

Comparison of Clinical Outcomes and Cost of Open vs. Laparoscopic Cholecystectomy in 10 Year Interval: A Retrospective Study

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Abstract

Background: Laparoscopic cholecystectomy is the preferred and widely used treatment modality for acute cholecystitis. Despite several positive outcomes, such as shorter hospital stay, less number of complications, it is sometimes not feasible to perform because of the need of trained specialists and high expenditure as it involves sophisticated expensive instruments. The purpose of this study was to determine differences in procedure duration, length of stay, outcomes, and cost based on types of surgery performed in the year 2004-2005 and 2014-2015.

Methods: The study design was a 10-year interval retrospective study conducted in a district hospital in Queensland, Australia. Data were extracted from the hospital record for the years 2004-2005 and 2014-2015. Incomplete and inaccurate data were excluded from the study and a total of 247 records were included in the final analysis. Fischer's exact test, Chi-Square test and Mann-Whitney U test with 0.05 level of significance were used. Odds ratio with 95% confidence interval were also calculated.

Results: Patients treated with laparoscopic surgery had significantly shorter hospital stay than those treated with mini-open surgery ($p < 0.001$), and it was consistent for both time period. Antibiotic use and postoperative complications were significantly higher in mini-open cholecystectomy cases ($p < 0.05$). Operative time was significantly less in the laparoscopic group compared with mini-open surgery in 2004-2005, but no significant difference was noted in 2014-2015. Lack of cost components restricts direct comparison of cost. However, increased complication, antibiotic use, and longer stay suggest high indirect cost in patients treated with mini-open cholecystectomy.

Conclusion: Laparoscopic cholecystectomy has become the preferred management of acute cholecystitis. This research provides evidence on improved intraoperative and postoperative outcome in laparoscopic cholecystectomy compared to mini-open cholecystectomy. Shorter hospital stay, less postoperative complications, and less antibiotic use make this technique more cost-effective. However, a longitudinal study using cost-effectiveness analysis in the future will provide a robust conclusion.

Keywords: Acute cholecystitis; Cholecystectomy; Laparoscopic; Treatment outcomes

Abbreviations: IOC: Intraoperative Cholangiography; LC: Laparoscopic Cholecystectomy; MC: Mini-open Cholecystectomy; SPSS: Statistical Package for Social Sciences

Introduction

Changes in surgical techniques in search of safe, easy-to-perform and effective procedure to manage acute cholecystitis have been the interest of researcher since the last decades. Several randomized trials during the 1980s and early 1990s showed that the conventional large subcostal incision in cholecystectomy could be replaced by a much smaller incision, giving a shorter convalescence period [1,2]. Ever since its inception, Laparoscopic Cholecystectomy (LC) has fast become the gold standard for operative gall bladder removal, especially in the industrialized world.

Studies have shown that LC holds several advantages as follows: Less postoperative pain, early ambulation, minimal scar, and, early return to work [1,2]. Though LC is found to take a longer time to perform compared to conventional cholecystectomy, it was found to have smoother postoperative course [2]. In spite of such overall benefits, this technique is tedious, requires expert and sophisticated expensive instruments, which makes this technique more costly. Because of this, controversies exist regarding the use of laparoscopic techniques, mainly in developing countries [3]. A recent Cochrane review in 2009 and a meta-analysis of randomized trials showed no differences in patient-related outcomes, such as mortality, complication, hospital stay, and convalescence between these techniques: Laparoscopic Cholecystectomy (LC) and Mini-open Cholecystectomy (MC) [4,5]. However, the external validity of these studies is difficult to assess as such procedures are affected by hospital factors, such as availability of trained specialists and patient preferences.

To reduce the unnecessary financial pressure on public health care, which is partly linked to increased expenses and spending on health care, economic evaluation of surgical procedures are deemed necessary

[6]. Reliable data regarding procedural costs may inform budget planning and prioritization by health facilities. Therefore, this retrospective study was conducted to compare the clinical outcomes between LC and MC; and to assess whether there was a change in 10-year interval. Furthermore, it attempted to compare the total costs incurred in these two techniques using the cost components such as pre-admission cost, operation cost, imaging and laboratory costs, hospital bed charges etc.

Aim

The study had two overarching goals as follows:

- To compare the clinical outcomes of the patients across two different types of surgeries in a ten-year interval
- To estimate and compare the cost of the surgical treatment of acute cholecystitis in a ten-year interval

We hypothesized that the cost of the LC is reduced over time due to improvement in clinical outcomes such as reduction in operative time, shorter hospital stay, decreased antibiotic use and reduction in complications.

Material and Methods

Study design

A hospital-based cross-sectional study was used to compare the outcomes and costs associated with two different types of cholecystectomy in the 10-year interval.

Data collection

All laparoscopic cholecystectomy and mini-open cholecystectomy cases were retrospectively analyzed for two time period, separated by a 10-year interval. Incomplete, inconsistent and missed data were removed from the analysis and in total, 247 records were analyzed.

Data analysis

Master chart was prepared in Microsoft Excel 2013 and double entry and cross-checking were done to ensure the accuracy of the data. Data were then transferred to Statistical Package for Social Sciences (SPSS) v20 for analysis. Normality of the continuous data was assessed using the Shapiro-Wilk test. In a study with small sample size and deviated data, this test is usually chosen for normality check because of its high power [7]. To compare across groups, the parametric test (independent t-test) couldn't be applied and its non-parametric counterpart, Mann Whitney U test was applied. For categorical or qualitative data, the Chi-Square test was used and if data do not meet the assumption of chi-square, Fisher exact test was used.

Results

Results are broadly categorized under two groups: a) Descriptive statistics and b) Comparison between two types of cholecystectomy separately for two time period.

Section (a): Descriptive measures

The line graph in Figure 1 shows the breakdown of cholecystectomy into two types for two time period. In 2004-2005, there was a total of 118 cases of cholecystectomy (106 were laparoscopic cholecystectomy

and 12 were mini-open cholecystectomy). In the year 2014-2015, there were altogether 129 cases of cholecystectomy (118 were laparoscopic cholecystectomy and 11 were mini-open cholecystectomy). From the figure it is evident that laparoscopic cholecystectomy outweighs the mini-open cholecystectomy (89.8% vs. 10.2%) in 2004-2005 and the pattern remains similar even after 10 years (Figure 1). There was a slight increase in the proportion of laparoscopic cases (91.5%), however, there is no doubt that in both times, it was the preferred and most common choice of treatment for acute cholecystitis.

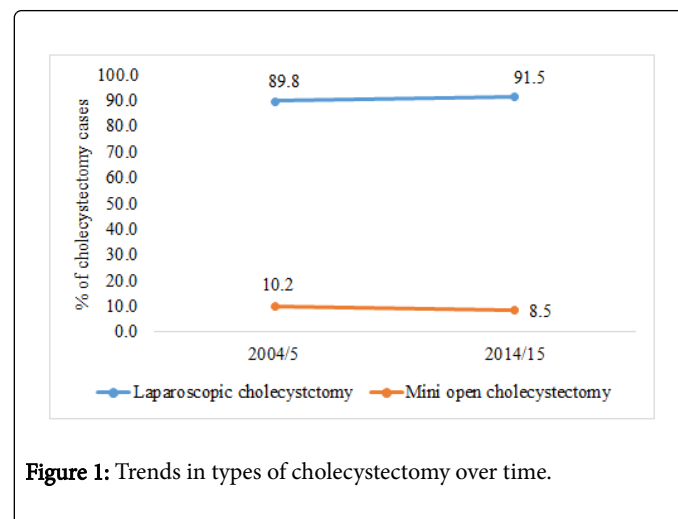


Figure 1: Trends in types of cholecystectomy over time.

Figure 2 compares laparoscopic and mini-open cholecystectomy in the year 2004-2005 and 2014-2015 according to age (Figure 2). It is found that mini-open cholecystectomy is more likely to be performed in older age patients and this was consistent in both years (Figure 2).

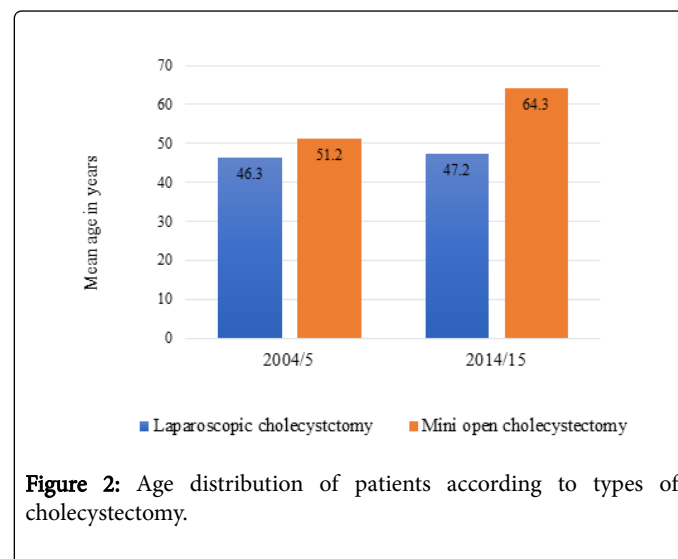


Figure 2: Age distribution of patients according to types of cholecystectomy.

Table 1 presents the summary statistics for two types of surgery in two-time frames. A significant difference in the mean age of patients undergoing two types of cholecystectomy was seen in the year 2014-2015 ($p=0.003$) (Table 1). What stands out in the table is the significant difference in length of hospital stay between laparoscopic and mini-open cholecystectomy ($p<0.001$) and a similar finding was seen over time. Laparoscopic cholecystectomy tended to have shorter hospital stay compared to mini-open cholecystectomy (in 2004/2005:

5.9 days vs. 1.5 days; in 2014/2015: 6 days vs. 2 days) (Figure 3). The data depicts longer procedure time for mini-open cholecystectomy in 2004-2005 and longer procedure time for laparoscopic cholecystectomy

in 2014-2015. However, no significant difference was seen across the two procedures ($p > 0.05$).

Variables	Year 2004-2005		p-value	Year 2014-2015		p-value
	Mini-open Cholecystectomy	Laparoscopic Cholecystectomy		Mini-open Cholecystectomy	Laparoscopic Cholecystectomy	
Age in years						
Mean ± SD	51.2 ± 16.0	46.3 ± 17.5	0.27	64.3 ± 18.5	47.2 ± 16.1	0.003
Range	26-77	13-94		34-85,	17-78	
Length of stay (days)						
Mean ± SD	5.9 ± 5.4	1.5 ± 1.3	<0.01	6.0 ± 7.3	2.0 ± 1.8	0.001
Range	2.1-22.1	-0.5-10.5		2.1-53.6	0.3-7.5	
Duration of surgeries (min)						
Mean ± SD	83.2 ± 20.3	77.7 ± 29.7	0.12	73.6 ± 12.2	74.6 ± 32.5	0.77
Range	61-130	6-187		53-94	6-169	
p-value derived from Mann Whitney U test. Bold indicates significant.						

Table 1: Year wise comparison of age, length of stay and duration of mini-open vs. laparoscopic cholecystectomy.

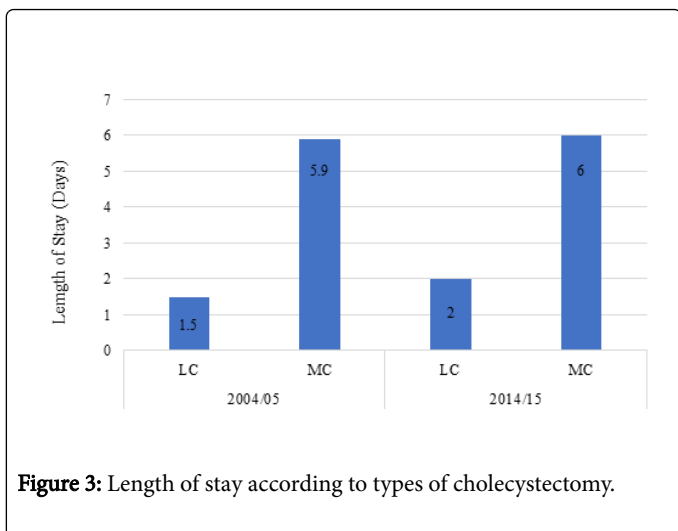


Table 2 illustrates the clinical profile of laparoscopic and open cholecystectomy in two time period. Closer inspection of the table shows no association of gender to the type of surgery in 2004-2005, while in 2014-2015, males were significantly less likely to have a mini-open cholecystectomy (OR=0.1, 95% CI: 0.03-0.5). Another striking finding was a significant reduction in antibiotic use among cases with laparoscopic cholecystectomy in 2004 (OR= 0.1, 95% CI: 0.03-0.4), while no such association seen in the year 2014-2015 ($p=0.05$). Intraoperative Cholangiography (IOC) was found to be predominant in laparoscopic cholecystectomy cases in both years and none of the mini-open cholecystectomies had undergone IOC. The most interesting finding is the lower odds of postoperative complications in 30 days in cases having laparoscopic cholecystectomy compared to cases with mini-open cholecystectomy. Our study couldn't find any significant association with intraoperative complications and postoperative complications in 60 days ($p > 0.05$). Among the cases with inpatient complications, nearly one fourth have undergone mini-open cholecystectomy and bivariate analysis shows a reduced risk of such complications in laparoscopic cholecystectomy compared to mini-open cholecystectomy (OR=0.14, 95% CI: 0.03-0.5). In accordance with this, a similar result was seen in 2014-2015 (OR: 0.1; 95% CI: 0.03-0.5).

Section b: Comparison between two types of cholecystectomy separately for two time period

Variables	Year 2004-2005		p-value	OR (95%CI)	Year 2014-2015		p-value	OR (95%CI)
	Laparoscopic Cholecystectomy	Mini-open Cholecystectomy			Laparoscopic Cholecystectomy	Mini-open cholecystectomy		

Sex								
Male	28 (87.5)	4 (12.5)	0.73*	0.7	22 (75.9)	7 (24.1)	0.003*	0.1
Female	78 (90.7)	8 (9.3)			96 (96.0)	4 (4.0)		
Antibiotic use								
Yes	11 (64.7)	6 (35.3)	<0.01*	0.1	22 (81.5)	5 (18.5)	0.05*	0.3
No	95 (94.1)	6 (5.9)			96 (94.1)	6 (5.9)		
Intraoperative cholangiography								
Yes	59 (100.0)	0 (0.0)	<0.01*	NA	86 (100.0)	0 (0.0)	<0.01	NA
No	47 (79.7)	12 (20.3)			32 (74.4)	11 (25.6)		
Postoperative complications in 30 days								
Yes	4 (57.1)	3 (42.9)	0.02*	0.1	12 (80.0)	3 (20.0)	0.12*	0.3
No	102 (91.9)	9 (8.1)			106 (93.0)	8 (7.0)		
Postoperative complications in 60 days								
Yes	2 (100.0)	0 (0.0)	1.00*	NA	4 (80.0)	1 (20.0)	0.36*	0.4
No	104 (89.7)	12 (10.3)			114 (91.9)	10 (8.1)		
Inpatient complications								
Yes	31 (77.5)	9 (22.5)	0.003*	0.14	28 (77.8)	8 (22.2)	0.002*	0.1
No	75 (96.2)	3 (3.8)			90 (96.8)	3 (3.2)		
p-value derived from Chi-Square test, *indicates fisher exact test, Bold indicates significant, NA means not applicable								

Table 2: Clinical Profile of patients who have undergone laparoscopic and mini-open cholecystectomy disaggregated by time period.

Discussion

This result undoubtedly supports that the laparoscopic cholecystectomy is the established and preferred procedure for managing cases of acute cholecystitis. However, some surgeons still consider mini-open cholecystectomy as an alternative to laparoscopic cholecystectomy, especially in centers where laparoscopic facilities are not available because it does not need special training, equipment and is also cost-effective [8].

The shorter operating time for LC versus MC in 2004-2005 was contradictory with the findings from previous studies which reported shorter time for MC. The average operating time of about 75 minutes for LC was shorter than that reported in other studies in 2010 [9]. Previous reports had reported of additional 10 minutes times for setting up and testing laparoscopic equipment.

Postoperative hospital stay was significantly longer for MC compared to LC. Consistent with these findings, randomized trials by MacMohan in 1994 and Ross in 2001 concluded that LC was associated with a short hospital stay. Smaller wounds, fewer complications might have attributed to a quick recovery, resulting in a shorter postoperative hospital stay. Based on the health-related quality of life of patients who had undergone laparoscopic cholecystectomy, a study suggested that patients can be discharged on the second postoperative day [10].

It was not possible to make a direct comparison of cost between the two surgeries in two time period as there is a lack of data related to

cost. Direct cost like expenses related to a hospital stay, medicine, laboratory, operation charge etc. wasn't available. To calculate the indirect costs, there was no information regarding how many days individual was not able to resume his/her work. Hence, proxy measures like use of antibiotics, complications, length of stay were used to make a gross comparison of the costs. These variables lead to improved medical economics and save on the costs of care [10].

From our finding, it is apparent that mini-open cholecystectomy is associated with more postoperative complications, higher antibiotic use, and longer hospital stay. Hence, it can be concluded that laparoscopic cholecystectomy is more cost-effective than mini-open cholecystectomy. A study done in Morocco compared the cost of LC and MC and showed that the LC technique was associated with a 27% significant reduction in hospital costs [11]. However, a study done in Pakistan in 2010, concluded MC as a relatively cost-effective procedure due to the lesser analgesic requirement, excellent cosmetic results, and quicker recovery.

This study confirmed the previously reported arguments in favor of laparoscopic cholecystectomy. Numerous techniques, namely four ports mini-laparoscopic cholecystectomy, three ports mini-laparoscopic cholecystectomy, two-ports mini-laparoscopic cholecystectomy, single port mini-laparoscopic cholecystectomy, have now been experimented and used in laparoscopic procedures and thus, further study needs to compare the effectiveness and safety across those techniques [12].

Conclusion

A significantly large proportion of cases having laparoscopic cholecystectomy highlights that it is the preferred treatment of acute cholecystitis. It is a safe and beneficial operative procedure because of certain advantages over mini-open cholecystectomy, including short hospital stay, less postoperative complications, fewer inpatient complications, and less antibiotic use. Wherever feasible, it should be undertaken as the initial procedure for most cases of cholecystitis considering the minimal cost associated with it. However, the findings need to be interpreted cautiously in light of small sample size, extreme data and wide confidence interval in odds ratio. To make more valid and robust conclusions, future studies should include comprehensive cost components and conduct cost-effectiveness analysis.

Declarations

Ethics approval and consent to participate

This research project has been approved by the Human Research Ethics Committee of the Metro North Hospital and Health Service, Queensland, Australia.

Any questions about the ethical conduct of this research may be sent to the Secretary of the Committee, The Prince Charles Hospital Research Office, Building 14, Road Chermside QLD 4032 Australia. E-mail: ResearchTPCH@health.qld.gov.au

Availability of Data and Material

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Authors' Contributions

CN carried out the data collection, analysis, literature studies and drafted the manuscript. AL helped to draft the manuscript. All authors read and approved the final manuscript.

Competing Interests

The authors declare that they have no competing interests.

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