Postoperative Pain Reduction After Additional Intraperitoneal Suction Following Laparoscopic Cholecystectomy: A Prospective Randomized Controlled Study

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ABSTRACT
Objective: To compare postoperative pain between conventional CO₂ releasing method and additional suction after laparoscopic cholecystectomy (LC) considering PCA Morphine consumption which makes pain measurement more accurate than pain score.

Methods: Eligible patients with indication for LC were randomly assigned preoperatively either to have the conventional CO₂ releasing method, or an additional 60 seconds of suction after LC. We collected demographic data, postoperative pain at 6, 12 and 24 hours, residual intraperitoneal pressure, operative time, intraoperative Morphine amount and Morphine PCA amount in 24 hours. Pain evaluation by PCA amount was designed to get more accurate primary outcomes.

Results: The patients were similarly distributed. Residual intraperitoneal pressure was statistically significantly different. Morphine PCA amount in both groups were not significantly different. Postoperative pain level at 6, 12 and 24 hours as secondary outcomes showed that suction group seemed to have slightly higher pain score at 6 and 12 hours but at 24 hours post LC, pain in suction group tended to be a bit lower than in non-suction group.

Conclusion: Additional CO₂ suction from this study does not reduce postoperative pain. However, with a larger study population, it might help us to consider results in the intervention group better.

Keywords: Post-laparoscopy pain syndrome; laparoscopic cholecystectomy; intra-abdominal pressure (Siriraj Med J 2018;70: 1-5)

INTRODUCTION
Cholecystectomy operation has been developed from open to laparoscopic surgery, which helps in reducing postoperative pain, returning faster to daily activities, and shortening recovery period.³,⁴ Despite decreasing of postoperative pain, it is still an unwanted condition the patients receive after laparoscopic cholecystectomy (LC). Postoperative pain consists of incisional pain (parietal pain), deep intra-abdominal pain (visceral pain), and shoulder tip pain due to diaphragmatic irritation.⁵ A post-laparoscopic pain syndrome is characterized by abdominal and shoulder tip pain for a few days after laparoscopic surgery.³,⁶ Shoulder tip pain could be aggravated by mobilization, and it could be so severe that readmission is required. Most patients can tolerate the pain and get discharged from the hospital with oral analgesic agents.

The cause of the post-laparoscopic pain syndrome is thought to be residual carbon dioxide (CO₂) in the abdomen after completion of laparoscopy.⁷ There have been some trials about relationship between residual intraperitoneal CO₂ and postoperative pain after LC. One
of those was a prospective randomized controlled trial, comparing patients receiving LC in 2 groups. First group had additional residual intraperitoneal CO\(_2\) suction via flexible cannula. Second group released gas from trocar alone, as conventional LC procedures. Results showed significantly better outcome in 24-hour postoperative pain reduction in suction group than in non-suction group. However, there was no difference in hospital stay and recovery.\(^8\)

However, there are not so many prospective randomized controlled studies of the relationship between residual intraperitoneal CO\(_2\) and postoperative pain after LC. Moreover, pain score measurement in those studies were not quite accurate due to variable individual pain thresholds and subjective pain interpretation. Thus for pain measurement in this study, besides visual analog scale, we evaluated pain from analgesic consumption for better accuracy, using patient-controlled analgesia (PCA). This study aimed to compare intraperitoneal gas reducing methods and to choose it properly, which would result in postoperative pain reduction and faster recovery.

**MATERIALS AND METHODS**

**Study Design and Participants**

We did a single center, randomized, prospective, double blind (patients and investigator who collected data were blind) study in Police General Hospital, Bangkok, Thailand, from April 2015 to January 2016. LC was performed by 3 experienced surgeons in Police General Hospital, under general anesthesia. Eligible patients were randomly assigned preoperatively either to have the conventional CO\(_2\) releasing method via trocar, or an additional 60 seconds of suction using laparoscopic suctioning device after LC.

We collected data including age, sex, BMI (kg/m\(^2\)), underlying diseases, ASA classification, diagnosis and indication for LC, postoperative pain by visual analog scale (0-10) at 6, 12 and 24 hours, residual intraperitoneal pressure, operative time, intraoperative morphine amount, PCA Morphine consumption in 24 hours, and postoperative complications, such as peritonitis, surgical site infection and surgical wound bleeding.

Inclusion criteria were patients between 18 and 70 years of age with indications for LC, such as acute cholecystitis following TG13 diagnostic criteria and severity grading of acute cholecystitis\(^9\), chronic cholecystitis, symptomatic gallstone or polyp, biliary pancreatitis, asymptomatic gallbladder polyp larger than 1 cm or gallstone larger than 2.5 cm. All patients with ASA status 1-3, who had no history of drug allergy, including paracetamol, narcotics, NSAIDs or sulfa. Patients who have been converted to open cholecystectomy, performance of an additional procedure, a surgical indication for postoperative intra-abdominal suction drainage, did not provide informed consent, or had contraindications for LC were excluded.

**Randomization and masking**

Randomization was done via a computer-generated permuted-block sequence, with a block size of 4. The treatment allocations were put in well-sealed, opaque envelopes and serially numbered. After cholecystectomy procedures, an envelope would be opened to identify intraperitoneal pressure reducing method. Each patient was blinded. Data collector was a doctor, who did not perform or assist the operation, who was not informed of intraperitoneal pressure reducing method intraoperatively.

**Procedures**

All patients had NPO at least 6 hours before the operation and received Celecoxib 400 mg, 1 capsule per oral on operating day. Prophylactic antibiotics were given 30 minutes before skin incision, which could be either Cefazolin 2 g IV or Ciprofloxacin 400 mg as alternative option, in case of penicillin or cephalosporin allergy. General anesthesia was established then Foley’s catheter No.14 was inserted for intra-peritoneal pressure measurement after LC. Intraoperative morphine was titrated and adjusted following patient’s vital signs.

LC was started with 3 ports insertion, first one was 10-mm port at umbilicus, second one was 5-mm port 2 fingerbreadths below xiphoid, and third one was 5-mm port below right costal margin crossing anterior axillary line. Pneumoperitoneum was created with 12 mmHg pressure. Critical view of safety was achieved to identify Calot’s triangle, then cystic duct and cystic artery were clamped with Hem-o-lok and cut.\(^10\) After gallbladder was dissected from hepatic bed, an envelope was opened to identify intraperitoneal pressure reducing method, either conventional CO\(_2\) reduction via trocar, or with additional suction for 60 seconds using laparoscopic suctioning device. When skin suture was done, intraperitoneal pressure measurement was performed by filling 50 ml of Normal Saline into urinary bladder via Foley’s catheter connected to 50 cm approximately extension tube. Then Foley’s catheter was clamped for 1 minute then released while holding extension tube upstraight. Pubic symphisis was considered as zero level baseline, and intraperitoneal pressure was measured in cmH\(_2\)O.\(^11,12\)

All patients received PCA morphine as the postoperative pain management; morphine 1 mg/ml, no basal rate, PCA
dose 1 mg, lock out interval 6 minutes, 4-hour limited to 30 mg, from the time of recovery from anesthesia until 24 hours postoperatively, as well as 2 tablets of 500 mg Paracetamol orally around the clock every 6 hours. No additional pain control medication was administered. Diet was stepped up postoperatively as liquid, soft and regular diet on day 1, 2 and 3 respectively. Pain score at 6, 12 and 24 hours postoperatively and 24-hour morphine consumption data were collected. Patients were discharged from the hospital when regular diet was tolerable with no postoperative complications.

**Outcomes**

Primary endpoint was 24-hour morphine consumption. Secondary endpoints were postoperative pain score at 6, 12 and 24 hours, using visual analog scale (0-10), intraperitoneal pressure (mmHg), operative time (minutes), postoperative complications, such as peritonitis, surgical site infection and surgical wound bleeding.

**Statistical analysis**

In this study, a sample size of 60 (30 per group) was required to compare continuous data using mean±SD between two groups, with 80% power and \( \alpha = 0.05 \) two-sided likelihood ratio test. We used SD 2.7 as a reference from literature review of Celik’s study in 2010.\(^1\) Pain score difference more than 2 was considered as significant difference. Nevertheless, in case of dropping out of some of the patients in our study group, we enrolled 5% more of calculated sample size. Statistical analysis was done using Stata version 14. T-test was used to analyze our results as residual intraperitoneal pressure after LC, pain score, 24-hour morphine consumption, and operative time were continuous variables. Chi-square was used for postoperative complications.

**RESULTS**

There were 63 eligible patients for LC in the Police General Hospital, Bangkok Thailand, from April 2015 to January 2016. LC was performed by 3 experienced surgeons in the Police General Hospital. Three patients in our study were excluded while receiving protocol treatment due to conversion to open surgery. Thus there were 60 patients randomized into 2 groups; suction and non-suction (Fig 1). The demographic data of 60 patients was shown in the Table 1.

![Fig 1. Consort diagram](image)

**TABLE 1.** Demographic data

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Suction (n=30)</th>
<th>Non-suction (n=30)</th>
<th>( p )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td>1.000</td>
</tr>
<tr>
<td>Female</td>
<td>20 (66.7)</td>
<td>20 (66.7)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>10 (33.3)</td>
<td>10 (33.3)</td>
<td></td>
</tr>
<tr>
<td><strong>Age (years) (mean±SD)</strong></td>
<td>47.6±13.5</td>
<td>50.2±11.9</td>
<td>0.428</td>
</tr>
<tr>
<td><strong>BMI (kg/m(^2)) (mean±SD)</strong></td>
<td>25.5±5.5</td>
<td>25.2±3.6</td>
<td>0.798</td>
</tr>
<tr>
<td><strong>ASA</strong></td>
<td></td>
<td></td>
<td>0.567</td>
</tr>
<tr>
<td>1</td>
<td>22 (73.3)</td>
<td>18 (60.0)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>6 (20.0)</td>
<td>8 (26.7)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2 (6.7)</td>
<td>4 (13.3)</td>
<td></td>
</tr>
<tr>
<td><strong>Diagnosis</strong></td>
<td></td>
<td></td>
<td>0.642</td>
</tr>
<tr>
<td>Cholecystitis</td>
<td>11 (37.9)</td>
<td>14 (46.7)</td>
<td></td>
</tr>
<tr>
<td>Symptomatic gallstone</td>
<td>16 (55.1)</td>
<td>16 (53.3)</td>
<td></td>
</tr>
<tr>
<td>Symptomatic gallstone polyp</td>
<td>1 (3.5)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Biliary pancreatitis</td>
<td>1 (3.5)</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
Most patients were female (66.7% and 66.7%) in both groups. Age ranged between 47.6±13.5 in suction group, and 50.2±11.9 in non-suction group respectively. BMI in suction group was 25.5±5.5 and 25.2±3.6 in non-suction group. ASA classifications were not different in both groups. Symptomatic gallstone was the diagnosis mostly found in both groups, with 16 patients each. According to the demographic data, patients in both study groups were not significantly different.

Residual intraperitoneal CO\textsubscript{2} suctioning was performed effectively with data showing significantly less intraperitoneal pressure in suction group ($p = 0.035$). 24-hour morphine consumption was 0.085±0.016 in suction group, and 0.104±0.019 mg/kg in non-suction group respectively (Table 2) with no statistical difference ($p=0.464$) as well as pain score at 6, 12 and 24 hours (Fig 2).

In this study, we collected data of intraoperative morphine use, which might affect postoperative morphine consumption and pain score. We found no significant difference between morphine consumption in both groups, which was 6.1±4.7 in suction group, and 7.1±4.4 mg/kg in non-suction group respectively ($p = 0.384$).

Mean operative time in suction group was 73.8±29.5 minutes, and 91.5±49.3 minutes in non-suction group, which took longer time in non-suction group than in suction group, without statistical difference ($p = 0.096$). Patients in both groups had no postoperative complications.

### TABLE 2. Primary and secondary outcome.

<table>
<thead>
<tr>
<th></th>
<th>Suction (n=30)</th>
<th>Non-suction (n=30)</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-hr Morphine consumption (mg/kg)</td>
<td>0.085±0.016</td>
<td>0.104±0.019</td>
<td>0.464</td>
</tr>
<tr>
<td>Pain score</td>
<td></td>
<td></td>
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<tr>
<td>6-hr Pain score</td>
<td>1.43±0.28</td>
<td>1.16±0.35</td>
<td>0.561</td>
</tr>
<tr>
<td>12-hr Pain score</td>
<td>1.16±0.31</td>
<td>0.60±0.24</td>
<td>0.156</td>
</tr>
<tr>
<td>24-hr Pain score</td>
<td>0.67±0.19</td>
<td>0.86±0.24</td>
<td>0.522</td>
</tr>
<tr>
<td>Intraoperative morphine (mg/kg)</td>
<td>6.1±4.7</td>
<td>7.1±4.4</td>
<td>0.384</td>
</tr>
<tr>
<td>Operative time (minutes)</td>
<td>73.8±29.5</td>
<td>91.5±49.3</td>
<td>0.096</td>
</tr>
<tr>
<td>Intraperitoneal pressure (mmHg)</td>
<td>4.1±2.1</td>
<td>5.7±3.5</td>
<td>0.035</td>
</tr>
</tbody>
</table>

### DISCUSSION

Since the first LC by Prof. Dr. Erich Mühe in 1985\textsuperscript{13}, LC is nowadays considered as a gold standard surgery for cholelithiasis. Compared with open cholecystectomy (OC), LC causes less pain, shorter recovery, and shorter hospital stay. Nevertheless, the most common complaint after LC is postoperative pain.\textsuperscript{14} Various causes of the pain are due to peritoneal stretching, diaphragmatic irritation by CO\textsubscript{2} or CO\textsubscript{2} absorption from the peritoneal cavity.\textsuperscript{3,15} Previous studies of the relationship between residual intraperitoneal CO\textsubscript{2} and postoperative pain after LC are still inconclusive.

Joris et al., performed a prospective study on patients who underwent LC in order to investigate the time course of different pain components after LC. The results showed that postoperative pain mostly occurred within the first 24 hours.\textsuperscript{16} Therefore we chose to evaluate visceral pain following this study. Pain level is caused by multiple factors, and pain score measurement in previous studies were not quite accurate due to variable individual pain thresholds and subjective pain interpretation. Besides using visual analog scale in our study, we measured pain level by analgesic consumption using patient-controlled analgesia (PCA) for finer accuracy.
Jorgensen et al., placed suprahepatic drain in all patients who underwent LC. Patients in treatment group received additional suction via suprahepatic drain which resulted in a dramatic decrease in the severity of shoulder tip pain and more favorable recovery than in control group.

The residual gas causes a loss of surface tension between visceral and parietal peritoneum especially at hepatic and diaphragmatic regions. In the same way as a study of Sarvestani et al., residual pneumoperitoneum was calculated by the length of the diaphragmatic arc and height of the gas bubble below each hemi-diaphragm in 24-hour postoperative chest x-ray. The pneumoperitoneum was graded as absent, mild (1-5 mm), moderate (6-10 mm) and severe (>11 mm). The results showed significant lower pain score in absent and mild grade group than in moderate and severe group.8

In our study, the residual intraperitoneal CO$_2$ suction did not affect postoperative pain score. Moreover, intraperitoneal pressure was not related either to pain score or 24-hour morphine consumption, although it was a more accurate variable than pain score. This could be a result of different CO$_2$ reducing technique from other studies. Mean residual intraperitoneal pressure in our study, in suction group and non-suction group were 4.1±2.1 and 5.7±3.5 mmHg respectively. This was considered as very small amount compared with the results of previous studies of Lee et al., in which residual intraperitoneal pressure was left higher than 10 mmHg after manual decompression. Patients with high intraperitoneal pressure would have moderate pain, when in our study, both groups experienced only mild pain, which explained why there was no difference of postoperative morphine use.

Residual intraperitoneal CO$_2$ suction only took 1 minute, but operative time was longer in non-suction group with no statistically significant difference compared to suction group. We think it might be due to operation difficulty in some complicated cases in non-suction group, rather than suctioning itself.

The limitation in this study is that we did not collect data of the shoulder-tip pain which can occur after most laparoscopic surgery. Such pain could be attenuated by active suction of residual CO$_2$. Further study is required to prove the effect of active suction of CO$_2$ and shoulder-tip pain.

In conclusion, residual intraperitoneal CO$_2$ suction could reduce intraperitoneal pressure effectively but did not decrease postoperative pain score or 24-hour morphine consumption.

REFERENCES