Hypothesis: There is wide variation in the use of laparoscopic cholecystectomy (LC) for acute cholecystitis among all public hospitals in Hong Kong. The objective of this study was to determine the factors responsible for the use of LC for acute cholecystitis in a stable population.

Design: A retrospective survey on 2353 patients with pathologically proven acute cholecystitis treated with cholecystectomy in Hong Kong from 1998 to 2002.

Setting: All public hospitals in Hong Kong.

Results: The rate of using LC for acute cholecystitis increased by 30.4% from 1998 to 2002. We observed a wide variation in the use of LC for acute cholecystitis ranging from 3.7% to 92.9% (P<.001). There was no correlation between the number of cholecystectomies performed and the percentage of LCs performed in each hospital (P=.39). Logistic regression analysis showed that the hospital, year of operation, and age of the patients were independent variables for LC.

Conclusions: A wide variation in the use of LC for acute cholecystitis was observed among the public hospitals in Hong Kong. Young female patients from selected hospitals recently are more likely to be treated with LC.


Laparoscopic cholecystectomy (LC) is a well-established technique for the management of symptomatic gallstone disease. It is the first laparoscopic technique widely used in general surgery. Acute cholecystitis has been considered a relative, if not absolute, contraindication for LC because of the technical difficulties and a higher complication rate. With accumulated experience in laparoscopic surgery, together with technical advances, the laparoscopic approach of management for acute cholecystitis has been considered a viable alternative therapy.

In the medical literature, several reports of large case series,\textsuperscript{1,2} nonrandomized studies,\textsuperscript{3,4} and 1 prospective randomized study\textsuperscript{5} have been published, documenting the emergency use of LC for acute cholecystitis. In these studies, LC was proven to be a feasible and safe treatment for acute cholecystitis. The hospital mortality rate was less than 1% and the bile duct injury rate was also around 1%. Furthermore, the postoperative hospital stay and the length of sick leave required by the patients after LC were significantly shorter.\textsuperscript{5} There was also a lower postoperative complication rate. The overall benefits conferred by the use of LC could lead to a reduced cost of treatment, as a result of a shorter hospital stay, rehabilitation, and sick leave needed by the patients.\textsuperscript{6}

However, despite the established evidence, the application of LC for acute cholecystitis was found to have a wide regional variation ranging from 30.3% to 75.5% in patients older than 65 years in the United States.\textsuperscript{7} Apart from these data, there are only a few population-based studies on its diffusion in the community as a whole.

In view of the limited evidence, this study aimed to investigate the variation in the surgical treatment of acute cholecystitis in a stable population and the factors determining the use of LC in the emergency condition.

METHODS

This study was a retrospective analysis on all adult patients (≥18 years) with emergency admission to Hospital Authority (HA) hospitals in Hong Kong from January 1998 to December 2002 for cholecystectomy with a pathological diagnosis of acute cholecystitis.
DATABASE

Data were obtained from the Clinical Data Analysis and Reporting System of the Hospital Authority of Hong Kong, which captures all patients’ medical information from all HA hospitals. We retrieved the data of patients with “emergency admissions” and the operative diagnosis of acute cholecystitis, empyema, or mucocele of the gallbladder (ICD-9-CM codes 575.0, 575.2, 575.3, and 575.4) treated with cholecystectomy (ICD-9-CM code 51.2) during the study period. Their pathology reports, operation records, and discharge records were studied.

We also used the forward conditional logistic regression analysis using the demographic variables of age, sex, and year of operation to determine the mortality risk of each patient to adjust the hospital mortality rates. Only patients with pathologic evidence of acute cholecystitis were included in the present study. Patients with a clinicoperative diagnosis of acute cholecystitis but with no acute inflammatory cells infiltration of the gallbladder observed pathologically were excluded from the study. Data collected included patient demographics, medical history, operative findings, and pathologic findings.

HISTOPATHOLOGICAL STUDY

The detailed pathologic reports were available for study in 2353 patients. In addition to acute inflammatory cells infiltration, gangrenous (or necrotizing) cholecystitis referred to gangrenous changes of the whole thickness of the gallbladder wall. Empyema of the gallbladder was diagnosed when frank pus was present inside the gallbladder whereas clear bile inside an inflamed gallbladder was referred to as mucocele.

LAPAROSCOPIC SURGERY

An attempted LC was defined as laparoscopy performed before the cholecystectomy. A successful attempt of LC required no additional laparotomy whereas an aborted attempt (conversion) required a laparotomy for the cholecystectomy.

OUTCOME MEASURES

Hospital mortality was defined as death in the same admission for surgery. The hospital mortality rate was adjusted using sex, age, and year of operation. The postoperative hospital stay was calculated from the date of surgery to the date of discharge from the hospital. All complications documented in the hospital records were recorded. Any form of bile leakage or bile duct injury detected intraoperatively or postoperatively was referred to as overall biliary complication. When comparing the outcomes of LC with those of open cholecystectomy, we adopted an intent-to-treat principle that included the conversion group in the laparoscopic surgery group.

STATISTICAL ANALYSIS

Comparison between groups was performed using a chi-squared test with a Fisher exact test when applicable for nominal variables and a t test for continuous variables. The Pearson correlation coefficient (r) was used to measure the association between the LC rate and other variables. We used a forward conditional logistic regression analysis using the demographic variables of age, sex, and year of operation to determine the mortality risk of each patient to adjust the hospital mortality rates. We also used the forward conditional logistic regression analysis to determine the independent variables for LC, including their specific odd ratios and associated 95% confidence intervals. All statistical analyses were performed using the SPSS statistical package (SPSS, Chicago, Ill). A P value less than or equal to .05 in a 2-tailed test was considered statistically significant.

RESULTS

A total of 2620 patients were identified to have fulfilled the inclusion criteria, but 21 patients were excluded from further analysis because of the presence of synchronous colorectal malignancy (n = 13), gastric malignancy (n = 6), abdominal aortic aneurysm (n = 1), and small-bowel perforation (n = 1) that required additional operations during the cholecystectomy. One hundred and eighty-three (7.0%) patients were found to have no acute inflammatory cells infiltration in their resected gallbladders and were therefore excluded. Sixty-three patients were found to have cancer of the gallbladder in addition to the acute cholecystitis and they were also excluded. Hence, 2353 patients from 14 HA hospitals were studied. Among them, LC was performed on 1145 (48.7%) patients and 1208 (51.3%) patients had open surgery.

DEMOGRAPHIC PARAMETERS

The mean±SD age of the 2353 patients was 63.80±16.14 years. The mean age of patients undergoing LC was 7 years younger than those who were treated with open cholecystectomy (60.0±16.4 years vs 67.4±15.0 years; P < .001).

The male patients outnumbered the female patients at a ratio of 1.15:1 (1259/1094). Although a higher proportion of male patients had open cholecystectomy compared with LC, the difference did not reach statistical significance (male-female ratio in open surgery, 657:551, vs laparoscopic surgery, 602:543; P = .38).

PATHOLOGIC ABNORMALITIES OF THE RESECTED GALLBLADDER

In addition to acute cholecystitis, 16.5% of the gallbladders showed gangrenous changes, 13.4% had empyema, and 2.5% had mucocele. Table 1 depicts the pathologic abnormalities of the gallbladder with respect to the approach of surgery used and shows no significant difference between patients undergoing open surgery and those treated with LC.

TIME TREND

The number of cholecystectomies performed for acute cholecystitis increased steadily during the study period.

Table 1. Pathologic Abnormality of the Gallbladder With Respect to the Approach of Cholecystectomy Used in 2353 Patients

<table>
<thead>
<tr>
<th>Abnormality</th>
<th>Open Approach (n = 1208)</th>
<th>Laparoscopic Approach (n = 1145)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute cholecystitis, No. (%)</td>
<td>818 (67.7)</td>
<td>774 (67.6)</td>
</tr>
<tr>
<td>Gangrenous cholecystitis, No. (%)</td>
<td>209 (17.3)</td>
<td>178 (15.6)</td>
</tr>
<tr>
<td>Empyema, No. (%)</td>
<td>157 (13.0)</td>
<td>158 (13.8)</td>
</tr>
<tr>
<td>Mucocele, No. (%)</td>
<td>24 (2.0)</td>
<td>35 (3.1)</td>
</tr>
</tbody>
</table>
Compared with 1998, a 30.4% increase in the use of LC was observed in 2002 (Figure 1). The percentage of LC performed for acute cholecystitis increased from 29.9% in 1998 to 66.0% in 2002.

PATTERN OF CHOLECYSTECTOMIES PERFORMED IN EACH HOSPITAL

There was a wide variation in the use of LC in the treatment of acute cholecystitis. The practice of LC varied significantly from 3.7% to 92.9% (P<.001) with a median of 52% (Figure 2). There was no correlation between the number of cholecystectomies performed and the percentage of LCs performed in individual hospitals (r=-0.25; P=.39). A low LC rate was observed in some hospitals with a high volume of cholecystectomies performed for acute cholecystitis.

CONVERSION RATE

Apart from a wide variation in the use of LC for acute cholecystitis, the conversion rate of LC also varied considerably. Five hospitals had conversion rates of 50% or greater, 4 hospitals had conversion rates of less than 20%, and the remaining 5 hospitals had conversion rates within this range. There was, however, no correlation between the conversion rate and the LC rate (r=0.02; P=.95) or the absolute number of LCs (r=-0.27; P=.34) performed.

OUTCOMES OF CHOLECYSTECTOMIES FOR ACUTE CHOLECYSTITIS

The mean hospital mortality rate was 3.2% during the study period. The hospital mortality rate of open approach was 5.0%, which was significantly higher than the 1.2% of the laparoscopic approach (including patients with conversion; P<.001). The difference persisted with the adjustment of age, sex, and year of operation (4.4% vs 1.7%; P=.01). When the patients with conversion were compared with those undergoing open cholecystectomy, there was no significant difference in their hospital mortality rate (5.0% vs 1.9%; P=.09) and 30-day mortality rate (4.0% vs 1.9%; P=.20).

The mean±SD postoperative hospital stay after laparoscopic cholecystectomy was 7.5±9.7 days and was significantly shorter than the 12.0±14.1 days (P<.001) of the open approach. Complications after cholecystectomy were documented in the discharge records of 452 (18.2%) patients. The overall complication rate for the open approach was 22.1%, which was significantly higher than that of 13.9% for the laparoscopic approach (P<.001). Although there was no difference in the overall biliary complication rate between these 2 approaches (open, 3.1%, vs laparoscopic, 2.7%; P=.53), the reoperation rate for complications was higher after open cholecystectomy (open, 1.9%, vs laparoscopic, 0.8%, P=.02).

The bile duct injury rate was 0.5% for the laparoscopic approach and 0.2% for the open approach (P=.17).

INDEPENDENT FACTORS DETERMINING THE USE OF LC

A forward conditional logistic regression analysis of 5 factors, including age, sex (female=0 and male=1), hospital, year of operation, and pathologic findings, showed that the hospital (P<.001) (Table 2 outlines the odds ratio of the 13 hospitals and the associated confidence limits), year of operation (P<.001; odds ratio, 0.60; 95% confidence interval, 0.55-0.65), sex of the patients (P=.02; odds ratio, 1.31; 95% confidence interval, 1.05-1.64), and age of the patients (P<.001; odds ratio, 0.97; 95% confidence interval, 0.96-0.97) were the independent variables for LC. Young female patients operated on recently in selected hospitals were more likely to have LC for acute cholecystitis.
Hong Kong is a city with a population of 6.7 million. The inpatient hospital services are provided by both public hospitals managed by the HA and private hospitals. In 2002, about 86% of inpatient hospital services in Hong Kong were provided by HA hospitals whereas the private hospitals rendered 14% of the services. Therefore, the present study reflected the practice of LC for acute cholecystitis in about 86% of the inpatient population in Hong Kong. Although the first step of data retrieval was based on an administrative data source, the accuracy of the data was verified by the pathology reports, operation records, and discharge records of individual patients.

The clinical presentations of gallstone disease vary from recurrent epigastric pain, as in the case of chronic cholecystitis, to more acute presentations of gallstone colic, acute cholecystitis, acute pancreatitis, and bile peritonitis. The clinical diagnosis of these different presentations is not always specific. Besides, for a retrospective analysis involving a large number of hospitals and surgeons, the criteria used for a clinical diagnosis of acute cholecystitis may vary. Hence, for the purpose of uniformity, an objective pathologic definition of acute inflammatory cells infiltration of the gallbladder wall was taken as the minimal criterion for the diagnosis of acute cholecystitis in the present study as in other published series. Moreover, there exists a range of different gallbladders, from minimally inflamed to grossly thickened edematous or even gangrenous cholecystitis with increasing technical difficulties. Therefore, the clinicopathological extent of inflammation was also recorded. The preceding data showed a gangrenous change of 16.5%, which was substantially lower than that reported from other published data, with a rate ranging from 23% to 41%.

In a relatively stable population in Hong Kong, a 30.4% increase in the rate of emergency cholecystectomy in a 5-year period probably reflects a change in practice from delayed cholecystectomy to early cholecystectomy. This possibility is further strengthened by the need to exclude 183 patients (7.0%) with a clinical diagnosis of acute cholecystitis but no pathological evidence of acute cholecystitis in the present study. Thus, a low threshold for early emergency surgery was observed in patients with suspected acute cholecystitis. Another possible postulation is the actual rise in the number of patients presenting with acute cholecystitis. This change, however, is not likely to take place in a stable population within a short period of time.

Even though the laparoscopic approach has become the method of choice for elective cholecystectomy, conventional open cholecystectomy still remains the treatment of choice for acute cholecystitis for many surgeons mainly because of the worries of bile duct injuries and an excessively high conversion rate. For these reasons, acute cholecystitis has been considered a relative, if not absolute, contraindication to LC. Nevertheless, numerous reports have been published on the feasibility and safety of LC for acute cholecystitis in the 1990s as a result of the maturity of the laparoscopic technique.

Although several nonrandomized studies have been published, there was only 1 prospective randomized study of 68 patients reported in 1998. Kiviluoto et al concluded that, in experienced hands, LC in patients with acute and gangrenous cholecystitis is technically demanding but feasible in a great majority of cases. It is a safe and effective technique with significantly shorter hospital stay than that for open cholecystectomy. In addition, the postoperative complication rate was also significantly lower after LC. Corroborated by these findings, it is not surprising to observe a 30.4% increase in the use of LC from 1988 to 2002 in Hong Kong. By 2002, two thirds of the emergency cholecystectomies were performed laparoscopically. Furthermore, in the present population-based study, the hospital mortality rate of 1.2% and the overall morbidity rate of 13.9% after emergency LC compared favorably with the reported results of 0.7% to 1.2% and 5.6% to 15%, respectively.

Nonetheless, despite the established evidence, the application of LC for acute cholecystitis was found to have a wide regional variation from 30.3% to 75.5% in patients older than 65 years in the United States. A similar but wider variation was observed among the 14 HA hospitals in Hong Kong. This difference could not be explained simply by the number of cholecystectomies performed in each hospital. Our data suggested that there was a trend for younger patients to undergo LC, which could contribute a tremendous economical benefit to the society in view of the reduced cost of treatment. However, from the perspective of the health care system, it was the elderly who were most affected by this disease with the highest mortality. With more reports published advocating the safety of the application of LC, measures to narrow down the variation and to safely introduce the procedure to low-volume hospitals may be required, especially for the management of elderly patients.

The present retrospective study is limited in several aspects. First, we did not know the number of patients with acute cholecystitis treated conservatively or with drainage of the gallbladder followed by delayed chole-

### Table 2. Odds Ratios and the Associated 95% Confidence Intervals for 13 Hospitals

<table>
<thead>
<tr>
<th>Hospital</th>
<th>Odds Ratio (95% Confidence Interval)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.16 (0.09-0.28)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>2</td>
<td>0.15 (0.08-0.29)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>3</td>
<td>0.09 (0.05-0.15)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>4</td>
<td>0.32 (0.18-0.64)</td>
<td>.001</td>
</tr>
<tr>
<td>5</td>
<td>0.05 (0.03-0.09)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>6</td>
<td>0.20 (0.11-0.35)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>7</td>
<td>2.18 (1.17-4.04)</td>
<td>.01</td>
</tr>
<tr>
<td>8</td>
<td>0.02 (0.01-0.04)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>9</td>
<td>0.01 (0.01-0.01)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>10</td>
<td>0.16 (0.08-0.35)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>11</td>
<td>0.16 (0.07-0.33)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>12</td>
<td>0.36 (0.21-0.61)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>13</td>
<td>0.41 (0.24-0.68)</td>
<td>.001</td>
</tr>
</tbody>
</table>
cystectomy. Therefore, the true incidence of LC for all patients with acute cholecystitis could not be determined. Patients who were admitted electively to the HA hospitals for other reasons and who developed subsequent acute cholecystitis during the hospital stay would not be included in the present study. This would lead to an underestimation of the incidence of acute cholecystitis. However, this possibility is small.

The application of LC in the emergency condition is technically demanding and certainly needs to be performed by experienced laparoscopic surgeons. The present study demonstrated that, on a population basis, the use of LC for acute cholecystitis is increasingly popular among surgeons. More LCs for acute cholecystitis have been performed recently. In a relatively stable population, younger female patients in selected hospitals are more likely to have LC for acute cholecystitis.

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REFERENCES