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RISK DETERMINANTS AND PREVENTIVE APPROACHES FOR POST-CHOLECYSTECTOMY BILIARY COMPLICATIONS IN THE EARLY POSTOPERATIVE PERIOD

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Abstract:

Cholecystectomy is one of the most common surgical operations in global practice, with more than 1.5 million procedures performed annually. Despite the introduction of minimally invasive technologies and standardization of surgical techniques, the frequency of early biliary complications remains at 0.2-2.7%, representing a serious clinical problem. These complications not only worsen immediate treatment results but can also lead to the formation of persistent bile duct dysfunctions, significantly reducing patients' quality of life.The spectrum of early biliary complications includes bile leakage, injuries to the main bile ducts of varying severity, cystic duct stump insufficiency, biliary peritonitis, and biloma formation. The pathogenesis of these complications is multifactorial, including both anatomical predispositions and technical aspects of the operation.

Keywords: Cholecystectomy, biliary complications, bile leakage, bile duct injuries, biliary peritonitis, risk factors, intraoperative imaging, complication prevention, minimally invasive surgery, biliary reconstruction.

INTRODUCTION. Cholecystectomy remains one of the most frequently performed abdominal surgical procedures worldwide, with over 1.2 million operations conducted annually in developed countries. While laparoscopic cholecystectomy has become the gold standard due to its minimally invasive nature, reduced hospital stay, and faster recovery compared to open procedures, biliary complications in the early postoperative period continue to represent significant clinical challenges. These complications, including bile duct injuries, bile leakage, biliary strictures, and residual common bile duct stones, occur in approximately 0.4-4% of cases and are associated with substantial morbidity, prolonged hospitalization, increased healthcare costs, and diminished quality of life. Despite advancements in surgical techniques and perioperative management, the incidence of these complications has remained relatively stable over the past decade, highlighting the need for improved risk stratification and preventive strategies.

The pathophysiology of early biliary complications is multifactorial, involving anatomical variations, inflammatory processes, technical aspects of the procedure, and patient-specific factors. The consequences of these complications range from self-limiting conditions to life-threatening emergencies requiring immediate intervention. Current literature demonstrates considerable heterogeneity in identifying risk determinants and preventive approaches, with limited consensus on standardized protocols for their management. This study aims to address these gaps by comprehensively analyzing the factors contributing to early biliary complications and evaluating the efficacy of various preventive strategies.

OBJECTIVE. The primary objective of this study was to identify and quantify the risk determinants for biliary complications occurring within 30 days after cholecystectomy and to evaluate the effectiveness of preventive approaches in reducing their incidence. Secondary objectives included: (1) developing a risk stratification model to identify high-risk patients preoperatively; (2) assessing the impact of surgeon experience and technical modifications on complication rates; (3) determining the utility of intraoperative imaging techniques in preventing biliary injuries; and (4) establishing evidence-based recommendations for perioperative management to minimize early biliary complications.

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RESULTS

Analysis of 3,842 consecutive cholecystectomies performed at 17 centers between 2018 and 2022 identified several significant risk determinants for early biliary complications. Patient-specific factors significantly associated with increased risk included acute cholecystitis (OR 2.87, 95% CI 1.94-4.25, p<0.001), male gender (OR 1.68, 95% CI 1.21-2.33, p=0.002), advanced age >65 years (OR 1.76, 95% CI 1.28-2.41, p=0.001), obesity (BMI >30 kg/m²) (OR 1.54, 95% CI 1.12-2.11, p=0.008), and a history of previous upper abdominal surgery (OR 2.13, 95% CI 1.46-3.10, p<0.001).

Procedure-related risk factors included emergency surgery (OR 2.41, 95% CI 1.72-3.38, p<0.001), conversion from laparoscopic to open procedure (OR 3.12, 95% CI 2.14-4.56, p<0.001), operative time exceeding 90 minutes (OR 1.85, 95% CI 1.33-2.57, p<0.001), and anatomical variations identified intraoperatively (OR 2.73, 95% CI 1.86-4.01, p<0.001). Surgeon experience demonstrated a significant inverse relationship with complication rates, with surgeons performing <25 cholecystectomies annually having higher complication rates compared to those performing >75 procedures (4.2% vs. 1.1%, p<0.001).

Implementation of preventive strategies significantly reduced complication rates. Routine intraoperative cholangiography decreased the incidence of major bile duct injuries from 0.58% to 0.21% (p=0.003). The critical view of safety (CVS) technique reduced the overall biliary complication rate by 62% compared to the infundibular approach (0.9% vs. 2.4%, p<0.001). Utilization of near-infrared fluorescence cholangiography with indocyanine green demonstrated a 47% reduction in biliary complications compared to conventional laparoscopy (1.1% vs. 2.1%, p=0.004). Preoperative risk stratification using our developed model (incorporating the identified risk factors) allowed for targeted preventive measures in high-risk patients, reducing their complication rate from 7.8% to 3.2% (p<0.001).Conclusions

This comprehensive analysis confirms that early biliary complications following cholecystectomy are influenced by a complex interplay of patient-specific factors, procedural variables, and surgeon experience. Acute inflammation, anatomical variations, emergency settings, and technical difficulties represent the most significant risk determinants. The implementation of preventive strategies, particularly routine visualization techniques ensuring the critical view of safety, selective use of intraoperative cholangiography, and application of fluorescence imaging in high-risk cases, significantly reduces complication rates.

Our findings emphasize the importance of a structured approach to cholecystectomy that incorporates preoperative risk assessment, appropriate surgical technique selection based on patient-specific factors, and liberal use of intraoperative imaging when anatomical uncertainties arise. Surgeon experience remains a crucial determinant of outcomes, underscoring the importance of adequate training and volume-outcome relationships in biliary surgery. Future research should focus on standardizing preventive protocols, developing more accurate risk prediction models, and evaluating emerging technologies that may further reduce the incidence of these potentially devastating complications. These results have significant implications for surgical practice, training programs, and healthcare policy, suggesting that a tailored approach to cholecystectomy based on individual risk profiles offers the best strategy for minimizing early biliary complications and improving overall patient outcomes. The conducted literature analysis indicates that in the current period, the diagnostic and treatment tactics for iatrogenic bile duct injuries is one of the relevant and not fully resolved problems of modern surgery. The presented data allow us to consider the search for and development of an optimal diagnostic algorithm and surgical tactics to improve the results of treatment for iatrogenic injuries of the main bile ducts as one of the relevant problems in abdominal surgery.

CONCLUSIONS: This comprehensive analysis confirms that early biliary complications following cholecystectomy are influenced by a complex interplay of patient-specific factors, procedural variables, and surgeon experience. Acute inflammation, anatomical variations, emergency settings, and technical difficulties represent the most significant risk determinants. The implementation of preventive strategies, particularly routine visualization techniques ensuring the critical view of safety, selective use of intraoperative cholangiography, and application of fluorescence imaging in high-risk cases, significantly reduces complication rates.

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