

# Comparison of Laparoscopic Cholecystectomy Outcome with Laparoscopic Versus Endoscopic Bile Duct Exploration in Elderly Patients with Cholecystolithiasis and Choledocholithiasis

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## ABSTRACT

**Objective:** To evaluate the efficacy and safety of minimally invasive surgery in elderly patients with cholecystolithiasis and choledocholithiasis and its effects on liver function and stress response.

**Study Design:** Comparative observational study.

**Place and Duration of the Study:** Department of Hepatobiliary Surgery, Anyang City People's Hospital, Xinxiang Medical College, Anyang, China, from August 2021 to 2023.

**Methodology:** Eighty-six elderly patients with cholecystolithiasis and choledocholithiasis were divided into two distinct groups. The control group (n = 43) underwent endoscopic retrograde cholangiopancreatography (ERCP) in conjunction with laparoscopic cholecystectomy (LC). The observation group (n = 43) received LC along with laparoscopic common bile duct exploration (LCBDE). Comparative analysis of perioperative outcomes, complication rates, the frequency of residual stones, and liver function markers, including total bilirubin (TBil), aspartate aminotransferase (AST), and alanine aminotransferase (ALT) was made. Furthermore, inflammatory markers such as tumour necrosis factor-alpha (TNF- $\alpha$ ), C-reactive protein (CRP), and Interleukin-6 (IL-6), as well as stress markers including cortisol and epinephrine were also evaluated. Also, the quality of life both before and after surgery was assessed.

**Results:** The observation group had better perioperative outcomes with a lower complication rate (4.65% vs. 20.93% in controls,  $p < 0.05$ ). Both groups showed significant post-surgical improvements in liver function markers (TBil, AST, ALT,  $p < 0.05$ ), with no significant inter-group differences. Postoperative inflammatory (TNF- $\alpha$ , CRP, IL-6) and stress markers (cortisol, epinephrine) increased significantly ( $p < 0.05$ ), with trends favouring lower levels in the observation group. Quality of life scores significantly improved in both groups one month post-surgery ( $p < 0.05$ ).

**Conclusion:** LC combined with LCBDE is as effective as ERCP combined with LC for removing stones and improving liver function and quality of life in elderly patients with cholecystolithiasis and choledocholithiasis. However, the LC combined with the laparoscopic common bile duct exploration approach has fewer complications, reduces inflammation and stress responses, and supports better overall recovery, making it the preferred option for this patient population.

**Key Words:** Gallstone, Choledocholithiasis, Old age, Minimally invasive surgery, Liver function, Stress response.

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## INTRODUCTION

Gallbladder stones or cholelithiasis have a high prevalence in hepatobiliary surgery, with incidence rates ranging from 7-10%. This prevalence is increasing due to shifts in dietary and lifestyle habits, particularly affecting the elderly population, where rates can reach up to 30%.<sup>1</sup>

A significant proportion of gallstones migrate to the common bile duct, with approximately 10-20% of gallbladder stone patients also developing choledocholithiasis, often in the distal part of the duct, which can be less symptomatic.<sup>2</sup> Patients with concurrent cholecystolithiasis and choledocholithiasis typically present with severe symptoms such as nausea, vomiting, abdominal colic, and fever. Without prompt treatment, these conditions can lead to multiple complications, posing serious threats to life and reducing quality of life.<sup>3</sup>

Advancements in medical technology have increasingly favoured minimally invasive surgical techniques over traditional open surgeries. These methods, known for their minimal tissue trauma and reduced pain, align well with the goal of rapid postoperative recovery and have gained widespread acceptance in medical practice.<sup>4</sup> Laparoscopic cholecystectomy (LC)

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combined with laparoscopic common bile duct exploration (LCBDE) is now the preferred surgical approach for elderly patients with cholecystolithiasis and choledocholithiasis, often performed in a single anaesthesia session.<sup>5</sup> However, the safety of such procedures in elderly patients, who may have reduced physiological reserves and tolerance, remains a topic of ongoing debate.

Therefore, this study aimed to assess the efficacy and safety of LC with LCBDE in treating elderly cholecystolithiasis and choledocholithiasis patients, focusing on its effects on liver function and stress response. These findings may provide valuable data for optimising surgical strategies in clinical settings.

## METHODOLOGY

This study was approved by the Ethical and Research Committee of the Anyang People's Hospital, Anyang, China (Approval No: KS-2021-08-01). The research adhered to the principles outlined in the Declaration of Helsinki and local regulatory guidelines for clinical trials. All participants provided informed consent before participation. A retrospective analysis was conducted on clinical data from 86 elderly patients diagnosed with cholecystitis and choledocholithiasis who underwent minimally invasive surgery at the institution, between August 2021 and August 2023. Patients were divided into two groups based on the surgical techniques used: The control group (43 patients) underwent endoscopic retrograde cholangiopancreatography (ERCP) + LC while the observation group (43 patients) underwent LCBDE + LC.

The inclusion criteria for this study required participants to have a confirmed diagnosis of gallstone disease based on the guidelines for the prevention and treatment of gallstone disease,<sup>6</sup> with verification through clinical imaging techniques such as ultrasound, CT, or MRI. Eligible patients had to be suitable candidates for surgical intervention, with a total gallstone count of fewer than five. Moreover, only individuals with complete clinical records and follow-up data were included to ensure comprehensive analysis. Exclusion criteria were established to minimise confounding factors and enhance the reliability of the study outcomes. Patients with coagulopathy or any bleeding disorders were excluded due to potential surgical complications. Individuals with significantly impaired cardiopulmonary function, which could increase surgical risks, were also not considered. A history of abdominal surgery that might interfere with treatment efficacy or postoperative recovery constituted grounds for exclusion. Additionally, patients diagnosed with malignant neoplasms or concomitant cancers as well as those with haematological disorders were excluded. The presence of systemic infectious diseases further disqualified individuals from participation to ensure both patient safety and data integrity.

During the LC procedure, patients were positioned supine under general anaesthesia. Pneumoperitoneum was established as the standard practice, and the three-port technique was employed to access Calot's triangle and facilitate

complete gallbladder dissection. Initially, the cystic artery was isolated, ligated using hemoclips, and then divided using electrocoagulation. Subsequently, the gallbladder was dissected from the liver bed and extracted. Following surgery, both groups were monitored for one month postoperatively. In the ERCP/EST + LC procedure of the control group, patients were positioned supine under general anaesthesia. A duodenoscope was introduced to observe the papilla, and a precise amount of contrast medium was injected to fully visualise the pancreaticobiliary duct system, accurately assessing stone quantity, size, and location. The Oddi sphincter was then incised, and stones were either extracted using a basket for smaller volumes or fragmented with a lithotripter for larger ones under direct endoscopic guidance. After confirming clearance with a cholangiogram, nasal-biliary drainage was established. Patients underwent observation for 2-3 days before proceeding to LC surgery, with standard anti-inflammatory and hepatic protection treatments administered postoperatively. In the observation group, T-tube drainage was used during the LC + LCBDE procedure. Although modern minimally invasive surgeries have largely replaced T-tubes with simpler, lower-risk methods, T-tubes were chosen in this study for their effective biliary drainage, preventing bile accumulation or stenosis, especially during common bile duct exploration.

Additionally, T-tubes facilitate postoperative assessment of biliary patency and early detection of complications. Given the elderly population and potential comorbidities, T-tube drainage was particularly useful in reducing postoperative complications, especially in hepatobiliary surgeries. The evaluation of outcomes in this study encompassed several key metrics. Perioperative measures included monitoring vital signs and anaesthesia response. Stone clearance was assessed through postoperative imaging and clinical follow-up. All patients underwent routine imaging (e.g., abdominal ultrasound or CT) one week post-surgery to confirm complete stone removal. Residual stone rates were based on imaging results and reviewed by doctors. If stones were found in the bile ducts during follow-up, they were considered residual stones. Furthermore, a six-month follow-up was performed to assess stone recurrence, ensuring the long-term efficacy of the procedure. Complications such as cholangitis, biliary infection, pancreatitis, and bile leaks were meticulously recorded and compared across both groups. Liver function was assessed using the Hitachi 7600 automatic biochemistry analyzer for total bilirubin, AST, and ALT levels preoperatively and at three days post-surgery. Inflammatory markers TNF- $\alpha$ , CRP, and IL-6 were quantified *via* enzyme-linked immunosorbent assay (ELISA) using serum samples obtained as per protocol. Stress responses were evaluated by measuring cortisol (Cor) and adrenaline (E) levels *via* radioimmunoassay before surgery and on day three postoperatively. Finally, quality of life was assessed using the Gastrointestinal quality of life index (GIQLI) before surgery and one month postoperatively, with higher scores indicating better quality of life.

Data analysis in this study utilised SPSS version 23.0. Quantitative data were summarised as means ( $\pm$ ) and compared using the independent samples t-test. Categorical data were expressed as frequencies and percentages (%) and analysed using the Chi-square ( $\chi^2$ ) test. Statistical significance was defined as a p-value less than 0.05.

### RESULTS

In the control group, there were 20 males and 23 females aged between 62 and 78 years, with a mean age of  $67.45 \pm 3.53$  years. The disease duration ranged from five months to two years, with an average of  $1.14 \pm 0.47$  years. The largest stone diameter varied from 8 to 13 mm, with a mean of  $9.12 \pm 2.10$  mm. American Society of Anesthesiologists (ASA) classifications included 25 Grade I and 18 Grade II cases. Body mass index (BMI) ranged from 20 to 24 kg/m<sup>2</sup>, with an average of  $21.94 \pm 1.23$  kg/m<sup>2</sup>. In the observation group, there were 19 males and 24 females aged between 60 and 78 years, with a mean age of  $67.34 \pm 3.20$  years. The disease's duration ranged from several months to 2 years, averaging  $1.23 \pm 0.50$  years. Stone diameters ranged from 5 to 11 mm, with an average of  $7.93 \pm 2.07$  mm. ASA classifications included 22 Grade I and 21 Grade II cases. BMI ranged from 19 to 24 kg/m<sup>2</sup>, with an average of  $21.85 \pm 1.14$  kg/m<sup>2</sup>. Baseline characteristics between the two groups were well-balanced and comparable ( $p > 0.05$ ). The postoperative time to first bowel movement, used to assess bowel recovery, was shorter in the observation group compared to the control group ( $p < 0.05$ ), as shown in Table I. This indicates better bowel function recovery following surgery.

In the study, the complication rate among patients in the observation group was 4.65%, which was markedly lower compared to the rate (20.93%) observed in the control group ( $p < 0.05$ ). Regarding residual stone rates, there was no statistically significant difference observed between the two groups ( $p > 0.05$ ) as detailed in Table II.

Following the surgery, levels of TBil, AST, and ALT were significantly reduced compared to their preoperative values in both study groups ( $p < 0.05$ ). There were no statistically significant differences observed between the groups ( $p > 0.05$ ) as shown in Table III.

Three days after surgery, inflammatory markers such as TNF- $\alpha$ , CRP, and IL-6 were significantly elevated in both groups compared to their pre-surgery levels, indicating an acute inflammatory response. However, the increase was significantly lower in the observation group ( $p < 0.05$ ), as shown in Table III. This reduced elevation may be attributed to the less invasive LC combined with the LCBDE method, which results in a milder inflammatory response. It is also possible that differences in anaesthesia techniques and postoperative care, including pain management and anti-inflammatory treatments, contributed to these results. Additionally, cortisol (Cor) and norepinephrine (NE) levels significantly increased three days post-operation compared to pre-operation levels in both groups. Nevertheless, the observation group had comparatively lower levels ( $p < 0.05$ ). These findings suggest a distinct stress response between the two groups following the surgical procedure.

The quality of life scores for both groups one month after the operation were significantly higher compared to their scores before the operation ( $p < 0.05$ ).

### DISCUSSION

Although the male-to-female ratio in this study is close (39 males vs. 47 females), gallstones are more common in women, particularly in older age groups. Existing epidemiological studies show that women generally have a higher incidence of gallstones, partly due to hormonal influences (e.g., estrogen) on cholesterol metabolism, which increases the risk of gallstones. Furthermore, after menopause, the decline in estrogen levels alters cholesterol metabolism, further increasing the risk of gallstones.

**Table I: Comparison of perioperative conditions between the two groups ( $\bar{x} \pm s$ ).**

Groups	Length of surgery (min)	Intraoperative haemorrhage (ml)	Duration of postoperative defaecation (d)	Length of hospitalisation (d)
Control group (n = 43)	107.56 $\pm$ 8.43	60.35 $\pm$ 3.45	1.96 $\pm$ 0.25	8.33 $\pm$ 1.05
Observation group (n = 43)	102.31 $\pm$ 4.25	53.16 $\pm$ 5.91	1.68 $\pm$ 0.30	7.43 $\pm$ 1.10
t	6.647	6.890	4.702	3.881
p	0.001	<0.001	<0.001	<0.001

Note: \*p < 0.05 compared to preoperative in this group.

**Table II: Comparison of complication and residual stone rates between the two groups n (%).**

Groups	Complications (undesired side effect of medical procedure)				Total incidence	Residual stone rate	
	Cholangitis	Biliary tract infection	Pancreatitis	Biliary fistula		Residuals	Not retained
Control group (n = 43)	2 (4.65)	3 (6.98)	4 (9.30)	0 (0.00)	9 (20.93)	3 (6.98)	40 (93.02)
Observation group (n = 43)	0 (0.00)	0 (0.00)	0 (0.00)	2 (4.65)	2 (4.65)	1 (2.33)	42 (97.67)
$\chi^2$					5.108	0.262	
p					0.024	0.609	

Note: \*p < 0.05 compared to preoperative in this group.

**Table III: Comparison of liver function and inflammatory and stress response between the two groups ( $\bar{x} \pm s$ ).**

Groups	TBil ( $\mu\text{mol/L}$ )		AST (U/L)		ALT (U/L)		TNF- $\alpha$ (pg/mL)		CRP (mg/L)		IL-6 (pg/mL)		Cor ( $\mu\text{g/L}$ )		NE (ng/mL)	
	Pre-operative	Post-operative 3d	Pre-operative	Post-operative 3d	Pre-operative	Post-operative 3d	Pre-operative	Post-operative 3d	Pre-operative	Post-operative 3d	Pre-operative	Post-operative 3d	Pre-operative	Post-operative 3d	Pre-operative	Post-operative 3d
Control group (n = 43)	30.63 $\pm$ 3.10	14.42 $\pm$ 4.10*	39.26 $\pm$ 6.75	14.88 $\pm$ 3.03*	45.63 $\pm$ 5.82	15.86 $\pm$ 3.60*	75.26 $\pm$ 10.35	118.36 $\pm$ 10.34*	7.94 $\pm$ 0.26	19.13 $\pm$ 2.58*	11.56 $\pm$ 2.53	17.64 $\pm$ 3.06*	112.36 $\pm$ 11.27	135.39 $\pm$ 36.24*	308.45 $\pm$ 35.40	458.36 $\pm$ 31.41*
Observation group (n = 43)	30.36 $\pm$ 4.25	13.86 $\pm$ 3.98*	39.36 $\pm$ 7.40	14.62 $\pm$ 2.55*	45.43 $\pm$ 4.38	15.33 $\pm$ 3.24*	75.96 $\pm$ 10.22	110.25 $\pm$ 9.83*	7.87 $\pm$ 0.30	14.67 $\pm$ 1.31*	11.76 $\pm$ 2.37	15.20 $\pm$ 2.41*	112.41 $\pm$ 10.30	121.86 $\pm$ 15.12*	308.66 $\pm$ 34.36	375.25 $\pm$ 26.58*
t	0.337	0.643	0.066	0.409	0.180	0.718	1.533	3.728	1.156	10.107	0.378	4.108	0.022	2.259	0.028	13.245
p	0.737	0.522	0.948	0.684	0.858	0.475	0.129	<0.001	0.251	<0.001	0.706	<0.001	0.983	0.026	0.978	<0.001

\*p < 0.05 compared to preoperative in this group. \*\*p < 0.05 compared to preoperative values within the same group.

The gender distribution in this study may be influenced by the specific inclusion criteria and regional differences. Future multi-centre studies with larger sample sizes are needed to verify the effect of gender on the occurrence of gallstones and common bile duct stones.

The occurrence of gallstones can be linked to dietary patterns, bile stagnation, and obesity among other factors.<sup>7</sup> As the condition progresses, stones may move into the common bile duct, resulting in the formation of choledocholithiasis with associated risks, notably among elderly patients, including complications such as sepsis, cholecystitis, and septic shock.<sup>8</sup> Currently, there is no universally accepted treatment protocol for elderly patients with choledocholithiasis. Surgical intervention remains the mainstay, aimed at complete stone removal. Traditionally, open surgery was common due to technological constraints, offering straightforward procedures and high success rates in stone clearance, albeit with significant trauma and slow recovery, posing challenges for some elderly patients.<sup>9</sup> There is ongoing demand for effective and minimally invasive surgical approaches for elderly patients with choledocholithiasis. In recent years, minimally invasive techniques have significantly advanced and are increasingly preferred by patients. LC+ LCBDE and ERCP + LC are commonly used procedures, each with distinct characteristics. LC + LCBDE allows for the operation's completion in a single session, whereas ERCP + LC is performed in stages. Both methods effectively clear stones, but their comparative safety remains under scrutiny.<sup>10</sup>

Research indicates that perioperative outcomes for the LC+LCBDE group outperformed those of the control group, highlighting its efficacy in shortening treatment duration and improving postoperative recovery. This advantage may stem from ERCP/ESC requiring a two to three days' interval before LC, which prolongs recovery and hospital stay. Additionally, increasing the Oddi's sphincter during ERCP/ESC can increase intraoperative bleeding.<sup>11</sup> LC + LCBDE, which does not require staged operations and involves more straightforward procedures, maintains sphincter integrity, resulting in superior perioperative conditions.<sup>12</sup>

While this study suggests that LC combined with LCBDE reduces complications and improves safety compared to ERCP combined with LC, the conclusion should be cautious. LCBDE is more complex and has been associated with higher

complication rates, but advancements in laparoscopic techniques and surgical experience have improved its safety. The older comorbid patient population in this study along with strict management may have contributed to lower complication rates.

LC combined with LCBDE avoids Oddi sphincter incision, reducing the risk of pancreatitis and biliary infections. Performing the procedure under a single anaesthesia also minimises anaesthetic risks. Despite its complexity, minimally invasive techniques can reduce complications and improve recovery.<sup>13</sup> In contrast, ERCP carries risks such as pancreatitis and infection due to sphincterotomy and intestinal fluid backflow, increasing the likelihood of cholangitis and biliary infections. In this study, five patients in the control group developed biliary infections, confirmed through blood cultures and imaging. In the observation group, only two patients had milder infections, recovering quickly with routine anti-inflammatory treatment.<sup>14</sup>

Both procedures leverage the benefits of minimally invasive approaches to ensure thorough stone removal, with intraoperative reassessments significantly reducing the risk of residual stones.

The gallbladder, located near the liver, can impact surrounding tissues and organs when gallstones form, resulting in diminished liver function.<sup>15</sup> TBil, AST, and ALT are primary indicators of hepatic function, with their levels closely tied to liver health. Research also suggests that these liver function markers can help indicate the presence of cholelithiasis internally, particularly when ultrasounds fail to detect smaller stone.<sup>16</sup> In common bile duct stone cases, obstruction often occurs, leading to bile accumulation in the liver and elevated TBil, AST, and ALT levels. This study found that postoperative levels of TBil, AST, and ALT were reduced in both groups, more significantly in the observation group, suggesting that LC + LCBDE treatment is particularly beneficial in facilitating the recovery of liver function in elderly cholecystolithiasis and choledocholithiasis patients, consistent with findings by Xie.<sup>17</sup>

The inflammatory response is inherently elevated in cholecystolithiasis and choledocholithiasis, with TNF- $\alpha$  notably increasing after surgical intervention, triggering the secre-

tion of pro-inflammatory factors such as CRP and IL-6, exacerbating damage.<sup>18</sup> Surgery can also overstimulate the hypothalamic-pituitary-adrenal axis, disrupting the neuroendocrine system and leading to the release of stress markers, primarily cortisol (Cort) and norepinephrine (NE).<sup>19</sup> This study observed that although both minimally invasive procedures marginally elevate inflammatory and stress markers postoperatively, LC + LCBDE's effects were milder. This could be attributed to the fewer anaesthetic requirements and the absence of contrast injections or repeated treatment interventions associated with LC + LCBDE, which minimises trauma.<sup>20</sup> Although cholecystolithiasis and choledocholithiasis significantly reduce quality of life, the present study revealed an improvement in quality of life scores after surgery for both patient groups, without any notable differences between them. This indicates that both surgical interventions effectively enhance the quality of life for elderly patients suffering from these conditions.

## CONCLUSION

This study's results offer preliminary comparative insights between LC + LCBDE and ERCP + LC. The authors recognise some limitations, particularly the small sample size and the single-centre design, which may introduce statistical bias and limit the broader applicability of the findings. Although the baseline characteristics were comparable between the two groups, the results may not be generalisable to patients from different regions or demographics. Nevertheless, LC + LCBDE showed fewer postoperative complications and a reduced impact on inflammatory and stress responses, positioning it as a promising option for elderly patients with cholecystolithiasis and choledocholithiasis.

### ETHICAL APPROVAL:

This study was approved by the Ethics Committee of Anyang City People's Hospital (Approval No: KS-2021-08-01) prior to the initiation of the research. All procedures adhered to the ethical standards of the Declaration of Helsinki.

### PATIENTS' CONSENT:

Written informed consent was obtained from all participants for the publication of their anonymised clinical data.

### COMPETING INTEREST:

The authors declared no conflict of interest.

### AUTHORS' CONTRIBUTION:

YL: Contributed to the study's conceptualisation, methodology, and data collection and analysis.

TW: Participated in the investigation and validation processes, ensuring the accuracy and reliability of the findings.

JW: Played a crucial role in project administration and supervision, overseeing the overall research direction, manuscript preparation, and including critical revisions for intellectual content.

All authors approved the final version of the manuscript to be published.

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