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ROLE OF SURGICAL EXPERIENCE IN REDUCING THE INCIDENCE OF COMMON BILE DUCT INJURY DURING LAPAROSCOPIC CHOLECYSTECTOMY.

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ABSTRACT

BACKGROUND: Common bile duct injury CBDI is a significant complication during laparoscopic cholecystectomy LC, often associated with high morbidity. Previous studies have highlighted the importance of surgical experience in reducing the incidence of CBDI. However, the relationship between surgeon experience and CBDI rates remains to be fully explored. **Objective:** To evaluate the role of surgical experience in reducing the incidence of CBDI during LC.**MATERIALS AND METHODS:**This prospective observational study was conducted at Surgical Department within Surgical Units I, II, and III of Peoples Medical College Hospital Nawabshah from 1st March 2024 to 31st August 2024, including 132 patients undergoing elective LC. Patients were classified into three groups based on surgeon experience: Group A 0-20 cases, Group B 21-50 cases, and Group C >50 cases. The incidence of CBDI was recorded, and injuries were classified as minor or major. Data were analyzed in SPSS version 21.0.**RESULTS:**The overall incidence of CBDI was 8.3%. Group A exhibited the highest rate of CBDI 13.6%, followed by Group B 9.1%, and Group C 2.3%, showing a statistically significant reduction in injury rates with increasing experience p=0.025. Major injuries were only observed in Groups A 4.5% and B 2.3%, while no Long-term outcomes of common bile duct injury: a comparison between open and laparoscopic cholecystectomymajor injuries occurred in Group C p=0.041. Between Groups A and C, there was a statistically significant difference p=0.003, underscoring the protective effect of surgical experience. **Conclusion:** Surgical experience plays a critical role in reducing the incidence and severity of CBDI during LC. Surgeons with more experience demonstrated a significantly lower rate of complications, reinforcing the importance of expertise and continuous skill development in improving surgical outcomes.

KEYWORDS:laparoscopic cholecystectomy, common bile duct injury, surgical experience, bile duct injury, minimally invasive surgery, learning curve, cholecystectomy complications.

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INTRODUCTION

With advantages such as reduced postoperative pain, faster recovery, and fewer complications compared to open cholecystectomy, laparoscopic cholecystectomy LC has become the preferred method for managing symptomatic gallstone disease[1]. Despite its acceptance and advancement in surgical technique, common bile duct injury CBDI remains a significant problem. It was found that 0.3 to 1.5% of laparoscopic cholecystectomies may occur in CBDI and cause significant influence on

patient morbidity, quality of life, and healthcare costs[2,3]. However, severe consequences of this complication, including pancreatitis, bile leakage, and even need of additional surgery, emphasize the necessity of further surgical technique improvements[4]. One of the key factors to minimizing the risk of complication during procedure is surgical experience[5,6]. The learning curve theory assumes that experience makes the surgeon better at technique and thereby better patient outcomes[7,8]. CBDI rates of laparoscopic cholecystectomy may be affected by the complexity of individual cases, the surgeon's procedural volume and the overall case load at the institution. Despite this, literature to date has not definitively established a precise relationship between surgical experience and RSO following LC[9,10]. Studies have indeed shown that the odds of getting CBDI during laparoscopic surgeries are higher in the less experienced surgeons[1,10,11]. However, there is a large disparity on what level of experience can appropriately minimize these risks12. More research is necessary regarding how surgical training programs may be able to improve the basic skills of the novice surgeon and what role mentorship and simulation-based learning can play. Knowing how surgical experience influences CBDI rates is important to enhance the surgical education, creating training protocols, and facilitate patient safety.

In this study, we will analyze the effectiveness by which surgical expertise can decrease the risk of common bile duct injury in laparoscopic cholecystectomy. Through data analysis across various surgical experience levels, this research aims to discover useful inferences that can make a difference to surgical practice as well as education. The implications of this research are also critical to the development of evidence based guidelines to improve surgical training and practice, in addition to that of experience. For example, in an effort to constantly provide patients with top quality surgical outcomes, healthcare systems worldwide want to identify modifiable factors such as surgical experience. This study attempts to promote better training programs and mentorship opportunities by pushing attention on the role of expertise in lowering CBDI rates. The hope is that improved training programs and superior mentorship opportunities will translate to safer surgeries and better patient outcomes.

MATERIAL AND METHODS

Study Design and Setting

A Prospective Observational study was conducted in the Department of Surgery, Peoples Medical College Hospital Nawabshah from 01 March, 2024 to 31 August, 2024 within Surgical Units I, II and III.

Study Population

Participants included adults between the ages of 18 and above who had clinically confirmed symptomatic gallbladder disease as determined by clinical tests and imaging with ultrasound, CT, MR or even a combination thereof. Study exclusion criteria included those with a history of abdominal surgeries, acute cholecystitis, abdominal cancer, a major anatomical abnormality of the biliary system, or who were converted to open cholecystectomy.

Sample Size

Statistical power analysis indicated that a sample size of 132 patients was adequate to identify significant differences in the incidence of CBDI with respect to the surgical experience, significance threshold 0.05 and power 0.80% percent. Classification of Surgical Experience

Surgical Experience Classification

There were three groups of surgeons' experiences

- **Group A:** Novice surgeons 0-20 cases.
- **Group B:** Intermediate surgeons 21-50 cases.
- **Group C:** Experienced surgeons >50 cases.

The intent of this classification was to look at the inci dence of the CBDI and its relation to surgical experience.**Data Collection**

Data were collected using a standardized pro forma, capturing demographic information, clinical presentation, surgical history, and intraoperative complications. The incidence of CBDI was recorded for each patient, defined as any damage to the common bile duct that compromised its integrity.

Surgical Technique

All LC procedures were performed under general anesthesia using a standard four-port technique. Key steps included trocar insertion and pneumoperitoneum establishment, gallbladder and cystic duct identification, dissection of Calot's triangle, clipping and dividing the cystic duct and artery, and gallbladder removal. Intraoperative findings, including any CBDI, were meticulously

documented and categorized as minor e.g., bile leaks or major e.g., complete transection.

Ethical Considerations

The study was approved by the Institutional Review Board IRB of Peoples University of Medical and Health Sciences for Women Shaheed Benazirabad SBA. Informed consent was obtained from all patients, ensuring they were fully aware of the procedures and potential risks.

Statistical Analysis

Data were analyzed using SPSS version 21.0. Descriptive statistics were calculated for demographic and clinical variables. CBDI incidence across the three experience groups was compared using chi-square tests, with a p-value of <0.05 considered statistically significant.

RESULTS

The study population comprised 132 patients who underwent laparoscopic cholecystectomy, with participants evenly divided into three groups: Group A N = 44, Group B N = 44, and Group C N = 44. The demographic and clinical characteristics of the participants are as follows:

The mean age of the overall study population was 45.3 years SD ± 12.1. Group A had a slightly higher mean age of 48.2 years SD ± 11.7, followed by Group B at 45.1 years SD ± 10.8 and Group C at 43.5 years SD ± 12.5, but the difference in age across groups was not statistically significant p = 0.063.

Regarding gender distribution, the total population included 56 males 42.4% and 76 females 57.6%. Group A had 18 males 40.9% and 26 females 59.1%, Group B had 19 males 43.2% and 25 females 56.8%, and Group C had 19 males 43.2% and 25 females 56.8%. There was no statistically significant difference in gender distribution between the groups p = 0.923.

The mean BMI for the entire study population was 27.5 kg/m² SD ± 4.3. Group A had the highest mean BMI at 28.1 kg/m² SD ± 4.1, followed by Group B at 27.4 kg/m² SD ± 3.9 and Group C at 26.8 kg/m² SD ± 4.7, with no significant difference observed between the groups p = 0.316.

A total of 20 patients 15.2% had a history of previous abdominal surgery, with Group A having 8 patients 18.2%, and Groups B and C each having 6 patients 13.6%. The variation in the proportion of patients with previous abdominal surgery was not statistically significant p = 0.740.

The duration of gallbladder disease in years was reported with a mean of 3.5 years SD ± 2.1 across all participants. Group A had a slightly longer mean disease duration of 4.1 years SD ± 2.5, while Group B had 3.2 years SD ± 1.8 and Group C had 3.3 years SD ± 1.9. These differences were not statistically significant p = 0.195. **Table 1**

The data presented in **Table 2** highlights the significant impact of surgical experience on the incidence of common bile duct injury CBDI during laparoscopic cholecystectomy. Among the 44 procedures performed by novice surgeons Group A, the incidence of CBDI was highest at 13.6%, with 9.1% classified as minor injuries and 4.5% as major injuries p=0.041. In the intermediate experience group Group B, the incidence of CBDI decreased to 9.1%, with 6.8% being minor injuries and 2.3% major injuries p=0.209. The experienced group Group C exhibited the lowest occurrence of CBDI at 2.3%, with all cases classified as minor injuries 2.3% and no major injuries p=0.015. In total, the overall incidence of CBDI across all groups was 8.3%, with 6.1% categorized as minor and 2.3% as major injuries. These results suggest a clear relationship between increased surgical experience and a reduction in both frequency and severity of CBDI. Analysis of rates are statistically evaluated across groups with differing surgical experience. There was no difference in the difference between Group A less experienced and Group B moderately experienced CBDI rates $\chi^2 = 0.74$, $p = 0.389$. Likewise, the between group comparison of Group B least experienced and Group C most experienced was not statistically significant $\chi^2 = 3.52$, $p = 0.061$. But there was a big difference between Group A and Group C, with a chi square value of 8.95 and a p value of 0.003, suggesting that the chance of CBDI is less if you have had more experience in the operating room. Statistically significant overall comparison of all groups $\chi^2 = 9.46$, $p = 0.002$ confirms the effect that increased surgical expertise had in reducing the risk for CBDI during laparoscopic cholecystectomy. See Table 3 In this research the total incidence of common duct injury CBDI during laparoscopic cholecystectomy was 8.3% n=11. On the basis of surgical experience, Group A n=6 and

p=0.025 with the least experience, Group B n=4 and p=0.025 and Group C n=1 and p=0.025, the most experienced group, had the highest rate of CBDI at 13.6%,9.1% and 2.3% respectively. Bile leak occurred in 6.1% n=8 of cases, with the highest incidence in Group A 9.1%, n=4, but this difference was not statistically significant p=0.185. Complete transection of the common bile duct was reported in 2.3% n=3 of cases, with a significant reduction in incidence across groups, from 4.5% n=2 in Group A to 0% in Group C p=0.041. Conversion to open surgery occurred in 3.8% n=5 of cases, and blood loss exceeding 100 mL was observed in 2.3% n=3 of cases, both without significant differences between groups p=0.185 and p=0.999, respectively. **Table 4**

Table 1: Demographic and Clinical Characteristics of Study Population

Characteristic	Total n = 132	Group A n = 44	Group B n = 44	Group C n = 44	p-value
Age Mean ± SD	45.3 ± 12.1	48.2 ± 11.7	45.1 ± 10.8	43.5 ± 12.5	0.063
Gender Male/Female	56/76	18/26	19/25	19/25	0.923
BMI Mean ± SD	27.5 ± 4.3	28.1 ± 4.1	27.4 ± 3.9	26.8 ± 4.7	0.316
Previous Abdominal Surgery	20 15.2%	8 18.2%	6 13.6%	6 13.6%	0.740
Gallbladder Disease Duration Years, Mean ± SD	3.5 ± 2.1	4.1 ± 2.5	3.2 ± 1.8	3.3 ± 1.9	0.195

Table 2: Surgical Experience Classification and Incidence of CBDI

Surgical Experience Group	Total Procedures N	CBDI Incidence %	Minor Injury %	Major Injury %	p-value
Group A Novice	44	6 13.6%	4 9.1%	2 4.5%	0.041
Group B Intermediate	44	4 9.1%	3 6.8%	1 2.3%	0.209
Group C Experienced	44	1 2.3%	1 2.3%	0 0%	0.015
Total	**132**	**11 8.3%**	**8 6.1%**	**3 2.3%**	-

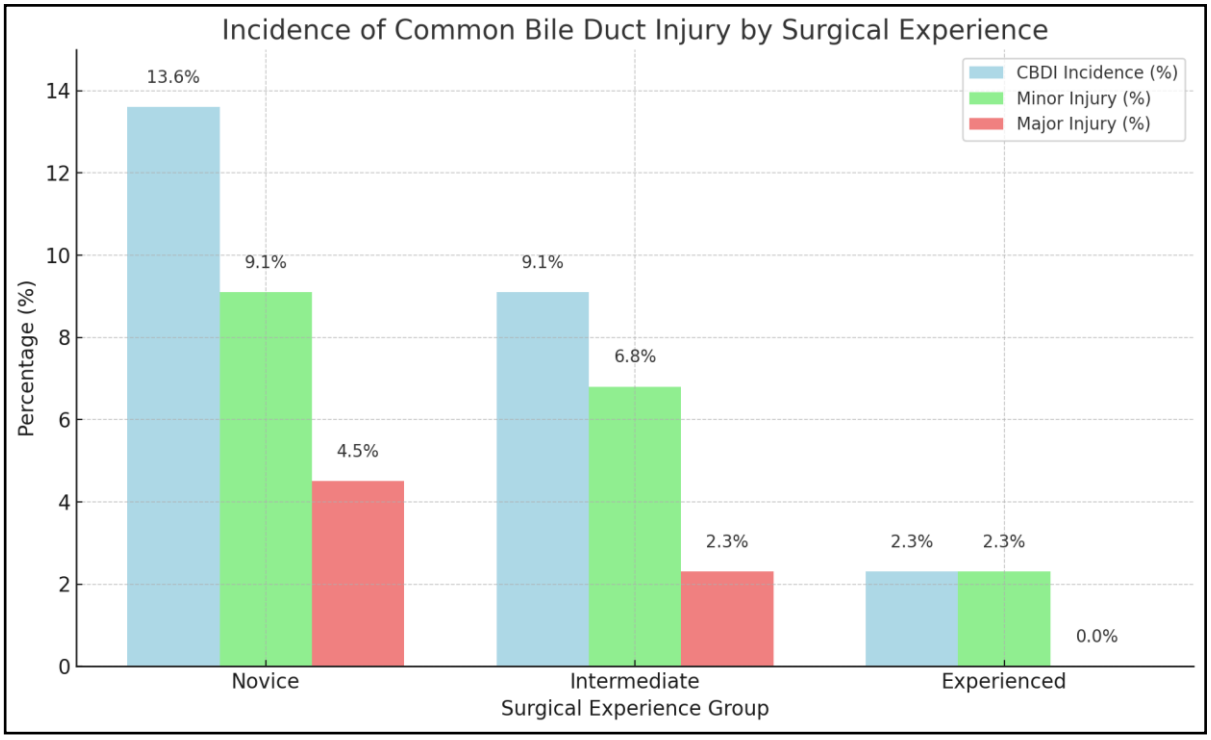
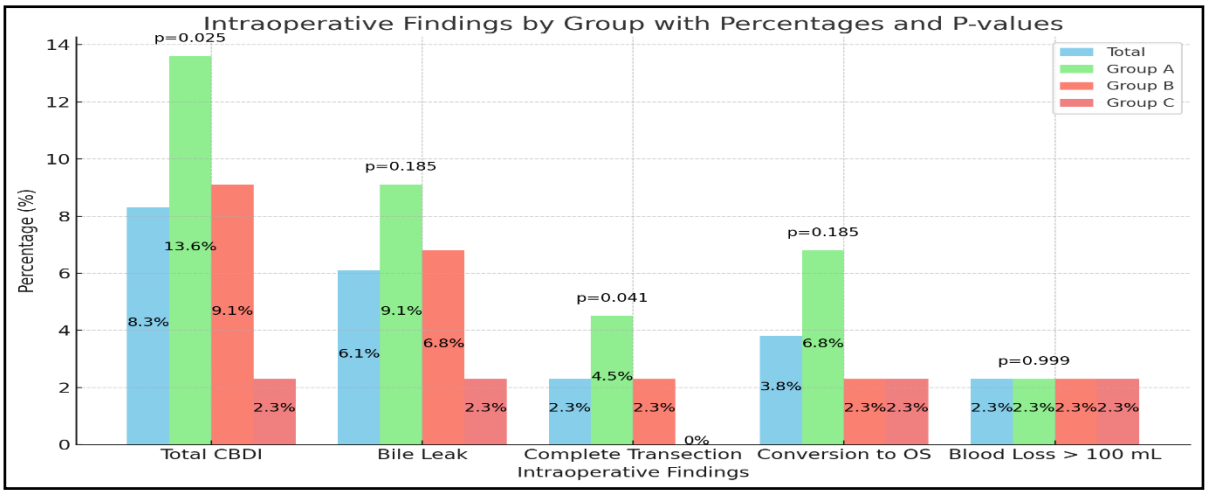


Table 3: Statistical Analysis of CBDI Incidence Across Surgical Experience Groups

Comparison	Chi-square Value	p-value	Significance
Group A vs. Group B	0.74	0.389	Not Significant
Group B vs. Group C	3.52	0.061	Not Significant
Group A vs. Group C	8.95	0.003	Significant
Overall Comparison	9.46	0.002	Significant

Table 4: Intraoperative Findings Related to CBDI

Intraoperative Findings	Total N = 132	Group A N = 44	Group B N = 44	Group C N = 44	p-value
Total CBDI	11 8.3%	6 13.6%	4 9.1%	1 2.3%	0.025
Bile Leak	8 6.1%	4 9.1%	3 6.8%	1 2.3%	0.185
Complete Transection	3 2.3%	2 4.5%	1 2.3%	0 0%	0.041
Conversion to Open Surgery	5 3.8%	3 6.8%	1 2.3%	1 2.3%	0.185
Blood Loss > 100 mL	3 2.3%	1 2.3%	1 2.3%	1 2.3%	0.999



DISCUSSION

The findings of this study highlight a clear association between surgical experience and the incidence of common bile duct injury CBDI during laparoscopic cholecystectomy LC. Our results demonstrated a gradual decrease in the occurrence of common bile duct injuries CBDI as surgical proficiency improves. The least experienced cohort Group A displayed the highest injury rate at 13.6%, while the most seasoned cohort Group C had a notably lower rate of 2.3%. These findings highlight the essential impact of surgical skill on reducing the likelihood of CBDI and enhancing patient outcomes13.

The average age of participants in our research was 45.3 years, and the groups were similar regarding age, gender distribution, body mass index BMI, and history of abdominal surgery, confirming that the differences in CBDI rates were mainly attributable to surgical experience.

Despite lack of statistical differences on demographic and clinical characteristics among the groups, CBDI rates were significantly different suggesting that surgeon proficiency, technique, and experience are important variables to prevent complications when CBDI is performed. In our group, the total incidence of CBDI was 8.3%, which lies in the higher range of reported incidences in existing literature14. For instance, a large study by Cinaroglu & Baser, et al. 2017 estimated a CBDI incidence of 0.4 % to 0.6 %, which was much lower than our results, possibly because their cohort was dominated by top flight surgeons. For example, the number of novice and intermediate surgeons in our study was much higher than in other, and

this could explain the elevated injury rate. This is an important difference, given that surgeon experience reduces complications in even high risk procedures, such as laparoscopic cholecystectomy LC.15 Our results are consistent with previous research on the impact of surgical experience on CBDI rates. A study by Fletcher et al 2020 studying the learning curve of surgeons to laparoscopic cholecystectomies noted that inexperienced surgeons had a higher incidence of CBDI 8.9%16 which matches our finding for Group A 13.6%16.

Their study also demonstrated a significant reduction in CBDI rates as surgeons gained experience, with rates decreasing to 4.2% in intermediate-level surgeons and 1.9% in experienced surgeons, findings that support our conclusion that experience correlates strongly with CBDI risk17.

In contrast, Manoj et al. 2022 reported an overall CBDI rate of 1.2%, much lower than the rate observed in our study. However, their study focused exclusively on senior surgeons with over 200 LC procedures performed, which highlights the protective effect of extensive surgical experience15,17. In our study, even the most experienced surgeons Group C had an injury rate of 2.3%, which could be attributed to differences in surgical training, patient complexity, or intraoperative conditions. Nevertheless, the significant decrease in injury rates from Group A 13.6% to Group C 2.3% in our study reinforces the consensus that surgical experience is a critical factor in reducing the likelihood of CBDI15. A more recent meta-analysis conducted by Gouma et al. 2015 reinforced the idea that the occurrence of common bile duct injury CBDI is inversely proportional to the number of laparoscopic procedures a surgeon performs18. Their research revealed that surgeons with fewer than 100 laparoscopic cholecystectomies LC faced a greater likelihood of significant bile duct injury compared to those with over 500 procedures, further validating the concept of a learning curve. This aligns with our findings, where the rate of major CBDI dropped from 4.5% in Group A to 0% in Group C.19 The statistically significant difference in CBDI rates between less experienced and seasoned surgeons in our analysis p=0.003 supports Browling et al.'s conclusion that surgical experience markedly decreases the risk of severe complications19.

But our proposed result findings of other scholars have given different opinions which deserve attention. For example, Surgical experience alone is not sufficient to explain the incidence of CBDI as Pallaneeandee et al. 2023 demonstrated and the experience as opposed to the learning curve and technique as aspect of surgical procedure is a crucial factor in the incidence of CBDI20. This investigation shows that novice surgeons are able to effectively minimize risks by undergoing a well organized training regimen in both cognitive and technical areas. Indeed, this viewpoint suggests that besides experience, such as the quantity and thoroughness of training, may be important in reducing complications. In addition, Liu et al. 2022 conducted a meta analysis of the results of laparoscopic versus open cholecystectomy, concluding that the complexity of the procedure and variability of the anatomy were responsible for the increased risk of CBDI21. Their findings indicated that inexperienced surgeons had similar skills when completing laparoscopic techniques, but difficulty with anatomical problem related to the individual patient. What this implies is that experiencing surgery should be coupled with the ability to assess and constantly adjust to the presence of conditions within patient. While the overall trends in our investigation are in line with much of the existing literature there are a number of studies that present contradictory data. Overall CBDI rate in the study by Asuri et al. 2023 was 0.7%22, no significant difference in CBDI rates and between surgeons with varying levels of experience was noted. The resultant analysis suggested that factors beyond experience, in particular, preoperative imaging, intraoperative cholangiography, and patient anatomy, were more important in preventing bile duct injuries. Our study did not directly evaluate these factors, but the meaningful differences in the CBDI rates for novice versus experienced surgeons are consistent with the conclusion that, at least within our cohort with a physicians, surgeon proficiency was the principle factor that influenced injury risk.Additionally, it is important to highlight that the rate of conversion to open surgery and blood loss exceeding 100 mL showed no significant differences between the groups in our study. This stands in contrast to studies like that of Halawani et al. 2017 ability to

detect meaningful differences in these secondary outcomes. Future research with larger cohorts might clarify these associations further21.

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CONCLUSION

In summary, this research reveals a notable relationship between surgical proficiency and the decrease in common bile duct injury CBDI during laparoscopic cholecystectomy. Less experienced surgeons Group A showed the greatest occurrence of CBDI 13.6%, whereas their more seasoned counterparts Group C demonstrated a significantly lower rate 2.3%. These results highlight the essential impact of enhancing surgical knowledge in lowering both the frequency and severity of CBDI, underscoring the necessity of experience and skill enhancement in reducing surgical complications and enhancing patient results.

ETHICS APPROVAL: The ERC gave ethical review approval.

CONSENT TO PARTICIPATE:written and verbal consent was taken from subjects and next of kin.

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AUTHORS' CONTRIBUTIONS:

All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated in the work to take public responsibility of this manuscript. All authors read and approved the final manuscript.

CONFLICT OF INTEREST: No competing interest declared

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