



Original Research Article

Subtotal vs total cholecystectomy for difficult gallbladders: A systematic review and meta-analysis



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ABSTRACT

Introduction: With severely inflamed gallbladders, laparoscopic cholecystectomy can be difficult and may require procedures like subtotal cholecystectomy (SC). Few studies exist comparing SC and total cholecystectomy (TC) in the setting of severe biliary inflammation. This meta-analysis aims to compare SC and TC for difficult gallbladders. **Methods:** Medline-OVID, Embase-OVID, and Cinahl were searched including only studies comparing SC to TC for difficult gallbladders. Primary outcome was CBD injury. Secondary outcomes included bile leak, duodenal injury, retained stone, bleeding, intraabdominal collection, wound infection, reoperation, and mortality.

Results: Ten studies were included. Compared to TC, SC significantly lowered the risk for CBD injury (0 % vs. 1.6 %, RR 0.30, 95%CI 0.10–0.87) but increased risk of bile leaks (RR 3.5, 95%CI 1.79–6.84), postoperative ERCP (RR 2.86, 95%CI 1.53–5.35), intraabdominal collections (RR 2.55, 95%CI 1.32–4.93), and reoperation (RR 2.92, 95%CI 1.14–7.47).

Conclusion: SC is a reasonable alternative to difficult gallbladders that may decrease the risk of CBD injuries. Knowing both approaches is crucial to manage the difficult gallbladder while minimizing harm. Further studies are needed to understand the value of SC for difficult cholecystectomy.

1. Introduction

Gallstone disease is common, affecting approximately 10–15 % of the U.S population, and is often managed surgically.¹ Laparoscopic cholecystectomy (LC) is the gold standard for uncomplicated gallbladder disease with over 750,000 cases performed annually in the U.S.^{2–4} Approximately 16 % of all cholecystectomies are considered “difficult”, which represents a significant number of surgical cases annually.⁵ In patients with severe cholecystitis, there is increased risk due to severe inflammation and altered or unrecognized aberrant anatomy. These challenging scenarios are often referred to as a “difficult gallbladder”, and are associated with higher risk of significant operative complication (i.e. bile duct or major vascular injury).³ As a result, conversion to open cholecystectomy (COC) or subtotal cholecystectomy (SC) are known rescue procedures that may help complete the operation safely while minimizing harm.^{6–9}

Subtotal cholecystectomy was first described in 1955 by GF Madding when he felt total cholecystectomy was unable to be safely performed in

four of his patients.⁶ In 1993, laparoscopic subtotal cholecystectomy (LSC) was performed successfully on six patients with severe inflammatory changes.⁷ There were no reported complications subsequently. The SC approach has since emerged as an alternative approach that may lower risk of CBD injury, but increase post-operative morbidity (i.e. bile leak).^{10,11}

Since 2003, rates of subtotal cholecystectomy have more than doubled.¹² However, previous comparative studies of SC and total cholecystectomy (TC) do not exclude patients based on gallbladder inflammation severity.^{2,9,13–16} As a result, there are no comparative reviews of SC and TC specifically in the “difficult” gallbladder, which is the setting in which subtotal cholecystectomy is most practical.^{17–19} Therefore, the aim of this systematic review and meta-analysis (SRMA) is to compare SC and TC in this population.

2. Methods

This SRMA was written in accordance with PRISMA reporting guidelines.²⁰ No ethics approval was necessary for this research.

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Abbreviations

LC	laparoscopic cholecystectomy
COC	conversion to open cholecystectomy
SC	subtotal cholecystectomy
LSC	laparoscopic subtotal cholecystectomy
TC	total cholecystectomy
SRMA	systematic review and meta analysis
CBDI	common bile duct injury

We included studies specifically comparing SC to TC in the setting of severe cholecystitis. The definition of “difficult gallbladder” is not well defined, but many described cases of complicated or severe inflammatory changes in which traditional laparoscopic total cholecystectomy would be technically difficult [Table 1]. The primary outcome was common bile duct injury (CBDI). Secondary outcomes included biliary leak, duodenal injury, retained stone, vascular injury/bleeding, intra-abdominal infection, intra-abdominal fluid collection, wound infection, reoperation, and mortality.

2.1. Data acquisition

Medline-OVID, Embase-OVID, and Cinahl were searched using database specific MeSH headings and keywords prior to October 2021 [Supplemental Table 1]. We provide the following search strategy for Medline-Ovid: [(exp Cholecystectomy, Laparoscopic) OR ((laparoscop* or celioscop* or coelioscop* or abdominoscop* or peritoneoscop*) AND (cholecystecto* or colecystecto*) AND (subtotal or partial or fenestrat* or reconstitut* or insufficient or incomplete))] AND [(exp Cholecystitis/ or exp Acalculous Cholecystitis/ or exp Emphysematous Cholecystitis/ or exp Cholecystitis, Acute/) OR (complicated* or gangren* or *hemorrhag* or perf*) AND (cholecystitis or colecystitis or colecistitis*)]. No MeSH headings exist for “subtotal cholecystectomy” thus, was only incorporated into keywords during the final search. A similar search strategy was then run for EMBASE and CINAHL as seen in the Supplemental Table 1 with the provided MeSH and keywords [Supplemental Table 1].

2.2. Data screening

Included studies were collected from each database and imported into EndNote for analysis. Duplicates were removed and remaining data was subsequently transferred to Covidence systematic review software for study screening.²¹ Two authors (SSK and RJK) independently screened studies according to the inclusion criteria. Final data extraction and verification was performed by SSK and RJK prior to analysis. The PRISMA diagram outlines the screening process based on our inclusion and exclusion criteria [Supplemental Table 2].

After reviewing the study operative reports and pathology, “difficult gallbladders” were described as gangrenous, emphysematous, chronic, perforated, hydropic, or having anatomical changes making traditional LC dangerous. One study defined “difficult gallbladders” as grade three or four on the Nassar scale [Table 1].

2.3. Statistical analysis

Meta-analyses were conducted using STATA statistical software.²² Random-effects meta-analysis with risk ratios (RR) and 95 % confidence intervals (95 % CI) were computed. Significance was calculated at $p < 0.05$. Heterogeneity was examined using the I² statistic. If data allowed, exploratory subgroup analysis was also planned, a-priori, based on subtotal cholecystectomy technique (fenestrating vs reconstituting).

3. Results

Of the 4218 unique articles screened, ten studies (1911 patients) were included in the meta-analysis, three of which were abstracts.^{23–32} There were 626 SC patients, of which 476 patients underwent primary LSC (76.0 %), 93 COC (14.9 %), and 56 treated with open subtotal cholecystectomy (8.9 %). On the other hand, there were 1285 TC patients, of which 673 underwent primary LC (52.4 %), 534 COC (41.5 %), and 78 treated with open total cholecystectomy (6.1 %) [Table 2]. In the SC group, 47.8 % were female, the average age was 58.7 years,

Compared to TC, SC demonstrated significantly lower risk of CBD injury (0 % vs. 1.6 %, RR 0.30, 95 % CI 0.10–0.87) as seen in the forest plot [Fig. 1]. However, there was increased risk for post-operative bile leak (RR 3.5, 95 % CI 1.79–6.84), ERCP (RR 2.86, 95 % CI 1.53–5.35), intra-abdominal fluid collection (RR 2.55, 95 % CI 1.32–4.93), and reoperation (RR 2.92, 95 % CI 1.14–7.47) [Table 3].

Table 1
Baseline characteristics and study specific definition of difficult gallbladder.

Study	Country	Surgical Population	Patients (N)	
			Subtotal Cholecystectomy	Total Cholecystectomy
Davis et al., 2012	USA	Complicated cholecystitis consisting of mostly hydrops, gangrenous, and emphysematous gallbladders	58	58
Freddie et al., 2021 (Abstract)	USA	Severe cholecystitis	65	85
Hirajima et al., 2017	Japan	Severe cholecystitis with anatomical changes in Calot's triangle making traditional laparoscopic cholecystectomy dangerous	14	19
Ilyashenko et al., 2016 (Abstract)	Ukraine	Complicated cholecystitis with technically difficult gallbladders	96	149
Kaplan et al., 2014	USA	Complicated cholecystitis in which the original surgical approach could not be completed and conversion to open cholecystectomy or any form of subtotal cholecystectomy was required	63	151
Lee et al., 2013	Korea	Severe cholecystitis	20	68
Peker et al., 2017	Turkey	Difficult cholecystectomy in which the anatomy of Calot's triangle made it unlikely for cystic duct to be isolated or exposed patient to increased risk of CBD injury or hemorrhage (e.g., acute calculous cholecystitis, acute on chronic calculous cholecystitis, chronic calculous cholecystitis with or without cirrhosis, chronic calculous atrophic cholecystitis with dense fibrosis)	48	65
Purzner et al., 2019	Canada	Severe cholecystitis consisting of mostly gangrenous, perforated, chronic or acute on chronic cholecystitis, or Mirizzi syndrome	46	105
Loh et al., 2021	UK	Nassar scale 3 and 4; indications for operation included acute cholecystitis, acute cholangitis, acute gallstone pancreatitis	132	317
Ukhanov et al., 2011 (Abstract)	Russia	Acute destructive cholecystitis consisting of phlegmonous or emphysematous cholecystitis, gangrenous cholecystitis, cholecystitis complicated by peri vesical infiltrate or abscess.	84	268

Table 2
Distribution of surgical techniques used in each study.

Study	Surgical Technique	Subtotal Cholecystectomy	Total Cholecystectomy
Davis et al., 2012	Primary laparoscopic	–	–
	Laparoscopic converted to open	36 of 58 (62 %)	48 of 58 (83 %)
	Primary open	21 of 58 (36 %)	10 of 58 (17 %)
Freedle et al., 2021 (Abstract)	Primary laparoscopic	55 of 65 (85 %)	–
	Laparoscopic converted to open	–	85 of 85 (100 %)
	Primary open	10 of 65 (15 %)	–
Hirajima et al., 2017	Primary laparoscopic	14 of 14 (100 %)	–
	Laparoscopic converted to open	–	19 of 19 (100 %)
	Primary open	–	–
Ilyashenko et al., 2016 (Abstract)	Primary laparoscopic	96 of 96 (100 %)	–
	Laparoscopic converted to open	–	149 of 149 (100 %)
	Primary open	–	–
Kaplan et al., 2014	Primary laparoscopic	5 of 63 (8 %)	–
	Laparoscopic converted to open	46 of 63 (73 %)	151 of 151 (100 %)
	Primary open	12 of 63 (19 %)	–
Lee et al., 2013	Primary laparoscopic	–	–
	Laparoscopic converted to open	7 of 20 (35 %)	–
	Primary open	13 of 20 (65 %)	68 of 68 (100 %)
Peker et al., 2017	Primary laparoscopic	48 of 48 (100 %)	–
	Laparoscopic converted to open	–	65 of 65 (100 %)
	Primary open	–	–
Purzner et al., 2019	Primary laparoscopic	46 of 46 (100 %)	94 of 105 (89 %)
	Laparoscopic converted to open	–	11 of 105 (11 %)
	Primary open	–	–
Loh et al., 2021	Primary laparoscopic	132 of 132 (100 %)	317 of 317 (100 %)
	Laparoscopic converted to open	–	–
	Primary open	–	–
Ukhanov et al., 2011 (Abstract)	Primary laparoscopic	80 of 84 (95 %)	262 of 268 (97 %)
	Laparoscopic converted to open	4 of 84 (5 %)	6 of 268 (3 %)
	Primary open	–	–

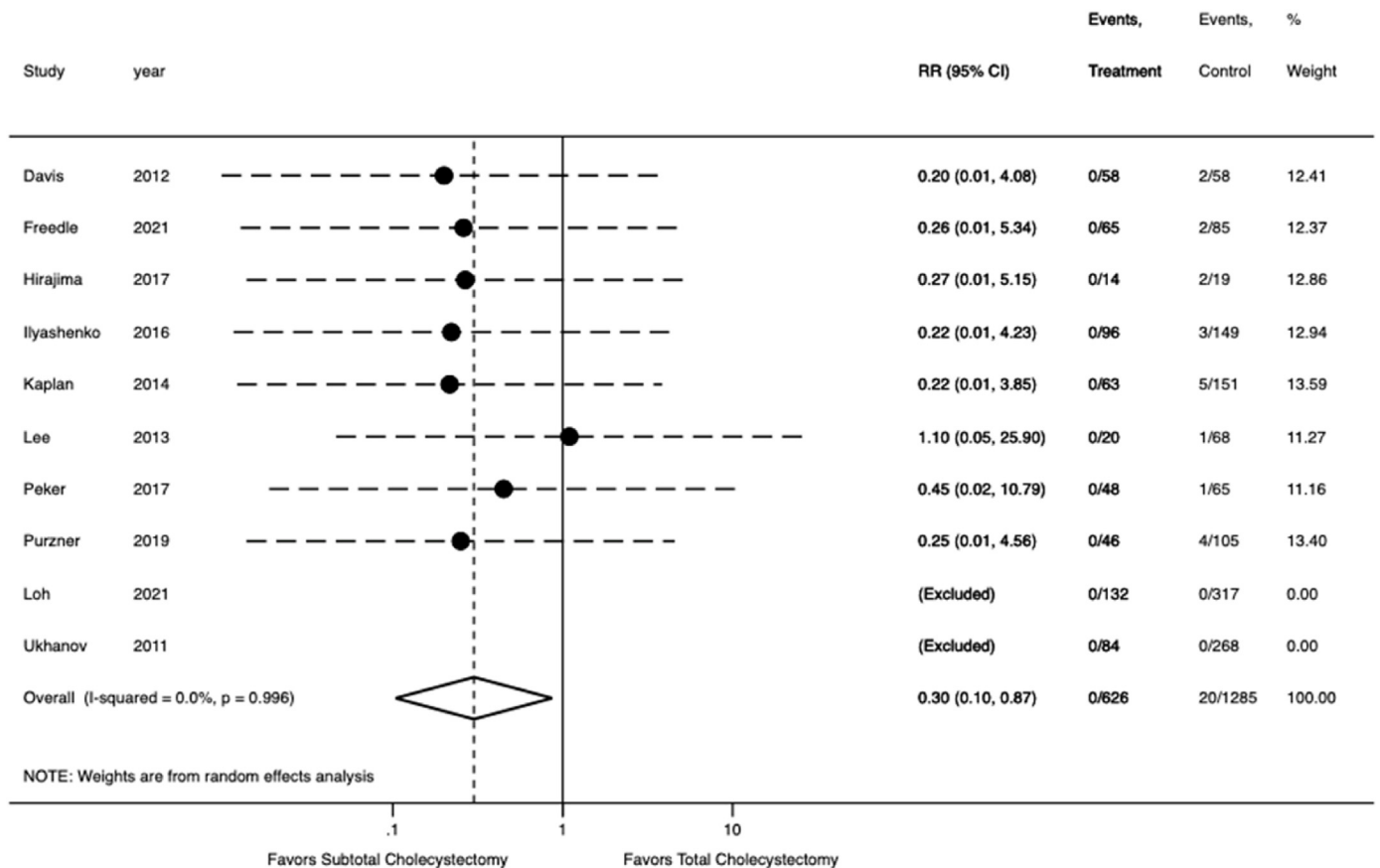


Fig. 1. Forest plot comparing subtotal to total cholecystectomy for common bile duct injury. Subtotal cholecystectomy significantly reduced the risk of CBD injury compared to total cholecystectomy (RR 0.30, 95 % 0.10–0.87).

Table 3
Post-operative outcomes of SC vs TC.

Outcomes (Number of studies)	Subtotal Cholecystectomy	Total Cholecystectomy	RR (95 % CI)	I2 (%)
CBD Injury (10)	0 of 626 (0 %)	20 of 1285 (1.6 %)	0.30 (0.10, 0.87)	0
Duodenal Injury (4)	0 of 301 (0 %)	4 of 591 (0.84 %)	0.40 (0.07, 2.45)	0
Bile Leak (6)	23 of 361 (6.4 %)	13 of 715 (1.8 %)	3.50 (1.79, 6.84)	0
Retained Stone (6)	8 of 367 (2.2 %)	9 of 764 (1.2 %)	1.82 (0.67, 4.94)	0
Post-operative ERCP (4)	22 of 256 (8.6 %)	17 of 548 (2.9 %)	2.86 (1.53, 5.35)	0
Vascular injury and/or bleeding (3)	1 of 176 (0.57 %)	10 of 301 (3.3 %)	0.43 (0.06, 3.30)	28.8
Intrabdominal infection (4)	7 of 183 (3.8 %)	7 of 293 (2.4 %)	1.41 (0.49, 4.10)	0
Intrabdominal fluid collections (4)	18 of 289 (6.2 %)	15 of 638 (2.4 %)	2.55 (1.32, 4.93)	0
Wound infection (6)	5 of 249 (2.0 %)	24 of 466 (5.2 %)	0.67 (0.28, 1.56)	0
Reoperation (3)	8 of 198 (4.0 %)	8 of 490 (1.8 %)	2.92 (1.14, 7.47)	0
Mortality (6)	2 of 436 (0.46 %)	7 of 965 (0.93 %)	1.19 (0.33, 4.34)	0

Table 4
Proportion of IOC and intraoperative drain.

Study	Intraoperative Cholangiogram (IOC)		Intraoperative Drain	
	Subtotal Cholecystectomy	Total Cholecystectomy	Subtotal Cholecystectomy	Total Cholecystectomy
Davis 2012	10 of 58 (17 %)	35 of 58 (60 %)	51 of 58 (88 %)	22 of 58 (38 %)
Freedle 2021 (Abstract)	NI	NI	NI	NI
Hirajima 2017	NI	NI	3 of 14 (21 %)	NI
Ilyashenko 2016 (Abstract)	NI	NI	NI	NI
Kaplan 2014	NI	NI	NI	NI
Lee 2013	NI	NI	4 of 20 (20 %)	NI
Peker 2017	NI	NI	NI	NI
Purzner 2019	1 of 46 (2 %)	NI	30 of 46 (65 %)	36 of 105 (34.3 %)
Loh 2021	17 of 132 (13 %)	75 of 317 (24 %)	128 of 132 (97 %)	195 of 317 (62 %)
Ukhanov 2011 (Abstract)	NI	NI	NI	NI
Total	28 of 236 (12 %)	110 of 375 (29 %)	216 of 270 (80 %)	253 of 480 (53 %)

*NI: Not included.

Eight patients required reoperation in the SC group. Reoperations occurred for a biliary fistula, unspecified peritonitis, retained stone, wound infection, bowel obstruction, laparoscopic washout of bile leak and ERCP, intra-abdominal hematoma, and biloma.^{28,30,31} In the TC group, eight patients required reoperation-one for unspecified peritonitis, two for wound infections, one for a CBDI, and the remaining four were not specified.^{28,30,31}

Three studies reported use of intraoperative cholangiogram (IOC) in 28 patients (12 %) in the SC group and 110 patients (29 %) in the TC group. Five studies reported intraoperative drain placement in 216 (34.5 %) SC patients and 253 (19.7 %) TC. The remaining studies did not report on IOC or drain use [Table 4].

Publication bias was also explored using a funnel plot for the primary outcome of CBD injury [Supplemental Table 3]. The funnel plot was not fully symmetrical with some evidence of missing studies in the bottom left of the funnel plot. Based on this plot, publication bias can be suspected but cannot be definitively ruled in. This is because publication bias is only one of many factors (e.g. effect size, heterogeneity, number of studies) that affects funnel plot symmetry.

4. Discussion

Gallbladder disease and cholecystectomy are among the most common surgical problems and procedures performed worldwide. One of the most dreaded complications of cholecystectomy is common bile duct injury—the rates of which are between 0.2 % and 1.4 % and carry potentially devastating consequences for the patient.^{33–35} In the literature, the definition of “difficult gallbladder” is not standardized, however the challenges and morbidity of this real world entity is well-known.

For difficult gallbladders, we found the risk of CBDI may be lowered with the SC, however this was also associated with higher rates of post-operative bile leak, ERCP, intra-abdominal fluid collection, and reoperation—which is similar to other studies.^{18,36} The incidence of CBDI in both groups was low (0 % SC versus 1.6 % TC)—however CBDI can be

associated with significant morbidity and need for additional procedures. Flum et al. previously suggested that CBDI may be associated with an increase in 5-year mortality rate by three-fold.³⁵ Although CBDI rates are low, the resultant morbidity from CBDI is often more substantial than the morbidities typically associated with SC (i.e. bile leak, ERCP, fluid collection)—at least one study reported higher reoperation rates in the TC group to address the CBDI definitely, as well as higher rates of secondary biliary cirrhosis.⁸

In our study, bile leaks were more common in the SC group. Poorly controlled leaks may progress to biliary fistulas, abscesses, peritonitis, and/or sepsis. However, cystic duct stump or gallbladder remnant leaks are readily addressed with drainage and ERCP and do not carry the same challenges of CBDI.³⁷ In fact, transient biliary leaks often occur after fenestrating SC from the cystic duct stump, and frequently resolve spontaneously. Yet, there is a possibility that more clinically insignificant bile leaks were noted because there was a higher rate of drains placed in the SC group among the studies that were included in our study.

Use of intraoperative cholangiogram and post-operative drains was poorly reported in our reviewed studies. Generally, there was an increased use of IOC in TC patients, which may help identify challenging anatomy and CBDI, but not prevent it. Drains were also used more frequently in SC patients, which may help identify and treat post-operative bile leaks. Unfortunately, significant information on IOC and drains was not consistent over the reviewed studies and comparisons were non-significant.³⁸ Finally, the distinction of fenestrating or reconstituting SC was not well-reported in the included studies.

Therefore, SC represents a valuable alternative approach to minimize the risk of CBD injury in severely inflamed gallbladders. Our results are similar to other reviews, however this is the first and only to study SC specifically in the difficult or severely inflamed gallbladder whereas others compare techniques in the setting of uncomplicated cholecystitis¹⁷ or are non-comparative.^{18,19}

5. Limitations

This study has several limitations. The definition for the “difficult gallbladder” is not standardized in the literature and is determined subjectively (i.e. by the comfort and experience of the operating surgeon). We searched the literature for patients with cholecystitis, treated by laparoscopic cholecystectomy, who were found to have severe (i.e. gangrenous, emphysematous, hemorrhagic, etc) cholecystitis intra-operatively—which when many surgeons are able to confirm the diagnosis of what we feel is a “difficult gallbladder”.

This SRMA includes studies up until October 2021, during which the use of and comfort for laparoscopic SC has grown and evolved. We are limited by the best available data and the quality and completeness of the studies that are reviewed. The included studies were also observational, demonstrated overall heterogeneity, and had moderate to high risk of bias [Supplemental Table 4].

6. Conclusion

Subtotal cholecystectomy is a viable alternative approach to “difficult gallbladders” that may help decrease the risk of major complications such as common bile duct injury, while increasing risk of secondary complications with relatively less associated morbidity. It is important to know both approaches to safely and successfully manage this condition while minimizing harm.

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CRediT authorship contribution statement

Sylvia S.J. Koo: Conceptualization, Data curation, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. **Rohin J. Krishnan:** Data curation, Formal analysis, Methodology, Software, Writing – original draft. **Kyle Ishikawa:** Formal analysis, Methodology. **Masako Matsunaga:** Formal analysis, Methodology. **Hyeong Jun Ahn:** Formal analysis, Methodology. **Kenric M. Murayama:** Supervision, Validation. **Riley K. Kitamura:** Supervision, Validation, Writing – review & editing.

Declaration of competing interest

None

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.amjsurg.2023.12.022>.

References

- Stinton LM, Shaffer EA. Epidemiology of gallbladder disease: cholelithiasis and cancer. *Gut Liver*. Apr 2012;6(2):172–187. <https://doi.org/10.5009/gnl.2012.6.2.172>.
- Kim Y, Wima K, Jung AD, Martin GE, Dhar VK, Shah SA. Laparoscopic subtotal cholecystectomy compared to total cholecystectomy: a matched national analysis. *J Surg Res*. Oct 2017;218:316–321. <https://doi.org/10.1016/j.jss.2017.06.047>.
- MacFadyen Jr BV, Vecchio R, Ricardo AE, Mathis CR. Bile duct injury after laparoscopic cholecystectomy. The United States experience. *Surg Endosc*. Apr 1998;12(4):315–321. <https://doi.org/10.1007/s004649900661>.
- Pucher PH, Brunt LM, Davies N, et al. Outcome trends and safety measures after 30 years of laparoscopic cholecystectomy: a systematic review and pooled data analysis. *Surg Endosc*. May 2018;32(5):2175–2183. <https://doi.org/10.1007/s00464-017-5974-2>.
- Kimura Y, Takada T, Strasberg SM, et al. TG13 current terminology, etiology, and epidemiology of acute cholangitis and cholecystitis. *J Hepatobiliary Pancreat Sci*. Jan 2013;20(1):8–23. <https://doi.org/10.1007/s00534-012-0564-0>.
- Madding GF. Subtotal cholecystectomy in acute cholecystitis. *Am J Surg*. Mar 1955;89(3):604–607. [https://doi.org/10.1016/0002-9610\(55\)90108-2](https://doi.org/10.1016/0002-9610(55)90108-2).
- Bickel A, Shtamler B. Laparoscopic subtotal cholecystectomy. *J Laparoendosc Surg*. Aug 1993;3(4):365–367. <https://doi.org/10.1089/lps.1993.3.365>.
- Chavez-Villa M, Dominguez-Rosado I, Figueroa-Mendez R, De Los Santos-Perez A, Mercado MA. Subtotal cholecystectomy after failed critical view of safety is an effective and safe bail out strategy. *J Gastrointest Surg*. Oct 2021;25(10):2553–2561. <https://doi.org/10.1007/s11605-021-04934-1>.
- Roesch-Dietlen F, Perez-Morales AG, Martinez-Fernandez S, Diaz-Roesch F, Gomez-Delgado JA, Remes-Troche JM. Safety of laparoscopic subtotal cholecystectomy in acute cholecystitis. Experience in Southeast Mexico. Oct - Dec *Rev Gastroenterol Mex (Engl Ed)*. 2019;84(4):461–466. <https://doi.org/10.1016/j.rgmx.2018.11.012>.
- Seguridad de la colecistectomía subtotal laparoscópica en colecistitis aguda. Experiencia en el sureste de México.
- Ibrahim R, Abdalkodous M, Mahendran B, Mownah OA, Nawara H, Aroori S. Subtotal cholecystectomy: is it a safe option for difficult gall bladders? *Ann R Coll Surg Engl*. Nov 25 2021. <https://doi.org/10.1308/rcsann.2021.0291>.
- Nzenwa IC, Mesri M, Lunevicius R. Risks associated with subtotal cholecystectomy and the factors influencing them: a systematic review and meta-analysis of 85 studies published between 1985 and 2020. *Surgery*. Oct 2021;170(4):1014–1023. <https://doi.org/10.1016/j.surg.2021.03.036>.
- Sabour AF, Matsushima K, Love BE, et al. Nationwide trends in the use of subtotal cholecystectomy for acute cholecystitis. *Surgery*. Mar 2020;167(3):569–574. <https://doi.org/10.1016/j.surg.2019.11.004>.
- Lidsky ME, Speicher PJ, Ezekian B, et al. Subtotal cholecystectomy for the hostile gallbladder: failure to control the cystic duct results in significant morbidity. *HPB (Oxford)*. Jun 2017;19(6):547–556. <https://doi.org/10.1016/j.hpb.2017.02.441>.
- Beldi G, Glattli A. Laparoscopic subtotal cholecystectomy for severe cholecystitis. *Surg Endosc*. Sep 2003;17(9):1437–1439. <https://doi.org/10.1007/s00464-002-9128-8>.
- Nakajima J, Sasaki A, Obuchi T, Baba S, Nitta H, Wakabayashi G. Laparoscopic subtotal cholecystectomy for severe cholecystitis. *Surg Today*. 2009;39(10):870–875. <https://doi.org/10.1007/s00595-008-3975-4>.
- Tamura A, Ishii J, Katagiri T, Maeda T, Kubota Y, Kaneko H. Effectiveness of laparoscopic subtotal cholecystectomy: perioperative and long-term postoperative results. *Hepato-Gastroenterology*. Sep 2013;60(126):1280–1283. <https://doi.org/10.5754/hge13094>.
- Elshaer M, Gravante G, Thomas K, Sorge R, Al-Hamali S, Ebdewi H. Subtotal cholecystectomy for “difficult gallbladders”: systematic review and meta-analysis. *JAMA Surg*. Feb 2015;150(2):159–168. <https://doi.org/10.1001/jamasurg.2014.1219>.
- Toro A, Teodoro M, Khan M, et al. Subtotal cholecystectomy for difficult acute cholecystitis: how to finalize safely by laparoscopy—a systematic review. *World J Emerg Surg*. Sep 8 2021;16(1):45. <https://doi.org/10.1186/s13017-021-00392-x>.
- Henneman D, da Costa DW, Vrouenraets BC, van Wagenveld BA, Lagarde SM. Laparoscopic partial cholecystectomy for the difficult gallbladder: a systematic review. *Surg Endosc*. Feb 2013;27(2):351–358. <https://doi.org/10.1007/s00464-012-2458-2>.
- Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. *BMJ*. Jul 21 2009;339:b2700. <https://doi.org/10.1136/bmj.b2700>.
- Covidence systematic review software, veritas health innovation, Melbourne, Australia. Available at: www.covidence.org.
- StataCorp. *Citing Stata Software, Documentation, and FAQs*. Stata Statistical Software: Release 17. College Station, TX: StataCorp LLC; 2021.
- Davis B, Castaneda G, Lopez J. Subtotal cholecystectomy versus total cholecystectomy in complicated cholecystitis. *Am Surg*. Jul 2012;78(7):814–817.
- Freedle C, Rahesh J, Holder K, Dhanasekara S, Dissanaik S. Bailout procedures for the difficult gallbladder: comparing outcomes of laparoscopic sub-total fenestrated cholecystectomy, with open cholecystectomy. *JACS*. 2021;233(5):S87 (1).
- Hirajima S, Koh T, Sakai T, et al. Utility of laparoscopic subtotal cholecystectomy with or without cystic duct ligation for severe cholecystitis. *Am Surg*. Nov 1 2017;83(11):1209–1213.
- Grubnik VV, Ilyashenko VV, Prikupenko VV, V GV. Subtotal cholecystectomy versus total cholecystectomy in complicated cholecystitis. *Surg Endosc*. 2016;30:S38.
- Kaplan D, Inaba K, Chouliaras K, et al. Subtotal cholecystectomy and open total cholecystectomy: alternatives in complicated cholecystitis. *Am Surg*. Oct 2014;80(10):953–955.
- Lee W. Experience with partial cholecystectomy in severe cholecystitis. *Korean J Hepatobiliary Pancreat Surg*. Nov 2013;17(4):171–175. <https://doi.org/10.14701/kjhbps.2013.17.4.171>.
- Peker KD, Alis H. Laparoscopic subtotal cholecystectomy could Be an alternative to conversion. *Medical Journal of Bakirkoy*. 2017;13(3):113–117.
- Purzner RH, Ho KB, Al-Sukhni E, Jayaraman S. Safe laparoscopic subtotal cholecystectomy in the face of severe inflammation in the cystohepatic triangle: a retrospective review and proposed management strategy for the difficult gallbladder. *Can J Surg*. Dec 1 2019;62(6):402–411. <https://doi.org/10.1503/cjs.014617>.
- Loh AYH, Chean CS, Durkin D, Bhatt A, Athwal TS. Short and Long Term Outcomes of Laparoscopic Fenestrating or Reconstituting Subtotal Cholecystectomy versus Laparoscopic Total Cholecystectomy in the Management of Acute Cholecystitis. Oxford: HPB; Sep 24 2021. <https://doi.org/10.1016/j.hpb.2021.09.018>.
- Ukhanov AP, Chakhmakhchev SR, Ignatjev A, et al. Laparoscopic subtotal cholecystectomy in treatment of severe acute cholecystitis. *Surg Endosc*. 2011;25:S30.

33. Calvete J, Sabater L, Camps B, et al. Bile duct injury during laparoscopic cholecystectomy: myth or reality of the learning curve? *Surg Endosc*. Jul 2000;14(7): 608–611. <https://doi.org/10.1007/s004640000103>.
34. Mangieri CW, Hendren BP, Strode MA, Bandera BC, Faler BJ. Bile duct injuries (BDI) in the advanced laparoscopic cholecystectomy era. *Surg Endosc*. Mar 2019;33(3): 724–730. <https://doi.org/10.1007/s00464-018-6333-7>.
35. Flum DR, Cheadle A, Prael C, Dellinger EP, Chan L. Bile duct injury during cholecystectomy and survival in medicare beneficiaries. *JAMA*. Oct 22 2003; 290(16):2168–2173. <https://doi.org/10.1001/jama.290.16.2168>.
36. Braschi C, Tung C, Tang A, et al. Early outcomes of subtotal vs total cholecystectomy for acute cholecystitis. *JAMA Surg*. Sep 14 2022;157(11):1062–1064. <https://doi.org/10.1001/jamasurg.2022.3146>.
37. Tzovaras G, Peyser P, Kow L, Wilson T, Padbury R, Tooouli J. Minimally invasive management of bile leak after laparoscopic cholecystectomy. *HPB (Oxford)*. 2001; 3(2):165–168. <https://doi.org/10.1080/136518201317077189>.
38. van Dijk AH, Donkervoort SC, Lameris W, et al. Short- and long-term outcomes after a reconstituting and fenestrating subtotal cholecystectomy. *J Am Coll Surg*. Sep 2017; 225(3):371–379. <https://doi.org/10.1016/j.jamcollsurg.2017.05.016>.