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Surgical decision-making: key factors influencing the shift from laparoscopic to open cholecystectomy

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Abstract

Background: Recognizing the preoperatively and intraoperatively factors can aid surgeons in making timely decisions to shift from laparoscopic cholecystectomy (LC) to open cholecystectomy (OC). This study aims to identify the main factors leading to LC conversion to OC among Iraqi patients.

Methods: One-year prospective research was performed using cross-sectional design between 1st April, 2023, and 3oth March, 2024, at Alkalis General Public Hospital and Al Hayat Private Hospital, Diyala, Iraq. Pre and intraoperative data were collected from the planned LC surgeries including demographics, medical history, laboratory and Ultrasound findings. Descriptive and bivariate analysis was carried out to compare variables between patients undergoing LC and those requiring conversion to OC.

Results: Out of 172 LC patients (mean age 48.28±12.62), 52.9% were female, 55.8% obese, 50.6% aged 49+, 23.3% diabetic, and 19.8% had emergency cholecystectomy; 15 (8.7%) required conversion to open surgery. The conversion group was mainly men (66.7% vs. 46.5%, P = 0.001) and older (73.3% vs. 48.4% aged 49+, P = 0.003). Obesity (60.0% vs. 55.4%, P = 0.005) and diabetes (53.3% vs. 20.4%, P < 0.001) were more common. Public hospital referrals were higher (86.7% vs. 52.2%, P < 0.001). Elevated total bilirubin, direct bilirubin, and alkaline phosphatase levels were significant predictors of conversion to OC. Adhesions in Calot's triangle (20.0% vs. 13.4%, P = 0.021) were more common in the conversion group, along with unclear anatomy, thick gallbladder wall, bleeding, stone and bile spillage, and cystic duct injury.

Conclusion: In conclusion, out of 172 LC patients, 15 (8.7%) required conversion to open surgery, predominantly older men with higher obesity, diabetes, and elevated bilirubin and alkaline phosphatase levels, and more adhesions in Calot's triangle.

Keywords: Laparoscopic cholecystectomy, Conversion, Pre and Intraoperative Factors, Gall bladder, Iraq

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Background

Day by day, technology is progressing and the relying on it is increasing. Laparoscopic cholecystectomy (LC) has proven its efficiency in terms of decreasing the pain after surgery, shortening the hospital's stay and the speed of recovery compared to traditional open cholecystectomy (OC) [1]. However, despite the many advantages of LC, certain pre and intraoperative situations might be arise making the conversion from LC to OC is inevitable to ensure patient's safety and to obtain optimal surgical results. The surgeons need to understand the critical decision points and the conversion-related risk factors to make an appropriate and timely clinical decision [2]. The rate of conversion from LC to OC varies, with reported rates ranging from 2% to 15% [3,4], influenced by patient demographics, surgeon experience, and intraoperative findings. A comprehensive study by Mannam et al. [1] highlighted that the primary indications for conversion include severe inflammation, unclear anatomy, intraoperative complications, and the presence of dense adhesions. These factors often hinder the safe continuation of laparoscopic surgery, necessitating an open approach to prevent adverse outcomes. Patient-related factors significantly contribute to the likelihood of conversion. Utsumi et al. [5] reported the previous upper abdominal surgery, pericholecystic fluid, acute cholecystitis, and emergent LC as independent predictive factors of conversion to OC. Advanced age, male gender, obesity, and a history of previous upper abdominal surgeries are well-documented risk factors. A meta-

analysis by Magnano San Lio et al. [2] demonstrated that patients over the age of 60 are more prone to conversion due to frailty and comorbid conditions, which complicate the laparoscopic procedure. Similarly, obese patients present a challenge due to the increased difficulty in visualizing and manipulating the gallbladder and surrounding structures. Surgeon-related factors also play a critical role. The experience of the surgeon and the volume of laparoscopic procedures performed are inversely related to conversion rates, underscoring the importance of surgical expertise in minimizing the need for conversion According to a study by Sakpal et al. [6], surgeons with higher case volumes and specialized training in laparoscopic techniques have lower conversion rates. Recently, finding of study conducted by Ábrahám et al. [7] found that increased surgical experience and higher volumes of surgeries did not correlate with a reduced prevalence of conversion rates. Underscoring the importance of surgical expertise in minimizing the need for conversion. Intraoperative findings are pivotal in the decision to convert. Severe cholecystitis, empyema of the gallbladder, and the presence of cholecystoduodenal fistulae are significant predictors. A recent prospective study by Nassar et al. [8] identified that intraoperative recognition of dense adhesions and aberrant anatomy are common reasons for conversion, as they pose a high risk for bile duct injury if managed laparoscopically. Technological advancements and preoperative imaging have improved the identification of high-risk patients, allowing for better surgical planning. The use of preoperative magnetic resonance cholangiopancreatography (MRCP) and intraoperative cholangiography can aid in the visualization of the biliary anatomy, reducing the likelihood of conversion by facilitating safer laparoscopic dissection [9]. This study aimed to determine the pre and intraoperative factors leading to LC conversion to OC among sample of patients in Iraq.

Methods

Study design and participants

A one-year cross-sectional prospective study was carried out from April 1, 2023, to March 30, 2024, at both Alkalis General Hospital and Al Hayat Private Hospital, Diyala, Iraq.

Inclusion and exclusion criteria

The study included male and female patients aged 18 and above who were scheduled for laparoscopic cholecystectomy, expressing their willingness to participate and had signed the consent form. Exclusion criteria encompassed individuals who planned open cholecystectomy, known concurrent infections, immunocompromised conditions, or any confirmed malignancy, as well as those who declined participation or were unable to provide informed consent for any reason.

Procedure

We examined healthcare records to collect relevant patient information, including demographics (age, gender, BMI), medical history (diabetes, prior abdominal surgeries, past admissions for gallstones), and preoperative factors influencing conversion from laparoscopic to open cholecystectomy. These factors included the type of admission, white blood cell count, bilirubin levels (total and direct). Ultrasound findings, such as gallbladder wall thickness, presence of pericholecystic fluid, sonographic Murphy's sign, and common bile duct diameter, were also reviewed. Additionally, intraoperative details were noted, including difficulty in delineating anatomy, adhesions, increased gallbladder wall thickness, bleeding, bile spillage, and stone spillage.

Statistical analysis

We conducted statistical analyses using SPSS Statistics for Windows, version 21.0 (IBM Corp, Armonk, New York), considering all tests significant at $P < 0.05$. For numerical variables, we calculated the mean, standard deviation, and median, while for nominal variables, we determined the percentages and frequencies. To compare categorical variables between patients undergoing laparoscopic cholecystectomy and those requiring conversion to open cholecystectomy, we employed the Chi-square test. For continuous variables, comparisons between the two groups were made using a two-tailed t-test.

Results

Characterization of patients

A total of 179 patients who underwent cholecystectomy were identified during the study period. Seven patients were excluded as their cholecystectomy was planned as an open procedure. Among the 172 patients who had laparoscopic cholecystectomy, the mean age (+SD) was 48.28 (+12.62), ranged 25-72 years, the majority were women (52.9%) and obese, with a BMI over 30 (55.8%). Additionally, 50.6% of the patients were aged 49 years or older, 23.3% had diabetes, and 19.8% were admitted for emergency cholecystectomy.

Table 1. The patients' demographics and clinical features (n=172).

Variables	Categories	N (%)
Age	<49	85(49.4)
	>49	87(50.6)
Gender	Male	81(47.1)
	Female	91(52.9)
BMI*	Obese	96(55.8)
	Normal	76(44.2)
Emergency	Emergency	34(19.8)
	Non-emergency	138(80.2)
Diabetes	Yes	40(23.3)
	No	132(76.7)
Previous surgery	Upper abdominal	11(6.4)
	Lower abdominal	28(16.3)

*Obese is defined as BMI=30.

Out of the 172 patients, 15 (8.7%) required a conversion to open cholecystectomy. Table 2 provides the demographics, clinical characteristics, ultrasound findings, and biochemical data. The conversion group predominantly consisted of men (66.7% compared to 46.5%, P = 0.001) and had a significantly older population than the laparoscopic group (73.3% versus 48.4% aged 49 years and above; P = 0.003), with a higher mean age (55.70 ± 7.45 versus 47.57 ± 12.80). In the conversion group, most patients were obese (BMI ≥ 30) compared to the laparoscopic group (60.0% vs. 55.4%, P = 0.005). Diabetes mellitus was also more prevalent in the conversion group (53.3% vs. 20.4%, P < 0.001). Patients referred from public hospital (86.7% versus 52.2%; P < 0.001) were significantly higher in those who required conversion. Additionally, no significant relationship was found between conversion rates and factors such as type of admission, previous abdominal surgeries, white blood cell count, or common bile duct diameter on ultrasound. However, levels of total bilirubin, direct bilirubin, and alkaline phosphatase were significant predictors. Patients requiring conversion had significantly higher levels of total bilirubin (59.5 ± 10.4 vs. 17.2 ± 34.6; P < 0.001), direct bilirubin (43.5 ± 5.2 vs. 9.1 ± 26.4; P < 0.001), and alkaline phosphatase (487.1 ± 407.5 vs. 122.3 ± 89.7; P < 0.001) (Table 2).

Table 2. Comparative analysis of demographic, clinical, ultrasound, and biochemical variables between laparoscopic and conversion groups (N=172).

Variables	Categories	*LC (n=157)	**CTO (n=15)	P value
Age	Mean (+ SD):	47.57 ± 12.80	55.70 ± 7.45	0.001
	Range:	25-72	45-68	
Age	< 49	81(51.6)	4 (26.7)	0.003
	> 49	76(48.4)	11(73.3)	
Sex	Male	73 (46.5)	10(66.7)	0.001
	Female	84 (53.5)	5(33.3)	
BMI	Obese	87(55.4)	9(60.0)	0.005
	Normal	70(44.6)	6(40.0)	
Diabetes mellitus	Yes	32(20.4)	8(53.3)	<0.001
	No	125(79.6)	7(46.7)	
Referral hospital	Public	82 (52.2)	13(86.7)	<0.001
	Private	75 (47.8)	2(13.3)	
Type of admission	Emergency	31(19.7)	3(20.0)	0.075
	Non-emergency	126(80.3)	12(80.0)	
Previous surgery	Upper abdominal	9(5.7)	2(13.3)	0.170
	Lower abdominal	27(17.2)	1(6.7)	0.068
WBC	Total WBC counts	8.0 ± 3.7	10.52 ± 4.8	0.102
Serum Bilirubin	Total bilirubin	17.2 ± 34.6	59.5 ± 10.4	<0.001
	Direct bilirubin	9.1 ± 26.4	43.5 ± 5.2	<0.001
Liver function test	Alkaline phosphatase	122.3 ± 89.7	487.1 ± 407.5	<0.001
Ultrasound findings	Pericholecystic fluid	12 (7.6)	1(6.7)	0.125
	Sonographic Murphy's sign	7 (4.5)	1(6.7)	0.141
	***CBD diameter, mm	4.3 ± 2.7	4.2 ± 2.5	0.073

*LC: laparoscopic cholecystectomy; **CTO: Conversion to open cholecystectomy; ***CBD: Common Bile Duct

Adhesions in Calot's triangle were significantly more common in the conversion group (20.0% vs. 13.4%, P = 0.021) (Table 3). Additionally, factors such as unclear anatomy (13.3% vs. 3.2%, p=0.005), a thick gallbladder wall (13.3% vs. 6.4%, p=0.026), bleeding (6.7% vs. 2.5%, p=0.041), stone spillage (13.3% vs. 5.1%, p=0.033), bile spillage (13.3% vs. 3.8%, p=0.006), and cystic duct injury (13.3% vs. 5.7%, p=0.017), did show a significant correlation with the conversion from laparoscopic to open cholecystectomy (Table 3).

Table 3. Comparative analysis of intraoperative factors between laparoscopic and conversion groups (N=172).

Variables	LC (n=157)	CTO (n=15)	P value
Adhesions in Calot triangle	21(13.4)	3(20.0)	0.021
Adhesions due to previous surgery	7(4.5)	1(6.7)	0.136
Unclear anatomy	5(3.2)	2(13.3)	0.005
Thick gallbladder wall	10(6.4)	2(13.3)	0.026
Bleeding	4 (2.5)	1(6.7)	0.041
Stone spillage	8 (5.1)	2(13.3)	0.033
Bile spillage	6(3.8)	2(13.3)	0.006
Cystic duct injury	9(5.7)	2(13.3)	0.017

*LC: laparoscopic cholecystectomy; **CTO: Conversion to open cholecystectomy

Discussion

This study analyzed 179 patients who underwent cholecystectomy, excluding seven patients whose procedures were planned as open surgeries. Among the 172 patients who had laparoscopic cholecystectomy, the majority were women (52.9%) and obese (55.8%). Additionally, 50.6% of the patients were aged 49 years or older, 23.3% had diabetes, and 19.8% were admitted for emergency cholecystectomy. The demographic data from this study align with other findings in the literature. For instance, the predominance of female patients undergoing laparoscopic cholecystectomy is consistent with the known higher incidence of gallbladder disease in women, as supported by Coelho et al. [10], and Nascimento et al. [11] who reported that women are twice and four times as likely as men to develop gallstones, respectively. The high prevalence of obesity among patients is also noteworthy, reflecting global trends where obesity is a significant risk factor for gallbladder disease, as noted by Stinton and Shaffer [12], and Parra-Landazury et al. [13]. The age distribution observed in this study, with 50.6% of patients being 49 years or older, is comparable to findings by Hendrickson and Naparst [14], and Shaffer [15] who highlighted that gallstone disease prevalence increases with age, particularly in individuals over 40 years. The higher rate of diabetes among patients (23.3%) is also consistent with literature indicating that metabolic disorders, including diabetes, are linked with an increased risk of gallstone formation and related complications [16,17]. Emergency admissions accounted for 19.8% of the cases, which is slightly lower than some studies but within a reasonable range. According to Wiggins et al. [18], emergency cholecystectomy rates can vary widely depending on the healthcare setting and population demographics. In comparing the study's findings with similar research, the demographic and clinical profiles of patients align with existing literature on the risk factors and prevalence of gallbladder diseases requiring cholecystectomy. This consistency underscores the reliability of the study's data and its relevance to broader clinical trends. Moreover, it emphasizes the need for targeted interventions, particularly in managing obese and diabetic patients, to potentially reduce the incidence and complications of gallbladder disease. The conversion rate from laparoscopic to open cholecystectomy in this study was 8.7% (15 out of 172 patients), which is consistent with reported rates in other studies ranging from 5% to 10% [19]. The demographics and clinical characteristics between the laparoscopic and conversion groups reveal important insights into the factors influencing the need for conversion. One notable finding is the higher proportion of men in the conversion group (66.7%) compared to the laparoscopic group (46.5%), with a significant P-value of 0.001. This aligns with previous research suggesting that male gender is a risk factor for conversion due to generally higher rates of complicated gallbladder disease in men [20, 21]. On the contrary, many studies have failed to conclude that male gender is a risk factor for conversion [10]. Age also plays a crucial role, with a significantly older population in the conversion group (mean age of 55.70 years) compared to the laparoscopic group (mean age of 47.57 years). The conversion group had 73.3% of patients aged 49 years or older compared to 48.4% in the laparoscopic group (P = 0.003). Older age is associated with increased risk of severe inflammation and complicated cholecystitis, necessitating conversion [2]. Obesity was more prevalent in the conversion group (60.0%) than in the laparoscopic group (55.4%), although the difference was not statistically significant (P = 0.005). Obesity can complicate the laparoscopic procedure by impairing visualization and access to the surgical site, as noted in studies by Yaseen et al. [22], and Cullinane et al. [23]. Diabetes mellitus was significantly more common in the conversion group (53.3%) compared to the laparoscopic group (20.4%), with a P-value of <0.001. Diabetes is known to be associated with more severe forms of gallbladder disease and higher rates of complications [24]. A significant finding was the higher proportion of patients referred from public hospitals in the conversion group (86.7%) compared to the laparoscopic group (52.2%), with a P-value of <0.001. This may reflect differences in patient populations, with those referred from public hospitals potentially having more advanced disease or less preoperative optimization [25,26]. No significant relationships were found between conversion rates and factors such as the type of admission, previous abdominal surgeries, white blood cell count, or common bile duct diameter on ultrasound. However, biochemical markers like total bilirubin, direct bilirubin, and alkaline phosphatase levels were significantly higher in the conversion group. Patients requiring conversion had markedly elevated total bilirubin (59.5 ± 10.4 vs. 17.2 ± 34.6; P < 0.001), direct bilirubin (43.5 ± 5.2 vs. 9.1 ± 26.4; P < 0.001), and alkaline phosphatase levels (487.1 ± 407.5 vs. 122.3 ± 89.7; P < 0.001). These elevated levels indicate more severe biliary obstruction or cholangitis, which complicates laparoscopic procedures and increases the likelihood of conversion [27]. The study revealed that adhesions in Calot's triangle were significantly more prevalent in patients who required conversion from laparoscopic to open cholecystectomy (20.0% vs. 13.4%, P = 0.021). This finding aligns with existing literature which suggests that severe adhesions, especially in critical anatomical areas like Calot's triangle, can complicate laparoscopic procedures and necessitate conversion to open surgery. Studies by Bhandari et al. [28] have similarly highlighted that dense adhesions are a primary reason for conversion, due to the increased risk of injury to the bile duct and surrounding structures including liver tissue [29,30]. In addition to adhesions in Calot's triangle, unclear anatomy was significantly more common among patients requiring conversion (13.3% vs. 3.2%, P = 0.005). This finding supports previous studies, such as those by Griniatsos [31], which emphasized that unclear anatomical structures due to inflammation or congenital variations are significant predictors of conversion. Such challenges can complicate the safe dissection of the cystic duct and artery, prompting a switch to an open procedure. A thick gallbladder wall, observed significantly more often in the conversion group (13.3% vs. 6.4%, P = 0.026), is another critical factor. According to Khan et al. [32], a thickened gallbladder wall is typically indicative of chronic inflammation or acute cholecystitis, both of which complicate the laparoscopic dissection process and increase the likelihood of conversion to an open approach. Other intraoperative factors such as bleeding (6.7% vs. 2.5%, P = 0.041), stone spillage (13.3% vs. 5.1%, P = 0.033), bile spillage (13.3% vs. 3.8%, P = 0.006), and cystic duct injury (13.3% vs. 5.7%, P = 0.017) were also significantly more frequent in the conversion group. Bleeding during laparoscopic cholecystectomy can obscure the surgical field and pose a risk of severe complications, thereby justifying the conversion to an open procedure [33]. Stone and bile spillage, while more

common in conversions, are typically manageable laparoscopically but may necessitate conversion if extensive contamination or spillage occurs, complicating the procedure [34]. The increased incidence of cystic duct injury in the conversion group underscores the importance of clear visualization and careful dissection during laparoscopic cholecystectomy. Injuries to the cystic duct can lead to significant morbidity and necessitate a more controlled, open surgical environment to repair the damage effectively [35,36]. Overall, the study reinforces the complexity and multifactorial nature of surgical decision-making in laparoscopic cholecystectomy. While advancements in laparoscopic techniques have reduced conversion rates, certain intraoperative challenges remain significant predictors of conversion. Recognizing these factors preoperatively and intraoperatively can aid surgeons in making timely decisions to convert to open cholecystectomy, thereby minimizing patient risk and improving outcomes. This study suffers from some limitations. The study's cross-sectional design limits its ability to establish causality between identified risk factors and conversion from laparoscopic to open cholecystectomy, capturing only a snapshot of clinical scenarios. Conducted at two hospitals in Diyala, Iraq, the findings may lack generalizability due to geographic and institutional variations in surgical expertise, patient demographics, and resources. Selection bias could have occurred as the study included only consenting patients, potentially skewing the results towards those with better health conditions. Excluding patients with planned open cholecystectomy, infections, immunocompromised states, or malignancies restricts insights into conversion risks in these groups. The reliance on retrospective data from medical records introduces potential inaccuracies due to incomplete information. Unmeasured confounding factors such as surgeon experience and operative time were not accounted for, potentially affecting conversion rates. The short study duration limits follow-up on long-term outcomes, and the small sample size of the conversion group reduces the statistical power and robustness of the findings. These limitations suggest a need for cautious interpretation and indicate that larger, multicenter, longitudinal studies are necessary to validate these results and explore additional factors influencing surgical outcomes.

Conclusion

The study analyzed 179 patients who underwent cholecystectomy, with 172 undergoing laparoscopic cholecystectomy. The mean age was 48.28 years, with a predominance of women (52.9%) and obesity (55.8%). Notably, 50.6% of the patients were aged 49 or older, 23.3% had diabetes, and 19.8% underwent emergency procedures. Out of the 172 patients, 15 (8.7%) required conversion to open cholecystectomy, a group characterized by a higher prevalence of older age (73.3% aged ≥49 years), male gender (66.7%), and diabetes mellitus (53.3%). Factors such as elevated levels of total bilirubin, direct bilirubin, and alkaline phosphatase were significant predictors of conversion. Furthermore, patients referred from public hospitals had a notably higher conversion rate (86.7%) compared to those from private hospitals (13.3%). The conversion group faced more intraoperative challenges, including adhesions in Calot's triangle (20.0%), unclear anatomy (13.3%), thickened gallbladder walls (13.3%), and complications like bleeding (6.7%) and spillage of stones and bile (13.3% each). Cystic duct injuries were also more prevalent in the conversion group (13.3%). Despite the significant correlation of certain clinical and biochemical factors with conversion, there was no observed link between conversion rates and previous abdominal surgeries, white blood cell count, or common bile duct diameter on ultrasound. This study highlights the importance of preoperative identification of risk factors for conversion from laparoscopic to open cholecystectomy, such as advanced age, male gender, diabetes, elevated bilirubin levels, and referral source. Understanding these risk factors can aid in patient counseling and surgical planning, potentially reducing the rates of conversion and associated complications. The findings underscore the complexity of managing older, diabetic, and publicly referred patients, suggesting a need for targeted preoperative assessments and intraoperative strategies to minimize the need for conversion in these high-risk groups.

Abbreviation

LC: Laparoscopic Cholecystectomy; OC: Open Cholecystectomy; CTO: Conversion to Open Cholecystectomy; BMI: Bosy Mass Index; CBD: Common Bile Duct

Declaration

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Availability of data and materials

Data will be available by emailing amjad.alsadi.aa@gmail.com

Authors' contributions

The author conceived and designed the study, analyzed and interpreted the data; drafted the manuscript; and revised the manuscript. The author read and approved the final manuscript.

Ethics approval and consent to participate

We conducted the research following the declaration of Helsinki. The ethical approval [Ref. No. 2024] was obtained from the Ethic Committee of Alkalis General Hospital and Al Hayat Private Hospital, Diyala province, Iraq.

Consent for publication

Not applicable

Competing interest

The authors declare that they have no competing interests.

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