Case Report
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Use of a laparoscopic linear stapler as a bailout strategy in difficult laparoscopic cholecystectomy

Abstract

Background: Difficult laparoscopic cholecystectomy (LC) with failure to obtain the Critical View of Safety (CVS) is associated with an increased risk of bile duct injury (BDI) and often necessitates bailout strategies.

Objective: To evaluate the role of laparoscopic linear staplers (LLS) as a bailout strategy during difficult LC when CVS cannot be achieved, focusing on prevention of major BDI (primary outcome) and on conversion to open surgery, postoperative complications, and length of hospital stay (LOS) (secondary outcomes).

Methods: A structured literature review was performed across PubMed/MEDLINE, Scopus, Web of Science, Embase, the Cochrane Library, Dimensions, and open-access databases. Studies published between January 2000 and July 2026 in English or Spanish of adult patients undergoing difficult LC in which LLS were used to control the cystic duct and/or complete a subtotal cholecystectomy as a bailout in the setting of failed CVS or hostile Calot's triangle. Data extracted comprised patient characteristics, indications, operative technique, stapler use, conversion, postoperative complications, and length of stay. Owing to heterogeneity, a descriptive synthesis was undertaken.

Results: The review identified retrospective cohorts, case series, and technical reports including patients with complex biliary pathology. LLS were most commonly employed for dilated, short, or friable cystic ducts and for reconstituting subtotal cholecystectomy. Across series, only one case of BDI was attributable to LLS-assisted bailout. Selective LLS use was associated with low conversion rates, acceptable overall complication rates, and LOS generally comparable to or shorter than that observed after conversion to open surgery, although bile leak, stone migration, and remnant gallbladder syndrome were reported.

Conclusion: In selected patients with difficult LC and failed CVS, LLS appear to be a useful bailout adjunct that may help preserve a minimally invasive approach. However, current evidence is limited to heterogeneous observational studies. LLS use should be restricted to experienced surgeons within a broader strategy of safe bailout, pending prospective multicenter studies with standardized outcome reporting.

Keywords: laparoscopic cholecystectomy; laparoscopic stapler; bailout surgery; critical view of safety; bile duct injury

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Background

Laparoscopic cholecystectomy (LC) is the gold-standard treatment for benign gallbladder disease but carries a higher risk of bile duct injury (≈0.5%), about 2–3 times that of open cholecystectomy.[1]

Nevertheless, surgeons frequently encounter difficult cholecystectomy, characterized by acute inflammation, fibrosis, or dense adhesions within Calot's triangle that obscure normal anatomy. Failure to achieve the Critical View of Safety (CVS) represents a pivotal intraoperative threshold that substantially increases the risk of bile duct injury (BDI). When safe dissection cannot be achieved, bailout procedures, including subtotal cholecystectomy or conversion to open surgery, are recommended. Although conversion has traditionally been considered the standard bailout strategy, it is associated with increased pain, longer operative time, greater blood loss, and prolonged hospital stay. In this setting, the laparoscopic linear stapler (LLS) may be a minimally invasive alternative for managing complex operative scenarios.[1–4]

Stapling devices are particularly useful for closure of the cystic duct when it is dilated (>1 cm), short, or friable. These are situations in which conventional clips may be inadequate or may predispose to postoperative bile leakage. Likewise, they facilitate reconstituting subtotal cholecystectomy by providing closure of the gallbladder remnant while avoiding intracorporeal suturing, but requires advanced laparoscopic skills and may be unreliable in inflamed or fragile tissues. Several studies have also demonstrated their usefulness in the management of cholecystoenteric fistulas, where uniform staple-line closure may improve perioperative outcomes. Despite these advantages, several technical considerations must be taken into account. Including the potential migration of gallstones during stapler firing if adequate pre-compression is not performed. The purpose of this structured literature review with narrative analysis was to evaluate the role of LLS as a bailout strategy during difficult LC, focusing on prevention of major BDI (primary outcome) and its association with conversion to open surgery, postoperative complications, and length of stay (secondary outcomes).

Materials and methods

In this review, LLS use is considered a bailout strategy during difficult LC when employed to control the cystic duct and/or complete a subtotal cholecystectomy in the setting of failed CVS or hostile Calot's triangle. The literature search included PubMed/MEDLINE, Scopus, Web of Science, Embase, the Cochrane Library, Dimensions,

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and Open Access databases. Medical Subject Headings (MeSH) and free-text terms, including *difficult cholecystectomy*, *laparoscopic cholecystectomy*, *laparoscopic stapler, laparoscopic linear stapler, surgical stapler*, *subtotal cholecystectomy*, *bail-out strategy*, and *rescue technique*, were combined using the Boolean operators AND and OR.

Studies published between January 2000 and May 2026 in either English or Spanish were considered eligible. The study population included adult patients undergoing difficult laparoscopic cholecystectomy. Eligible publications comprised retrospective and prospective observational studies, case series, and case reports describing the technical use of laparoscopic linear staplers and the associated surgical outcomes. Pediatric studies, duplicate publications, and articles lacking specific information regarding the use of LLS in difficult biliary surgery were excluded. Data extraction was independently performed by the same two reviewers, and discrepancies were resolved by consensus. It included patient demographics, surgical indications, operative technique, stapling device characteristics, conversion to open surgery, postoperative complications, and length of hospital stay. Owing to the heterogeneity of the included studies, a descriptive synthesis of the available evidence was performed. The primary outcome was the occurrence of major bile duct injury (requiring endoscopic or surgical repair). Secondary outcomes included conversion to open cholecystectomy, overall and specific postoperative complications (bile leak, hemorrhage, reintervention) and postoperative length of hospital stay.

Results

Study characteristics and patient population.

The structured literature review identified retrospective cohort studies, case series, and technical reports describing the use of laparoscopic linear staplers as one of the bailout options during difficult laparoscopic cholecystectomy. The study population consisted primarily of adult patients with complex biliary disease, including Tokyo Guidelines (TG18) grade II and III acute cholecystitis, Mirizzi syndrome, and cholecystoenteric fistulas. Across the included studies, patients requiring bailout surgery were generally older, had higher Charlson Comorbidity Index (CCI) scores, and more frequently had a history of previous abdominal surgery. These factors were consistently associated with greater operative difficulty and increased technical complexity during laparoscopic cholecystectomy.[4–6]

Surgical indications and failure to achieve the critical view of safety

The LLS was most commonly used when the CVS could not be safely achieved because of severe inflammation, advanced fibrosis, or dense adhesions involving Calot's triangle. Higher Nassar grades, particularly grades 4 and 5, were consistently identified as independent predictors of failure to obtain the CVS (OR 18.44) and of the subsequent need for bailout procedures.[6] The principal technical indications for stapler use included difficult cystic ducts characterized by marked dilatation (>1 cm), edema, friability, or short length, all of which limited the safe application of conventional clips.[7,8,11] Additional indications included closure of the gallbladder remnant during reconstituting subtotal cholecystectomy and the management of complex biliary anatomy, such as cholecystocolic fistulas, cholecystoduodenal fistulas, and type V Mirizzi syndrome.[5,8,9]

Surgical technique and stapling devices

The most frequently reported technique involved the use of Endo-GIA® or Tri-Staple™ laparoscopic linear staplers equipped with either 2.5-mm vascular cartridges or 3.5-mm medium-thickness tissue cartridges, selected according to the thickness of the cystic duct or gallbladder wall.[7,10,11] During reconstituting subtotal cholecystectomy, stapling devices were used as one of the available methods for secure closure of the gallbladder remnant in inflamed or friable tissues.[5] In patients with cholecystoduodenal fistulas, several authors described laparoscopic stapled closure of the duodenal defect using a patch fashioned from the preserved gallbladder wall as part of the reconstructive procedure.[8]

Nevertheless, some authors emphasized that additional dissection may occasionally be required to safely position the stapler in patients with severely distorted anatomy or advanced inflammatory changes and avoid remnant syndrome.[8,11,18]

Conversion rate and length of hospital stay

The included studies evaluated different laparoscopic bailout strategies, including subtotal cholecystectomy, stapler-assisted techniques, intracorporeal manual suturing, and conversion to open surgery.[5,8,9,12] In the comparative study by Huang et al., conversion rates reached 44.4% among patients managed with laparoscopic suturing, whereas no conversions occurred in the stapler-assisted group.[9] Similarly, several studies demonstrated shorter operative times when staplers were employed compared with conversion to open surgery (146 vs. 175 minutes) and with laparoscopic manual suturing (72.5 vs. 115 minutes).[5,9] Reported hospital stay ranged from 3.4 to 9 days, varying according to the bailout strategy adopted and the characteristics of each study population. [5,8] Taken together, these observations suggest that selective use of LLS as a bailout strategy may contribute to lower conversion rates and shorter hospital stay compared with conversion to open surgery, while maintaining an acceptable safety profile in terms of BDI and other postoperative complications.[6,8,9] Although limited to patients with cholecystoduodenal fistulas, Huang et al. demonstrated that stapler-assisted closure may simplify technically demanding reconstructive procedures while maintaining favorable postoperative outcomes.[9]

Postoperative outcomes and safety considerations

Across the included series, only one case of major bile duct injury directly attributable to inappropriate stapler application was reported, although the observational design and small sample sizes limit the ability to accurately quantify this risk.[13]

These findings should be interpreted in the context of contemporary population-based evidence indicating that the overall risk of BDI during standard LC is approximately 0.5%, which is two- to three-fold higher than that reported for open cholecystectomy, underscoring the critical importance of any strategy that safely mitigates BDI during difficult cases.[15]

The reviewed literature suggests that laparoscopic linear staplers are associated with favorable perioperative and postoperative outcomes in appropriately selected patients.[5,11,13] However, several procedure-specific complications have also been described. Postoperative bile leakage has been reported in 1.1% to 13% of patients and was generally managed successfully with conservative treatment or endoscopic retrograde cholangiopancreatography

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(ERCP).[5,8] Another recognized concern is migration of gallstones into the common bile duct during stapler firing when adequate pre-compression and evacuation of cystic duct stones are not performed potentially leading to postoperative biliary pancreatitis.[14] In addition, reconstituting subtotal cholecystectomy carries a small but recognized risk of gallbladder remnant syndrome, characterized by recurrent stone formation within the residual gallbladder stump, with a reported incidence ranging from 3.1% to 3.3%.[5,12] These findings underscore the importance of careful patient selection, meticulous surgical technique, thorough evacuation of gallstones before stapler application, and a clear understanding of the technical limitations of stapling devices during difficult biliary surgery. Although LLS-related complications such as bile leakage, retained stones, or remnant gallbladder syndrome have been described, they generally appear manageable with endoscopic or minimally invasive approaches and must be weighed against the substantially more severe consequences of a major BDI.[14,16,17]

Discussion

This structured literature review demonstrates that the LLS represents a valuable bailout option in some cases of difficult laparoscopic cholecystectomy when the **CVS** cannot be achieved. Consistent with the prospective observations of Nassar et al., intraoperative findings rather than preoperative characteristics ultimately determine whether the Critical View of Safety can be safely achieved and whether a bailout strategy becomes necessary.[7] The available evidence allows its role to be examined from three complementary perspectives: its contribution to bailout surgery, its technical applications in complex biliary anatomy, and the safety considerations associated with its use (Figure 1)[5,7]

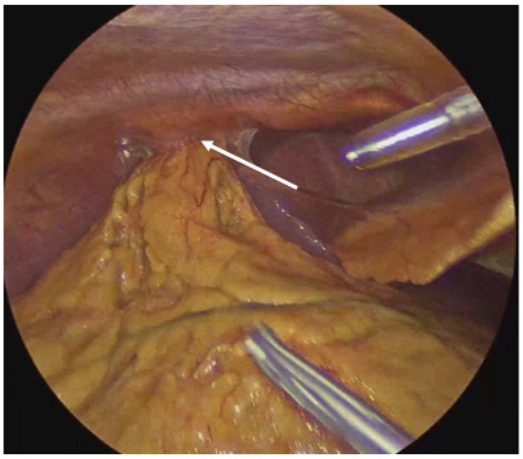

Figure 1 Difficult cholecystectomy, with acute inflammation, fibrosis, and dense adhesions. Nassar Difficulty Grade V, associated with Csendes Type III Mirizzi Syndrome, gangrenous cholecystitis with fundus sealed perforation to the abdominal wall (white arrow).

Bailout surgery and prevention of bile duct injury

International recommendations emphasize that when the CVS cannot be safely achieved, surgeons should abandon further dissection in a hostile Calot's triangle and proceed to a defined bailout strategy—such as subtotal cholecystectomy or early conversion to open—in order to minimize the risk of BDI.[6,7] Our findings align with this paradigm and suggest that, in selected patients, LLS-assisted techniques may facilitate bailout completion of LC, thereby potentially reducing the likelihood of major BDI compared with persisting with hazardous dissection (Figure 2).[6,8]

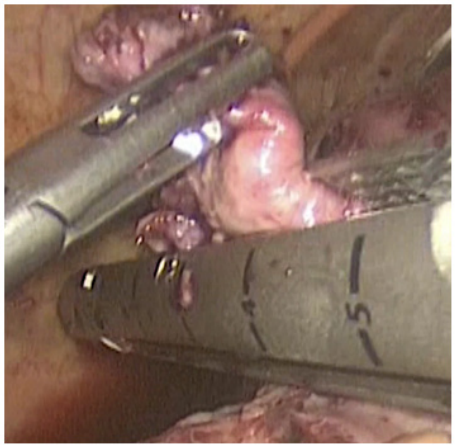

Figure 2 Laparoscopic linear stapler as an alternative for managing complex scenarios during laparoscopic cholecystectomy. (Evacuation of gallstones in the cystic duct was performed before stapler application.)

Large population-based data in severe cholecystitis further indicate that among patients requiring a bailout procedure, conversion to open surgery is associated with the highest 1-year BDI rate (4.4%), whereas laparoscopic subtotal cholecystectomy and laparoscopic cholecystostomy demonstrate substantially lower BDI rates (0.8% and 0.3%, respectively), despite higher subsequent biliary intervention rates.[15] Within this broader context, LLS-assisted subtotal or reconstituting procedures can be viewed as part of a spectrum of laparoscopic bailout strategies that may help preserve a minimally invasive approach while prioritizing prevention of BDI.[6,15]

Failure to obtain the CVS should prompt the surgeon to abandon further dissection within a hostile Calot's triangle and adopt the safest available bailout strategy rather than persist with increasingly hazardous maneuvers.[1–3,6,7] This principle has become one of the fundamental concepts in contemporary biliary surgery. The studies included in this review compared several bailout approaches, including conversion to open surgery, subtotal cholecystectomy, and laparoscopic linear stapler-assisted techniques. Kitasaki et al. reported that conversion to open surgery was associated with greater blood loss, longer operative time, and higher postoperative morbidity than laparoscopic bailout procedures. Long-term population-based data further demonstrate that the consequences of the selected bail out strategy extend well beyond the immediate postoperative period, reinforcing the importance of selecting the manifest minimally invasive bailout whenever feasible.[15]

Ramírez-Giraldo et al.[12] reported that conversion to open surgery was associated with greater blood loss, longer hospital stay, and a higher incidence of major bile duct injury than selected laparoscopic bailout procedures. These findings suggest that, in appropriately selected patients, the LLS may facilitate completion of the procedure while avoiding further dissection within a severely inflamed or fibrotic Calot's triangle.[7] Nevertheless, the currently available evidence is derived predominantly from observational studies, and therefore these findings should be interpreted with appropriate caution, taking into account patient selection and intraoperative decision-making. Consistent with previous reports, higher Nassar grades—particularly grades 4 and 5—were strongly associated with failure to obtain the Critical View of Safety and with the subsequent need for bailout surgery.[5,7] In these circumstances, stapler-assisted closure, subtotal cholecystectomy, or conversion to open surgery should not be viewed as competing techniques but rather as complementary options whose

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selection depends on intraoperative findings, surgeon experience, and patient safety.[5,6,12]

Technical applications in difficult cystic ducts and cholecystoenteric fistulas

The available literature consistently identifies the LLS as particularly useful in patients with markedly dilated, edematous, shortened, or friable cystic ducts, in whom conventional clips may not provide reliable closure. Under these circumstances, stapling devices offer a reproducible method for secure occlusion of the cystic duct or closure of the gallbladder remnant during reconstituting subtotal cholecystectomy, potentially reducing the need for advanced intracorporeal suturing in severely inflamed tissues. Morales Díaz et al.[8] reported slightly longer operative times in stapler-assisted procedures likely reflecting greater procedural complexity rather than the use of the stapler itself. Importantly, no increase in postoperative complications attributable to stapler use was observed. Similarly, Huang et al.[9] described successful laparoscopic closure of cholecystoduodenal fistulas using stapling devices. Compared with intracorporeal suturing, stapler application was associated with significantly shorter operative time (72.5 vs. 115 minutes) and no postoperative duodenal leaks in their series. Although these findings are encouraging, in this subgroup they should be interpreted cautiously because of the limited sample size and observational design of the available studies.[8,9,12]

Safety considerations and technical limitations

Despite the favorable outcomes reported in several series, LLS are not free of technical limitations or potential complications. Chaudery et al.[14] and Odabasi et al.[17] stated the possibility of stone migration to the cystic and common bile duct if precompression is not maintained before firing the stapler. Such migration may result in retained common bile duct stones or postoperative biliary pancreatitis.[16] Several additional technical considerations deserve emphasis. Safe stapler deployment requires insertion through a 12-mm trocar, adequate working space for opening and positioning the device, and meticulous confirmation that neither the common bile duct nor adjacent vascular structures are inadvertently included within the stapler jaws before firing.[10,18,19] Accordingly, the LLS should not be regarded as a routine substitute for meticulous dissection or standard clip ligation. Rather, it should be considered a selective bailout tool that may enhance operative safety when conventional techniques are no longer feasible and safe completion of the procedure requires an alternative strategy.

The centrality of BDI prevention is underscored by contemporary series showing that BDIs after LC, although infrequent, have devastating clinical and medico-legal consequences, and remain more common than after open cholecystectomy.[1,19] Notably, even with newer technologies such as robotic-assisted cholecystectomy, recent data suggests a higher adjusted BDI rate compared with standard laparoscopic cholecystectomy (0.38% vs 0.18%), highlighting that any novel technique must be critically evaluated against its impact on BDI before widespread adoption.[15] Accordingly, LLS use should not be regarded as a routine alternative to careful dissection and clip ligation but as a selective bailout adjunct whose primary justification is the avoidance of major BDI when conventional techniques are no longer safe or feasible.[6,7]

Clinical implications

In all cases of difficult laparoscopic cholecystectomy, the surgeon is obliged first to optimize the anatomy. When the CVS cannot be obtained it is necessary to change the strategy. The principal objective in these cases is not necessarily to complete a total cholecystectomy, but rather to avoid major bile duct injury while safely resolving the patient's biliary disease.[6] From this perspective, the LLS broadens the surgeon's armamentarium of bailout strategies and may contribute to preserving the minimally invasive approach in selected patients. Based on the evidence identified in this review and current principles of safe cholecystectomy, we propose a practical decision-making algorithm illustrating the potential role of laparoscopic linear staplers within the broader spectrum of bailout strategies during difficult laparoscopic cholecystectomy (Fig. 3). However, its successful use depends on appropriate patient selection, accurate intraoperative judgment, familiarity with the device, and strict adherence to the principles of safe biliary surgery. Future prospective multicenter studies with standardized outcome reporting are needed to better define the indications, long-term outcomes, and comparative effectiveness of stapler-assisted bailout procedures relative to other established bailout strategies or new technologies.[15,18]

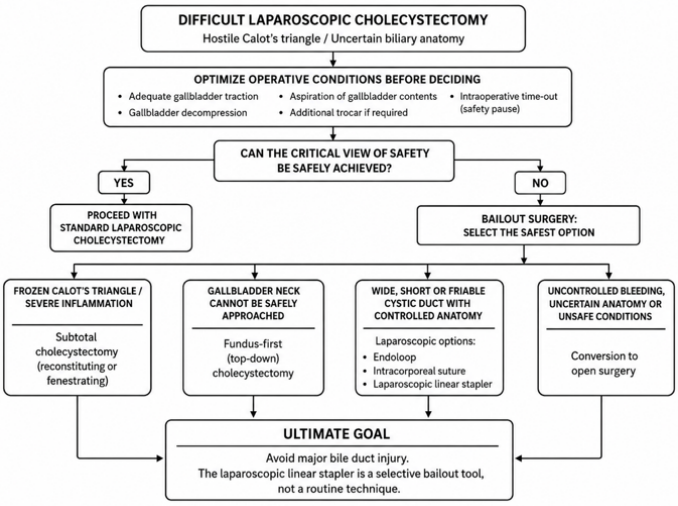

Figure 3 Practical Algorithm for Difficult Laparoscopic Cholecystectomy.

Conclusion

The laparoscopic linear stapler appears to be a safe and effective bailout option in carefully selected patients undergoing difficult laparoscopic cholecystectomy. Its ability to provide secure closure of a wide or friable cystic duct and of the gallbladder remnant during reconstituting subtotal cholecystectomy may facilitate preservation of the minimally invasive approach while reducing the morbidity associated with conversion to open surgery. Rather than replacing established bailout strategies, the stapler should be considered part of the surgical armamentarium available when safe dissection cannot be achieved. Appropriate patient selection, sound intraoperative judgment, meticulous surgical technique, and strict adherence to the principles of safe biliary surgery remain the cornerstones for preventing major bile duct injury. Further prospective multicenter studies are warranted to better define the optimal indications, long-term outcomes, and comparative effectiveness of stapler-assisted bailout procedures.

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Conflicts of interest

The authors declare that they have no conflicts of interest related to this work.

AI disclosure

Artificial intelligence (ChatGPT, OpenAI) was used as a writing and editorial support tool to improve the clarity of the English language, refine the scientific writing, assist with manuscript organization, and help verify the consistency between cited references and the corresponding statements in the text. All scientific decisions, interpretation of the evidence, final content, and responsibility for the manuscript remained exclusively with the authors.

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