS) (**Fig.1**) score will be used to further analyses shoulder and right hypochondrial pain. VAS is a pain rating scale from 0(no pain) to 10 (worst pain) that can be used to help patient care providers to asses pain severity post-operative (**Bazarganipour et al .,2017).**

Fig.1.The Visual Analogue Scale (VAS) for pain

Statistical analysis

The SPSS statistical program, version 26 (IBM Corp., Armonk, NY, USA), was used to analyse the patient data. and the data from the patients were compared using a repeated ANOVA test, with Bonferroni posthoc correction utilised for the pairwise comparison between each pair of groups. The significantly distinct couples were denoted by distinct letters. To compare quantitative variables, chi-square and Z-score tests for proportion tests were utilised. The potential correlations between numerical quantities were evaluated using the Pearson correlation test. The statistically significant parameters were included in a multivariable analysis. If the p-value was 0.05, differences were regarded statistically significant**.**

Results

Sociodemographic characteristics and past history among the studied group

The results obtained in (**Table.1**) showed the sociodemographic characteristics and past history among the studied group. The study included 90 patients. The participants' ages ranged from 20 to 65 years old with the median age (40 years). Females represented 86.7%. Almost all of the participants (92.2%) were non-smokers. About three fourth of the participants (74.4%) suffer from chronic disease. Between the study and control group, there were no noticeable differences regarding age, gender and chronic diseases (p-value 0.429, 0.215 and 0.809 respectively).

Table 1. Sociodemographic parameters and past history among the studied group

Characteristics	Total (n=90)	Study group (n=45)	Control group (n=45)	p-value
Age (years)				
Mean ± SD	40.6±10.6	41±11	40±10	0.40 NS
Median (range)	40 (20-65)	42 (21-65)	39 (20-60)	0.42 NS
Gender (No.,%)				
• **Female**	78 (86.7%)	41 (91.1%)	37 (82.2%)	0.21 NS
• **Male**	12 (13.3%)	4 (8.9%)	8 (17.8%)	
Chronic disease (No.,%)				
• **No**	23 (25.6%)	12 (26.7%)	11 (24.4%)	
• **Yes**	67 (74.4%)	33 (73.3%)	34 (75.6%)	0.80 NS

SD: standard deviation NS = Non significant

Symptoms among the studied group

(**Table. 2**) shows symptoms among the studied group. All of the participants complained of pain, Right hypochondria pain occurs in 87.8% of the participants. The pain associated with nausea in 28.9%, and with Nausea and vomiting in 28.9%.

Table 2. Clinical symptoms among the studied group

Characteristics (No.,%)	Total (n=90)	Study group (n=45)	Control group (n=45)	p-value
Pain	90 (100%)	45 (100%)	45 (100%)	0.40 NS
Description of the pain				
• **Colicky**	38 (42.2%)	16 (35.6%)	22 (48.9%)	0.42 NS
• **Colicky not radiated**	1 (1.1%)	1 (2.2%)	0 (0%)	0.33 NS
• **Colicky radiating to the back**	43 (47.8%)	24 (53.3%)	19 (42.2%)	0.22 NS
• **Colicky radiating to the epigastrium**	6 (6.7%)	2 (4.4%)	4 (8.9%)	0.21 NS
• **Dull aching**	2 (2.2%)	2 (4.4%)	0 (0%)	0.15 NS
Site of the pain				
• **Epigastric**	11 (12.2%)	6 (13.3%)	5 (11.1%)	0.22 NS
• **Right hypochondria**	79 (87.8%)	39 (86.7%)	40 (88.9%)	0.12 NS
Association				
• **None**	40 (44.4%)	20 (44.4%)	20 (44.4%)	0.11 NS

• **Retching**	1 (1.1%)	1 (2.2%)	0 (0%)	0.14 NS
• **Right. & left loin pain**	1 (1.1%)	1 (2.2%)	0 (0%)	0.12 NS
• **Vomiting**	1 (1.1%)	0 (0%)	1 (2.2%)	0.11 NS
• **Heartburn**	2 (4.4%)	2 (2.2%)	0 (0%)	0.13 NS
• **Constipation**	3 (3.3%)	3 (6.7%)	0 (0%)	0.15 NS
• **Nausea**	26 (28.9%)	11 (24.4%)	15 (33.3%)	0.12 NS
• **Nausea and constipation**	1 (1.1%)	0 (0%)	1 (2.2%)	0.15 NS
• **Nausea and vomiting**	15 (16.7%)	7 (15.6%)	8 (17.8%)	0.16 NS

NS = Non- significant

Operative data among the studied group

(**Table .3**) shows Operative data among the studied group. All patients undergo Laparoscopic Cholecystectomy with versus needle. The median operative time was 2 hours, ranging from (1-3 hours), with no significant difference between the study and control groups (p-value= 0.674).

Table 3.Operative data among the studied group

Characteristics (No.,%)	**Total (n=90)**	**Study group (n=45)**	**Control group (n=45)**	**p-value**
Laparoscopic Cholecystectomy	90 (100%)	45 (100%)	45 (100%)	0.15 NS
Insufflation technique				
Versus needle	90 (100%)	45 (100%)	45 (100%)	0.14NS
Operative time (hours)	2 (1-3)	2 (1-3)	2 (1-2.5)	0.67 NS
Post-operative drain				
Number				
One	90 (100%)	45 (100%)	45 (100%)	0.16 NS
Site				
Subhepatic " Morison "	90 (100%)	45 (100%)	45 (100%)	0.17 NS

NS = Non- significant

Comparison of postoperative pain scores among the studied group.

Table (4) and (**Fig.2, 3, 4, 5**) cleared that, The study group's average pain score was significantly lower than the control group's average pain score at 2 hours, 4 hours, and 6 hours (p-value 0.001), as well as at 8 hours (p-value =0.007). However, there were no significant differences between the study group and the control group on the second postoperative day (p-value = 0.900).

Table 4. Comparison of postoperative pain scores among the studied group

Characteristics	Total (n=90)	Study group (n=45)	Control group (n=45)	p-value
Pain score				
Two hours				
Mean ±SD	8.1±1.3	7.6±1.3	8.7±1.1	
Median (range)	8 (6-10)	8 (6-10)	8 (6-10)	<0.001**
Four hours				
Mean ±SD	5.7±1.8	4.8±1.7	6.7±1.3	
Median (range)	6 (2-8)	4 (2-6)	6 (4-8)	<0.001**
Six hours				
Mean ±SD	3.6±2.2	2.8±2.2	4.4±1.7	
Median (range)	4 (0-8)	2 (0-8)	4 (2-8)	<0.001**
Eight hours				
Mean ±SD	1.9±2	1.4±1.8	2.5±2	
Median (range)	2 (0-6)	0 (0-6)	2 (0-6)	0.007**
Second day				
Mean ±SD	0.5±0.9	.53±1	.49±0.869	
Median (range)	0 (0-4)	0 (0-4)	0 (0-2)	0.900NS

NS = Non-significant ** = Significant at (P < 0.01)

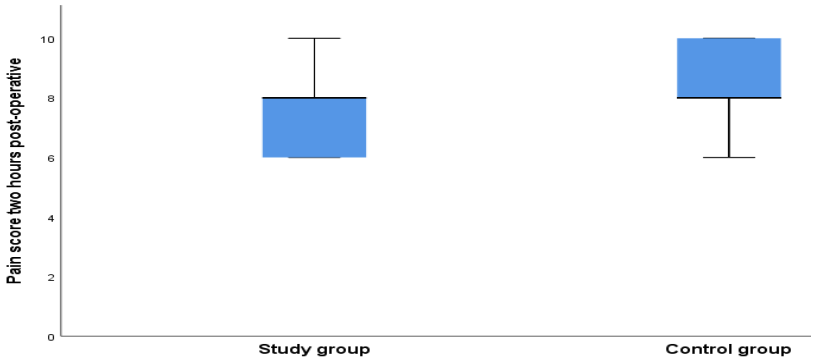

Fig.2. Pain score two hours post-operative among the study and control groups

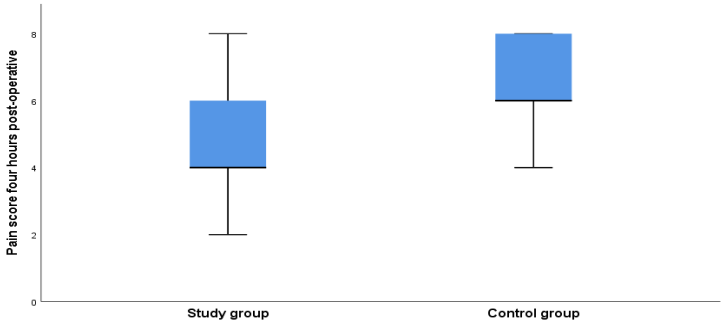

Fig.3. Pain score four hours post-operative among the study and control groups

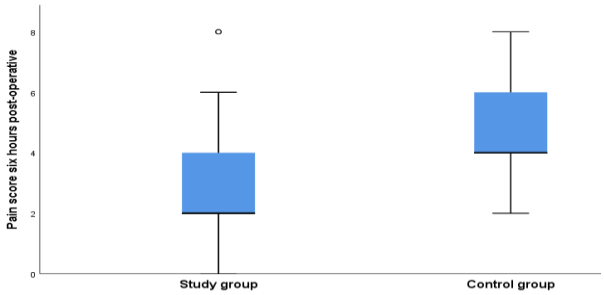

Fig.4. Pain score six hours post-operative among the study and control groups

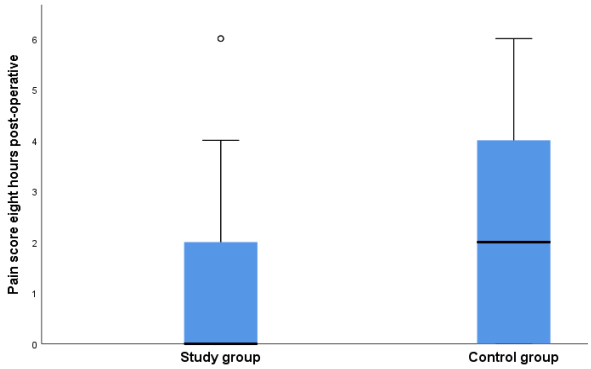

Fig.5. Pain score eight hours post-operative among the study and control groups

Table (5) and (**Fig. 6**) shows the postoperative analgesic usage and dosage among the studied groups. The study group significantly receive a lower dose of analgesic in comparison to the control group (p-value <0.001).

Table 5. Post-operative analgesic usage and dosage among the studied groups

Characteristics	**Total (n=90)**	**Study group (n=45)**	**Control group (n=45)**	**p-value**
Post-operative analgesic				
Type				
• Paracetamol 1gm vial PRN	90 (100%)	45 (100%)	45 (100%)	------
• The dose received for 48 hours	3.5 (0-6)	1 (0-3)	6 (4-6)	<0.001

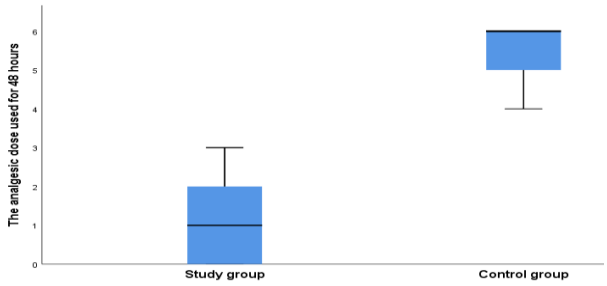

Fig.6. Post-operative analgesic usage and dosage among the studied group

Discussion

Chest physiotherapy is usually performed to patients in cardiothoracic and upper abdomianl surgery. Abdominal surgical operations that were performed by large incisions is now replaced by laparoscopy. Various organs, including the gall bladder, liver,, colon, small intestine, stomach and pancreas are involved in laparoscopic surgical procedures **(Denehy et al.,2007)**.

Intraoperative pulmonary alterations in laparoscopy are caused by a reduction in pulmonary compliance as a result of the diaphragm's elevation when CO2 is insufflated, and also due to CO_2 homeostasis as a result of its peritoneal absorption **(do Nascimento et al.,2014)**. Pain that comes with general anaesthesia and surgical operation also cause alterations in the pattern of the ventilation as inhaling short breaths that decrease the clearance of sputum from the chest **(Alaparthi et al.,2016)**.

The result on the sociodemographic pattern and past history among the studied groups cleared that, The participants' ages ranged from 20 to 65 years old with the median age (40 years). Females represented 86.7%. Almost all of the participants (92.2%) were non-smokers. About three fourth of the participants (74.4%) suffer from chronic disease. No significant difference among the study and control group for age, gender, smoking habit, and chronic diseases.

In the studies by **Borges et al. (2018)** comparing single-port laparoscopic cholecystectomy to traditional surgery, the participants' mean ages (in years) were found to be 34.2110.51 years and 38.3811.72 years respectively.

While, our result on the Clinical symptoms between the studied groups showed that All the participants complained of pain, especially the right hypochondrial pain that observed in in 87.8% of the participants . The pain associated with nausea in 28.9%, and with Nausea and vomiting in 28.9%.

The proportion of shoulder tip pain post laparoscopic cholecystectomy varies between 30 and 50%, according to Sarli et al .The pattern of pain, duration, and its intensity differs among the patients and highly unpredictable. There is debate regarding how to prevent and treat that pain. multi variants researches have been done searching for the methods to decrease the intensity of shoulder pain post laparoscopic surgery **(Sarli et al.,2000)**.

Incentive spirometry (IS) is one of the best methods that could affect mechanically the movement of diaphragm and respiratory muscles So,it reduces the pain score level post operation **(Kotani et al.,2015)**.

Our results on the comparison of postoperative pain scores among the studied group showed that, the average pain score at two hours, four hours, and six hours was significantly lower in the study group of patients in relation to the control group, in addition, The study group's pain score was significantly lower at eight hours than the control group, but there were no discernible differences between the study group and control group on the second postoperative day.

This results attributed to the pressure of carbon dioxide that used during insufflation of the abdominal cavity during LC that cause the postoperative shoulder tip pain. This pain is commonly frequently believed to be caused by the diaphragmatic muscle fibres being overstretched as a result of a high pressure of the insufflated gas **(Yasir et al.,2012)**.

Due to pain and the anaesthetic effect, individuals who have undergone abdominal surgery typically have trouble breathing and exert little effort when coughing. Implementing incentive spirometry has an impact on the respiratory muscles, which lowers the likelihood of pulmonary problems following surgery. The technique of incentive spirometry is frequently used for preoperative and postoperative lung expansion. Postoperatively, it is critical to effectively recruit the diaphragm and other inspiratory muscles via incentive spirometry. The chest wall is often symmetrical in the erect position of the spine. Improper placement, such as tilting to the painful side, can impede alveolar ventilation and cause mucociliary abnormalities, which will induce mucus to accumulate and cause infection. **(Frownfelter et al.,2014; Gayathiri al.,2021;Paisani et al.,2013)**.

The thoracic cavity expands during inspiration when incentive spirometry is used, which decreases the pleural pressure that is delivered to the alveoli. Alveoli and airway openings will generate a trans respiratory pressure gradient, which causes air to flow from the alveoli. Mean inspiratory pressure improved in patients underwent effective inhalatory exercise than patients which underwent expiratory and inhalatory exercise on the 7 day postoperative **(Gayathiri et al.,2021 ;Rastaghi ,2021)**.

Saremirad et al. (2021) showed that the results of Pain scores following LC is significantly reduced at 4 ,8,12,24 and 48 hours in the treated group by incentive spirometry in relation to the control group and control groups requiring postoperative analgesics in relation to the studied group.

While, our results The average pain score at two hours, four hours, ,sex hours and eight hours was significantly lower in the study group compared to the control group in addition, however no significant differences among the study group and the control group at the following day postoperative .The study group significantly receive a lower dose of analgesic than the control group .

Conclusion

IS can be used routinely post LC at first day postoperative alleviating shoulder and right hypochondrial pain also decreasing analgesics requirement postoperative.

Strength and limitations

The present study is one of a few prospective randomized controlled studies assessing the effectiveness of ARE following laparoscopic cholecystectomy. The feasibility of IS and its accepted cost in relation to analgesics and its side effects. However, the study is limited by the small number of patients.

Declaration of informed consent: Each individual participant in the study gave their consent after receiving all necessary information.

Declaration of no conflict of interest: The authors affirm that they do not.

Ethical approval: The appropriate institutional research ethics committee has given its permission for this investigation (code :MS-472-2022)**.**

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