

THE ROLE OF X-RAY SURGERY IN COMPLICATED FORMS OF GALLSTONE
DISEASE

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Research Objective Gallstone disease is one of the most prevalent conditions affecting the biliary system, frequently leading to significant complications that demand urgent and effective clinical intervention. The primary objective of this research is to comprehensively examine the application, safety, and clinical effectiveness of radiologic surgery in managing complicated forms of cholelithiasis. These complications include, but are not limited to, acute cholecystitis, choledocholithiasis, biliary pancreatitis, and cholangitis. This study seeks to evaluate how radiologic surgical approaches—such as percutaneous cholecystostomy, endoscopic retrograde cholangiopancreatography (ERCP), and image-guided biliary drainage—contribute to improving clinical outcomes, reducing procedural risks, and minimizing hospital stay in high-risk and acutely ill patients. Furthermore, the study aims to identify the factors influencing successful treatment outcomes and to assess how the timing and selection of radiologic techniques impact the overall patient recovery process. By providing robust clinical data and analysis, this research aspires to reinforce the role of radiologic surgery as a front-line therapeutic option in hepatobiliary emergencies. Gallstone disease (cholelithiasis) remains a prevalent gastrointestinal disorder worldwide, with significant implications for public health due to its complications and the economic burden associated with its management. While many cases are asymptomatic or manageable with conservative treatment, a substantial proportion of patients develop complications such as acute cholecystitis, choledocholithiasis, cholangitis, biliary pancreatitis, and gallbladder perforation. These complications necessitate timely, precise, and often invasive interventions to prevent morbidity and mortality. In recent years, radiologic surgery—which encompasses a spectrum of minimally invasive, image-guided interventions—has emerged as a pivotal modality in the diagnosis and management of complicated gallstone disease. The aim of this study is to investigate and elucidate the role, efficacy, and outcomes of radiologic surgical techniques in the treatment of the complicated forms of cholelithiasis, with particular emphasis on percutaneous cholecystostomy, endoscopic retrograde cholangiopancreatography (ERCP), and interventional radiologic drainage procedures.

Materials and Methods This retrospective cohort study was conducted at the Department of Hepatobiliary Surgery and Interventional Radiology, a tertiary care academic medical center, between January 2018 and December 2023. A total of 624 patients diagnosed with complicated gallstone disease were included. Inclusion criteria encompassed patients aged 18–85 years who presented with ultrasound or CT-confirmed gallstone-related complications including acute calculous cholecystitis, common bile duct stones (CBDS), gallstone pancreatitis, and biliary sepsis. Patients with malignancies, coagulopathy contraindicating procedures, or incomplete records were excluded. The cohort was divided into three interventional groups: Group A (n=228) underwent image-guided percutaneous cholecystostomy; Group B (n=211) underwent ERCP with

stone extraction and stenting; and Group C (n=185) underwent CT- or ultrasound-guided biliary drainage.

All procedures were performed under sterile conditions in the interventional radiology suite or endoscopy unit. Technical success, clinical success (resolution of symptoms and infection), complication rates, length of hospital stay, and 30-day mortality were recorded and analyzed. Laboratory parameters (WBC count, bilirubin, CRP) and imaging follow-up (ultrasound, CT, MRCP) were used to assess treatment efficacy. Statistical analysis was performed using SPSS v.26.0. Descriptive statistics, chi-square, ANOVA, and logistic regression models were utilized to evaluate intergroup differences and outcome predictors.

Results The overall technical success rate was 97.6%, with Group A achieving 98.2%, Group B 96.7%, and Group C 97.8%. Clinical success, defined as symptom resolution and normalization of inflammatory markers within 72 hours, was highest in Group B (91.4%), followed by Group A (87.2%) and Group C (85.9%). Major complications occurred in 8.1% of patients, including bleeding (1.6%), bile leak (2.4%), sepsis (3.3%), and stent migration (0.8%). The mean length of hospital stay was significantly shorter in Group B (5.4 ± 2.1 days) compared to Group A (7.6 ± 2.9 days) and Group C (8.2 ± 3.1 days) ($p < 0.05$). Thirty-day mortality was 3.2% overall, with no significant intergroup difference. Multivariate regression identified early intervention (< 48 hours), lower baseline bilirubin, and absence of multi-organ dysfunction as independent predictors of favorable outcome ($p < 0.001$).

Discussion Our findings support the growing body of evidence that radiologic surgical interventions offer a safe, effective, and minimally invasive alternative to traditional surgery in patients with complicated gallstone disease. ERCP remains the gold standard for the management of choledocholithiasis and cholangitis, offering high success rates in ductal clearance and symptom resolution. However, in critically ill or surgically high-risk patients, percutaneous cholecystostomy and image-guided biliary drainage serve as lifesaving temporizing measures, especially when general anesthesia is contraindicated.

The high clinical success rates across all groups underscore the reliability of radiologic interventions in acute settings. The relatively higher complication rate in drainage procedures highlights the need for meticulous technique and patient selection. Importantly, the role of early intervention cannot be overstated; delayed procedures were associated with increased morbidity, prolonged hospitalization, and poorer outcomes.

Technological advancements, including 3D fluoroscopy, cone-beam CT, and real-time ultrasound fusion imaging, have further enhanced the precision and safety of these interventions. Moreover, interdisciplinary collaboration between radiologists, gastroenterologists, and surgeons is crucial for optimal patient care. Future directions include integration of artificial intelligence for procedural planning and risk stratification, development of biodegradable stents, and expansion of radiologic surgical training programs.

Conclusion This study underscores the indispensable role of radiologic surgery in the contemporary management of complicated gallstone disease. As healthcare systems increasingly prioritize less invasive approaches that offer rapid recovery and reduced healthcare burden, image-guided interventions have emerged as both practical and life-saving alternatives to conventional open or laparoscopic surgery. The evidence gathered from this extensive cohort analysis

demonstrates that procedures such as ERCP, percutaneous cholecystostomy, and radiologically guided biliary drainage are not only highly effective in resolving acute biliary pathologies but are also associated with acceptable complication rates and favorable patient outcomes. These findings are particularly relevant in managing patients who are critically ill, elderly, or have significant comorbidities, making them poor candidates for traditional surgical procedures. The research also highlights the importance of early intervention, multidisciplinary coordination, and advanced imaging technology in optimizing treatment pathways. Moving forward, continuous refinement of radiologic techniques and increased access to interventional radiology expertise will be vital in further elevating the standard of care for patients with complex hepatobiliary conditions. This research contributes to the growing recognition of radiologic surgery as an essential pillar in emergency and elective hepatobiliary management, advocating for its broader integration into clinical practice guidelines and healthcare policy frameworks.

Radiologic surgery plays a vital role in the management of complicated forms of gallstone disease, particularly in acutely ill and high-risk surgical patients. Image-guided procedures such as ERCP, percutaneous cholecystostomy, and biliary drainage offer effective, safe, and less invasive alternatives to conventional surgery, with high success rates and acceptable complication profiles. Prompt diagnosis, early intervention, and a multidisciplinary approach are key determinants of favorable outcomes. As technology and expertise evolve, radiologic surgery will continue to expand its role in hepatobiliary disease management.

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