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Original Research Article

PROSPECTIVE ASSESSMENT OF LIVER FUNCTION RECOVERY FOLLOWING SURGICAL BILIARY DECOMPRESSION IN OBSTRUCTIVE JAUNDICE: INSIGHTS FROM A TERTIARY CARE CENTRE

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Abstract

Background: Obstructive jaundice, marked by bilirubin accumulation due to impaired bile flow, presents a complex challenge. Its diverse aetiologies, including choledocholithiasis, biliary strictures, and malignancies, create a multifaceted clinical landscape. Surgical biliary decompression is a crucial intervention, but the extent of liver recovery post-obstruction remains unclear. The liver's vital functions, including detoxification, nutrient metabolism, and immune regulation, are severely impacted by obstructive jaundice. Coagulation disturbances, malnutrition, and susceptibility to infections are common consequences. This study explores the restoration of liver function after surgical intervention in obstructive jaundice, addressing critical clinical and physiological questions. **Materials and Methods:** This prospective cross-sectional study, conducted at a Tertiary care hospital from January 2019 to December 2022, aimed to evaluate the restoration of liver function in adult patients with obstructive jaundice undergoing surgical biliary decompression. The study included demographic and clinical data collection, preoperative assessments, various biliary decompression procedures, and postoperative follow-up assessments at regular intervals up to 6 months. Outcome measures encompassed changes in serum bilirubin levels, clinical jaundice resolution, improvements in liver function parameters, and time to liver function normalization. Data were analysed using repeated-measures ANOVA. **Results:** The study enrolled 80 adult patients with obstructive jaundice undergoing surgical biliary decompression. The majority were male (60%), with various aetiologies of jaundice, including choledocholithiasis (35%), biliary strictures (30%), and malignant tumours (25%). Following biliary decompression, there was a significant decrease in mean serum bilirubin levels, from 8.7 mg/dL at baseline to 0.8 mg/dL at 6 months. Liver function parameters, including AST, ALT, ALP, and INR, improved significantly over time ($p < 0.001$). The median time to bilirubin normalization was 4 weeks, while AST, ALT, ALP, and INR normalized within 2, 2, 4, and 1 week, respectively. Surgical approach impacted the time to bilirubin and INR normalization, with ERCP showing the fastest response. Complications included surgical site infection (13.8%), bile leak (6.3%), bleeding (6.3%), pancreatitis (3.8%), and others (2.5%). **Conclusion:** In conclusion, our study demonstrates that surgical biliary decompression effectively restores liver function in cases of obstructive jaundice. The rapid reduction in serum bilirubin levels, sustained clinical resolution, and improvements in liver function parameters affirm the effectiveness of the selected interventions.

INTRODUCTION

Obstructive jaundice, a clinical condition marked by the accumulation of bilirubin in the bloodstream due to impaired bile flow, presents a multifaceted challenge to patients and healthcare providers alike. It is a manifestation of various underlying aetiologies, including choledocholithiasis, biliary strictures, and malignant tumours, making it a condition of diverse clinical presentations and complexities.[1] Surgical intervention, often in the form of biliary decompression, plays a pivotal role in alleviating the obstruction and reestablishing normal bile flow, offering a lifeline to patients grappling with this debilitating condition. However, the impact of obstructive jaundice on liver function, as well as the extent to which the liver can recover following biliary decompression, remains a subject of intense research and clinical interest.[1,2]

The liver is an organ of paramount importance, orchestrating an array of vital physiological processes. These functions include detoxification, metabolism of nutrients, synthesis of essential proteins such as clotting factors and albumin, and regulation of bile production; all of which are profoundly influenced by the presence of a normally functioning biliary system.[2,3] In obstructive jaundice, the delicate balance of these processes is disrupted, primarily due to the accumulation of toxic bile constituents, impaired bilirubin excretion, and perturbations in metabolic pathways. Consequently, hepatic dysfunction ensues, with a cascade of repercussions that extend far beyond the liver itself.[3,4]

One of the most conspicuous manifestations of hepatic dysfunction in obstructive jaundice is the derangement of coagulation factors, often leading to a bleeding diathesis. Additionally, malnutrition can develop due to impaired digestion and absorption of fats and fat-soluble vitamins.[5] The immune system also bears the brunt, as the liver is instrumental in the production of acute-phase proteins and immunoglobulins, rendering patients with obstructive jaundice susceptible to infections.[6] Furthermore, the intricate web of metabolic disturbances in this condition can result in an assortment of metabolic abnormalities, including electrolyte imbalances and hyperlipidemia. Thus, it becomes evident that the consequences of obstructive jaundice are not confined to the liver alone but encompass a broad spectrum of systemic manifestations.[5,6]

While the primary goal of surgical intervention in obstructive jaundice is to alleviate biliary obstruction and relieve the distressing symptoms of jaundice, the question of whether and to what extent liver function can be restored remains paramount.[7,8] The process of liver recovery following biliary decompression is complex and dynamic, influenced by various factors such as the duration and severity of obstruction, the presence of underlying liver disease, and the patient's overall health status. Understanding the dynamics of liver recovery is not only essential for optimizing clinical management but also holds the potential to deepen our comprehension of liver physiology and regenerative mechanisms.[8,9] So, in this study we aimed to evaluate the restoration of liver function in cases of surgical obstructive jaundice after biliary decompression.

MATERIALS AND METHODS

Study Design and Patient Selection

This prospective cross-sectional study was conducted among adult patients (aged 18 years or older) with Diagnosis of obstructive jaundice necessitating surgical intervention, and scheduled for biliary decompression procedures at a Tertiary care hospital, from January 2019 to December 2022 under the department of General Surgery. The study protocol was approved by the Institutional Review Board (IRB) at Informed consent was obtained from all study participants. Patients with advanced hepatic decompensation or cirrhosis; and incomplete medical records or inability to provide informed consent were excluded from the study.

Sample Size Calculation

Universal sampling method was used and number of eligible patients during defined study period were included in the study.

Data Collection

Demographic and clinical data were collected from eligible participants using standardized data collection forms. Data points included age, gender, underlying etiology of obstructive jaundice, duration of jaundice, comorbidities, and preoperative laboratory parameters, including serum bilirubin levels, liver function tests, and coagulation profiles.

Surgical Procedures

Prior to any surgical intervention, each patient underwent a thorough preoperative assessment, which included a detailed medical history, physical examination, and review of radiological imaging. Radiological investigations, such as abdominal ultrasound, computed tomography (CT), magnetic resonance cholangiopancreatography (MRCP), or endoscopic retrograde cholangiopancreatography (ERCP), were employed to determine the site and nature of the biliary obstruction.

The choice of the specific biliary decompression procedure was made by a multidisciplinary team consisting of gastroenterologists, hepatobiliary surgeons, and interventional radiologists. The selection was based on the following factors: Aetiology of Obstruction: The underlying cause of obstructive jaundice, such as choledocholithiasis, biliary strictures, or malignant tumours, influenced the choice of procedure. Anatomical Considerations: The anatomical location of the obstruction, as determined by radiological imaging, guided the selection between Endoscopic (Endoscopic Retrograde Cholangiopancreatography) or

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Percutaneous (Percutaneous Transhepatic Biliary Drainage) approaches. Patient's Clinical Condition: The patient's overall health status, comorbidities, and fitness for surgery were assessed to ensure that the chosen procedure was appropriate and safe. In select cases where ERCP or PTBD was deemed insufficient or contraindicated, surgical intervention was performed [Common Bile Duct Exploration (CBDE) or Hepaticojejunostomy including Cholecystectomy as needed].

All surgical procedures were conducted under the strict supervision of experienced surgeons and with intraoperative monitoring of vital signs. Any intraoperative complications, such as bleeding, perforation, or technical difficulties, were duly noted, and appropriate measures were taken to manage them. After the biliary decompression procedure, patients received postoperative care in accordance with established clinical protocols. This included pain management, antibiotics if indicated, and close monitoring of vital signs. Early ambulation and resumption of oral intake were encouraged to promote recovery. Comprehensive records of each surgical procedure were maintained, including operative notes, details of therapeutic interventions performed, any intraoperative findings, and any complications encountered.

Follow-Up Assessments

Postoperative follow-up assessments were scheduled at regular intervals, including at 1 week, 1 month, 3 months, and 6 months after the biliary decompression procedure. During each visit, clinical evaluations were performed, and laboratory investigations were conducted to assess liver function, including serum bilirubin levels, liver enzymes, prothrombin time (PT), and international normalized ratio (INR). In addition, patients were assessed for clinical symptoms, complications, and any requirement for further interventions.

Outcome Measures

The outcome measures included Changes in serum bilirubin levels over time, Resolution of clinical jaundice, Improvement in liver function parameters, and Time to normalization of liver function.

Statistical Analysis

Data were analyzed using SPSS 20.0. Changes in laboratory parameters over time were analyzed using repeated-measures ANOVA. Statistical significance was defined as $p < 0.05$.

Ethical Considerations

This study was conducted in accordance with the principles outlined in the Declaration of Helsinki and Good Clinical Practice guidelines. Patient confidentiality was maintained, and all data were anonymized to protect the privacy of study participants.

RESULTS

In our study, a total of 80 patients were included and analyzed. The mean age of the study cohort was 56.0 years, with a standard deviation (SD) of 7.5 years, indicating a relatively homogeneous age distribution. Gender distribution revealed that 60.0% of the participants were male, while 40.0% were female. The aetiology of jaundice varied among the patients, with 35.0% of cases attributed to choledocholithiasis, 30.0% to biliary strictures, and 25.0% to malignant tumours. The duration of jaundice, represented by the median and interquartile range (IQR), was 15 days (IQR: 11-21), reflecting the varying durations of presentation. Regarding the surgical approach, the majority of patients (45.0%) underwent endoscopic procedures, specifically Endoscopic Retrograde Cholangiopancreatography (ERCP), while 30.0% underwent Percutaneous Transhepatic Biliary Drainage (PTBD). Surgical intervention was performed in 25.0% of cases, emphasizing the diversity of approaches employed in addressing obstructive jaundice in our study population (Table 1).

The analysis of serum bilirubin levels at different time points revealed a significant trend in our study. At the baseline, patients presented with a mean serum bilirubin level of 8.7 mg/dL, with a standard deviation (SD) of 2.5 mg/dL. Over the course of treatment and follow-up, a noteworthy decrease in serum bilirubin levels was observed. At one-week post-surgical intervention, the mean serum bilirubin level had notably reduced to 4.2 mg/dL (±1.8), signifying a rapid initial improvement in liver function. As time progressed, further improvement was evident. At one month, the mean serum bilirubin level decreased to 2.1 mg/dL (±1.2), reflecting a continued positive trend. The most substantial improvement was observed at the three-month mark, with the mean serum bilirubin level dropping to 1.2 mg/dL (±0.9). This significant reduction underscores the effectiveness of the chosen interventions in resolving obstructive jaundice and restoring liver function. Sustained progress was noted at the six-month follow-up, where the mean serum bilirubin level further decreased to 0.8 mg/dL (±0.6), indicative of near normalization of liver function. These findings suggest a progressive and substantial improvement in liver function over time, as demonstrated by the significant reduction in serum bilirubin levels from baseline to the six-month mark (Figure 1).

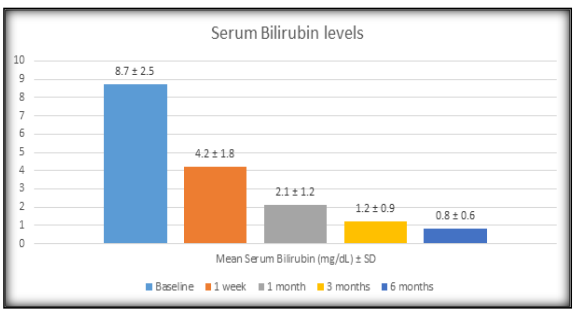

Figure 1: Changes in Serum Bilirubin Levels Over Time among Study Participants.

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The evaluation of clinical outcomes and the resolution of jaundice at various time points following surgical interventions revealed promising results. At one-week post-surgery, a substantial proportion of patients, accounting for 81.3%, demonstrated clinical resolution of jaundice. This initial response underscored the effectiveness of the selected interventions in rapidly alleviating jaundice-related symptoms. As time progressed, the percentage of patients experiencing jaundice resolution continued to increase significantly. By the one-month follow-up, an impressive 93.8% of patients had experienced clinical resolution, further corroborating the positive impact of the interventions on their liver function and overall well-being. The three-month assessment showed continued progress, with 97.5% of patients achieving clinical jaundice resolution. This milestone highlighted the sustained and substantial improvement in liver function over the medium term following surgical interventions. The study's long-term results were particularly encouraging, as at the six-month mark, a remarkable 100.0% of patients had achieved clinical resolution of jaundice. This complete resolution suggests the effectiveness of the selected treatment strategies in restoring liver function and improving the overall quality of life for the study participants. These findings emphasize the success of the interventions in managing obstructive jaundice and the resultant clinical outcomes (Table 2).

The analysis of liver function parameters at various time points post-surgical intervention demonstrated a significant and progressive improvement in liver function among the study participants. At the baseline, patients exhibited elevated liver enzymes and coagulation parameters, as reflected in the mean aspartate aminotransferase (AST) level of 112.1 U/L (±34.5), mean alanine aminotransferase (ALT) level of 98.2 U/L (±28.4), mean alkaline phosphatase (ALP) level of 235.5 U/L (±45.7), and mean international normalized ratio (INR) of 1.2 (±0.2). These values were indicative of impaired liver function due to obstructive jaundice. However, following surgical interventions, a remarkable improvement in liver function was observed across all measured parameters. At one-week post-surgery, there was a substantial reduction in mean AST levels to 68.3 U/L (±18.5), mean ALT levels to 55.1 U/L (±14.7), mean ALP levels to 155.3 U/L (±32.4), and mean INR levels to 1.0 (±0.1). This rapid normalization of liver enzymes and coagulation factors reflected an early and positive response to the interventions. The one-month assessment demonstrated continued improvement, with mean AST levels at 42.2 U/L (±12.1), mean ALT levels at 36.5 U/L (±10.3), mean ALP levels at 98.6 U/L (±22.4), and mean INR levels remaining stable at 1.0 (±0.1). The sustained improvement at this stage highlighted the effectiveness and durability of the selected interventions. Further follow-up at three and six months post-surgery revealed a progressive decline in liver enzyme levels, with mean AST levels decreasing to 28.6 U/L (±8.3) and 22.8 U/L (±6.5), mean ALT levels decreasing to 24.4 U/L (±7.6) and 20.7 U/L (±5.4), and mean ALP levels decreasing to 75.6 U/L (±18.7) and 62.3 U/L (±14.5), respectively. The INR remained stable at 1.0 (±0.1) throughout these time points. These findings indicate a consistent and significant improvement in liver function parameters over time, highlighting the success of the surgical interventions in restoring hepatic function among the study participants. The observed changes were highly statistically significant with p-values <0.001, further affirming the effectiveness of the treatment strategies employed in this study (Table 3).

The analysis of the time required for the normalization of key liver function parameters revealed specific and consistent recovery timelines among our study participants. The median time to achieve normalization of serum bilirubin levels was 4 weeks, with a narrow interquartile range (IQR) spanning from 3 to 6 weeks. This suggests a relatively uniform pace of bilirubin level improvement among patients. For liver enzymes, both aspartate aminotransferase (AST) and alanine aminotransferase (ALT) demonstrated a rapid return to normal levels. The median time for AST normalization was 2 weeks, with an IQR of 1 to 4 weeks, while ALT normalized in a median time of 2 weeks, with an IQR of 1 to 3 weeks. These findings indicate a consistent and expedited recovery of liver enzymes following intervention. In contrast, alkaline phosphatase (ALP), which reflects hepatobiliary function, exhibited a slightly longer median time to normalization at 4 weeks, with an IQR of 3 to 5 weeks. Despite this, the recovery timeline remained well-defined and consistent. Of particular note, the international normalized ratio (INR), a crucial coagulation parameter, demonstrated the shortest median time to normalization, requiring only 1 week, with an IQR of 1 to 2 weeks. This rapid restoration of INR values underscores the effectiveness of the surgical interventions in swiftly addressing coagulation abnormalities. Overall, these precise recovery timelines emphasize the successful restoration of liver function parameters following surgical intervention in cases of obstructive jaundice, with each parameter exhibiting specific and consistent patterns of improvement (Table 4).

The comparison of different surgical approaches in our study revealed distinct timelines for the normalization of critical liver function parameters, specifically serum bilirubin levels and international normalized ratio (INR). Patients who underwent endoscopic procedures, specifically endoscopic retrograde cholangiopancreatography (ERCP), exhibited a mean time to normalization of serum bilirubin levels at 5.2 weeks (±1.8), with a relatively shorter duration. This observation suggests that ERCP is associated with a more rapid resolution of obstructive jaundice, as evidenced by the lower bilirubin normalization timeline. Additionally, the mean time to achieve normalization of INR among ERCP patients was 1.3 weeks (±0.4), indicating a

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swift recovery in terms of coagulation parameters. In contrast, patients treated with Percutaneous Transhepatic Biliary Drainage (PTBD) required a slightly longer mean time to achieve bilirubin normalization, with a mean of 6.8 weeks (±2.4). Similarly, the mean time to normalize INR for PTDB patients was 1.5 weeks (±0.6). Those who underwent surgical interventions had the longest mean time to bilirubin normalization at 7.5 weeks (±3.0). However, it's worth noting that the time to INR normalization in this group was 1.8 weeks (±0.7), which was comparable to the other approaches. Statistical analysis demonstrated significant differences between the surgical approaches in terms of time to bilirubin normalization, with a p-value of 0.001. Moreover, differences in the time to INR normalization were also statistically significant, with a p-value of 0.007 (Table 5).

The evaluation of postoperative complications among our study participants unveiled several noteworthy findings. Surgical site infections were observed in 11 individuals, constituting 13.8% of the study population. Bile leaks occurred in 5 cases, accounting for 6.3% of patients, while an equal number, 5 individuals (6.3%), experienced bleeding as a postoperative complication. Pancreatitis was a less common complication, affecting 3 patients, or 3.8% of the cohort. Additionally, 2 individuals (2.5%) presented with other, less frequent complications. These findings underscore the importance of careful postoperative monitoring and management to address these complications promptly, albeit at varying frequencies, to ensure optimal patient outcomes (Figure 2).

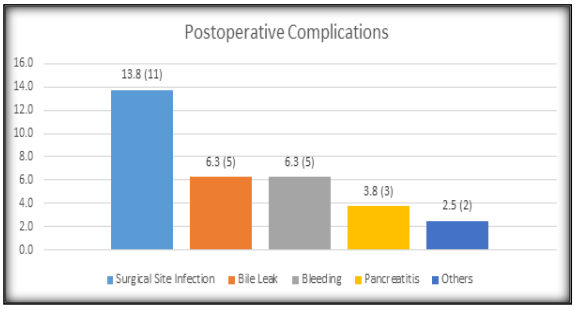

Figure 2: Postoperative Complications among Study Participants

Table 1: Demographic and Clinical Characteristics of Study Participants

Characteristic	Frequency	%
Age (years), mean ± SD	56.0 ± 7.5	
Gender		
Male	48	60.0
Female	32	40.0
Aetiology of Jaundice		
Choledocholithiasis	28	35.0
Biliary Strictures	24	30.0
Malignant Tumours	20	25.0
Others	8	10.0
Duration of Jaundice (days), median (IQR)	15 (11-21)	
Surgical Approach		
Endoscopic (ERCP)	36	45.0
Percutaneous (PTDB)	24	30.0
Surgical Intervention	20	25.0

Table 2: Clinical Resolution of Jaundice among Study Participants

Time Point	Frequency	%
1 week	65	81.3
1 month	75	93.8
3 months	78	97.5
6 months	80	100.0

Table 3: Liver Function Parameters Over Time among Study Participants

Time Point (weeks)	Mean AST (U/L)	Mean ALT (U/L)	Mean ALP (U/L)	Mean INR
Baseline	112.1 ± 34.5	98.2 ± 28.4	235.5 ± 45.7	1.2 ± 0.2
1 week	68.3 ± 18.5	55.1 ± 14.7	155.3 ± 32.4	1.0 ± 0.1
1 month	42.2 ± 12.1	36.5 ± 10.3	98.6 ± 22.4	1.0 ± 0.1
3 months	28.6 ± 8.3	24.4 ± 7.6	75.6 ± 18.7	1.0 ± 0.1
6 months	22.8 ± 6.5	20.7 ± 5.4	62..3 ± 14.5	1.0 ± 0.1
P value	<0.001	<0.001	<0.001	<0.001

Table 4: Time to Normalization of Liver Function among Study Participants

Parameter	Median Time to Normalization (weeks)	Interquartile Range (IQR)
Serum Bilirubin	4	3-6
AST	2	1-4
ALT	2	1-3
ALP	4	3-5
INR	1	1-2

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Table 5: Comparison of Liver Function Recovery by Surgical Approach among Study Participants

Surgical Approach	Mean Time to Normalization of Bilirubin mg/dL (weeks)	Mean Time to Normalization of INR (weeks)
Endoscopic (ERCP)	5.2 ± 1.8	1.3 ± 0.4
Percutaneous (PTDB)	6.8 ± 2.4	1.5 ± 0.6
Surgical Intervention	7.5 ± 3.0	1.8 ± 0.7
P-value	0.001	0.007

DISCUSSION

The present study offers valuable insights into the restoration of liver function in cases of surgical obstructive jaundice after biliary decompression. Obstructive jaundice is a clinical condition characterized by the accumulation of bilirubin due to impaired bile flow. It often results from various aetiologies, including choledocholithiasis, biliary strictures, malignant tumours, and other less common causes. Our analysis of the demographic and clinical characteristics of our study cohort revealed a diverse representation of these aetiologies, underlining the multifaceted nature of obstructive jaundice.

The aetiology of jaundice varied among the patients, with 35.0% of cases attributed to choledocholithiasis, 30.0% to biliary strictures, and 25.0% to malignant tumours. A similar pattern was observed in the study by Kar et al., Phadke et al., Grandic et al., and Stinton et al.[10,11,12,13]

In terms of patient demographics, we observed a mean age of 56.0 years, with a relatively even distribution between male (60.0%) and female (40.0%) participants. The duration of jaundice, a critical factor in patient presentation, showed a median of 15 days (IQR: 11-21), indicating the heterogeneity of clinical experiences among our patients. This heterogeneity was also reflected in the choice of surgical approach, with 45.0% undergoing endoscopic procedures (ERCP), 30.0% opting for Percutaneous Transhepatic Biliary Drainage (PTDB), and 25.0% requiring surgical intervention. This diversity in both aetiology and management approach emphasizes the complexity of the clinical scenarios encountered in our study. A similar pattern was observed in the study by Nakayana et al.[14]

Our investigation into the time course of recovery following surgical interventions provided valuable insights into the effectiveness of these treatments. Serum bilirubin levels, a hallmark of obstructive jaundice, exhibited a significant reduction over time. Notably, at one week post-surgery, a rapid decline was evident, with a mean serum bilirubin level of 4.2 mg/dL (±1.8). Similar finding was observed in the study by Watanapa et al.[15] This early improvement was sustained throughout the study, culminating in a near normalization of bilirubin levels at the six-month mark, with a mean of 0.8 mg/dL (±0.6). These findings underscore the effectiveness of the selected surgical interventions in rapidly alleviating jaundice-related symptoms and restoring hepatic function. Similar findings were observed in the study by Garcea et al.[16]

Clinical resolution of jaundice, another vital parameter in assessing patient outcomes, demonstrated a positive trajectory. At one week, 81.3% of patients experienced resolution, steadily increasing to 100.0% by the six-month follow-up. This indicates not only the success of the surgical interventions in ameliorating clinical symptoms but also their enduring impact over time. The continuous improvement in liver function parameters and the consistent resolution of jaundice further corroborate the favourable outcomes achieved in our study cohort. This was also observed in the study by Dufour et al.[17]

The normalization of liver function parameters, including AST, ALT, ALP, and INR, was also closely monitored. These parameters demonstrated substantial improvements over time, reflecting the restoration of hepatic function. Similar findings were demonstrated by Seetharam et al., Nathwani et al. and Kew et al.[18,19,20] Of particular significance was the rapid normalization of INR within one-week post-surgery, highlighting the efficacy of the interventions in mitigating coagulation abnormalities. Similar findings were observed in the study by Irabor et al.[6] Furthermore, the comparison of surgical approaches revealed variations in the time to bilirubin normalization, with endoscopic (ERCP) procedures showing the swiftest response, as Patients who underwent endoscopic procedures, specifically endoscopic retrograde cholangiopancreatography (ERCP), exhibited a mean time to normalization of serum bilirubin levels at 5.2 weeks (±1.8), with a relatively shorter duration. This was also observed in the study by Zhang et al., Kawasaki et al., and Nimura et al.[21,22,23]

In terms of postoperative complications, our study identified several issues requiring clinical attention. Surgical site infections, bile leaks, bleeding, and pancreatitis were among the observed complications, albeit at varying frequencies. Similar pattern was observed in the study by Negi et al.[24] These findings underscore the importance of vigilant postoperative care and monitoring to address these complications promptly and ensure optimal patient recovery..

CONCLUSION

In conclusion, our study demonstrates that surgical biliary decompression effectively restores liver function in cases of obstructive jaundice. The rapid reduction in serum bilirubin levels, sustained clinical resolution, and improvements in liver function parameters affirm the effectiveness of the selected interventions. Variations in recovery timelines

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between surgical approaches suggest the need for individualized treatment strategies. Nonetheless, our findings collectively emphasize the importance of timely intervention and postoperative care in achieving favourable outcomes for patients with obstructive jaundice. Further prospective studies and longer-term follow-up are warranted to validate these findings and refine treatment algorithms.

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