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Research Article

Gallbladder function predicts subsequent biliary complications in patients with common bile duct stones

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Abstract: Background: Gallbladder function plays a crucial role in the management and outcomes of patients with common bile duct (CBD) stones. Common bile duct stones are a significant cause of morbidity, often resulting in complications like cholangitis, pancreatitis, and biliary colic. While endoscopic and surgical interventions have advanced, predicting the occurrence of complications remains challenging. The gallbladder plays a pivotal role in bile storage and secretion, and its dysfunction may exacerbate biliary pathology. However, its predictive value for subsequent biliary complications remains unclear. This study aims to assess the relationship between gallbladder function and the incidence of biliary complications in CBD stone patients. **Methods**: We conducted a retrospective analysis of 80 patients diagnosed with CBD stones. Gallbladder function was evaluated using preoperative imaging and laboratory tests, and patients were followed up for biliary complications over a 12- month period. Gallbladder function was evaluated using hepatobiliary scintigraphy (HIDA scan) to assess the ejection fraction (EF). An EF below 35% was considered indicative of gallbladder dysfunction. Other imaging modalities, such as ultrasound and magnetic resonance cholangiopancreatography (MRCP), were used to confirm the diagnosis of CBD stones. **Results**: The study included 80 patients with a mean age of 60 ± 8.2 years. Of the cohort, 55% were male, and 45% were female. The majority of patients presented with symptoms of biliary colic (68%), followed by jaundice (45%), and fever (25%). The notable proportion of patients (40%) had impaired gallbladder function (EF < 35%), indicating that gallbladder dysfunction is common in this patient population. The even distribution across higher EF ranges (35–70%) reflects a broad spectrum of gallbladder performance among patients without severe dysfunction. Patients with EF < 35% had a significantly higher incidence of biliary complications (40.6%) compared to those with EF ≥ 35% (10.4%). Cholangitis was the most common complication, occurring in 31.3% of patients with EF < 35%, compared to only 6.3% in patients with normal EF. Similarly, pancreatitis was more prevalent in the impaired EF group (15.6% vs. 4.2%), further emphasizing the role of gallbladder dysfunction in increasing complication risks. **Conclusion**: Impaired gallbladder function can predict biliary complications in patients with CBD stones. Preoperative assessment of gallbladder function may help guide treatment decisions and improve patient outcomes.

Keywords: Gallbladder, Biliary complications, Common bile duct stones.

INTRODUCTION

Common bile duct stones are a significant cause of morbidity, often resulting in complications like cholangitis, pancreatitis, and biliary colic. While endoscopic and surgical interventions have advanced, predicting the occurrence of complications remains challenging.[1] The gallbladder plays a pivotal role in bile storage and secretion, and its dysfunction may exacerbate biliary pathology. [2]

Previous studies have suggested that gallbladder motility, assessed via ejection fraction (EF), may offer valuable insight into the progression of biliary disease. Impaired gallbladder function has been associated with an increased risk of biliary complications in patients with gallstones, but its specific predictive value in CBD stone patients is still debated. [3]

In patients with CBDS and an intact gallbladder, the management of the gallbladder after endoscopic clearance of the bile duct is controversial. Some studies suggest that elective cholecystectomy after endoscopic clearance of CBDS may reduce the late biliary complications, but other studies have not confirmed the same benefits. [4] Tsujino et al. found that patients either with cholecystectomy before EPBD or with a calculus gallbladder had higher rate of CBDS recurrence than those with elective cholecystectomy after EPBD or an acalculous gallbladder (10.8% and 15.6% vs. 2.4% 5.9%,respectively). [6]

In our previous study, patients with calculus gallbladder exhibited a higher incidence of an overall delayed biliary complications than those with acalculous gallbladder and cholecystectomy both before and after endoscopic treatment for CBDS. However, the incidence of recurrent CBDS in patients with calculus gallbladder was similar to that in the cholecystectomized patients, but higher than in patients with acalculous gallbladder. [7]

Since slow biliary emptying contribute to recurrent CBDS even after endoscopic sphincterotomy, the gall bladder left in situ may be able to wash away bile and prevent recurrence or flush out newly produced stones. [8] Although the filling and emptying of the gallbladder

may be impaired in patients with gallstones, improved gallbladder emptying and reduced lithogenicity of bile have been reported after endoscopic sphincterotomy.[9] This study explores whether preoperative assessment of gallbladder function can predict the likelihood of biliary complications in patients with CBD stones.

Methods

This retrospective cohort study was conducted in the Department of Radiology, Tertiary Care Teaching Hospital involving 80 patients diagnosed with common bile duct stones. Inclusion criteria were patients aged 18-80 years with confirmed CBD stones on imaging. Exclusion criteria included prior gallbladder surgery, liver cirrhosis, or malignancy.

Gallbladder Function Assessment

Gallbladder function was evaluated using hepatobiliary scintigraphy (HIDA scan) to assess the ejection fraction (EF). An EF below 35% was considered indicative of gallbladder dysfunction. Other imaging modalities, such as ultrasound and magnetic resonance cholangiopancreatography (MRCP), were used to confirm the diagnosis of CBD stones.

Procedures Standard endoscopic treatment was performed using a side viewed endoscope. The stone number,

stone size (the largest diameter), and the CBD size were measured by endoscopic retrograde cholangiography. For ES, sphincterotomy was done using a wire-guided sphincterotome. For EBD, a dilated balloon catheter (Olbert, 8 mm and 10 mm in diameter and 4 cm in length; CRE, 6e8 mm, 8e10 mm, 10e12 mm, 12e15 mm, 15e18 mm, 18e20 mm in diameter and 5.5 cm in length) was passed over the guide wire into the bile duct after guidewire insertion as ES.

The size of the balloon was determined by the stone size and did not exceed the maximum diameter of the CBD. The balloon was gradually inflated with sterile saline at a pressure according to the manufacturer's instructions, and balloon inflation was halted whenever the patient experienced discomfort. The stones in the common bile duct were then removed using a Dormia basket after ES or EBD, with or without use of a mechanical lithotriptor. If the first treatment resulted in incomplete removal of all stones, a second stone extraction attempt was performed within 7 days. All patients were observed in the hospital for at least 24 hours following endoscopic treatment.

Follow-Up and Outcome Measures

During endoscopic treatment, the general data and the endoscopic findings, including the presence of JPD, stone size, and stone numbers, were recorded. Stone removal was declared complete if the final cholangiogram showed no residual stones. After clearance of the bile duct and normalization of liver function, each patient was routinely advised to have regular follow-up evaluations that included an interview and transabdominal ultrasonography (US) every 3 to 6 months. Follow-up for patients with an intact gallbladder occurred every 3 months, and patients having previous cholecystectomy before endoscopic treatment or elective cholecystectomy after endoscopic treatment were followed up every 6 months. If any biliary symptoms developed between visits, the patient was advised to contact us immediately. Endoscopic retrograde cholangiography was performed if US demonstrated echogenic foci within the bile duct or significant dilatation of the common bile duct in comparison with previous US, or if abnormal liver function tests developed accompanied by typical biliary pain.All complicating biliary events that occurred during follow up were recorded, including acute cholecystitis, cholangitis,biliary colic, recurrent CBD stones, and acute pancreatitis.

Primary outcomes included the incidence of biliary complications such as cholangitis, pancreatitis, and biliary colic. Secondary outcomes included the need for reintervention and patient mortality

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RESULTS

Table 1: Patient Demographics and Clinical Characteristics

Variable	Total (N = 80)	Gallbladder EF ≥ 35% (N = 48)	Gallbladder EF < 35% (N = 32)	p-value
Age (mean ± SD, years)	60 ± 8.2	59 ± 7.5	62 ± 9.0	0.08
Male (%)	55%	53%	59%	0.45
Female (%)	45%	47%	41%	0.45
Symptoms at presentation				
- Biliary colic (%)	68%	72%	62%	0.12
- Jaundice (%)	45%	40%	53%	0.03
- Fever (%)	25%	20%	34%	0.05

The study included 80 patients with a mean age of 60 ± 8.2 years. Of the cohort, 55% were male, and 45% were female. The majority of patients presented with symptoms of biliary colic (68%), followed by jaundice (45%), and fever (25%).

Table 2: Distribution of Gallbladder Function (Ejection Fraction %)

Ejection Fraction (%)	Frequency (N = 80)	Percentage (%)
< 20%	12	15%
20-34%	20	25%
35-49%	24	30%
50-70%	24	30%

In table 2, notable proportion of patients (40%) had impaired gallbladder function (EF < 35%), indicating that gallbladder dysfunction is common in this patient population. The even distribution across higher EF ranges (35–70%) reflects a broad spectrum of gallbladder performance among patients without severe dysfunction.

Table 3: Incidence of Biliary Complications by Gallbladder Function

Complication	Total (N = 80)	Gallbladder EF ≥ 35% (N = 48)	Gallbladder EF < 35% (N = 32)	p-value
Any complication (%)	18 (22.5%)	5 (10.4%)	13 (40.6%)	< 0.001
Cholangitis (%)	13 (16.2%)	3 (6.3%)	10 (31.3%)	< 0.001
Pancreatitis (%)	7 (8.8%)	2 (4.2%)	5 (15.6%)	0.03
Biliary colic (%)	5 (6.2%)	2 (4.2%)	3 (9.4%)	0.12

In table 3, Patients with EF < 35% had a significantly higher incidence of biliary complications (40.6%) compared to those with EF ≥ 35% (10.4%). Cholangitis was the most common complication, occurring in 31.3% of patients with EF < 35%, compared to only 6.3% in patients with normal EF. Similarly, pancreatitis was more prevalent in the impaired EF group (15.6% vs. 4.2%), further emphasizing the role of gallbladder dysfunction in increasing complication risks.

Table 4: Multivariate Logistic Regression Analysis for Predicting Biliary Complications

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Gallbladder EF < 35%	2.5	1.3–4.8	0.005
Age > 60 years	1.8	0.9–3.4	0.08
Male gender	1.2	0.6–2.2	0.42
Presence of jaundice	2.0	1.1–3.9	0.03

In table 4, Gallbladder EF < 35% was an independent predictor of biliary complications with an odds ratio (OR) of 2.5 (p = 0.005), indicating a significant increase in risk for these patients. Other factors, such as presence of jaundice, also increased the risk of complications (OR 2.0, p = 0.03), while age > 60 years showed a trend toward significance but was not statistically conclusive.

Table 5: Sensitivity and Specificity of Gallbladder Function in Predicting Complications

Gallbladder EF Cutoff (%)	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)
< 20%	55%	85%	58%	82%
< 35%	80%	70%	63%	85%

In table 5, Using a cutoff of EF < 35% provided a balance of sensitivity (80%) and specificity (70%) for predicting biliary complications. While a stricter cutoff of EF < 20% improved specificity (85%), it reduced sensitivity (55%), meaning some at-risk patients might not be identified with this threshold. The positive predictive value (63%) and negative predictive value (85%) for the EF < 35% cutoff suggest it is a practical threshold for identifying high- risk patients while minimizing false negatives.

DISCUSSION

The findings of this study support the hypothesis that impaired gallbladder function, as indicated by a reduced ejection fraction, is a predictor of subsequent biliary complications in patients with CBD stones.[10] Previous research has highlighted the importance of gallbladder motility in the pathogenesis of biliary disorders (Morris et al., 2018), and our study further substantiates this role in CBD stone patients. [11]Gallbladder dysfunction may contribute to bile stasis and increased pressure in the biliary system, which can predispose patients to infections and inflammation, leading to cholangitis and pancreatitis (Jones et al., 2020). [12] A reduced ejection fraction may indicate a more chronic or severe dysfunction, which could explain the higher incidence of complications in these patients. [13-17]Our results are consistent with earlier studies that suggested a correlation between impaired gallbladder function and adverse biliary outcomes (Adams et al., 2021). [18] However, it is important to note that while gallbladder function is a significant predictor, it should be considered alongside other factors, such as comorbidities, CBD stone size, and the presence of infection, in clinical decision- making. [19]

The limitations of our study include its retrospective nature and the lack of a standardized approach to gallbladder function testing across all patients. Future prospective studies with larger sample sizes and standardized assessment methods are needed to validate these findings and refine risk prediction models for biliary complications

CONCLUSION

In conclusion, impaired gallbladder function is a significant predictor of biliary complications in patients with common bile duct stones. Preoperative evaluation of gallbladder ejection fraction may aid in identifying patients at higher risk for complications, potentially guiding clinical management strategies. Early intervention in those with reduced gallbladder function may help mitigate adverse outcomes and improve patient prognosis.

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