Original research

Different setups of laparoscopic cholecystectomy: Conversion and complication rates: A retrospective cohort study

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Highlights

• Laparoscopic cholecystectomy for acute cholecystitis has higher complication rates.
• Elective laparoscopic cholecystectomy has very low conversion/complication rates.
• Interval laparoscopic cholecystectomy has higher complication rates than elective.
• No other study has defined and compared four laparoscopic cholecystectomy setups.
• We saw higher conversion/complication rates along the Group I to Group III axis.

Article info

Article history:
Received 7 August 2014
Received in revised form 21 September 2014
Accepted 14 October 2014
Available online 22 October 2014

Keywords:
Laparoscopic cholecystectomy
Conversion
Complications
Percutaneous cholecystostomy

Abstract

Background: Laparoscopic cholecystectomy (LC) is the gold standard treatment for gall bladder disease.

Methods: We retrospectively reviewed charts of patients who underwent LC. Four LC groups were defined: elective LC – Group I; interval LC – Group II; LC during acute cholecystitis – Group III; and LC following percutaneous cholecystostomy (PCC) – Group IV.

Results: The study comprised 1658 patients (mean age: 51.0 years (range 17–94): Group I: 1221 patients (73.6%); Group II: 271 patients (16.3%); Group III: 125 patients (7.6%); Group IV: 41 patients (2.5%). The operative time was significantly different between the groups (p<0.05). The conversion rate was highest in Group III (24.8%) and was significantly higher than all the other groups. Group II had a higher conversion rate than Group I (p<0.05). The length of hospital stay was not significantly different between Groups I and II (1.5 and 1.96 days, respectively), and between Groups III and IV (4.46 and 4.78 days, respectively). The differences between Groups I and II, and between Groups III and IV were significant. Complication rates were significantly different between Groups I (2.2%), II (5.6%), and III (13.6%) (p<0.05). There were no differences between Groups III and IV and there were no significant differences in 30-day readmission rates between the groups.

Conclusions: The highest conversion and complication rates were encountered in patients undergoing LC during acute cholecystitis. A gradual increase of conversion and complication rates was noted between the groups of elective LC, interval LC and LC post PCC.

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1. Introduction

Laparoscopic cholecystectomy (LC) is the gold standard operation for gall bladder disease. It is a safe and cost-effective procedure, with less post-operative pain and an early return to work compared to open surgery [1–3]. It is estimated that over one million patients undergo cholecystectomy each year in the USA, mostly on an elective basis [4–7].

We can identify four LC set-ups. The first and probably most practiced is elective LC. The second is LC performed 6 or more weeks following an episode of acute cholecystitis (AC), also termed interval LC (ILC). The third is LC performed during an acute episode of cholecystitis, and the fourth is LC performed following a percutaneous cholecystostomy (PCC) for severely sick high-risk patients.

It was our impression that of all these groups, the group of patients undergoing LC following a PCC posed the highest technical difficulties to the operating surgeon and hence the highest conversion and complication rates. Based on this assumption and with

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http://dx.doi.org/10.1016/j.ijsu.2014.10.006
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the aim to either endorse or negate it, we decided to review our results in operating on these four different groups of patients.

2. Material and methods

This is a retrospective study performed with the authorization of the Institutional Review Board of our medical center (No. 64/12). All patients who underwent LC during the period from July 2007 to December 2012 entered the study. The indications for surgery were biliary colic, AC, resolved AC, cholecystocholedocholithiasis (resolved obstructive jaundice, resolved biliary pancreatitis, and resolved ascending cholangitis). Patients who underwent LC during another operation such as laparoscopic adjustable gastric banding and any type of colectomy were excluded.

Patient records were reviewed and the data was collected in a computerized database. The following parameters were studied: age, sex, comorbidities, length of surgery, need for perioperative blood transfusion, conversion rate, complication rates, length of hospital stay, 30-day readmission rate, and mortality.

All operations were performed by the same technique, using a four-trocar technique (2 × 10 mm and 2 × 5 mm), insufflating the abdominal cavity to a maximum pressure of 15 mmHg. The use of drains was based on the senior surgeons’ judgment. Drains were taken out within 12–24 h depending on the amount and type of discharge (bloody/biliary), or left in situ for a longer period of time in cases of biliary discharge until full clearance.

Patients were divided into four groups: Group I—patients undergoing elective LC, Group II—patients undergoing interval LC following an episode of AC (average of 15.1 weeks); Group III—patients undergoing LC during an episode of AC; and Group IV—patients undergoing LC following PCC performed in very high-risk patients not fit for surgery or not responding to medical treatment during an episode of AC.

Prophylactic antibiotics were used in all operated patients, usually one portion of a third-generation cephalosporin (ceftriaxone 1 g, half an hour before surgery, intra-venous). In cases of AC, a combination of antibiotics was used and continued based on clinical grounds (empyema of gall bladder, gangrenous cholecystitis, or perforation). In cases of conversion from LC to open cholecystectomy (OC), the preferred incision was a subcostal incision.

2.1. Statistical analysis

In order to compare quantitative (continuous) variables between two independent groups, the two sample t-test was applied as well as the non-parametric Mann–Whitney test. The comparison of quantitative (continuous) variables between three or more groups was carried out using the ANOVA procedure, with the Bonferroni post hoc test. The association between two categorical variables was assessed using either the Chi-square test or the Fisher’s exact test. The logistic regression model was applied in order to test the simultaneous effect of several independent variables on a qualitative, dichotomous dependent variable. All statistical tests applied were two-tailed, and a p-value of 5% or less was considered statistically significant.

3. Results

Between July 2007 and December 2012, a total of 1658 patients underwent LC in our medical center. Group I consisted of 1221 patients (73.6%) who underwent elective LC due to biliary colic or following an episode of biliary pancreatitis or resolved obstructive jaundice. Group II consisted of 271 patients (16.3%) who underwent interval LC following an episode of AC. Group III consisted of 125 patients (7.5%) operated during an episode of AC. Group IV consisted of 41 patients (2.5%) who underwent LC following a PCC performed during an episode of AC that did not respond to medical treatment or patients at risk for surgery. For the whole cohort of patients, the female to male ratio was 2.4:1 and the mean age 51.0 years (range 17–94). The mean operative time was 45.8 ± 26 min and the median length of hospital stay was 1 day (range 1–67 days). There was a 5% (83 patients) conversion rate. Complications occurred in 62 patients (3.7%). The 30-day readmission rate was 4.9% (80 patients).

The demographic data, including comorbidities, operative time, conversion rate, length of hospital stay, complications, and readmission rate for the four different groups are summarized in Table 1. The operative data are listed in Table 2.

The patients of Group IV who underwent PCC were the oldest (67 ± 12 years) and had the highest comorbidity rates (63.4%), while the elective group of patients undergoing LC (Group I) were the youngest (50 ± 17 years) and had the lowest comorbidity rates (34%). The difference in mean age was significant (p < 0.05). The female/male ratio was significantly different between Group I (3:1 F/M) and the other groups, but this ratio was not significantly different between the other groups (Groups II, III, and IV).

The operative time was significantly different between the groups (p < 0.05). It was the shortest in elective LC (39 ± 19 min) and longest in LC following PCC (81 ± 32 min).

The conversion rate was highest in Group III (24.8%). It was significantly higher than for all the other groups (p < 0.05). Group II had higher conversion rates (8.5%) than Group I (2.1%) (p < 0.05).

The length of the hospital stay was not significantly different between Groups I and II (1.96 respectively), and between Groups III and IV (4.46 and 4.78 respectively). The differences between Groups I and II, and Groups III and IV were statistically significant (p < 0.05).

Complication rates were significantly different between Groups I, II, and III (2.2%, 5.6%, and 13.6%, respectively) (p < 0.05). Group I had the lowest complication rates (2.2%) while Group III had the highest complication rates (13.6%). There were no statistically significant differences between Groups III and IV. There were no

Table 1

<table>
<thead>
<tr>
<th>Demographic data</th>
<th>Group I elective LC</th>
<th>Group II interval LC</th>
<th>Group III AC</th>
<th>Group IV S/P PCC</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>1221 (73.6%)</td>
<td>271 (16.3%)</td>
<td>125 (7.3%)</td>
<td>41 (2.5%)</td>
<td>1658</td>
</tr>
<tr>
<td>Age (mean in years)</td>
<td>50 ± 17</td>
<td>55 ± 17</td>
<td>57 ± 16</td>
<td>67 ± 12</td>
<td>67 ± 12</td>
</tr>
<tr>
<td>Female to male ratio</td>
<td>3:1</td>
<td>1:4:1</td>
<td>1:2:1</td>
<td>1:15:1</td>
<td>2:4:1</td>
</tr>
<tr>
<td>Comorbidities – overall</td>
<td>34%</td>
<td>46.5%</td>
<td>54.4%</td>
<td>63.4%</td>
<td>38.2%</td>
</tr>
<tr>
<td>HTN</td>
<td>29.5%</td>
<td>39.1%</td>
<td>42.9%</td>
<td>51.2%</td>
<td></td>
</tr>
<tr>
<td>IHD</td>
<td>7.3%</td>
<td>13.7%</td>
<td>9.5%</td>
<td>34.1%</td>
<td></td>
</tr>
<tr>
<td>DM</td>
<td>13%</td>
<td>19.2%</td>
<td>25.4%</td>
<td>31.7%</td>
<td></td>
</tr>
</tbody>
</table>

LC, laparoscopic cholecystectomy; AC, acute cholecystitis; S/P PCC, status post percutaneous cholecystostomy; HTN, hypertension; IHD, ischemic heart disease; DM, diabetes mellitus.
significant differences in the 30-day readmission rate between the groups.

4. Discussion

All clinical presentations of gallstone disease (biliary colic, biliary pancreatitis, obstructive jaundice, ascending cholangitis) have been recognized immediately and repaired by a Roux-en-Y hepatojejunostomy. The injury has remained more or less constant over the 20 years since radioucler raphe and underlying percutaneous cholecystostomy.

For the elective group, the conversion rate was extremely low (2.1%) and this compares very well with another publication [12]. However, our conversion rate in the group of patients operated for AC was as high as 24.8% and compares well to the conversion rates cited in the literature, which are as high as 30% [7,10,11]. On the other hand, the conversion rate in Group II was very low (8.5%) compared with that in the literature. Most studies report that the conversion rate for AC is the same as for ILC [7,10,11]. ILC is technically more difficult to perform than elective LC and therefore the conversion rate is expected to be higher. We were surprised to find that, contradictory to our assumption, the conversion rate in Group IV was lower than expected.

4.3. Complications

The complication rate was lowest in the elective group (Group I = 2.2%) and compares well with the reported figures of around 4% in the literature [9]. The complication rate was significantly lower in Group II (5.6%) compared with Group III (13.6%) (p < 0.05). According to different studies, there is no difference in the complication rate between the two groups.

Bowel injury resulting in perforation was four times higher in Groups III and IV compared with Groups I and II. We have no explanation for this high rate of complication (0.7%). However, all perforations were recognized during the procedure and repaired with no sequelae for the patients. Bowel injury was also reported in other series, with an incidence of 0.75% [12].

4.4. Iatrogenic bile duct injury (IBDI)

During the study period, we encountered one case of IBDI in the ILC group, accounting for an incidence of 0.06% (1/1658). The injury was recognized immediately and repaired by a Roux-en-Y hepaticojunostomy. IBDI has remained more or less constant over the 20 years since LC was introduced, with an average rate of 0.3—0.95% [8,9,17]. The possible reasons for IBDI and the long-term results of the repair are

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**Table 2**

<table>
<thead>
<tr>
<th></th>
<th>Group I elective LC</th>
<th>Group II interval LC</th>
<th>Group III AC&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Group IV S/P PCC&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operative time (min)</td>
<td>39 ± 19</td>
<td>57 ± 32</td>
<td>69 ± 27</td>
<td>81 ± 32</td>
<td>45.8 ± 26</td>
</tr>
<tr>
<td>Conversion rate</td>
<td>2.1%</td>
<td>8.5%</td>
<td>24.8%</td>
<td>7.3%</td>
<td>5%</td>
</tr>
<tr>
<td>Length of hospital stay (days)</td>
<td>1.5</td>
<td>1.96</td>
<td>4.78</td>
<td>4.46</td>
<td>1.9</td>
</tr>
<tr>
<td>Complication (%)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.2%</td>
<td>5.6%</td>
<td>13.6%</td>
<td>7.3%</td>
<td>3.7%</td>
</tr>
<tr>
<td>Wound infection</td>
<td>5 (0.4%)</td>
<td>4 (1.5%)</td>
<td>2 (1.6%)</td>
<td>1 (2.4%)</td>
<td>12 (0.7%)</td>
</tr>
<tr>
<td>Bowel perforation</td>
<td>7 (0.6%)</td>
<td>1 (0.4%)</td>
<td>3 (2.4%)</td>
<td>1 (2.4%)</td>
<td>12 (0.7%)</td>
</tr>
<tr>
<td>Iatrogenic bile duct injury</td>
<td>1 (0.4%)</td>
<td>1 (0.4%)</td>
<td>1 (0.06%)</td>
<td>1 (0.06%)</td>
<td>12 (0.7%)</td>
</tr>
<tr>
<td>Bile leak</td>
<td>6 (0.5%)</td>
<td>3 (1.1%)</td>
<td>3 (2.4%)</td>
<td>12 (0.7%)</td>
<td>12 (0.7%)</td>
</tr>
<tr>
<td>Collection</td>
<td>3 (0.4%)</td>
<td>1 (0.4%)</td>
<td>1 (0.8%)</td>
<td>5 (0.3%)</td>
<td>5 (0.3%)</td>
</tr>
<tr>
<td>Sepsis</td>
<td>1 (0.1%)</td>
<td>2 (0.7%)</td>
<td>2 (1.6%)</td>
<td>7 (0.42%)</td>
<td>10 (0.6%)</td>
</tr>
<tr>
<td>Blood transfusion</td>
<td>3 (0.2%)</td>
<td>2 (0.7%)</td>
<td>4 (3.2%)</td>
<td>10 (0.6%)</td>
<td>10 (0.6%)</td>
</tr>
<tr>
<td>Cardiac &amp; pulmonary</td>
<td>3 (0.2%)</td>
<td>2 (0.7%)</td>
<td>1 (0.8%)</td>
<td>1 (0.06%)</td>
<td>1 (0.06%)</td>
</tr>
<tr>
<td>Death</td>
<td>2 (0.15%)</td>
<td>1 (0.4%)</td>
<td>4 (3.2%)</td>
<td>7 (0.42%)</td>
<td>7 (0.42%)</td>
</tr>
<tr>
<td>30-day readmission rate (%)</td>
<td>4.2%</td>
<td>6.3%</td>
<td>6.3%</td>
<td>12.2%</td>
<td>4.5%</td>
</tr>
</tbody>
</table>

LC, laparoscopic cholecystectomy; AC, acute cholecystitis; S/P PCC, status post percutaneous cholecystostomy.

<sup>a</sup> Some patients had more than one complication. However, they were counted as one.

<sup>b</sup> Acute cholecystitis.

<sup>c</sup> Percutaneous cholecystostomy.
well known and widely discussed in the literature and are out of the scope of this study [8,17].

We believe that the low rate of IBDI in our series was due to adhering to a strict protocol, especially important in a teaching set-up.

4.5. Mortality

Only one of the 1658 operated patients died, accounting for 0.06% of our patients. This was a 91-year-old female admitted for septic shock, who needed vasopressor drugs due to perforated cholecystitis and generalized peritonitis, and died shortly following septic shock, who needed vasopressor drugs due to perforated cholecystitis and generalized peritonitis, and died shortly following the event of pathological findings of gangrenous cholecystitis (36% of Group III).

A logistic regression model found LC performed in this set-up to be an independent risk factor for complications (odds ratio [OR] of 2.3 with 95% confidence interval [CI] of 1.14–4.84) and conversion to open surgery (OR of 4.8 with 95% CI of 2.5–9.1).

The debate regarding the timing of surgery in patients with AC is not yet settled. While some studies favor an emergency operation, other studies show a higher complication rate and therefore recommend the delayed approach [4–7].

Until recently, it was our policy to “cool” patients with AC and operate on them at a later stage by performing ILC. Therefore, the group of patients operated during an episode of AC was a highly selected group of severely sick patients and not the “whole” group of AC patients. Changing the policy and operating all patients presenting with AC of less than 96 h seems to lower the conversion and complication rates, but we will need more time to evaluate our results.

4.7. Readmission

We were surprised to learn that the readmission rate was 4.2% in the group of elective LC. This rate compared well with that in the literature [13]. The readmission rate was the highest in Group IV (12.2%), as expected.

In conclusion, we defined four different set-ups of LC operated on by the same group of surgeons. To the best of our knowledge, no such classification has been reported in the literature. The highest rates of conversion and complications were in Group III, LC performed during AC, contrary to our assumption that LC following PCC (Group IV) would be the most difficult to perform and hence followed by a high rate of conversion and complications. We found that ILC (Group II) had a medium risk for complications and conversion, with higher rates than the elective LC (Group I), but lower rates than LC performed during AC (Group III).

Ethical approval

YES, The Institutional Review Board at Assaf Harofeh Medical Center, Judgment’s reference number: No. 64/12.

Funding

There were no sources of funding or financial support.

Author contribution

Study concept and design: Ariel Halevy.
Analysis and interpretation of data: Bar Chikman, Ariel Halevy.
Acquisition of data: Hasan Kais, Yehuda Hershkovitz, Yassir Abu-Snina, Bar Chikman.

Drafting of the manuscript: Hasan Kais, Yehuda Hershkovitz, Yassir Abu-Snina, Bar Chikman, Ariel Halevy.
Critical revisions of the manuscript: Ariel Halevy.

Approval of the final version to be submitted: All the authors.

Conflict of interest

The authors declared no conflicts of interest with respect to the research, authorship, and/or publication of this article.

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