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REVIEW ARTICLE

Is fundus first laparoscopic cholecystectomy a better option than conventional laparoscopic cholecystectomy for difficult cholecystectomy? A systematic review and meta-analysis

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Abstract

The gallstone disease prevalence is up to 27% in the general adult population. Though most of the patients are asymptomatic, about 1–4% of these patients became symptomatic every year and will require treatment. Fundus first laparoscopic cholecystectomy (FFLC) was first reported by Cooperman in 1990 when he utilized the approach to safely perform LC for patients with acute cholecystitis and dense adhesion around the calot's triangle which precluded safe dissection. Some surgeons reported that the FFLC may be quicker than the traditional dissection starting at the Calot's triangle, although no randomized trial has been undertaken to confirm that. We aim to perform this systematic review and meta-analysis to compare outcome of fundal first laparoscopic cholecystectomy with conventional laparoscopic cholecystectomy. Three reviewers independently searched the Pubmed, medline, google schoolar, Cochrane library and Embase databases for prospective or retrospective articles comparing outcomes of fundus first LC and conventional LC. The search terms were "retrograde cholecystectomy", "antegrade cholecystectomy", "fundus first cholecystectomy", "fundus down cholecystectomy", and "dome down cholecystectomy". Studies were selected based on predetermined criteria and data were extracted from the study for meta-analysis. Twelve studies were included for meta-analysis. Our analysis revealed that FFLC is associated with less conversion to open surgery, less time of surgery, less risk of bile duct injuries and shorter duration of hospital stay compared conventional cholecystectomy in patients with difficult cholecystectomy. In conclusion, fundus first laparoscopic cholecystectomy is a safer alternative to conventional laparoscopic cholecystectomy in patients with difficult cholecystectomy.

Keywords Fundus first cholecystectomy · Conventional cholecystectomy · Feasibility

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Abbreviations

FFLC	Fundus first laparoscopic cholecystectomy
CLC	Conventional laparoscopic cholecystectomy
BDI	Bile duct injury
CVS	Critical view of safety

Introduction

The gallstone disease prevalence is up to 10–15% in the general adult population [1, 2]. Though most of the patients are asymptomatic, about 1–4% of these patients became symptomatic every year and will require treatment [1, 3]. The treatment of choice for symptomatic gall stone disease is laparoscopic cholecystectomy (LC) [4–10].

Since the introduction of LC in the 1990's, it has gained remarkable acceptance among surgeons and it is now a routine procedure for treatment of almost all gall bladder

pathologies [11–13]. LC is associated with reduction in postoperative pain, hospital stay, and recovery time. With the acceptance of LC as a treatment of choice for gall bladder diseases, there was also significant rise in bile duct injuries (BDIs) especially at the initial phase of practice of LC during which BDIs was said to be up to two times higher than open cholecystectomy [14]. However, as surgeons perfect the skill of LC, there was reduction of incidence of BDIs to 0.15–1.4% of cholecystectomies [15, 16].

The most important tool for the surgeon to perform safe cholecystectomy is knowledge of anatomy and the use of a correct technique [17, 18]. The "infundibular" technique; in which the cystic duct is identified first has been used for most cholecystectomies. As an alternative, Strasberg introduced the "Critical View of Safety" (CVS) in 1995, to reduce the risk of BDI and to avoid mistakes related to anatomical variants and inability to adapt to depth perception [17, 18]. Despite the widespread use of CVS, reduction in BDI was not recorded. Moreover, the scientific evidence supporting this technique to prevent BDI is controversial [17–21].

Other efforts at reducing BDIs include Intraoperative cholangiography, replacing the bile in the distended gallbladder with methylene blue, use of 30° laparoscope, and extra biliary reference points may play some role in allowing a safer LC [6, 22].

Fundus first laparoscopic cholecystectomy (FFLC) was first reported by Cooperman in 1990 when he utilized the approach to safely perform LC for patients with acute cholecystitis and dense adhesion around the calot's triangle which precluded safe dissection [23]. Since then, there have been numerous reports of the application of FFLC approach in patients in which severe difficulty is anticipated [23, 24]. Some surgeons reported that the FFLC may be quicker than the traditional dissection starting at the Calot's triangle, although no randomized trial has been undertaken to confirm that [9, 25, 26]. The reported advantages of the FFLC has resulted in some surgeons researching whether it should be utilized as the standard approach rather than a fallback option during difficult cholecystectomy [26].

We aim to perform this systematic review and meta-analysis to compare outcome of fundal first laparoscopic cholecystectomy with conventional laparoscopic cholecystectomy (CLC).

Methodology

This systematic review was performed in compliance with the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guideline.

Search strategy

Three reviewers (BA, SW and YA) independently searched the Pubmed, medline, google schoolar, Cochrane library and Embase databases for prospective or retrospective articles comparing outcomes of fundus first LC and conventional LC. The search terms were "retrograde cholecystectomy", "antegrade cholecystectomy", "fundus first cholecystectomy", "fundus down cholecystectomy", and "dome down cholecystectomy". Boolean logic was used to combine the keywords. Related articles and reference list were searched to avoid omission.

Study selection and inclusion criteria

1. Studies that compared the outcomes of FFLC and CLC were included.
2. Studies published in English.
3. Studies with full texts.
4. Randomized control trial, controlled clinical trial, retrospective and prospective studies were all included

Exclusion criteria

1. Conference presentations, letters to the editor, editorials and commentaries.
2. Publications in other languages apart from English.
3. Lack of relevant data or insufficient data
4. Study population less than 10

Quality assessment

Quality assessments of studies were was done by The Medical Education Research Study Quality Instrument (MERSQI) [27]. It contains ten items that reflect six domains of study quality, each domain with a maximum score of 3. The overall minimal score is 5 while the maximum score is 18. A score of 5–7 is considered insufficient quality, 8–9 is considered low quality, 10–11is considered moderate quality and those with ≥ 12 a considered high-quality.

Data extraction

Data were extracted by two reviewers separately (AA and AA). The data extracted include: authors, year of publication, country in which the study was conducted, study design, sample size of participants per group, conversion rate in each group, duration of the surgery in each group, gall bladder perforation during dissection, bile duct injuries and duration of hospital stay in each group.

Disagreements between reviewers were discussed with a third reviewer (IUG) to reach an agreement.

Statistical analysis

All statistical analyses were performed using RevMan software (version 5.4.1).

Pooled analysis

For dichotomous variables, the relative risk (RR) was calculated with 95 per cent confidence interval. For continuous variables, the weighted mean difference (WMD) or standardized mean difference (SMD) with 95 percent CI was calculated. Random effect or fixed effect model were used depending on the level of heterogeneity. Degree of heterogeneity was measured by I^2 value and a value over 50 percent was considered significant. Standard deviation was imputed from standard error, confidence interval or from *P* values if it was not given directly in the articles. Sensitivity analysis was perfomrmed by eliminating individual studies from the analysis, one at a time, to see if the overall result will change.

Subgroup analysis

Subgroup analysis is performed on studies that compared outcome of FFLC and CLC in patients with difficult cholecystectomy. There are four studies that compared outcome in difficult cholecystectomy.

Results

Description of selected studies

We identified 8841 references during the initial search. Out of these, 432 duplicates and 8376 irrelevant articles were excluded (Fig. 1). The 33 remaining references were retrieved for complete assessment. Twenty one references were excluded as they were the data were incomplete for meta-analysis. Twelve references were included for the meta-analysis. The study included two randomized controlled trial [28, 29], four retrospective studies[10, 30–32] and six prospective studies[5, 25, 26, 33–35]. The articles were published between 2004 and 2020. There were a total of 3466 patients with 2083 of these patients undergoing

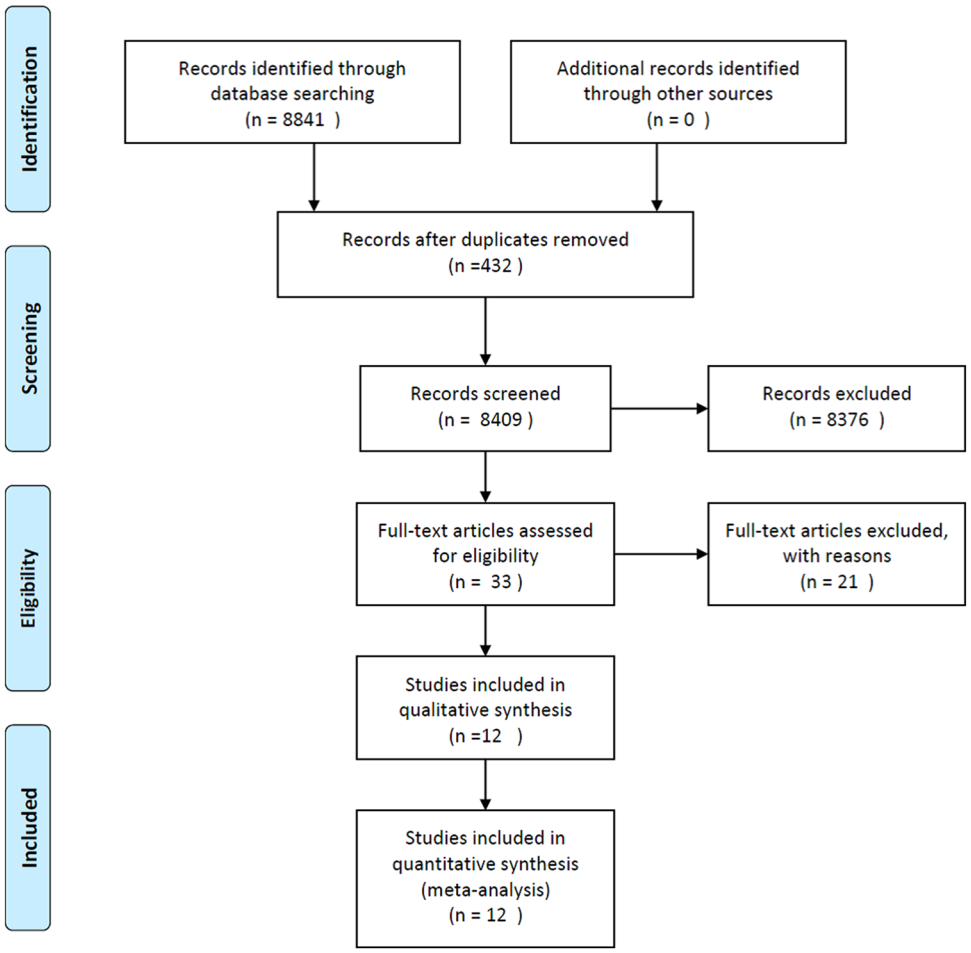

Fig. 1 Study selection process

FFLC. The endpoints differ from one study to another but they generally included: duration of surgery, duration of stay in the hospital, surgical complications like common bile duct injury, perforation of the gallbladder and rate of conversion to open surgery. There were more females recruited in to the study constituting about 87% of all participants. Both FFLC and CLC were performed using the standard four-port technique for laparoscopic cholecystectomies described by all authors except two [25, 34]. Details of selected studies were displayed in Table 1.

Comparıson of outcomes between fflc and clc

Bile duct injuries

Bile duct injuries was reported in four studies [10, 26, 33, 34] with a total of 1552 patients in FFLC and 653 patients in CLC group. Bile duct injury was seen in 1 of 1552 patients with FFLC while it was observed in 8 patients in the CLC group. The heterogeneity between studies was notsignificant with $I^2 = 9\%$ so the fixed effect was used to estimate pooled effect. The pooled RR was 0.21 with 95% CI 0.06–0.73, and significant difference was observed ($p = 0.01$) (Fig. 2).

Gallbladder perforation

Gallbladder perforation was reported in 3 studies[5, 25, 32] with a total of 210 patients in FFLC and 252 patients in CLC group. Gallbladder perforation was seen in 34 of 210 patients with FFLC, while it was observed in 20 patients in the CLC group. The heterogeneity between studies was significant with $I^2 = 90\%$ so the random effect was used to estimate pooled effect. The pooled RR was 1.70 with 95% CI 0.28–10.15, and no significant difference was observed ($p = 0.56$).

Table 1 Characteristics of included studies

S/N	Author	Year	Country	Study desıgn	Sample sıze		Outcomes compared
					FFLC	CLC	
1	Sormaz et al	2018	Turkey	Retrospective	13	197	1. Operation time 2. Hospital stay
2	Tuveri et al	2008	Italy	Retrospective	29	242	1. Conversion 2. Bile duct injuries 3. Hospital stay
3	Neri et al	2007	Italy	Retrospective	127	19	1. Gallbladder perforation 2. Conversion 3. Operation time 4. Hospital stay
4	Cengiz et al	2019	Sweden	Prospective	1425	320	1. Operation time 2. Bile duct injury 3. Conversion
5	Huang et al	2011	China	Prospective	33	31	1. Operation time 2. Conversion 3. Bile duct injury
6	Sewefy et al	2017	Egypt	Prospective	65	60	1. Conversion 2. Bile duct injury 3. Hospital stay 4. Operation time
7	Saeed et al	2020	Pakistan	Randomized control trial	41	41	Operation time
8	Gupta et al	2008	India	Prospective	45	100	1. Operation time 2. Conversion 3. Gallbladder perforation
9	Mishra et al	2019	India	Prospective	38	33	1. Conversion 2. Operation time 3. Gallbladder perforation
10	Cengiz et al	2005	Sweden	Prospective	43	37	1. Conversion 2. Operation time 3. Hospital stay
11	Tuveri et al	2009	Italy	Retrospective	70	124	1. Conversion 2. Hospital stay
12	Cengiz et al	2010	Sweden	Randomized control trial	154	79	1. Operation time 2. Gallbladder perforation

FFLC Fundus first laparoscopic cholecystectomy, *CLC* conventional laparoscopic cholecystectomy

Fig. 2 Meta-analysis of bile duct injuries in the included studies

Operation time

The overall operation time was reported in 8 studies[5, 25, 26, 28, 29, 31, 33, 34] with total of 1814 patients in the FFLC and 861 patients in the CLC group. The heterogeneity between studies was significant with $I^2 = 95\%$ so the random effect was used to estimate pooled effect. The Mean Difference (MD) was − 13.29 with 95% CI (− 21.62, − 4.95), and significant difference was observed ($p = 0.002$). The operation time is shorter in the FFLC as oppose to CLC.

Conversion to open surgery

Nine studies [5, 10, 25, 26, 30, 32–35] reported the conversion to open surgery. The studies included 1875 patients in FFLC and1066 patients in CLC group. A total of 48 patients were converted in FFLC, while 117 were converted in the CLC group. The heterogeneity between studies was significant with $I^2 = 61\%$ so the random effect was used to estimate pooled effect. The pooled RR was 0.42 with 95% CI 0.20–0.92, and a significant difference was observed ($p = 0.03$) (Fig. 3).

Hospital stay

Only two studies[31, 34] provided adequate information to be included in the analysis of hospital stay. The total numbers of patients were 78 for FFLC and 257 for CLC group. The heterogeneity between studies was not significant with $I^2 = 0\%$ so the fixed effect was used to estimate pooled effect. The Mean Difference (MD) was − 1.49 with 95% CI (− 1.93, − 1.06), and significant difference was observed ($p < 0.0001$) Those that underwent FFLC tend to have shorter hospital stay compared to CLC group.

Sub-group analysis

We performed a sub-group analysis on studies that compared outcome of FFLC and CLC in patients with difficult cholecystectomy only.

Four studies [25, 31, 33, 34], comprising of 469 patients (FFLC = 148, CLC = 321) compared outcome of FFLC to CLC in patients with difficult cholecystectomy.

Three of the four studies compared conversion rate from laparoscopic to open cholecystectomy and meta-analysis of these studies revealed that FFLC has a lower conversion rate compared to CLC. ($p < 0.0001$, $I^2 = 0\%$) [25, 33, 34]. Two of the studies compared Bile duct injuries during laparoscopic cholecystectomy and meta-analysis of these studies

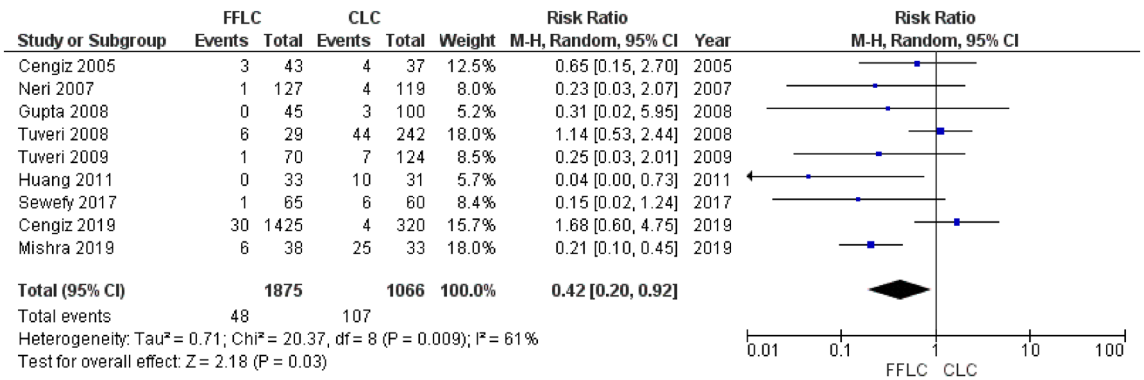

Fig. 3 Meta-analysis of the studies that reported conversion to open cholecystectomy

revealed significant difference in bile duct injury between FFLC and CLC ($p=0.02$, $I^2=0\%$) with more injuries seen among patients with CLC [33, 34].

We also performed meta-analysis of operation time among the studies that compared the outcomes among those with difficult cholecystectomy and we found that the operation time is shorter among patients that had FFLC compared to CLC. ($p<0.0001$, $I^2=96\%$).

Discussion

The current practice by most surgeons is to perform laparoscopic cholecystectomy initiating dissection from the Calot's triangle to the fundus [2, 17, 19, 20, 36]. The fundus first approach came to prominence in the early 1990's [23, 24]. Since then, it has become an alternative technique for cases in which it is difficult to dissect the Calot's triangle [37]. To the best our knowledge, this is the first systemic review and meta-analysis that aimed to compare outcome of laparoscopic cholecystectomy using the fundus first approach and the conventional approach.

This review has shown that FFLC can be safely used in patients with difficult cholecystectomy with good outcome.

We found that that though BDIs are commoner in difficult cholecystectomies that utilized the conventional approach as oppose to the fundus first approach.

Our meta-analysis also revealed that FFLC has a low conversion rate among those with difficult cholecystectomy compared to CLC with a RR of 0.42 and $p=0.03$. There is some heterogeneity between the studies included for analysis and this may be attributed to the different inclusion criteria by this studies. One of the studies[33] only included patients with contracted gall bladder in their study. Another study[30] only included patients with obesity into their study. We performed a sub-group analysis on studies that compared outcome of FFLC and CLC in patients with difficult cholecystectomy only and the finding is still the same.

There was no significant difference between FFLC and CLC when it comes to gall bladder perforation during dissection ($p=0.56$). There was also significant heterogeneity between studies with $I^2=90\%$. This was also related to the difference in inclusion criteria for the studies included.

Eight studies were included for the meta-analysis of the operation time and we found that FFLC has a shorter operation time compared to CLC in patients with difficult cholecystectomy. ($p=0.002$, Mean Difference $=-11.17$). However there was significant heterogeneity ($I^2=95\%$) between studies as only two of the studies[5, 28] defined operation time while the remaining six studies did not do that. Reduced hospital stay was one of the key advantages of laparoscopic cholecystectomy[38–43], our meta-analysis found that hospital stay after FFLC was significantly shorter that CLC.($p<0,00,001$, $I^2=0\%$, Mean difference $=-1.49$). Subgroup analysis among studies comparing FFLC and CLC among those with difficult cholecystectomy also revealed the same findings.

Conclusion

This systematic review and meta-analysis showed that fundus first laparoscopic cholecystectomy has a lower risk of conversion to open surgery, bile duct injury and shorter operation time when compared with conventional laparoscopic cholecystectomy among patients with difficult laparoscopic cholecystectomy. We also found that there is no difference between the two approaches regarding gall bladder perforation during dissection off the gallbladder fossa.

Author contributions Concept—AA, AA AND IUG; design—BA, YA AND SW; supervision—AA, SW AND IUG; resources—ALL; materials—ALL; data collection and/or processing—IUG, AA AND BA; analysis and/or ınterpretation—AA, YA AND SW; literature search—IUG, AA AND BA; writing manuscript—ALL; critical review—IUG AND AA; other—XX.

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Declarations

Conflict of interest All contributing authors must complete the ICMJE form individually and the completed forms should be submitted to the online system by the corresponding author. The form is available at http://www.icmje.org/conflicts-of-interest/ After that the information which were stated at the end of the forms must be combined and declared in this section.

Ethical approval Not needed as this is a systematic review and meta-analysis.

Informed consent Not needed as this is a systematic review and meta-analysis.

Research involving human participants and/or animals This is a meta-analysis of previously published studies, no humans or animals were used for the research. As such, this disclosure in not available.

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