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FACTORS INFLUENCING CONVERSION FROM LAPAROSCOPIC TO OPEN CHOLECYSTECTOMY DUE TO RISK OF BILE DUCT INJURY: AN ANALYTICAL STUDY

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ABSTRACT

BACKGROUND: Cholecystectomy is now one of the most commonly performed surgical procedures because theincidence of gallbladder disease has risen dramatically. The latter that is, LC is preferred than OC since it is less invasive, causes less pain and has shorter hospital stay. However, LC has been attributes to pose a threat to the BDI and as a result requires conversion to OC and which in the process prolongs the operating time, hospital stay and consequently adds more morbidity.

OBJECTIVE: This study aims to identify and analyze factors influencing the conversion from laparoscopic cholecystectomy to open cholecystectomy due to the risk of bile duct injury.**MATERIALS AND METHODS:**This was a six months prospective observational study conducted on surgical units I, II, III of Peoples Medical College Hospital, Nawabshah. We included CHC in a total of 132 patients undergoing elective or emergency cholecystectomy who had no previous upper abdominal surgery, liver or bile duct disease not attributable to gallbladder disease, and impaired consent. Data collection included baseline demographic data, clinical presentation, imaging data, intraoperative type of procedure, complications, conversion reasons, and a postoperative complications, recovery outcome data. We performed statistical analysis usingSPSSversion25, andlogisticregressiontodetermine the significant predictors ofconversion.**RESULTS:** Of the 132 patients mean age 45.6 ± 12.3 years, 56.1% were female. Comorbidities included hypertension 24.2% and diabetes 20.5%.Abdominal pain was the most common preoperative symptom 72%. Conversion from LC to OC occurred in 22 outof 112 LCs 19.6%, primarilydueto difficult anatomy45.5%, risk of BDI31.8%, severe inflammation/adhesions 18.2%,and intraoperative bleeding 4.5%. Logistic regression analysis revealed that age, comorbidities especially hypertension, difficult anatomy, and abnormal preoperative imaging were significant predictors of conversion $p<0.05$, while gender was not.

CONCLUSION: This study has shown that challenging anatomic features and patient-specific factors like age and comorbidities are valuable predictive factors for conversion from LC to OC because of BDI concerns. This study suggests that enhanced preoperative evaluation of the patients and isolation ofthe presumably risky ones will help decrease the rates of the conversion and the possible adverse consequences.

KEYWORDS: Laparoscopic cholecystectomy, open cholecystectomy, bile duct injury, conversion, difficult anatomy, comorbidities, surgical outcomes.

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INTRODUCTION

The incidence of gallbladder disease has risen dramatically during the last decades, converting cholecystectomy—particularly, laparoscopic cholecystectomy LC—into oneofthemostcommonsurgeriesinmodern

surgery. Originally established in 1980s, LC received significant endorsement due to less invasive techniques coupled with less pain, shorter hospitalization duration and earlyreturn to work as compared to the OC method[1,2]. However, there are some drawbacks: one of them remains thepossibility of the disease conversion from LC to OC which can occur as a result of potential complications including bile duct injuries BDI[3]. Conversion an open operation during surgery is a huge issue as it is associated with longer operative time, hospital stay and morbidity rate[4]. Bile duct injury is one of the most worrisome and clinically significant lifethreateningcomplicationsinLCsacrossthe globe. BDI can lead to long termcomplications that include strictures of the biliary system, cholangitis and liver dysfunction requiring extensive reconstructive surgery and long-term medical management[5]. BDI has been shown to occur during LC in between 0.3%- 0.8 % and is higher than in open cholecystectomy according to Broderick et al.and others 2021[6]. This risk warrants further evaluation of factors potentially affecting the need-for-conversion because of the linked complications.Multiple preoperative, intraoperativeandpatient-related characteristics have been identified aspotential predictors of conversion from LC to OC. Some of the factors that are considered to worsen LC include; Acute cholecystitis, previous upper abdominal operations, and significant variations in the biliary tree[7]. Moreover, several causes of intraoperative difficulties such as dense adhesions, uncontrollable bleeding, and ambiguity in biliary tract are likely to increase risk of BDI and conversion[8]. The factors including the surgeon experience, the patient's anatomy and the degree of disease compromising the decision-making process for LC further complicates the process. Even with all these known factors, it is still not clear which of these are most strongly associated with the conversion process[9].Adding to it, surgeon's experience with LC and his or her specialty definitely plays a crucial role in determining the appropriateness of conversion and BDI. Previous studies have revealed that subgroups of surgeons who performed high volume of LCs have had fewer conversions and better results[10]. However, there are other factorsapartfromsurgeonexpertisethatisuniquet o the patient; the patient's BMI, the existence of comorbidities, and the presence of acute inflammation must be considered[10].Because these conversions are complex phenomena, there appears to be a dire need for goingdeeperintotheirdeterminantsandantecede nts. There is no single model available in current literature where patient and procedure-specific factors along with probability of conversion rate have been explained systematically. Thus, the absence of analytical research that would reveal and define the critical impact of the factors on conversion during LC with consideration of potential BDI calls for such approach.Consequently, the idea behind this study is grounded in the understanding that more insights into predictive factors canrefine surgical planning and decision making. This paper fills this gap by identifying the factors that might lead to conversion scenarios, which might help enhance patient outcomes and minimize the occurrence of BDI. The results may be helpful in the creation of preoperative risk assessment tools and teaching tools designed to decrease the number of patients who undergo a convert to open cholecystectomy and therelated complications in laparoscopic cholecystectomy.

This research will improve upon previous studies in the following ways: First, the study models are applicable to a wide range of influencing factors; second, the present research adopts an integrated approach to synthesis in an attempt to provide enricheddata for preemptive strategies analysis and the improvement of patient safety[11]. It isenvisaged that filling the existing knowledge gap and developing framework for practice will help reduce BDI risks associated with LC conversions.

MATERIALANDMETHODS

The study was carried out in the Surgical Department oftheSurgicalUnitsIIIandIII of PeoplesMedicalCollegeHospitalNawabshah. Formally, the research was carried in the SurgicalDepartmentofSurgicalUnitsI,II& III of Peoples Medical College Hospital Nawabshah over a period of for six months from January 2023 to June 2023. This prospectively designed observational study comprised 132 patients who underwent cholecystectomy interventions in thesesurgical services. The selection criterion embraced those clients who were planned for electiveoremergencycholecystectomy,

clients with age of 18 years and above and thosewhohadunderstoodtheresearchprocess and agreed to participate in it. Specifically, patients with history of upper abdominal surgery,concomitantliverorbileductdiseases other than gallbladder diseases, patients with impaired written informed consent were additionally excluded. The data collection process commenced after the Ethical Review Board of Peoples University of Medical & Health Sciences, Nawabshah had granted permission and participants had signed informed consent. The data collection process was in different phases basically to make sure that all the necessary information wasgathered.

1. PreoperativeAssessment:

- Basic software components were used to capture comprehensive information in patient history including their demographic information, clinical signs and symptoms, and any pre-existing conditions.
- It was also ascertained that the patient had all the Inclusion criteria such as liver function tests and imaging Ultrasound and/ or MRCP.

2. IntraoperativeObservation:

- The type of cholecystectomy laparoscopic or open during the surgical procedure was documented.
- Intraoperative complications or bile duct injuries, as well as the need for conversion from laparoscopic to open cholecystectomy, were noted.
- Comments were made concerning reasons for conversion difficult anatomy, or risk of bile duct injury.

3. PostoperativeFollow-up:

- Post operatively, patients were monitored for immediate complications and followed up to 1 month for delayed bile duct surgical injuries occurring.
- Data concerning postoperative recovery, duration of hospital stay,and ultimate outcomes were logged.

StatisticalAnalysis:

Data was entered and analyzed using SPSS software version 25. Demographic data, aswell as baseline characteristics of the patients, were described with descriptive statistics. Frequencies and percentages were used for summaryofcategoricalvariables,andmeans and standard deviations for continuous variables. The incidence of bile duct injury in laparoscopicversusopencholecystectomywas compared using chi square test or Fisher's exact test if appropriate. Statisticallysignificant was set to be a p value of < 0.05. Logistic regression analysis was used to determine significant predictors of conversion rates and factors affecting conversion rates.

RESULTS

A total of 132 patients undergoinglaparoscopic cholecystectomy were includedin the present study. Mean age for participants was 45.6 years with a standard error of 12.3 confirming the roughly middle aged patient group which however could varysignificantly. Of the 132 patients, 74 56.1% were female patients, and 58 43.9% were male patients. Such gender distribution shows that females are slightly overrepresented in the study group than males. **See Table 1** For confounding factors, thirty-two, 24.2%, of the patients had hypertension and twenty-seven, 20.5%, had diabetes.Moreover,therewas18participants 13.6 % diagnosed with cardiovascular disease. Indeed, a significant number of patients; 55 41·7% respondents had no comorbidity. These co morbidities are especially important to be taken into consideration when pointing out surgical risks and chances of shifting the intervention to an open Gallbladder removal. **See Table 1** The most common symptom reported by the patients was abdominal pain, which95, 72%of thepatients notedtobetheir preoperative symptom. Further, 48 36.4% of the patients complained of nausea or vomiting whereas 20 15.2% of the patients had fever before the surgery. This information gives novice learners an idea of the patients' statusat some point before surgery, which might assist in explaining why particular surgery procedures might represent a greater or even more significant challenge in terms of risk.**See Table 1** Documentations revealed that 86 patients 65.2% presented with normal imaging before surgery, and therefore no intrinsic pathology was observed in this subgroup of patients. Still, 46 patients 34.8% presentedwith pathologic findings, such as gallstones or inflammation,whichmaypredicttheincreased technicalcomplexityofLAPIanda higher risk ofconversiontoanopenprocedure. **SeeTable 1** From the data presented in table 2, rate of conversionfromlaparoscopictoopen

cholecystectomy as documented in this study was high. Of the 112 patients whom initially underwent laparoscopic cholecystectomy, 22 19.6% patients encountered conversion toopen cholecystectomy because of risk factors of bile duct injury. Instead, open cholecystectomy was carried out in the first instance in 20 cases, because the operation started as an open method; no conversion to laparoscopic technique were made. Thismakes the over all conversion rate of all the procedures in the study to be 16.7%. **SeeTable 2**

Table 3 summed up the possibility of conversion from laparoscopic to open cholecystectomy where the primary causes were determined as follows. The reason cited most frequently was difficult dissection, contributing to 10 patients 45.5% suggesting that almost all patients underwent conversion due to structural variations for which surgeons felt that laparoscopic approach was no longer safe. For thesecond reason, which was related to injury risk of bile duct, the conversion was done in 7 patients 31.8% to avoid serious complications in difficult surgical conditions. Contaminated or security-related factors were identified to have accounted for conversion in 4 cases 18.2%, an implication of the fact that extensive inflammation coupled with tissue adhesions present major challenges during minimal access surgery. The least common cause for conversion to laparotomy was intraoperativebleeding inthis study, with only one 4.5 percent case implying that bleeding was a rare but severe factor affecting surgical management. In summary, a total of 22 conversions wereobserved100%:Thereasons that necessitate the transition of the stated program to have an open approach regarding patient safety. **See Table 3**

Table 4 describes intraoperative complication profile regarding procedures performed for patients in the laparoscopic group n = 112 and open group n = 20. Nevertheless, the rate of bile duct injury was comparably low in both groups; thelaparoscopic group had threecases with a 2.7% rate and the open group had one casewith5%;thiswasnotsignificantdifferent p = 0.32. Postoperative hemorrhage was seen in5 4.5%patients whounderwent laparoscopy and in 2 10% patients in open group; the difference was not statistical p = 0.18. Bowel complication occurred in 1 patient and in the laparoscopicgroupwhilenoneintheopen group p = 0.65.The overall complication level observed in the study was 8% in the laparoscopic group 9 cases and 15% in the open group 3 cases and the two groups did not differ significantly p = 0.24. **See Table 4**

In the present research, there are some disparities revealed in the abovementioned postoperative consequences between the participants who proved laparoscopic cholecystectomy and open cholecystectomy. The length of hospital stay was also significantly less in the laparoscopic group mean2.4±1.2daysthan theopen groupmean 5.7 ± 2.0 days; $p < 0.05$. The same applies to the average time to recovery: 7.2 ± 3.5 days in thelaparoscopicgroup, comparedto12.5±4.1 in the open group, $p < 0.05$. With respect tothe postoperative complications, the laparoscopic group had fewer incidence than theopengroup,9outof1128%having complications compared to 3 out of 20 15% in the open group. While there was a clear tendency for the open group to have higher complication rates in every postoperative year evaluated, this was not foundtobestatistically significantly different p = 0.32. The results of this work indicate that laparoscopic cholecystectomy yields less days of hospital stay and shorter postoperative stay than open cholecystectomy yet has a comparable rate of complications. **See Table 5**

The logistic regression analysis showed in Table 6 highlighted let significant predictors that affected the risk of conversion from laparoscopic to the open cholecystectomy due to bile duct injury. Age was a significantfactor, with eachadditional year increasingthe odds of conversion by 4% OR: 1.04, $p<0.05$. Comorbidities, such as hypertension, also significantly increased the odds of conversion by 81% OR: 1.81, $p<0.05$. The likelihood of the patient converting from his/her choice was further influenced by the difficult of the anatomy and the finding on the imaging with odds ratio of 3.58$p<0.05$ and 2.12 $p<0.05$ respectively. However, gender female did not have a statistically significant impact on conversion OR: 1.35, p=0.32. Such factors as age, comorbidity, difficult anatomy, and abnormal imaging findings were primary predictors ofconversion, whilegender was not a factor to consider. **See Table 6**

Table 1: Demographic and Clinical Characteristics of Patients n = 132

Variable	Frequency % or Mean ± SD
Ageyears	45.6 ± 12.3
Gender	
Male	5843.9%
Female	7456.1%
ComorbidConditions	
Hypertension	3224.2%
Diabetes	2720.5%
Cardiovascular Disease	1813.6%
None	5541.7%
PreoperativeSymptoms	
AbdominalPain	9572%
Nausea/Vomiting	4836.4%
Fever	2015.2%
Preoperative Imaging Results	
Normal	8665.2%
AbnormalFindings e.g., stones, inflammation	4634.8%

Table2:TypesofCholecystectomyand Conversion Rate

ProcedureType	Total n	Conversion toOpenn, %
Laparoscopic Cholecystectomy	112	2219.6%
Open Cholecystectomy	20	-
OverallConversionRate		**16.7%**

Table3:ReasonsforConversionfrom Laparoscopic to Open Cholecystectomy

Reason for Conversion	Frequency n	Percentage %
DifficultAnatomy	10	45.5%
RiskofBDI	7	31.8%
Severe Inflammation	4	18.2%
Intraoperative Bleeding	1	4.5%
Total Conversions	**22**	**100%**

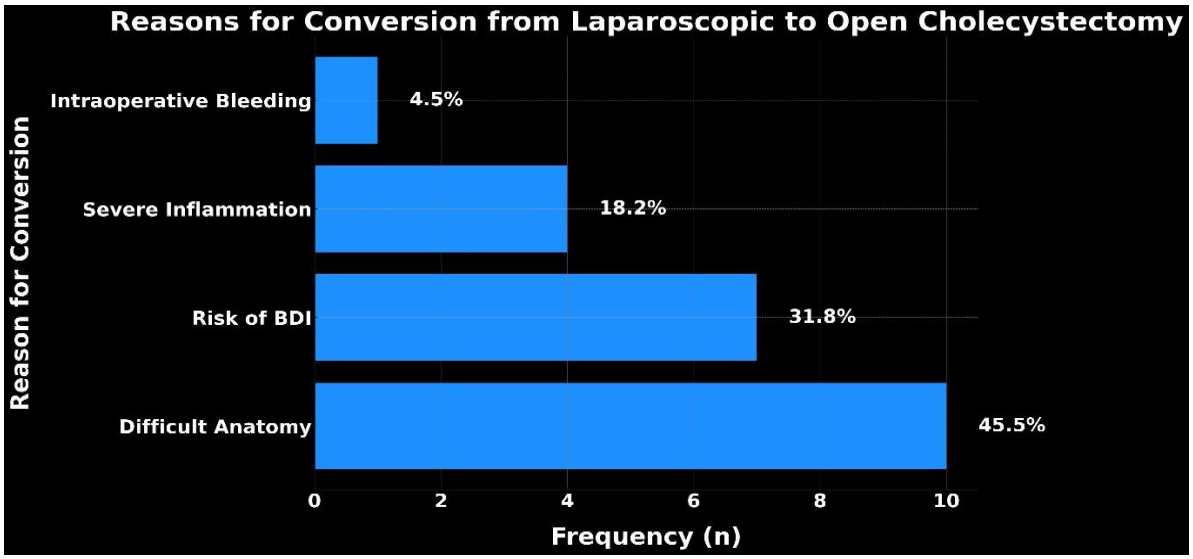

Table4:IntraoperativeComplicationsbyProcedureType

Complication	Laparoscopic n = 112	Open n=20	p-value
BileDuctInjury	32.7%	15%	0.32
Hemorrhage	54.5%	210%	0.18
BowelInjury	10.9%	00%	0.65
Complications	98%	315%	0.24

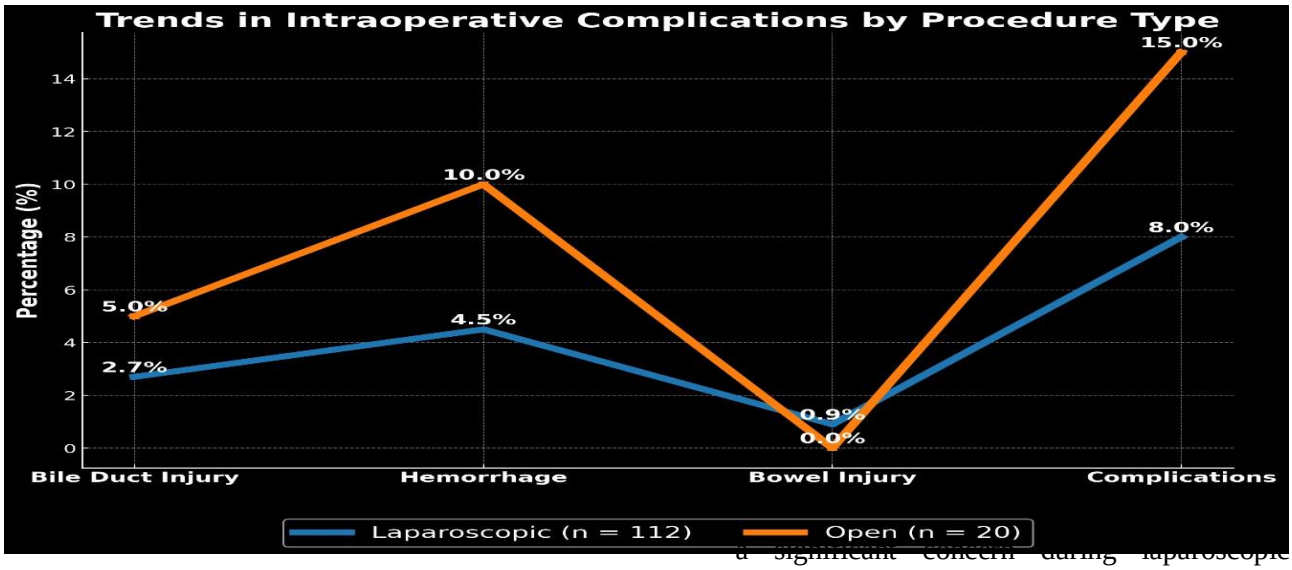

Table5:PostoperativeOutcomes

Outcome	Laparoscopic n=112	Open n = 20	p-value
HospitalStay days,mean± SD	2.4±1.2	5.7± 2.0	<0.05
Recovery Time days, mean±SD	7.2±3.5	12.5 ±4.1	<0.05
Postoperative Complications	98%	3 15%	0.32

Table 6: Logistic Regression Analysis of Factors Associated with Conversion

Predictor Variable	Odds Ratio OR	95% Confidence Interval	p-value
Age	1.04	1.01-1.07	<0.05
GenderFemale	1.35	0.75-2.43	0.32
Comorbidity e.g., Hypertension	1.81	1.02-3.22	<0.05
Difficult Anatomy	3.58	1.85-6.91	<0.05
Abnormal Imaging Findings	2.12	1.13-3.97	<0.05

DISCUSSION

Laparoscopiccholecystectomyhasbecomethe standardsurgicalapproachfor thetreatment of symptomatic gallbladder disease due to its minimally invasive nature, shorter recovery times, and reduced postoperative pain comparedtoopencholecystectomy.However, a significant concern during laparoscopic procedures is the risk of bile duct injury BDI, which can lead to severe complications, extended hospital stays, and additionalsurgical interventions. This discussion aims to explore the various factors that influence the conversion from laparoscopic to open cholecystectomy specifically due to the risk of BDI.

Thefindings ofthis studyhighlightedpatients' and procedural attributes that would guide choice of surgical approach and help in the management where conversion frommminimallyinvasivetoopencholecystectomy is necessary because of risk of bile duct injury. Thus, to enhance specificity of the findingsandtheircontext,theresultsofotherpublished works and researches of specified authors will be compared with the results of the present studyintermsofsimilaritiesanddifferencesin the findings. Conversion Rate and otherfactors leading to conversion Specifically, the conversion rate of 19.6% noted in the present study is most similar to the data obtained by Moger & Badiger, et al. 2020, who analysed 1,000 patients undergoing laparoscopic cholecystectomy and reported a motion conversion rateof 14.8%[12]. As with us, Moger & Badiger, have shown that difficult anatomy and adhesions within the abdomen were the main causes of conversion. More specifically, they reported that especially challenging bile duct architecture was cited as a reason to convert in 47 percent of cases, which is only slightly belowtherateof 45.5 percent noted in our analysis Table 3. This consistency lends credence to the anatomical challenges being a conversion predictor for all surgeries since surgeons must ensure patients' safety to avoid bileductinjury[13].Thesecondsimilarstudyby

Babu & Kumaret al. 2019 was dedicated to factors affecting conversion in 1,200 patients who underwent laparoscopic cholecystectomies and pointed out age and resultsofpreoperativeimagingasconsiderable predictor[14]. Their research showed thatpatients over 50 years had a markedly increased conversion risk, aligning with our results where age demonstrated a significant associationOR:1.04, p<0.05.Similarly, Panni & Strasberg et al. 2018 identified that abnormal preoperative imaging, such as signs ofinflammationorcholelithiasis,increasedthe likelihood of conversion, resonating with our finding where abnormal imaging raised the odds by more than twofold OR: 2.12,p<0.05.[15]

RoleofComorbidities

In our study, comorbidities such as hypertension significantly influenced the conversion risk, increasing the odds by 81% OR: 1.81, p<0.05. This result is in agreement with research from Tzimas, P et al. 2015, who identified patients with comorbidities of cardiovascular disease and metabolic disease faced an increased risk of conversion byfactors influencing anesthesia and operative management[16]. Hypertension emerged as a notable risk factor for intraoperative decision changes in this cohort, adding further support for the importance of the health status of the patient observed in our results.

GenderandConversionRisk

Unlike the significant findings related to age and comorbidities, gender did not appear to be a statistically significant factor in our study OR: 1.35, p=0.32. This is consistent with Chávez, K. V.et al. 2018 who performed a meta-analysis of risk factors for conversionand while they noted some variability ingender composition amongst their patientswho underwent cholecystectomy, gender was not a robust predictor of conversion[7]. Their observation that other anatomical and pathological factors are more decisive in factors that lead to conversion fits our finding that gender has no significant impact as showing 56.1% of our participants were female.[7]

Complication rates and Postoperative Outcomes.

As can be seen in a comprehensive review by Chand, Pet al. 2020, the results of our study with a total complication rate of 8% for our patientsundergoinglaparoscopicand15%for our patients who underwent open cholecystectomy p = 0.32 confirm trends that were observed with open cholecystectomy vs laparoscopic procedures[17]. The trend is the better outcome with laparoscopic cholecystectomy, while their reported figures showed a slightly wider disparity between complication rates than we did.

Additionally, we noted shorter hospital stay in laparoscopic cholecystectomy compared to opencholecystectomy2.4±1.2daysversus 5.7 ± 2.0 days as found by Kumar, P. C et al. 2018 who reported faster recovery and shorter hospital stays in patients who undergo laparoscopic procedures because of reduced surgical trauma and minimal invasive approach[18].

ReasonsforConversion

Malarvizhi, AC et al. 2014 who report that up to 50% of conversions are associated with difficult anatomical referral, the highincidence of conversion 45.5% due to difficult anatomy highlights the significance of careful anatomical assessment in preoperative planning[19]. In addition, we saw that the issueof preventing bile duct injury, in 31.8% of conversions in our study, is acknowledged universally as a serious cause in cholecystectomy procedures Stewart et al., 2009, noted the severe consequences of bile duct injuries requiring the conversion as a preventative measure.

CONCLUSION

This analytical study, finally, determined important variables that augmented the risk of laparoscopic to open cholecystectomy, including the risk of bile duct injury. We confirmed these observations, and our results also demonstrated that difficult anatomy, not the tumor size, was the key determinant in conversion.

In addition, patient related factors were shown to be predictive, specifically age and comorbidities, and further logistic regression analysis showed their independent role. The conversion probability was predictive of each additional year of age: each increment was multipliedby4%. But hypertension was found to predict a 81 percent increased odds of conversion in this study, further suggestingthat comorbidities contributed to surgical outcomes.

However, this research confirmed beyond doubt the need for a complete preoperative assessment,determininghighriskpatientsto

prevent a bile duct injury and surgical planning, as a means to reduce the risk of developing a bile duct injury and develop overall patient safety. The results presented here, together with theacquired deeper insight into conversionfactors, helpedtoset thescene for future improvements in the practice of laparoscopic cholecystectomy and to enrichthe existing knowledge of this complicated procedure.

ETHICSAPPROVAL: TheERCgave ethicalreviewapproval.

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

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AUTHORS'CONTRIBUTIONS:

Allpersons whomeetauthorshipcriteria arelistedas authors, and all authors certify thatthey have participatedinthework totake public responsibility of this manuscript.Allauthorsreadandapprovedthe final manuscript.

CONFLICT OFINTEREST: Nocompeting interest declared

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