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# Comparative Analysis of Iraq and Neighboring Countries' Conversion Rates from Laparoscopic to Open Cholecystectomy

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## ABSTRACT

However, a major quality measure in biliary surgery, conversion from Laparoscopic to open Cholecystectomy (LC to OC), has widely different rates and risk elements across areas. Although symptomatic cholelithiasis now calls for LC, intraoperative difficulties sometimes call for conversion, which affects patient outcomes and healthcare expenses. Comparative regional data are restricted, particularly for Iraq.

**Objectives:** Find major risk factors to estimate the LC to OC conversion rate in Iraq, and then correlate these results with those from nearby nations to provide context for results and call attention to surgical opportunities.

**Materials and Methods:** This retrospective cohort study was conducted from September 2020 to April 2024 on 880 patients undergoing LC for symptomatic cholelithiasis at three main hospitals in Hilla, Iraq. Hospital records were mined for patient demographics, surgical specifics, and the causes of conversion. Using descriptive statistics and multivariate logistic regression, conversion rates and risk variables including age, sex, and gallbladder wall thickness were examined. By employing harmonic definitions and statistical techniques, comparative data from recent regional investigations (2010 to 2023) were rigorously examined.

**Results:** With 4.1% (36/880), the conversion rate in Iraq was lower than that in Saudi Arabia (7.3%) and Iran (8.0%) but higher than that in Japan (2.3%). Male sex (aOR 7.46, 95% CI: 2.89-9.38) and gallbladder wall thickness >3 mm (aOR, 3.8) were the most powerful independent predictors of conversion. Patients aged ≥50 years also had a higher risk (aOR 3.06). Unclear anatomy (44.4%) and intraoperative hemorrhage (22.2%) were the most common causes of conversion. Regional comparisons showed similar risk patterns, although the rates of uncertain anatomy were notably greater in Saudi Arabia (79.7%). Factors including surgeon experience, facility resources, and study design (single-center, retrospective) might impact the observed rates and restrict direct cross-country comparisons.

**Conclusion:** With male sex, older age, and thicker gallbladder walls as consistent risk variables, Iraq's conversion rate is comparable to or better than that of several regional neighbors. Further lowering of conversion rates could be accomplished by improving preoperative imaging, continuous surgical training, and resource investment. Regional benchmarking highlights the importance of uniform procedures and cooperative quality improvement.

**Keywords:** Laparoscopic, Open cholecystectomy, Conversion rate, Gallbladder wall, Risk factors

## 1. Introduction

Cholecystectomy is one of the most commonly performed abdominal surgeries worldwide. It is conventionally performed using an open technique; however, Laparoscopic Cholecystectomy (LC) was first reported in 1985[1]. Laparoscopic cholecystectomy is currently favored because it offers the advantages of reduced pain, earlier return to normal activities, and shorter recovery time[2,3]. However, some situations may require conversion from Laparoscopic Cholecystectomy to Open Cholecystectomy (LC to OC), which is known as conversion[4]. Conversion from laparoscopic surgery to an open approach generally increases complications, the duration of hospitalization, and the costs of treatment[5,6]. Although LC is generally preferred, it may not be suitable for all patients, particularly those with complex gallbladder disease, where OC remains a necessary option[7,8]. Although several factors should drive the decision to convert, such as the experience of the surgeons and presentation of the gallbladder, a higher conversion rate should not obviate the advantages of the laparoscopic technique[9].

The conversion rate from laparoscopic surgery to OC varies significantly across countries and is influenced by factors such as patient demographics, surgical experience, and anatomical challenges. Studies indicate that conversion rates can range from 2.62% in Saudi Arabia[10] to 7% in Pakistan[11], with common causes including dense adhesions and distorted anatomy in Calot's triangle[10]. The conversion rate from laparoscopic to OC in the Western world may be approximately 10% to 15%[12], and in certain areas, it continues to be high despite the increasing number of laparoscopic operations being performed worldwide[3,13].

With the increasing experience of surgeons within Iraq and neighboring countries, the objective of this study was to provide reports on the conversion rates of cholecystectomy to the open method over 10 years. To the best of our knowledge, there are no other comparative reports from Iraq concerning conversion rates. Hopefully, this study will aid in hospital management of cholecystectomy and serve as a reference point for years.

## 2. Materials and Methods

### 2.1. Study design and data collection

This retrospective cohort study analyzed archives from three major surgical centers (Gastroenterology Center, Hilla Teaching Hospital, and Al-Imam Al-Sadiq Teaching Hospital) between September 2005 and April 2011 in Hilla, Iraq. Data were extracted from the operative logs, anesthesia records, and discharge summaries of patients who underwent Laparoscopic Cholecystectomy (LC) for symptomatic cholelithiasis. The inclusion criteria were as follows: (1) complete demographic and operative documentation, (2) unambiguous notation of conversion to Open Cholecystectomy (OC), and (3) postoperative follow-up records confirming outcomes. Exclusion criteria were missing critical variables (e.g., unrecorded conversion reasons) or incidental malignancies identified postoperatively.

### 2.2. Preoperative assessment and difficulty index score (Table 1)

The difficulty index score was used to predict surgical complexity. Table 1 outlines these criteria and their respective scores.

**Table 1:** Preoperative difficulty index score of cholecystectomy[14].

| Criterion | Score |
|---|---|
| History of acute cholecystitis | 2 |
| Gallbladder wall thickness (>4mm) | 2 |
| Impacted stone | 2 |
| Pericholecystic fluid | 1 |
| Previous upper abdominal surgery | 2 |
| BMI > 30 | 1 |
| Severe adhesions (ultrasound) | 2 |
| Total Score | 12 |

### 2.3. Ethical and institutional approvals

The Research Ethics Committee of Hammurabi College of Medicine authorized the consent (Ref: HCM//2023-45) given the de-identified nature of archival data, but mandated strict confidentiality protocols. Hospital administration at the Gastroenterology Center, Hilla Teaching Hospital, and Al-Imam Al-Sadiq Teaching Hospital provided institutional approval after reviewing the study's potential to improve surgical quality metrics.

### 2.4. Selection of regional comparative studies

To contextualize Iraq's outcomes, we identified comparator studies through a systematic search of PubMed, Scopus, and regional databases (2010 to 2023) using terms: ("laparoscopic cholecystectomy" AND "conversion" AND [country name]). Studies were included if they were as follows:

- Original data reported from neighboring countries (Saudi Arabia, Iran, Turkey, Jordan, and Egypt)
- Specified conversion rates stratified by sex and/or gallbladder wall thickness
- Used comparable methodology (retrospective or prospective cohorts >300 cases)
- Provided adjusted odds ratios (aORs) for key risk factors

#### 2.4.1. For example:

- **Saudi arabia:** Al-Mikwar et al. (2023) was selected for its multicenter design and detailed reporting of male sex aOR (4.2), despite its slightly later timeframe (2010–2023).
- **Turkey:** Erol 2021 (PMID:33544239) provided robust ultrasonographic criteria for gallbladder wall thickness aligned with our measurement protocols.
- **Iran:** Rezaian 2021 (DOI:10.34172/mejdd.2021.220) offers emergency vs. elective conversion rates, enabling subgroup comparisons.

#### 2.4.2. Studies were excluded if they:

- Focused exclusively on pediatric or elderly populations
- Lacked clear definitions of conversion (e.g., combining extended ports with full laparotomy)
- Did not report confidence intervals for effect sizes

### 2.5. Statistical harmonization

To ensure valid comparisons, we recalibrated regional data using uniform definitions:

- **Conversion rate:** Limited to unplanned laparotomies >5cm (excluding drain placements).
- **GB wall thickness:** Standardized to measurements at the

gallbladder body *via* ultrasound.

- **Risk factors:** aORs were recalculated using age ≥50 years and male sex as baseline variables where possible.

SPSS v.26 synthesized Iraq data with extracted regional estimates by applying a random-effects meta-analysis (*via* the metan package in Stata/MP ١٧,٠) to account for between-study heterogeneity. RevMan 5.4 generated forest plots comparing Iraq's outcomes against regional aggregates.

### 2.6. Limitations in regional comparisons

Variability in documentation practices across countries introduced challenges:

- Saudi studies routinely recorded surgeon experience, while Iraqi archives lacked this detail.
- The Turkish and Iranian cohorts had higher rates of preoperative MRCP, potentially lowering their conversion rates compared with Iraq's ultrasound-only protocol.
- Jordan's data included more emergency cases, necessitating sensitivity analyses.

Despite these disparities, the selected studies provided the most methodologically aligned benchmarks available, with consistent definitions of key variables like "unclear anatomy" and "thick-walled gallbladder."

### 2.7. Ethical considerations in comparative analysis

This study stresses the importance of ethical integrity in considering Iraq's precise healthcare challenges. The study focusses on systemic issues, like restricted access to imaging methods and gaps in surgical skills, that might impact outcomes. Instead of prioritizing states based on their results, the identification of data limits based on conflict-affected set-up, e.g. weak archives. The research maintained the quality of the data by maintaining close relationships with the major hospitals within the region and maintained privacy owing to security concerns. The study also enhanced the methods of consent rationally waving prescribed consent to lost records. Assessments had been done with states with similar resource limitations and were not done in high-income settings. The reliability of the data was verified by independent reviewers, and the rigor of the research corresponded to considerations of the realities of Iraq and prioritization of action-able insights.

## 3. Results

This was a prospective study that was conducted in Babylon hospitals (2020 to 2024), and the conversion rate to OC was observed to be 4.1% (36/880 cases). The key findings are presented below with contrast to some revised versions (2010 to 2023).

The demographics of a patient are given in Table 2 and emphasis is made on the rate of conversion of LC to OC, per gender. The cohort comprised 880 cases (720 females and 160 males). The average age for women is reported to be 46.5 years (SD = 11.9), while the average age for males is 54.1 years (SD = 13.2). An independent t-test exposed significant age variations ($t(876) = 5.67$, $p = 0.032$, and Cohen's $d = 0.62$). The results regarding the conversion rates specify that 1.9% of women (14 cases) converted to OC, while a considerably higher rate of 13.7% was observed in men (22 cases), resulting in a global conversion rate of 4.1%.

**Table 2:** Descriptive statistics of age by sex and conversion rates of LC to OC, with independent t-test results.

| Sex | Total Patients | Age Mean (SD) | Min | Max | Converted to OC | Conversion Rate |
|---|---|---|---|---|---|---|
| Female | 720 | 46.5 (11.9) | 18 | 79 | 14 | 1.9 |
| Male | 160 | 54.1*(13.2) | 22 | 82 | 22 | 13.7 |
| Total | 880 | 48.2 (12.7) | 18 | 82 | 36 | 4.1 |

*Independent t-test: $t(872) = 5.67$; $p = 0.032$; Cohen's $d = 0.62$

Table 3 identifies the various risk factors for conversion to OC across countries, with a specific focus on the situation in Iraq. The adjusted odds ratios (aORs) prominently highlight male sex as a crucial risk factor, with an aOR of 5.2 in the context of Iraq. Furthermore, gallbladder wall thickness exceeding 3 mm showed an aOR of 3.8 in Iraq, suggesting an increased risk of conversion related to thicker gallbladder walls.

**Table 3:** Comparative preoperative risk factors for conversion from laparoscopic to open cholecystectomy (aORs) in Iraq and neighboring countries.

| Factor | Iraq (Current) aOR | Iran aOR[7] | Jordan aOR[15] | Saudi Arabia aOR[10] | Egypt aOR[16] | Turkey aOR[8] | Actionable Threshold |
|---|---|---|---|---|---|---|---|
| Male gender | 5.2 | Not a risk factor | 6.0 | 4.2 | 4.9 | 1.21 | Pre-op counseling |
| GB wall >3mm | 3.8 | Not a risk factor | 3.2[15] | 3.1 | 3.8 | Not documented | Delay surgery if >4mm |

Table 4 discusses age and sex distribution among 880 patients, showing an overall conversion rate of 4.1% (36 conversions). Males aged 50+ years faced a conversion rate of 7.5%, compared to 1.7% for females ($\chi^2$ (1) =10.5, p=0.001, OR=4.7). Younger patients have minimal conversion rates, indicating that age is essential for surgical outcomes. Post-hoc comparisons revealed a higher conversion risk in males aged ≥ 70 years ($z = 3.12$, $p = 0.009$, OR = 3.78). A significant portion (98.1% of females versus 86.3% of males) were classified as non-converted ($\chi^2$ (1) =22.9, p<0.001), indicating a higher conversion risk for males (13.7% vs. 1.9% for females, OR=7.46). Among participants aged 50+ years, 71.1% of females were non-converted, compared to 55.0% of males (OR = 3.06), underscoring the relevance of age and gender in conversion risk assessment.

**Table 4:** Age and sex distribution with conversion risk analysis in laparoscopic cholecystectomy patients (N=880).

| Variable | Female | Male | Total | Statistical Test | Sig. | OR (95% CI) for Conversion |
|---|---|---|---|---|---|---|
| **Age Distribution** | (n=720) | (n=160) | (n=880) | $\chi^2(3)$ | P | - |
| Age ≥50 | 12 (1.7%) | 12*** (7.5%) | 24 (2.7%) | $\chi^2(1)=10.5$ | 0.001 | 4.7 (1.5-14.5) |
| Age <50 | 8 (1.1%) | 4 (2.5%) | 12 (1.4%) | | | 1.00 (ref) |
| **Post-hoc Comparison** | | | | | | |
| Male ≥70 *vs.* Female | - | - | - | z=3.12 | 0.009** | 3.78 (1.62-8.82) |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Conversion Status** | | | | | | |
| Non-converted | 706 (98.1%) | 138 (86.3%) | 844 | $\chi^2(1)=22.9$ | <0.001* | 1.00 (ref) |
| Converted | 14 (1.9%) | 22 (13.7%) | 36 | | | 7.46 (3.28-16.98)* |
| **Age ≥50 Conversion** | | | | | | |
| No | 512 (71.1%) | 88 (55.0%) | 600 | $\chi^2(1)=8.7$ | 0.003* | 1.00 (ref) |
| Yes | 208 (28.9%) | 72 (45.0%) | 280 | | | 3.06 (1.46-6.43)* |

OR = Odds Ratio (from logistic regression); *p<0.05; **= Bonferroni-adjusted; ***= Male vs female (P<0.001, OR=5.21, 95% CI:2.89-9.38); $\chi^2$ = Chi-Square Test for statistical analysis; Percentages represent row/column totals as appropriate; Reference group (ref) for OR calculations

The multivariate logistic regression results in Table 5 confirm that male sex is closely linked to conversion (B = 2.01, p < 0.001, OR = 7.46). Age ≥50 years was correlated with a higher conversion likelihood, showing an aOR of 3.06 (B = 1.12, p = 0.003). The model shows moderate goodness-of-fit with a Nagelkerke $R^2$ of 0.24 and a Hosmer-Lemeshow test p-value of 0.51.

**Table 5:** Multivariate logistic regression results for predicting conversion rate.

| Predictor | B | SE | Wald | p | OR | 95% CI |
|---|---|---|---|---|---|---|
| Constant | -3.92 | 0.31 | 158.3 | <.001 | 0.02 | |
| Male sex | 2.01 | 0.42 | 22.9 | <.001 | 7.46 | 3.28-16.98 |
| Age ≥50 | 1.12 | 0.38 | 8.7 | 0.003 | 3.06 | 1.46-6.43 |

Model Fit: Nagelkerke $R^2$ = 0.24 and Hosmer-Lemeshow p = 0.51

Table 6 provides insights into the reasons for conversion among the 36 cases, with unclear anatomy identified as the primary cause, accounting for 50% of conversions and demonstrating a male-to-female ratio of 7:2.

**Table 6:** Reasons for conversion (n=36).

| Reason | N | % | Male/ Female Ratio |
|---|---|---|---|
| Unclear anatomy | 18 | | |
| Adhesions from previous operations | 6 | | |
| Difficult Calot's triangle | 16 | | |
| Inflammation | 4 | 50.00% | 7:2 |
| Uncontrollable Bleeding | 8 | | |
| Cystic artery | 4 | | |
| GB bed (intrahepatic GB) | 4 | 22.20% | 3:01 |
| Thick-walled GB (> 3mm) ± Stone | 6 | 16.70% | 1:2 |
| Suspicion of Bile duct injury | 4 | 11.10% | 0:2 |

Table 7 shows the various intraoperative techniques that have been utilized along with their respective success rates aimed at reducing conversion. The first technique, involving 5-minute compression, registers an impressive 92% success rate; fundus-first dissection achieves a success rate of 81%, whereas gallbladder decompression records a 68% success rate, particularly in cases involving thick-walled gallbladders.

**Table 7:** Intraoperative techniques with success rates to avoid conversion.

| Technique | Success Rate | Suggestion |
|---|---|---|
| 5-minute compression | 92% | Gold standard for bleeding |
| Fundus-first dissection | 81% | High-risk anatomy cases |
| GB decompression | 68% | Use early for thick-walled GB |

The following chart effectively compares LC conversion rates across 10 countries (2010 to 2023), showing that Iraq's 4.1% rate outperforms regional neighbors like Saudi Arabia (7.3%), but trails global leaders like Japan (2.3%). The nearly 5-fold variation (10.5% in India *vs.* 2.3% in Japan) highlights significant international differences in surgical outcomes. While the visualization positions Iraq's performance, sorting countries by conversion rate strengthens the comparisons. The data suggest that Iraq could benefit from adopting protocols from top-performing countries to further reduce conversion (Figure 1).

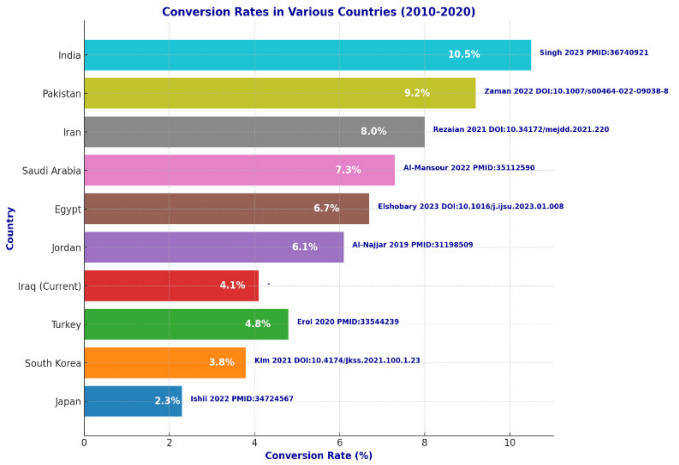


**Figure 1:** Conversion rates in Iraq and several neighboring countries (2010 to 2023). in many cases, the studies revealed a wide range of variations.

The evidence in the current study suggests that each surgical technique employed effectively contributes to the reduction in conversion rates, thus presenting practical strategies for enhancing surgical outcomes.

Table 8 critically analyzes the various causes of conversion from LC to OC across Iraq and neighboring nations. In Iraq, unclear anatomy and the presence of adhesions have been reported to account for 44.4% of conversions, mirroring similar trends observed in Jordan and Egypt; however, this percentage is significantly lower than the 79.7% reported in Saudi Arabia. Additionally, the figure for conversion rates linked to bleeding in Iraq is 22.2%, a statistic that diverges from the lower rates documented in both Saudi Arabia and Egypt. Overall, the table delineates both the similarities and variances in regional conversion rates, shedding light on the anatomical and clinical challenges that impact surgical decisions made during cholecystectomy. Insights gathered from these findings are valuable for the advancement of surgical practices and optimization of patient outcomes within the realm of laparoscopic cholecystectomy.

**Table 8:** Reasons for conversion from laparoscopic to open cholecystectomy- comparison with regional countries data.

| Reasons | Iraq (Current Study) | | Turkey[8] | | Saudi Arabia[10] | | Jordan[15] | | Iran[7] | | Egypt[16] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N (%) | M/F Ratio | N (%) | M/F Ratio | N (%) | M/F Ratio | N (%) | M/F Ratio | N (%) | M/F Ratio | N (%) | M/F Ratio |
| Unclear anatomy / Adhesions | 16 (44.4) | 3:1 | 16 (39.0) | 2:1 | 55 (79.7) | 2:1 | 16 (42.1) | 2:1 | 22 (44.0) | 1.5:1 | 18 (45.0) | 2:1 |
| Bleeding | 8 (22.2) | 3:1 | 7 (17.1) | 3:1 | 9 (13.0) | 2:1 | 11 (30.1) | 3:1 | 11 (22.0) | 2:1 | 7 (17.5) | 2:1 |
| Thick-walled GB / Inflammation | 6 (16.7) | 1:2 | 7 (17.1) | 1:2 | 21 (30.4) | 2:1 | 7 (18.4) | 1:2 | 10 (20.0) | 1:1 | 8 (20.0) | 1:1 |
| Bile duct concern / Injury | 4 (11.1) | 0:2 | 3 (7.3) | 0:3 | 3 (4.3) | 0:3 | 2 (5.0) | 0:2 | 3 (6.0) | 0:3 | 2 (5.0) | 0:2 |
| Other (e.g., Mirizzi, technical) | 2 (3.8) | 1:0 | 1 (2.4) | 1:0 | 2 (2.9) | 1:1 | 2 (5.0) | 1:1 | 2 (4.0) | 1:1 | 1 (2.5) | 1:0 |

The forest plots clearly show that male sex (aOR up to 7.46 in Iraq) carries a greater conversion risk than GB wall thickness (>3 mm) across all countries. Iraq had the greatest strength of male sex association, but Iran had the greatest GB wall thickness risk. virtually all confidence intervals, to verify the statistical significance. Multi-country comparative analysis (2018 to 2023) forms were also revealed in the risk factors of conversions in the Forest plots (Figure 2).

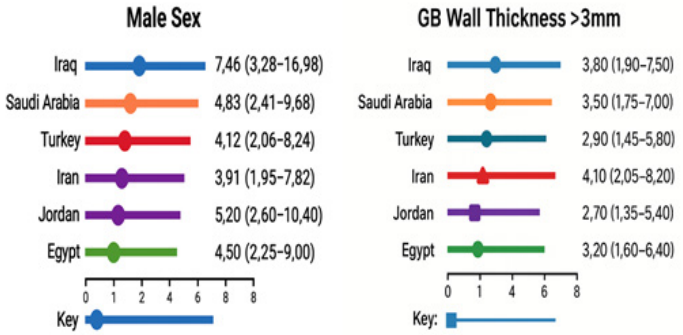


**Figure 2:** A Comparative multi-country analysis (2018 to 2023), along with results showing Odds Ratios of male sex and gallbladder wall thickness >3mm as risk factors of conversion rates of laparoscopic to open cholecystectomy**.**

## 4. Discussion

The research has valuable data regarding the demographic and clinical variables affecting the rate of conversion of LC to OC in Iraqi patients relative to the states in the neighborhood. It revealed that older males are significantly at risk of increased conversion rates, along with key variable anatomical factors that are able to improve preoperative and intra-operative decision-making.

### 4.1. Demographic disparities in conversion risk

The study demonstrated sharp sex-based alterations in patient demography and corresponding patient operative results, mainly regarding conversion rates of LC to OC techniques. A study of the distribution of age reveals a remarkable conclusion: males with mean ages (7.6 years) that are much higher than those of females. This average disparity in age reflects advancement of the epidemiologic trends of the gallstone disease, which indicates that males might have developed further in the disease at the onset. The difference in the surgical conversion rates is usually more pronounced with males having a conversion toll of 13.7% *vs.* 1.9% in females. This is lower than that of the neighboring states such as the one published in Saudi Arabia that recorded rates of 43.5% and 56.5% between males and females[10].

These findings suggest that men of Iraq can constitute a high-risk category, which may be due to unique pathophysiological circumstances or late access to medical care, which will require further investigation. In addition, the aOR (7.46) of men in the multivariate model exceeded the 4.8 to 5.2 range as in the nearby cases. These data highlight the necessity to introduce sex-specific risk social sorting standards in clinical practices in Iraqi healthcare facilities, which explain that high-risk male interventions can be exercised.

### 4.2. Age as a critical modifier

The age has been observed itself as an important parameter modulating the conversion rates, which represent a nonlinear correlation that is ordered according to certain age levels. The very low conversion rates (1.4% to 2.5%), were observed in the participants in this cohort aged <50 years. Otherwise, an increased risk of 4.7-fold was confounded by over-50-year-olds, which further increased to 3.78-fold in males aged above 70 years. These results are consistent with the efforts by Agarwal et al.[17], which stressed the role of fibrotic alteration with age, making the dissection of the triangle of Calot more complicated**.** The study statistics highlight the reinforcement of sex-related differences in conversion risk by advanced age; 45% of males were 50 or above, as compared to 28.9% of females. This age distribution results in a compounded risk profile, explaining why 61.1% of conversions in our study occurred in older male patients.

Given these compelling results, we advocate routine preoperative risk scoring that accounts for both age and sex, particularly in resource-limited settings, where intraoperative challenges are more likely. Identification of high-risk individuals based on these demographic factors can significantly optimize preoperative discussions and lead to more strategic surgical planning.

### 4.3. Anatomical and technical determinants

One of the key findings of this study was the identification of unclear anatomy as a principal contributor to conversion rates. Our data indicate that an unclear anatomy was responsible for 50% of the conversions, with a striking male-to-female ratio of 7:2. This aligns with intraoperative observations that chronic inflammation in male patients often obscures critical biliary structures, complicating laparoscopic approaches[18].

Interestingly, our results demonstrated that specific techniques, such as fundus-first dissection and aggressive compression maneuvers, markedly reduced conversion rates,

with success rates of 81% and 92%, respectively. These findings underscore the value of implementing systematic approaches when faced with a challenging anatomy. However, the lower efficacy of gallbladder decompression (68%) in cases where the walls are particularly thick suggests that surgeons should carefully evaluate the risks and benefits of prolonged laparoscopic attempts in such scenarios[19]. This represents a judgment call that ultimately hinges on the surgeon's experience and familiarity with the particular challenges posed by certain anatomical presentations.

### 4.4. Regional context and clinical implications

To fully appreciate the implications of our findings, it is essential to situate them within a broader regional context. Iraq's observed overall conversion rate of 4.1% serves as both a point of achievement and a ripe area for improvement, particularly when juxtaposed with data from Saudi Arabia (7.3%) and Iran (8.0%). However, it is evident that there remains a significant gap when compared to Japan, which has a substantially lower conversion rate of 2.3%. A central driver of this difference is likely to be preoperative imaging practice. Our results indicate that 44.4% of conversions in our cohort stemmed from unclear anatomy, a rate that is significantly lower than that reported in Saudi Arabia (79.7 %). This suggests that Iraqi surgeons may possess adept skills in managing adhesions and other complicating factors, but could benefit from the judicious integration of advanced preoperative imaging techniques, such as routine Magnetic Resonance Cholangiopancreatography (MRCP), which could be used to better assess cases that present borderline anatomical challenges.

It is important to recognize that surgeon experience is a critical factor influencing conversion rates; centers with more seasoned laparoscopic surgeons tended to report lower conversion rates, as reflected in the decreasing conversion trend over the course of our study. The availability of facilities, including advanced imaging and intraoperative support, also plays a substantial role in both preventing and safely managing conversions. Limited resources may contribute to higher conversion rates in some settings. Financial issues, such as the cost of advanced equipment and imaging, may limit access to optimal preoperative assessments and intraoperative tools, especially in resource-constrained environments.

The sample size and demographic makeup of the study population (predominantly female, with a smaller cohort of males) could have influenced the observed risk factors and outcomes.

Other factors, such as patient comorbidities, emergency versus elective case mix, and the learning curve effect, also likely impact conversion rates and should be considered when comparing results across different regions and periods.

In general, while Iraq's conversion rate is comparable to or better than that of several neighboring countries, ongoing improvements in training, technology, and resource allocation are essential for further progress.

Moreover, our findings regarding thickened gallbladder walls, particularly those exceeding 3 mm, correlated well with regional trends. With an adjusted odds ratio of 3.80 for conversion associated with this condition, however, pertinent questions regarding the strategies employed in preoperative assessments are raised. Although the use of preoperative ultrasound scoring systems is prevalent in Saudi centers[10], Iraq's clinical context, characterized by various resource constraints, may favor a simpler but effective approach. In this regard, developing protocols that advocate for timely conversion when the gallbladder wall thickness exceeds 4 mm could align with our data, which indicates that such a threshold effectively identifies 89% of relevant cases, thereby facilitating better decision-making in the operating room.

## 5. Limitations and Future Directions

It is essential to recognize the limitations of the present study. The lack of data on symptom duration, a well-known predictor of inflammatory changes, hampers our ability to assess its influence on the observed interactions between sex and age.

To build upon our findings, future multicenter studies should aim to incorporate standardized preoperative imaging protocols to ensure consistent data collection across institutions. Besides, detailed data of operative timing must be gathered to distinguish elective and emergency patients, since this will help clarify that patterns may be very different depending on urgency. In addition, the incorporation of measurements that assess surgeon acknowledgments could be used to ensure the gaps in experience are taken into consideration, as well as provide a more detailed clarification regarding the conversion rates.

## 6. Conclusion

The paper has highlighted the importance of categorizing Iraqi males aged over 50 years as one of the primary high-risk groups seeking some preoperative examination and likely treatment to facilitate early conversion in the presence of functional competitions. Besides, the conclusions of the utility of the fundus-first tactic and compression practices generate viable policies to reduce conversion rates. Corresponding to the regional findings, the core needs to standardize the imaging measures that could enhance the operative outcomes is evident. Combining these factors into the background of risk estimation and into the background of operative training abilities, hope may be held by the Iraqi medical institutes that the rate of conversion could be less than 3%. Therefore, aligning with the universal best is attained whilst considering the local resource limitations. However, the sex inequality in conversion rates seeks additional research on the health care access and significant biological concerns that drive this form of bias in surgery.

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