Review

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Assessing incidence and risk factors of laparoscopic cholecystectomy complications in Jeddah: a retrospective study

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Context: Laparoscopic cholecystectomy (LC) is the gold standard treatment for gallstones. However, it is associated with several complications. No previous studies have investigated LC complications and their associated risk factors in the western region of Saudi Arabia.

Aims: We aimed to identify the risk factors for postoperative complications (POCs) of LC at a tertiary institute in Jeddah, Western Saudi Arabia.

Settings and design: This retrospective study was conducted between June 2021 and August 2021 among patients who underwent LC at a tertiary centre in Jeddah, Saudi Arabia.

Materials and methods: Records of 596 patients were reviewed, and 510 patients were included in the final analysis after applying the exclusion criteria. Data were collected from hospital medical records. χ^2 tests and independent *t* tests were used to analyse categorical and continuous variables, respectively. The Mann–Whitney *U* test was used for nonparametric data. Multivariate regression analysis was used to adjust the *P* values to determine the most strongly and independently associated risk factors.

Results: Our data showed that the overall incidence of intraoperative complications (IOCs) was 10.8%. The most common complications were gallbladder perforation ($n = 28$, 5.5%), bile leakage ($n = 25$, 4.9%), and bleeding ($n = 15$, 2.9%). POCs occurred in 11% of the patients; the majority complained of abdominal pain ($n = 36$, 6.9%), had elevated liver function tests ($n = 14$, 2.7%), and retained stones ($n = 11$, 2.2%). Acute cholecystitis, overweight, diabetes, and male sex were significant predictors of IOC, POC, and conversion to open cholecystectomy ($P < 0.05$).

Conclusions: LC complications have a multifactorial aetiology. Patient awareness of all possible IOCs is fundamental. The improved skill and experience of the surgical team can mitigate serious complications.

Keywords: laparoscopic cholecystectomy, retrospective study, surgical complications

Introduction

Gallbladder pathologies are among the most common diseases worldwide and incur considerable annual expenditure on emergency visits[1]. In clinical practice, laparoscopic cholecystectomy (LC) is the gold standard treatment for symptomatic gallbladder disease[2]. This surgical technique was popularised in 1985 after Dr Erich Miuhe first used it to remove gallstones[3,4]. Since then, it has remained an effective surgical option that prompts further development of minimally invasive techniques[5].

HIGHLIGHTS

- Surgical complications are not uncommon with laparoscopic cholecystectomy.
- Acute presentation, overweight, diabetes, and male sex are complication predictors.
- Understanding complication risk factors can help the surgeon act more effectively.

LC is more beneficial than open cholecystectomy because it results in minimal wound-related complications, faster wound healing, less postoperative pain, a shorter hospital stay, and lower morbidity and mortality rates[5,6]. However, LC causes other intraoperative and postoperative complications (POCs), including biliary and nonbiliary complications[4,7], such as possible damage to the common bile duct that may result in bile leakage or translocation of gallstones that could cause a variety of symptoms[8].

LC outcomes and the associated risk factors have been assessed in different countries and regions. A 2012 study in Pakistan, with a conversion rate of 2%, found that gallbladder perforation, bile leakage (9.82%), and spilled stones (3.9%) were significant complications of LC[5]. Moreover, another study conducted in 2016 involving 4359 patients documented 394 different complications, the most common being wound infection and intra-abdominal abscesses[9]. A systemic review of 233 papers was

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conducted in 2018 and found that the most common complications were conversion to open cholecystectomy (58% of studies), bile leak (38%) and bile duct injury (32%)[10].

However, there has been insufficient recent literature addressing this topic in Saudi Arabia, particularly in the Western region. To the best of our knowledge, only one previous study has evaluated LC complications in Saudi Arabia[11]. Moreover, LC complications are usually preventable with improved surgical techniques and targeted healthcare, making their identification essential. Therefore, this study aimed to analyse the incidence of complications following LC and their predictive preoperative risk factors in patients admitted to a tertiary centre in Jeddah.

Materials and methods

Study design and setting

A retrospective analysis of records was performed between June 2021 and August 2021 at a tertiary centre in Jeddah, Saudi Arabia.

Study participants and sample size

All patients over 16 years of age who underwent LC between April 2018 and March 2021 were included. Patients who underwent surgery for acalculous cholecystitis or polyps were excluded. Medical records of all eligible patients ($n = 596$) were reviewed.

Data collection instrument

Patient data were collected from the Phoenix database of the hospital. A checklist predesigned using Google Forms was prepared to collect the following data: demographic characteristics such as age, sex, weight, and height; history of medical and abdominal surgery; presentation of cholelithiasis, including symptoms and admission diagnosis; laboratory values such as white blood cell count, liver function tests, and postoperative cultures; radiological findings and visualisation of the gallbladder assessed to differentiate acute presentations, with dilation of the intrahepatic biliary tree and common bile duct also being observed; surgical data, including records of intraoperative complications (IOCs) and conversion to open cholecystectomy; histopathological findings that confirmed the diagnosis, including the accurate thickness of all gallbladders extracted through LC; and information on POC provided by the patient's postoperative follow-up and readmission notes. Episodes of abdominal pain were considered as a POC if they caused the patient to visit the emergency department and were associated with other complications.

These data were analysed to investigate the relationships between preoperative risk factors and the chance of developing IOC and POC, ultimately to determine the risk factors associated with such morbidities.

Data analysis and entry

The data were entered into Microsoft Excel 2016, and the IBM Statistical Package for the Social Sciences (SPSS) version 25 was used for analysis. Descriptive statistics for categorical variables are expressed as frequencies. Normally distributed continuous variables are described using means and standard deviations. Categorical variables were analysed using the χ^2 test to check for all possible risk factors. An independent t test was used to assess normally distributed variables, and the Mann–Whitney U test was used for nonparametric data. Multivariate binary logistic regression was employed to adjust the P values and determine highly associated independent risk factors. Statistical significance was set at $P < 0.05$.

Research ethics

This study was authorised by the Institutional Review Board of the Facility (ethical approval no: 681-20). As well as fully compliant with the STROCSS (strengthening the reporting of cohort, cross-sectional and case–control studies in surgery) 2021 guidelines[12]. This study was registered in the Research Registry under the Research Registry Unique Identifying Number researchregistry8693.

Results

The medical records of 596 patients who underwent LC were reviewed. After applying the exclusion criteria and excluding those with missing medical records, 510 patients were included in the final analysis.

Patients' characteristics and presentation

Most patients who underwent LC were female (75.9%). The mean (SD) age of the patients was 42.6 years (13.45 years). Ultrasonography was the predominant choice of imaging performed in 441 patients (86.5%). Most patients had chronic (85.1%) or acute cholecystitis (14.9%). Patient characteristics are shown in Table 1.

Intraoperative details

IOC occurred in 55 patients (10.8%). The most frequent IOC was gallbladder perforation ($n = 28$, 5.5%), followed by bile leak ($n = 25$, 4.9%), and intraoperative bleeding ($n = 15$, 2.9%) (Fig. 1). Nearly half (46.7%) of the intraoperative bleeding cases were from the hepatic bed structures (Fig. 2).

Six out of 510 operations (1.2%) were converted from a laparoscopic approach to an open approach due to various intraoperative circumstances: three cases due to severe adhesions, two due to uncontrolled intraoperative bleeding, and one due to severe inflammation of the gallbladder and surrounding tissues, making it difficult to proceed with the dissection laparoscopically.

Eight patients who required complete LC underwent partial LC, in which only a portion of the gallbladder was resected due to circumstances such as acute inflammation. Overall, patients who underwent partial LC had longer hospital stays ($P < 0.001$), were more likely to be readmitted within 30 days because of similar episodes of abdominal pain ($P < 0.001$), and were more likely to require endoscopic retrograde cholangiopancreatography after surgery ($P = 0.002$) to remove retained stones in the common bile duct.

Postoperative complications

The rate of POC was close to that of IOC; 56 patients developed POC (11%). A total of 19 patients (3.7%) developed POC during their postoperative hospital stay, and 23 (4.5%) patients were readmitted with POC within 30 days. Only one case of

Table 1

Patient characteristics and operative details.

	Mean (range)	*n* (%) (Total = 510)
Age, years		42.6 (16–87)
Sex		
Female		387 (75.9)
Male		123 (24.1)
Nationality		
Saudi		395 (77.5)
Non-Saudi		115 (22.5)
Comorbidities		
Hypertension		90 (17.6)
Diabetes		68 (13.3)
Hypothyroidism		51 (10)
BMI		
Underweight		14 (2.7)
Normal		96 (18.8)
Overweight		159 (31.2)
Obese		241 (47.3)
Previous abdominal surgery		
Yes		92 (18)
Presentation		
Chronic biliary colic		388 (76.1)
Current abdominal pain		251 (49.2)
Pancreatitis		42 (8.2)
Ultrasound		
Acute		68 (14.9)
Chronic		387 (85.1)
Histopathology		
Acute		63 (12.4)
Chronic		447 (87.6)
Gangrenous		4 (0.8)
Length of hospitalisation, days	3.82	
Operative time, min	109.45 (45–657)	

postoperative mortality was documented, wherein the patient was readmitted 10 days after surgery with postoperative fever, pancreatitis, and respiratory infection complicated by sepsis.

Most patients with POC complain of postoperative abdominal pain. A total of 35 patients (6.9%) visited the emergency department within 30 days of surgery, complaining of abdominal pain similar to what they had experienced preoperatively.

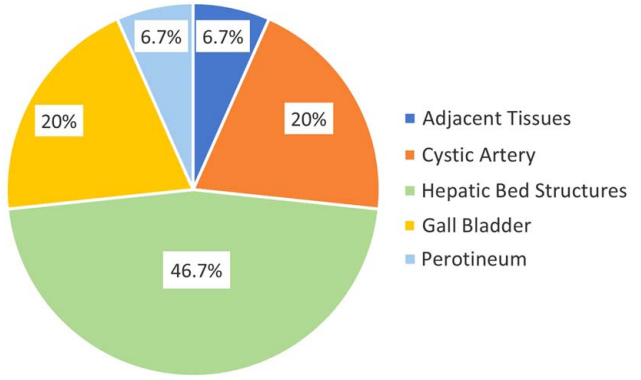

Figure 2. Intraoperative bleeding source.

Other reported POC included retained stones with obstructive jaundice ($n = 11$), postoperative fever ($n = 10$), postoperative pancreatitis ($n = 5$), and intra-abdominal collection ($n = 5$). Various other POC have also been reported, each managed differently, as highlighted in Table 2.

Factors related to developing IOC and POC

Men were more likely to experience both IOC and POC than women (24.4 vs. 6.5%; $P < 0.001$). Additionally, conversion from LC to open surgery was more common in men than in women ($n = 5$ vs. $n = 1$; $P = 0.004$). After multivariate regression analysis, being a male was still independently associated with developing both IOC ($P = 0.005$, CI = 0.2–0.75) and POC ($P = 0.045$, CI = 0.28–0.99).

Acute cholecystitis is independently associated with an increased risk of IOC, POC, and conversion to open surgery. Results showed that four of six patients (66.7%) who underwent open surgery had histopathological findings of acute cholecystitis. Those with acute cholecystitis also had a higher frequency of readmission after surgery ($P = 0.015$).

A gangrenous presentation of the gallbladder was also significantly associated with a higher risk of IOC ($P = 0.004$), POC ($P = 0.005$), and conversion to open surgery ($P = 0.046$). Three of

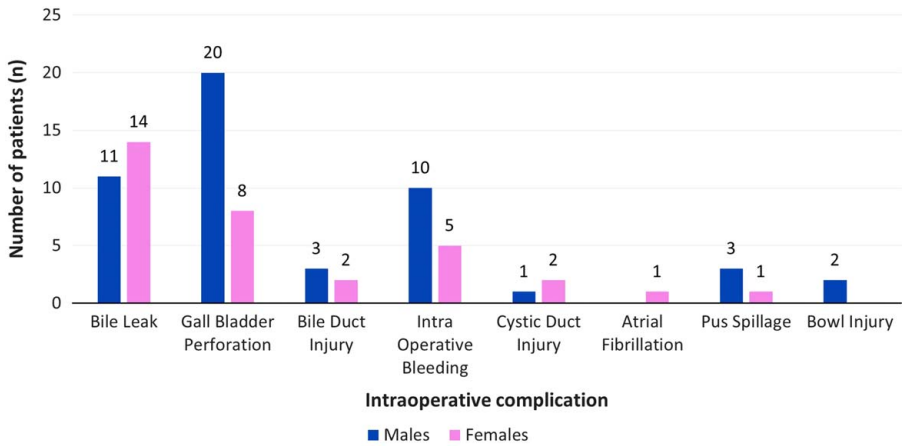

Figure 1. Intraoperative complications.

Table 2

Postoperative complications of LC and their management.

Postoperative complication	Management of postoperative complications (*n*) Conservative	Minimally invasive procedure	Surgery	Total
Abdominal pain	16	18	1	35
Elevated LFT findings	5	8	0	13
Bile leak	1	3	0	4
Fever	6	4	0	10
Wound infection	2	1	0	3
Retained stone	0	11	0	11
Port-site hernias	2	0	0	2
Urinary tract infection	3	0	0	3
Redness on wound site	3	0	0	3
Postoperative pancreatitis	2	3	0	5
Intra-abdominal collections	0	5	0	5
Pleural effusion	1	1	0	2
Paralytic ileus	1	0	0	1
Hospital-acquired pneumonia	0	1	0	1
Shortness of breath	2	1	0	3
Infected biliary stent	0	1	0	1
Ascending cholangitis	0	1	0	1
Atrial fibrillation	1	0	0	1
Keloid scar	1	0	0	1
Subcutaneous haematoma	1	0	0	1

Total number of patients with postoperative complications = 56 patients

LC, laparoscopic cholecystectomy; LFT, liver function tests.

Table 3

Relationship between different variables with intraoperative and postoperative outcomes of LC.

Variable	*P* value Conversion to open	Intraoperative complication	Postoperative complications
Sex	***P* = 0.004***	***P* = 0.00***	***P* = 0.008***
LOH	***P* = 0.00***	***P* = 0.001***	***P* = 0.00***
Age	*P* = 0.123	***P* = 0.00***	*P* = 0.155
Weight	***P* = 0.033***	***P* = 0.00***	*P* = 0.951
Diabetes	*P* = 0.184	***P* = 0.001***	*P* = 0.093
Dilated intrahepatic biliary tree	***P* = 0.024***	***P* = 0.038***	*P* = 0.10
Admitting diagnosis	*P* = 0.785	***P* = 0.042***	***P* = 0.046***
Elevated WBC count before surgery	***P* = 0.036***	*P* = 0.297	*P* = 0.239
Elevated WBC count after surgery	*P* = 0.086	***P* = 0.017***	***P* = 0.027***
Elevated GGT before surgery	***P* = 0.02***	***P* = 0.004***	***P* = 0.001***
Gallbladder wall thickness	***P* = 0.00***	***P* = 0.00***	*P* = 0.362
Acute histopathology	***P* = 0.003***	***P* = 0.00***	***P* = 0.001***
Operation duration	***P* = 0.00***	***P* = 0.00***	***P* = 0.003***
Estimated blood loss	***P* = 0.00***	***P* = 0.00***	*P* = 0.139

*Significant $P < 0.05$.

GGT, gamma-glutamyl transferase; LC, laparoscopic cholecystectomy; LFT, liver function tests; LOH, length of hospitalisation; WBC, white blood cells.

the four patients with gangrenous gallbladders developed both IOC and POC.

Furthermore, weight had a notable effect on the likelihood of IOC; the mean weight of patients with IOC was higher than that of patients without IOC (87.23 vs. 75.54 kg; $P < 0.001$). Conversion to open surgery was also associated with greater weight ($P = 0.033$). On multivariate regression analysis, weight was only independently associated with the development of IOC ($P = 0.001$, CI = 0.96–0.99).

Patients with diabetes ($P = 0.001$) and hypertension ($P = 0.011$) were more likely to develop IOC than patients with other comorbidities. Moreover, patients with previous abdominal surgery were more likely to develop IOC than those without history (16.3 vs. 9.6%; $P = 0.059$).

The relationships between the different variables and IOC, POC, and conversion to open surgery are shown in Table 3. Furthermore, Table 4 highlights the adjusted *P* values after multivariate regression to determine the independently associated risk factors.

Discussion

Intraoperative complications

This study's rate of IOC (10.8%) was much lower than the findings of a study conducted in Switzerland in 1995, which reported an IOC of 34.4% during LC[13]. The lower complication rate in our study could be explained by improvements in surgical techniques and greater familiarity with laparoscopy over the years. Meanwhile, a study conducted in 2016 reported similar rates of IOC (13.1%) and the same predominant complications, namely, gallbladder perforation, as observed in our study (5.27 vs. 5.5%)[7]. A more recent study conducted in 2021 in India also found perforation as the most common IOC (5%) but reported a slightly higher overall incidence of IOC (17%)[14]. This variation might be related to the surgical team and the surgeon's experience with the operative technique and equipment. These are key factors preventing such complications. Further demonstration of the surgical procedure should be provided to trained surgeons to avoid the development of these complications.

The major source of intraoperative bleeding in our study was the hepatic bed structure (46.7%). This is in accordance with the findings of Radunovic *et al*.[7], who showed that the main source of bleeding was tissues adjacent to the gallbladder (21%).

Conversion of LC to open surgery

The overall conversion rate in our study (1.2%) was lower than that reported by another study (3.91%)[7]. Studies in Italy and the Netherlands reported conversion rates of 2.76 and 12%, respectively[15,16]. In addition, various other centres also reported substantially varying rates of conversion to open surgery (1.5–6%)[17]. This variation may have been due to unavoidable surgical errors during LC. Similar to our findings, other studies have reported adhesions as the most common cause of conversion (42.2%), followed by unclear anatomy (34.9%)[18]. Other researchers reported that the most common causes of conversion were difficulty in accessing to Calot's triangle (41.37%) and gallbladder empyema (17.24%)[7].

Our research also showed that the conversion rate was higher among men, which is supported by a previous study that showed similar findings [conversion rate (males vs. females): 7.98 vs. 1.99%][7]. Previous studies have indicated that male sex, age greater than 60 years, and history of abdominal operations are

Table 4

Adjusted *P* value following multivariate regression for different variables affecting intraoperative and postoperative outcomes of LC.

Variable	*P* value					
	Conversion to open		Intraoperative complication		Postoperative complications	
Sex	$P=0.070$	CI = 0.01–1.18	$\mathbf{P=0.005}^{*}$	CI = 0.2–0.75	$\mathbf{P=0.045}^{*}$	CI = 0.28–0.99
Age	$P=0.905$	CI = 0.93–1.06	$P=0.248$	CI = 0.96–1.01	$P=0.478$	CI = 0.97–1.01
Weight	$P=0.157$	CI = 0.93–1.01	$\mathbf{P=0.001}^{*}$	CI = 0.96–0.99	$P=0.377$	CI = 0.99–1.02
Diabetes	$P=0.497$	CI = 0.06–3.89	$P=0.093$	CI = 0.21–1.13	$P=0.313$	CI = 0.298–1.47
Acute histopathology	$\mathbf{P=0.022}^{*}$	CI = 0.02–0.74	$\mathbf{P=0.00}^{*}$	CI = 0.06–0.22	$\mathbf{P=0.010}^{*}$	CI = 0.198–0.799

*Significant $P<0.05$.

LC, laparoscopic cholecystectomy.

significantly correlated with an increased conversion rate to open laparotomy[19].

Conversion to partial LC

A consistent finding between our study and earlier studies is the greater prevalence of partial LC among men. An earlier study reported 23 cases, of which 16 were male[20]. In problematic LC cases, for example, in acute cholecystitis where dissection of Calot's triangle is difficult due to significant adhesions or inflammation, a surgical strategy modification such as partial LC may be more feasible than conversion to open surgery[21].

Postoperative complications

The rate of POC in our study (11%) was consistent with the results of another study that reported a POC rate of ~9.45%[7]. However, low POC rates (4.7%) have been reported in Japan[22]. This gap may be due to a higher level of postoperative follow-up in these regions. Another explanation is that surgeons in Japan use a single-port incision technique, which requires fewer incisions and is less invasive than the conventional 3-port incision technique[23]. In addition, the great variation in the rate of postoperative health complaints might be attributable to differences in pain perception, which is usually subjective and may differ between individuals. This disparity in results emphasises the need for effective analgesic therapies and accurate pain predictors.

Our study's rate of surgical site infections ($n=4$, 0.8%) was lower than in another study in Pakistan, where 1.8% of patients developed surgical site infections[24]. Such regional differences may be attributable to variations in the postsurgical care provided by different hospital facilities.

Risk factors of complications

Sex-based differences and LC

Our finding that more women than men underwent LC (75.9 vs. 24.1%) is consistent with the results of previous studies[11,14,25]. This variation might be due to the effect of pregnancy on developing gallstones and biliary sludge, as mentioned in a previous study in Mexico[25].

Moreover, several studies corroborate our findings that men are more likely to develop IOC and POC than women. One study found that men had a substantially greater overall rate of complications than women (3.7 vs. 1.6%)[26]. Other reports from different regions have shown similar relationships[7,11,14,27]. The underlying aetiology of sex-based differences in symptomatic cholelithiasis may be multifactorial. Men may seek medical counselling less frequently than women at the onset of symptoms and may be more likely to undergo surgery only after the disease process has progressed[28]. Women may be more sensitive to the inflammatory processes in cholecystitis, prompting them to seek treatment sooner than men would. Differences in hormonal status may also play a role in this variation[28]. The increased tendency of men to have comorbidities and to develop severe cholecystitis should remind surgeons of the need to inform patients accordingly and avoid disappointment with a lengthy recovery period.

Acute vs. chronic

A previous study corroborated our findings that acute cholecystitis was associated with higher rates and more severe complications than chronic cholecystitis[4]. In acute cholecystitis, inflammation in the gallbladder and surrounding tissues may distort the gallbladder anatomy, making surgery challenging and increasing the risk of complications. In comparison, chronic cases are more favourable because these patients can be admitted electively, so their operative procedures are usually less complicated and easier for surgeons to perform.

Weight and LC

Consistent with our study, earlier researchers also found that a body weight greater than 90 kg was independently associated with an increased rate of IOC[29]. This is because individuals with a higher body weight are more prone to severe gallbladder inflammation or fibrosis, making dissection more difficult for the surgeon[30].

Other factors and LC

Regarding comorbidities, diabetes was not independently associated with IOC, POC, or conversion to open surgery. Sato *et al*'s[23] study also found that diabetes did not affect the development of complications. In comparison, a previous study established diabetes as a risk factor for conversion[27].

Moreover, this study did not note any effect age has on the development of IOC, POC, or conversion. On the contrary, another study highlighted that older age was associated with higher rates of complications[7,9,14]. A possible hypothesis would be that the elderly population are generally weaker, making their recovery and healing slower, thus being more susceptible to complications.

Strengths and limitations

Some limitations may have influenced our results. First, our study was conducted in one centre, representing a small sample of the

population where some records were excluded due to inadequate documentation of the data in the system. Another limitation is that some patients who experienced complications after LC may not have been readmitted to the same hospital, limiting the documentation. Finally, several factors in this study are susceptible to variation because they depend on the surgeon's level of expertise and, thus, cannot be accurately predicted.

However, one strength of having the study conducted in one centre is the standardised care for all patients and correct observation of the risk factors leading to complications. Whereas, if the patients were from different centres, it could have been difficult to determine whether the complications developed because of certain risk factors or because of different standards of care in different centres.

Conclusion

In conclusion, our study reports the complications and preoperative risk factors of LC in a single centre in Jeddah, Saudi Arabia. Although the overall complication and mortality rates were low, our results emphasise the need for surgeons to identify preoperative risk factors to avoid possible complications and to pay more attention to postoperative care. Comprehensive critical assessment and risk stratification should be performed to predict potential complications and conversion to open cholecystectomy to facilitate accurate and prompt decision-making by surgeons. Further prospective multicentre studies with larger sample sizes are warranted to obtain more accurate predictive results.

Ethical approval

This investigation was authorised by the Institutional Review Board of King AbdulAziz University Hospital (Referral No. 681-20).

Consent

No patient names, initials, or hospital numbers were used in this research. All information remained confidential.

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Author contribution

Z.A., A.A., S.A., A.K., O.K., and F.A.: all of those who contributed to the study idea, concept, design, data collection, analysis, and writing of the manuscript. Editage English editing service was used for proofreading and grammar checking for this paper.

Conflicts of interest disclosure

There are no conflicts of interest.

Research registration unique identifying number (UIN)

This paper did not involve any direct intervention with human participants, and all data was accessed through hospital records retrospectively.

Guarantor

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