Original Article

Effectiveness of Early Versus Delayed Surgical Intervention in Bile Duct Injury Post Cholecystectomy

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ABSTRACT

Objective: To compare the clinical outcomes of early versus delayed surgical repair in patients with post-cholecystectomy bile duct injury (BDI).

Study Design: Prospective observational study

Place and Duration of Study: This study was conducted at the General Surgery Department of Hayatabad Medical Complex, Peshawar from June 2023 to December 2024.

Methods: A total of 45 patients with BDI were divided into an early intervention group (n=22; definitive repair within 6 weeks) and a delayed intervention group (n=23; repair after ≥6 weeks following conservative management). Patients diagnosed with BDI were included in the study. All patients were managed with Roux-en-Y hepaticojejunostomy performed by hepatobiliary surgeons. We evaluated intraoperative parameters, postoperative complications, hospital stay, and long-term outcomes. Statistical analysis was performed using SPSS version 25, with $p<0.05$ considered significant.

Results: The results show mean age is 47.3 ± 12.1 years, with a male-to-female ratio of 1:1.5. Most BDIs occur after laparoscopic cholecystectomy were included in study. The early intervention group experience significantly higher postoperative complication rates compared to the delayed group (40.9% vs. 17.4%, p=0.03), including bile leaks, surgical site infections, and sepsis. Hospital stay is longer in the early group (12.5 ± 3.8 vs. 9.2 ± 2.6 days, p=0.01). There are no significant differences in operative time, blood loss, intraoperative complications, or long-term outcomes such as anastomotic stricture and recurrent cholangitis. The delay in intervention group has a higher, though not statistically significant, overall success rate (91.3% vs. 81.8%, p=0.43).

Conclusion: Delayed surgical repair of post-cholecystectomy BDIs is associated with fewer postoperative complications and shorter hospital stays without compromising long-term outcomes. These findings support a delayed repair approach after initial resuscitation and inflammation resolution.

Key Words: Bile duct injury, cholecystectomy, hepaticojejunostomy, early repair, delayed repair, surgical outcomes

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INTRODUCTION

Laparoscopic surgery has been regarded as the standard treatment for symptomatic gallstone disease because it reduces perioperative pain and the need for analgesics, shortens hospital stays, and allows patients to return to normal activities more quickly than open surgery[1]. Cholecystectomy is one of the most common abdominal operations performed worldwide. Bile duct injury (BDI), which happens in roughly 0.3–1.5% of procedures, is a rare but dangerous complication even though it is usually safe[2]. These are devastating injuries with sequelae extending beyond the early postoperative period[3].

BDI comprises a spectrum of lesions extending from partial laceration to complete transection or ischemic destruction of the ducts, frequently complicated by associated vascular injury[4]. In severe cases, reconstruction of biliary continuity often requires complex operations such as hepaticojejunostomy[5]. Even if successful, it is associated with long-term complications such as secondary biliary cirrhosis, recurrent cholangitis, anastomotic strictures and poor quality of life.[6]

One of the most contentious issues in the treatment of BDI is when definitive surgical repair should be performed. There are basically two main ways to handle this issue: delay repair, which is typically done after six weeks[7], and early repair, which is typically thought of as those cases done two weeks (≤14 days)

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following injury. Proponents of early repair emphasize the ability to reduce psychological anxiety in patients, prevent subsequent biliary injury, and manage chronic inflammation[8]. Decompression of acute inflammation and oedema, according to proponents of delayed repair, provides a better plane for dissection with a lower risk of postoperative morbidity[9].

Owing to significant inflammation, maximal tissue softening, and the lowest threshold for technical failure, the intermediate phase—which falls between these two categories of treatments and usually takes place two to six weeks following injury—is normally the least preferred of all[10]. The clinical state of the patient, the degree of anatomical injury, the availability of skilled hepatobiliary surgeons, and institutional knowledge all play a role in the scheduling decision.

In addition to having severe financial and quality-of-life ramifications for healthcare systems, bile duct injury is a rare complication of cholecystectomy that can have catastrophic effects on patients. Both early and late surgical repairs are viable therapeutic alternatives; but, in this particular case as well, the best time to proceed will rely on consensus. While delayed repair may provide a potentially safer reconstruction, early repair may stop the advancement of biliary injury. However, the intermediate window is likewise thought to have unsolvable technical issues. Therefore, it is essential to evaluate the advantages and effectiveness of early versus late repair in this subgroup in order to guide clinical practice and enhance patient-centered outcomes for patients undergoing cholecystectomy with BDI.

METHODS

This prospective observational study was conducted at the department of general surgery, Hayatabad Medical Complex in Peshawar over a period of 18 months (June 2023 to December 2024). Patients that sustained a BDI following cholecystectomy were included in the study. A total of 45 patients with post-cholecystectomy BDI were enrolled. Patients were divided into two groups:

Early intervention group (n=22): Assuming local sepsis and patient optimization, participants in the early intervention group had definitive surgical repair within 6 weeks of injury.

Delayed intervention group (n=23): Patients in the delayed intervention group were treated conservatively for six weeks with endoscopic or percutaneous drainage, while the inflammation decreased before thrombin-based repair.

The diagnosis of bile duct injury was made using radiographic evidence, biochemical markers (elevated bilirubin/liver enzymes), and clinical suspicion (jaundice, bile leak, abdominal pain, or fever). Ultrasound, MRCP (Magnetic Resonance Cholangiopancreatography), and contrast-enhanced CT were often used imaging modalities as needed. In some cases, ERCP was performed for ductal mapping and, if practical, temporary drainage or stenting.

Consultant liver and hepatobiliary surgeons carried out all procedures. Roux-en-Y hepaticojejunostomy was the conventional surgical treatment for large BDIs. To guarantee the best plane for accurate anastomosis, all patients underwent intraoperative cholangiography and a meticulous dissection of the hepatic stump. The amount of blood loss, operative time, intraoperative complications, and the operative findings were recorded.

Immediate postoperative complications such bile leak, sepsis, surgical site infection, and reoperation were among the measured postoperative outcomes. Anastomotic stricture, recurrent cholangitis, and the requirement for further intervention through imaging and clinical and laboratory follow-up were assessed as long-term outcomes. Every patient had a follow-up from six months to one year.

A standardized proforma was used to gather the data, and SPSS version 25 was used for analysis. Age, length of surgery, and length of hospital stay were examples of continuous variables that were presented as mean with standard deviation. Categorical variables (such as reconstruction success and complication rates) were analyzed using the chi-square test. At $p < 0.05$, the significance level was set. The Hayatabad Medical Complex Ethical Review Committee gave their approval to the study. Informed consent papers were signed by each participant.

RESULTS

The mean age of patients was 47.3 ± 12.1 years, with a male-to-female ratio of 1:1.5. The majority of BDIs occurred following laparoscopic cholecystectomy (82.2%), while the remaining were post-open cholecystectomy (17.8%).

Table No.1: Baseline Characteristics of Study Participants

Variable	Early Intervention	Delayed Intervention	p-value
Age (years), mean ± SD	46.5 ± 11.8	48.1 ± 12.4	0.65
Gender (male: female)	9:13	8:15	0.78
Type of Cholecystectomy			
- Laparoscopic (%)	18 (81.8%)	19 (82.6%)	0.59
- Open (%)	4 (18.2%)	4 (17.4%)	
Injury Type (Strasberg Classification)			
- Type E1 (%)	6 (27.3%)	5 (21.7%)	0.42
- Type E2 (%)	9 (40.9%)	11 (47.8%)	
- Type E3 (%)	5 (22.7%)	4 (17.4%)	
- Type E4 (%)	2 (9.1%)	3 (13.1%)	

All patients underwent Roux-en-Y hepaticojejunostomy (HJ) as the definitive surgical procedure. The early intervention group had a significantly higher rate of postoperative complications (40.9% vs. 17.4%, p=0.03), including bile leaks, surgical site infections, and sepsis. The delayed intervention group had fewer complications and no reoperations required. Patients in the early intervention group had a longer hospital stay (12.5 vs. 9.2 days, p=0.01), likely due to higher complication rates.

Table No.2: Intraoperative and Postoperative Outcomes

Outcome	Early Intervention	Delayed Intervention	p-value
Operative Time (min), mean ± SD	185.4 ± 32.6	172.8 ± 28.9	0.18
Blood Loss (mL), mean ± SD	320 ± 85	290 ± 78	0.21
Intraoperative Complications	2 (9.1%)	1 (4.3%)	0.61
Postoperative Complications			
- Bile Leak (%)	3 (13.6%)	1 (4.3%)	**0.03**
- Surgical Site Infection (%)	4 (18.2%)	2 (8.7%)	
- Sepsis (%)	2 (9.1%)	1 (4.3%)	
- Reoperation (%)	2 (9.1%)	0 (0%)	
Hospital Stay (days), mean ± SD	12.5 ± 3.8	9.2 ± 2.6	**0.01**

Patients were followed for 6–12 months postoperatively to assess long-term complications, particularly anastomotic strictures and recurrent cholangitis. There was no statistically significant difference in long-term stricture rates or recurrent cholangitis between the two groups. However, the delayed intervention group had a numerically higher overall success rate (91.3% vs. 81.8%), though this was not statistically significant.

Table No.3: Long-Term Outcomes

Outcome	Early Intervention (n=22)	Delayed Intervention (n=23)	p-value
Anastomotic Stricture (%)	4 (18.2%)	2 (8.7%)	0.42
Recurrent Cholangitis (%)	3 (13.6%)	1 (4.3%)	0.34
Need for Reintervention (%)	3 (13.6%)	1 (4.3%)	0.34
Overall Success Rate (%)	18 (81.8%)	21 (91.3%)	0.43

DISCUSSION

The optimal timing for repair of bile duct injuries following cholecystectomy is a debate in hepatobiliary surgery. This is a valuable study that addresses the existing and controversial concepts of BDI management through comparison early Vs delayed surgical intervention. This extensive discussion is then followed by the assessment of our results in contrast with recent literature to critically consider consistent and inconsistent findings divergent from those reported here, and suggest possible explanations for between-study discrepancy.

Postoperative complication rates were a great way to distinguish between different intervention timings in our study. The study by Guerra et al[11], where the early vs. delayed was 35% to 18%, further supports this comparison. As a result, these parallels across many trials support the idea that the best outcomes from HBP surgery are achieved when inflammation following biliary trauma is managed prior to beginning restoration of a complex bile duct injury. Some explanation for this is provided by the classic work of Kambakamba et al[12] which found that early repairs are unsuccessful mainly because of continued periductal inflammation with eventual anastomotic breakdown. Additionally, our data on individual complications and the nearly three-fold higher incidence of bile leaks following early surgery (13.6 vs. 4.3%) are consistent with De Reuver et al.'s findings in the Dutch Bile Duct Injury Registry, which point to a suspect anastomosis due to acute edema and friability[13].

However, the advantages of delayed repair in our study extend beyond immediate postoperative morbidity; patients who underwent surgery after 48 hours also appeared to have a noticeably lower length of hospital stay (9.2 vs. 12.5 days). The cost-effectiveness analysis cited in Yang et al[14], whose model likewise indicated significant cost reductions if practice delayed because patients incur lower expenditures from complications, is consistent with this finding. However, this somewhat contradicts the findings of the Giuliante et al[15] study, which found no difference in the duration of hospitalization between the early and delayed timing groups.

During our cohort's follow-up, we observed a trend favoring the delayed group in terms of anastomotic stricture development, but no significant difference between the early and delayed groups (18.2% vs. 8.7%). This result lies somewhere between what is reported in the literature, Iannelli et al[16] demonstrated a significantly higher risk of strictures in early repair (23% vs 9%), whereas long-term patency rates were equal with or without early repair in Sreepathi et al[17]. These contradictory findings could be the result of a change in the biliary reconstruction technique. The conclusive early repair (ER) technique applied by our surgical team employed meticulous mucosa-to-mucosa approximation under magnification as opposed to a high-vs undiscriminating anastomosis that might still be possible even if mild inflammation is present.

The absence of an associated reduction in long-term stricture rates in response to the higher complication rate associated with early treatment was of special interest. Recently, two theories have been put out in the literature to explain this seeming paradox. Many early complications, including transient bile leakage, can be effectively handled without compromising long-term anastomotic function, as demonstrated by Kapoor et al[18]. According to the study by Torreta et al[19], timing may not be as important as the surgeon's experience and hospital volume. This could help to explain why, at our high-volume center, both groups have comparatively good long-term outcomes despite having different early morbidity profiles.

A few key points need to be taken into consideration when interpreting the safety and effectiveness of delayed repair in light of our findings. At first, the prospective method had a significant advantage in elective cases, but we agreed with a study of another researcher that certain clinical circumstances called for early management. Full biliary obstruction, which cannot be overcome with stenting, or unremittent sepsis despite adequate drainage are examples of situations in which one should think about deviating from the recommended delayed approach, according to the clinical decision tree in algorithms of the Americas Hepato-Pancreato-Biliary Association (AHPBA)[20]. Given that this only occurred under specific circumstances, this qualified viewpoint enables us to assess our overall results in favor of a delayed repair with minimal concern about an occasional need for the earlier intervention.

This study has limitations, including a single-center study design and a relatively small sample size (n = 45), which reduces the probability of generalizability compared to a larger multi-center trial; selective non-randomized allocation introduces the possibility of selection bias based on timing decisions that reflect clinical factors rather than protocol; strictures may develop after 6–12 months, leaving late strictures beyond a year in the follow-up interval. Further future research in larger RCTs with longer follow-up periods, improved patient selection using biomarkers like Claassen's cytokine profiling, and the inclusion of quality-of-life parameters to help more fully define surgical success over postoperative outcomes are all necessary to support recommendations for integrating these tools as aids to support individualized, timely decision-making.

CONCLUSION

We conclude that delayed (> 6 weeks) repair post-cholecystectomy bile duct injuries result in less morbidity and shorter postoperative hospital stays with similar long-term outcomes. This adds to mounting evidence for delayed repair when clinically feasible as it allows inflammation to settle and probably minimizes comorbidities. Conversely, our findings also show that in the hands of an experienced surgeon early repair may still result in good outcomes indicating that some portion of the risks associated with early intervention are mitigated by surgical expertise.

Recommendations: Further randomized, multi-center studies with extended follow-up are recommended to validate and generalize these findings.

Author's Contribution:

Concept & Design or acquisition of analysis or interpretation of data:	Rumman Khan, Musarrat Hussain, Yousaf Jan
Drafting or Revising Critically:	Aqib Ali Khan, Gohar Ali, Ammar Asadullah Khan
Final Approval of version:	All the above authors
Agreement to accountable for all aspects of work:	All the above authors

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