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Research Article

The Surgical outcomes of fundus-first technique in lowering the rate of bile duct injuries and bleeding during open cholecystectomy that facing intraoperative difficulties: A single-center prospective study

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ABSTRACT

Background: The problem of difficult gallbladder is not clearly defined and associated with real missing of therapeutic approaches that decreased morbidity. Moreover, the difficult gallbladder was reported as a contributing risk factor for biliary injury due to difficult surgical dissection within Calot's triangle. The aim of this study is to determine the surgical outcomes of the open fundus-first cholecystectomy in lowering the rate of lethal intraoperative risks.

Subjects and Methods: This is a prospective study conducted during the period of January 2019 to December 2022 at Ibn Sina specialized hospital, Khartoum, Sudan for two hundred and fifty-three patients. These patients had long-standing cholelithiasis with intraoperative difficulties which required open fundus-first cholecystectomy.

Results: Intraoperative difficulties were more common in females (77.9%) with ratio (3:1). The mean age ranged between 45-60 years in (35.6%) of cases. The operative surgical time was 120 minutes in (40.7%) of patients. The significant comorbidity that associated with intraoperative difficulties was obesity (>30 kg/m2) in (59.3%) of cases. The predominant intraoperative difficulty in this study was contracted intra-hepatic gallbladder seen in (62.1%) of patients. The mortality rate was zero.

Conclusions: There is a need for appropriate therapeutic and preventive strategies in healthcare systems for safe dealing with difficult cholecystectomy. Unclear anatomy due to severe inflammatory dense adhesions at Calot's triangle and CBD stones are leading factors for difficult fundus-first laparoscopic cholecystectomy. Hence, we humbly recommend an open approach of fundus-first cholecystectomy as safe surgical option to reduce the incidence of bile duct injuries and intra-operative bleeding.

Introduction

Gallstone disease is a common digestive health problem that affects 1–4% of the western world population per year (1). In the USA, it affects about 6.3 million men and 14.2 million women aged between 20–74 years (2). The female to male ratio of gallstone disease were (4:1) in young adults at 40 years old and (2:1) in old individuals (3). About 80% of the gallstones cases remain asymptomatic. However, between 0.1–4% of asymptomatic patients annually develop complications like chronic calcular cholecystitis (4). The absolute risk of symptomatic or complicated gallstone disease was (3.2 per 1000) for a male, while it raised in female with multiple stones up to

(23.5 per 1000), (5). The reported overall incidence of CBD stones in patients with gallstone was 11–25%. The clinical detection of these symptoms varies from 8-15% in patients younger than sixty years to 15–60% older than sixty years (6). By 1890 AD, the early modern surgeons gradually accepted cholecystectomy and its wide application attracted them to study its recurrent complications persistently. Recently, cholecystectomy is the most common intra-abdominal operative interventions and was estimated to be about 500,000 annually in the USA (7). Furthermore, in developing countries, some hospitals adopted the open cholecystectomy approach combined with surgical CBD exploration in single operation and reported its safety and effectiveness particularly at intra-operative difficulties with morbidity below 15% and mortality rate below 1% in patients up to 65 years old (8). The problem of difficult gallbladder is not clearly defined and associated with real missing of therapeutic approaches that decreased morbidity. It is defined as increased surgical risk of cholecystectomy compared with the standard procedure with an incidence of sixteen percent (1 in 6 cases). It's usually associated scleroatrophic gallbladder and reported as a contributing risk factor for biliary injury, (Figure 1), (9, 10).

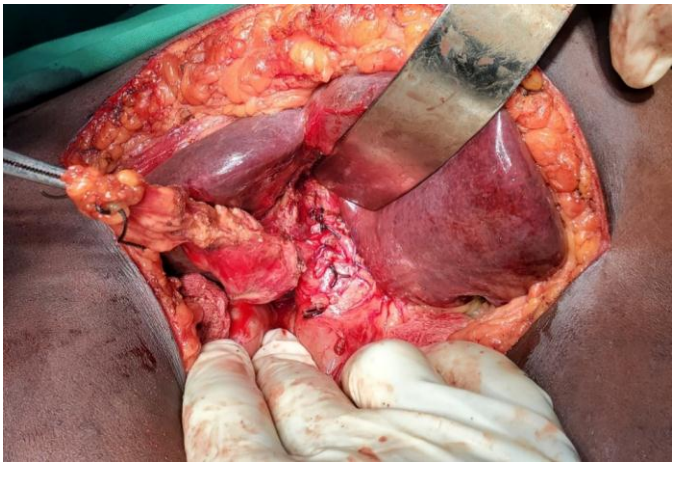

Figure 1: Intra-operative photo of scleroatrophic gallbladder is hanging on its cystic duct and completion of antegrade fundus-first cholecystectomy related to difficult dissection of tense fibrous tissue scars in the Calot's triangle. This result from long-standing chronic cholecystitis combined with CBD stones.

Until recently, open cholecystectomy is still considered as an alternative to LC in 10–30% in centers with unavailable laparoscopic facilities and when LC facing intraoperative difficulties in 5–10 of cases (11). Universally, there is no accepted grading of difficult cholecystectomy. Hence, Orhan classified it into four grades as follows: (A) Hollow viscus and omental adhesions to the gallbladder fundus; (B) Adhesions within Calot's triangle lead to difficult dissection of cystic duct and cystic artery; (C) Difficulties in the gallbladder dissection from liver bed; and (D) Difficulties in approaching of the Calot's triangle or gallbladder fundus because of intra-abdominal adhesions and technical problems (12). Several risk factors were reported to predict difficult cholecystectomy raising the chances of iatrogenic bile duct injuries. These include:

1. Patient-related factors: male patients, age greater than sixty years, uncontrolled diabetes mellitus because of altered immune status, increased obesity that is associated with internal fat deposition obscuring the Calot's triangle anatomy, previous upper abdominal operations and severe fatty livers (13).
2. Gallbladder diseases: contracted gallbladder, increased thickness of the gallbladder wall more than 4 mm, an impacted stone on preoperative radiological imaging. Also, chronicity with recurrent dense inflammatory pericholecystic adhesions which can lead to local biliary anatomical distortion (14).
3. Anatomical factors: non-identified preoperative anomalies which occur in 10–15% of cases such as low insertion of aberrant right hepatic duct into CHD, short cystic duct, low cystic duct insertion in the CBD and the duct of Luschka (15).
4. Surgeon-related factors: rush to finish the surgery, personal fatigue, anxiety and reluctancy for open conversion in doubtful cases (16).

Recently, an iatrogenic bile duct injuries (BDI) after laparoscopic cholecystectomy is more than open cholecystectomy (Strasberg E3-E5 injuries occur in 31% of LC vs 12% of open cholecystectomy), (17). Even in experienced hands, the laparoscopic fundus-first cholecystectomy remains a technically demanding procedure during the upward traction of the liver in cases of severely inflamed gallbladders. This will lead to easy hepatic laceration during further dissection on gallbladder fossa causing profuse bleeding that obscures the visualization of the surgical area. Any blind attempt to clip the cystic artery has a high risk of CBD injuries and iatrogenic perforation of gallbladder with stones spillage in the peritoneal cavity. These intraoperative difficulties give highly recommendation for conversion into fundus-first technique of open cholecystectomy in twenty percent of patients. Recently, to complete difficult cholecystectomy safely highest consensus was achieved on the importance of the antegrade open fundus-first cholecystectomy. It is well-recognized as safe damage control technique used routinely by many surgeons while others reserved it as a defensive technique during difficult cholecystectomies. Also, the advantages of fundus-first method strongly seen in rural areas where operative sophisticated equipment is less required when compared to LC in urban areas and it considered as part of surgical residency curriculum especially in the early learning curve due to its short learning curve and less operative time resulting in costs reduction (18-20). Many authors performed a lot of studies to seek predictive tools for diagnosing difficult cholecystectomy in patients who are on long-term waiting for cholecystectomy. They reported the preoperative trans-abdominal ultrasonography (TUS) can discover gallstones with high sensitivity and specificity (>90%). There are limitations with TUS including the low sensitivity (33–55%) in detection of the CBD stones, (Figure 2), (21, 22). Moreover, MRCP has an excellent overall sensitivity of 95% and a specificity of 97% in the diagnosis of CBD stones and help in the accurate diagnosis of cholelithiasis with distorted Calot's triangle for the long-term listed patients who were planned for cholecystectomy, (Figure 3), (23, 24).

Figure 2: Preoperative ultrasound image of solitary gallstone with long-standing chronic cholecystitis.

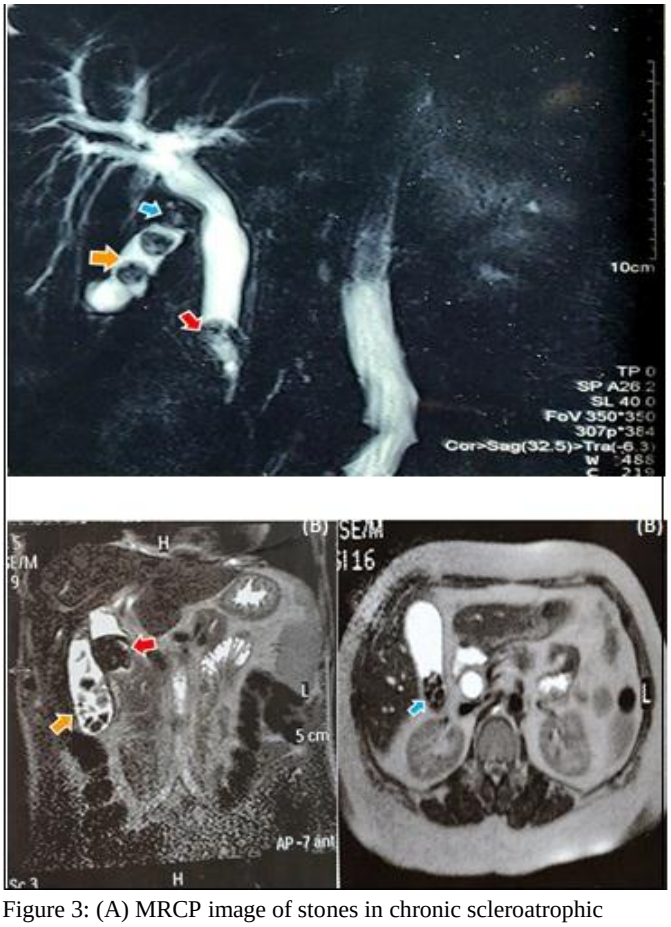

Figure 3: (A) MRCP image of stones in chronic scleroatrophic gallbladder with impaction inside the Hartmann's pouch complicated with secondary distal impacted CBD stones and stricture. (B) MRCP images of secondary giant CBD stone combined with impacted multiple gallstones.

Furthermore, Cohen et al. studied ninety-seven patients with CBD stones and revealed 100% sensitivity of MRCP for 11–27 mm stone, 89% for 6–10 mm stone and 71% for 3–5 mm stone in diameter (25). Therefore, the aim of this study is to determine the surgical outcomes of the open fundus-first cholecystectomy in lowering the rate of lethal intraoperative risks.

Subjects and Methods

This is prospective observational analytic cross-sectional clinical study conducted during the period of January 2019 to December 2022. The study was conducted in the gastroenterological surgical department of Ibn Sina specialized hospital, Khartoum, Sudan. Data in this study including demographic characteristics, clinical presentation, provisional diagnosis, modalities of investigation, indications for surgery, risk factors of elective difficult open cholecystectomy ± CBD exploration and postoperative complications were collected by a questionnaire. The inclusion criteria include the following: Sudanese patients aged 15 to 60 years or more of either sex who were clinically diagnosed as cholelithiasis and choledocholithiasis confirmed by TUS and MRCP. These patients underwent elective open cholecystectomy ± CBD exploration and were found to have intraoperative difficulties. The exclusion criteria included: laparoscopic cholecystectomy, bilioenteric fistula, ascending cholangitis, a-calculous cholecystitis and carcinoma of the gallbladder. Also, any other co-morbidity which precludes general anaesthesia (GA) was excluded. The clinical details of all patients included in this study were entered into a spread sheet (Excel 2016 for Windows software). This data was statistically analyzed by authors using computer program Statistical Package for Social Sciences (SPSS) version 20. The t-test was used and statistical results considered significant when (P-value <0.05).

The open fundus-first cholecystectomy technique in this study proceeded with placement of patients in the supine position. Then, elective open cholecystectomy ± CBD exploration was performed under GA with endotracheal intubation. Nasogastric tube was inserted for gastric decompression to give better operative field exposure. Through an oblique right subcostal incision the subcutaneous fat, fascia and muscles were cut and dissected with an electro-cautery. The peritoneum was opened. Large packs were inserted between the liver and the stomach, the duodenum and the transverse colon to distract them away from the operative field. Deaver's retractors used for direct exposure of narrowed Calot's triangle. The dissection was considered difficult if there was distorted anatomy of Calot's triangle and if there were dense adhesions of the gallbladder with the duodenum, the greater omentum and the gallbladder infundibulum with CBD. The gallbladder was identified and held by ovum forceps. Distended gallbladder with hard texture was aspirated until it became empty for easy fundus grasping and meticulous dissection. The gallbladder was removed by starting dissection on liver bed from fundus down to the cystic duct. Gallbladder fossa was re-examined and if there was actual bleeding then, a suction device, monopolar cautery device, absorbable haemostatic sheets of oxidized regenerated cellulose and sponge packing were applied to achieve hemostasis.

On Calot's triangle meticulous dissection was performed to reach the critical view of safety, (Figure 4). Superficial and deep branches of the cystic artery ligated by vicryl 2-0. Then, cystic duct ligated by silk 1-0 and both were divided in secure way. The gallbladder was delivered out through the wound. Intra-peritoneal drain in sub-hepatic region was used only in intraoperative bleeding and tedious difficult dissections and left in place usually for 24–48 hours. Peritoneum, abdominal muscles and rectus sheath were closed by continuous running suturing using a Naylon 2-0 on round bodied needle. Interrupted stitches of Vicryl 3-0 and Naylon 2-0 were applied to the subcutaneous fat and skin, respectively. Operative wound cleansed and a sterile dressing was applied. Postoperatively, patients were transferred to the post-anesthesia recovery room for monitoring of vital signs until fully awake. On day-0, during the evening at the ward, the nasogastric tube was removed and oral fluids allowed if active bowel sounds were present. Analgesics, IV antibiotics and anti-emetics were given to the patients. Early mobilization of the patients was encouraged regularly. After forty-eight hours of observation, patients were discharged once they are hemodynamically stable, tolerating oral feeding, adequate pain relief, empty intra-peritoneal drain and clean wound. All patients who underwent the fundus-first cholecystectomy were asked to come in the referral clinic on day-7 for follow up of postoperative surgical-related morbidities including wound infection, wound dehiscence, sepsis, haematoma, seroma, persistent fistula, bile leak through the wound. On day-14, our patients came back for sutures removal. Furthermore, after the dissection of fibrous adhesions to clear the common bile duct (CBD), open choledotomy approach in this study was performed through two 3-0 vicryl stay stitches and appropriate longitudinal CBD incision suitable for stone extraction by Disjagin forceps, (Figure 5). Then, removal of tiny stones by forced flushing of sterile normal saline within the CBD using small sized rubber catheter. The stone clearance of the CBD was confirmed by choledochoscope. According to the cases, choledotomy was ended through choledochodudeunostomy with interrupted 3-0 vicryl stitches or external biliary drainage using a T-tube exteriorized beside the wound. Postoperative monitoring including clinical follow up, biliary drains checking, requesting of liver function tests and pancreatic enzymes. After hospital discharge, T-tube cholangiography was performed on day-11 to exclude retained stones within the biliary tree. Before the study commenced, ethical approval was obtained from the local Research Ethics Committee of Faculty of Medicine and Health Sciences, Omdurman Islamic University, at the committee meeting number (109) on Thursday 13th December 2018.

Results

Two hundred and fifty-three patients were included in this study. These patients were diagnosed with gallstone disease who underwent elective difficult open cholecystectomy and difficult CBD exploration. Gallstone disease was more common in female 197 (77.9%) than males 56 (22.1%) with ratio (3:1). The peak incidence of patient's age for cholelithiasis and choledocholithiasis with intraoperative difficulties ranged between 45–60 years (middle age), which represent (35.6%), (Table 1).

Table 1: Age distribution of difficult open cholecystectomy

Age (Years)	Frequency	Percentage	P-value
16-30	32	12.6%	<0.05
31-44	72	28.5%	<0.05
45-60	90	35.6%	<0.05
> 60	59	23.3%	<0.05
Total	**253**	**100%**	

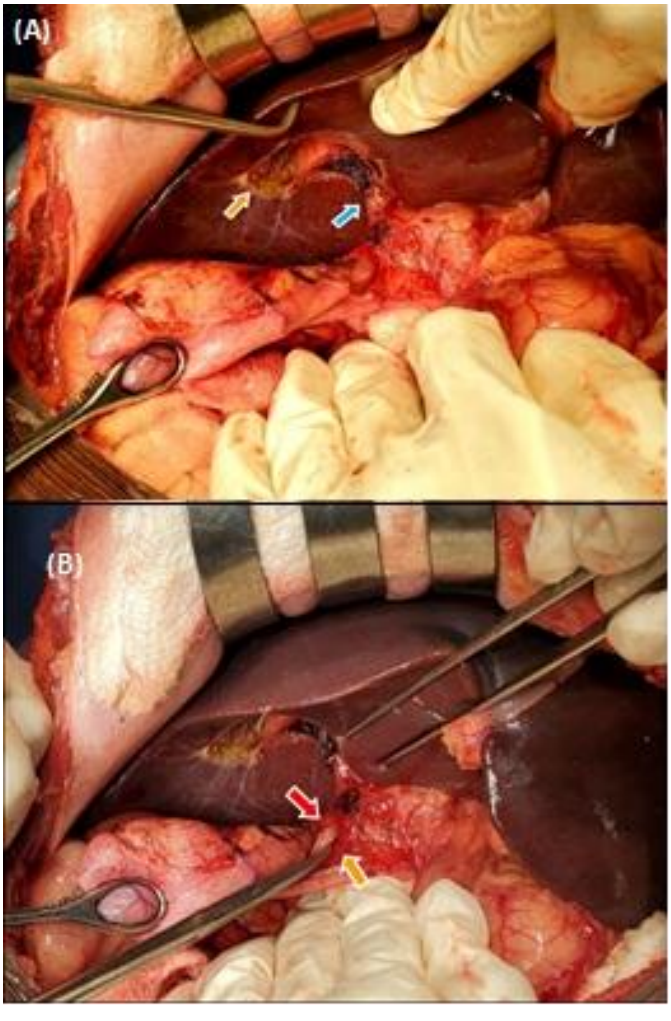

Figure 4: (A) Intra-operative photo of antegrade fundus-first cholecystectomy showed meticulous dissection of the gallbladder from its hepatic bed. (B) Intra-operative photo of open fundus-first cholecystectomy showed hanging of the gallbladder with the support of the cystic artery and cystic duct.

The most common presenting symptoms in patients having both cholelithiasis and choledocholithiasis with intraoperative difficulties were recurrent epigastric and right hypocondrial pain with dyspepsia

initiated by large fatty meal demonstrated in 173 (68.4%) of cases. Scleral icterus with highly dark coloured urine and itching were found in 80 (31.6%) of cases.

Clinical signs were discovered in abdominal examination. All two hundred and fifty-three (100%) patients have Murphy's tenderness in epigastrium and right hypochondrium. Deep yellowish jaundice was seen in 64 cases (25.3%) and mild tinge of jaundice was found in 16 cases (6.3%). The significant reported comorbidities that is associated with development of both cholelithiasis and choledocholithiasis with intraoperative difficulties were obesity (>30 kg/m2) found in 150 patients (59.3%), hypercholesterolemia in 81 patients (32%), diabetes mellitus in 11 patients (4.3%), sickle cell anaemia in 10 patients (4%) and chronic renal failure in 1 patient (0.4%). The total WBC account was 4000 per microliter in 140 cases (55.3%), 5000–11000 per microliter in 35 cases (13.8%) and >11000 per microliter in 72 cases (28.5%). Liver function tests and coagulation profile were normal in 173 patients (68.4%) and abnormal in 80 patients (31.6%). Three-dimension TUS has been done in all patients and studied preoperative difficulties. The presentation of cases arranged as follows: multiple gallstones with contracted thick GB wall in 109 cases (43.1%), multiple gallstones with dilated CBD caliper >8 mm in 80 cases (31.6%) and single gallstone with thick GB wall in 64 cases (25.3%). In addition, MRCP was done for all patients in this study and revealed contracted GB with thick wall with an impacted multiple stones inside the Hartmann's pouch in 173 (68.4%) of cases. Also, MRCP showed a stones in the contacted gallbladder with thick wall which was complicated with multiple stones within dilated CBD. This progressed into distal stones impaction and distal CBD stricture in 80 (31.6%) of cases. According to that, there are variable measures of CBD diameter as follows: 2 cm diameter in 18 (7.11%), 1.8 cm diameter in 35 (13.83%), 1.6 cm diameter in 11 (4.34%) and 1.2 cm diameter in 16 (6.32%) of cases. Sixty-four patients (25.3%) developed obstructive jaundice and required argent ERCP with CBD stent insertion. These biliary stents were removed intraoperatively within six weeks of insertion. Furthermore, the majority of cases in this study had long-standing cholelithiasis with severe recurrent acute inflammatory attacks and during open cholecystectomy intraoperative difficulties occurred which required fundus-first technique in 173 (68.4%) of patients. While 80 patients (31.6%) had both cholelithiasis and choledocholithiasis associated with obstructive jaundice and open intraoperative difficulties that needed fundus-first cholecystectomy and CBD exploration which ended with choledocho-dudeunostomy in 64 (25.3%) of patients and T-tube biliary drainage in 16 (6.3%) of patients, (Table 2).

The operative surgical time was 120 minutes in 103 cases (40.7%), 150 minutes in 86 cases (34%), 180 minutes in 25 cases (9.9%) and 240 minutes in 39 cases (15.4%). In operations which exceeded 120 minutes, the most common cause was obscured anatomy of Calot's triangle. During open cholecystectomy, variable intraoperative difficulties were found in all two hundred and fifty-three patients and were divided into three separate categories as follows:

A) Contracted intra-hepatic gallbladder seen in 157 (62.1%) of cases and redundant elongated gallbladder in 96 (37.9%) of cases; B) Distorted anatomy within Calot's triangle seen in 135 (53.4%) of patients and severe fibrotic omental adhesions between the gallbladder and surrounding viscera seen in 118 (46.6%) of patients; and C) Intraoperative bleeding from the liver bed was observed and classified to bloody oozing in 150 (59.3%) of cases and slow flow of bleeding related to small tear within the hepatic bed in 103 (40.7%) of cases.

Table 2: Types of surgical techniques used during open cholecystectomy facing intraoperative difficulties

Surgical techniques	Frequency	Percentage	P-value
Fundus-first open cholecystectomy	173	68.4%	<0.05
Open CBD exploration + fundus-first cholecystectomy + choledochodudeunostomy	64	25.3%	<0.05
Open CBD exploration + fundus-first cholecystectomy + biliary T-tube drainage	16	6.3%	<0.05
Total	**253**	**100%**	

Postoperatively, our patients with open fundus-first cholecystectomy had mild wound infection in 8 (3.2%) of cases. No patients in this study had an intraoperative or post-operative bile leak. Intra-peritoneal drains were placed at Morrison's sub-hepatic pouch in 103 (40.7%) of cases including 80 (31.6%) of patients with difficult CBD exploration and 23 (9.1%) of patients with difficult open cholecystectomy. These drains were removed within five days of fine postoperative care. Our patients were showed zero mortality rate.

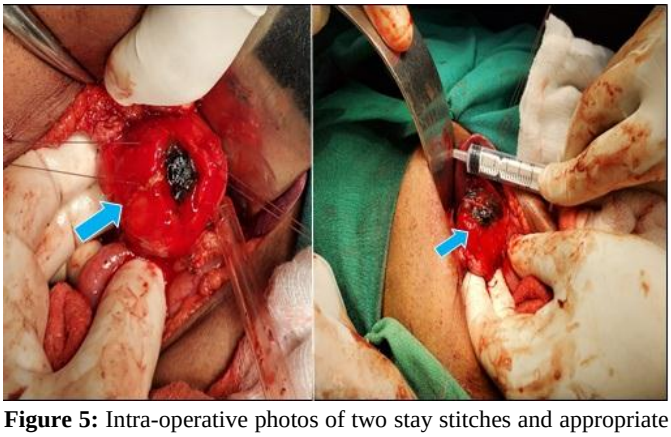

Figure 5: Intra-operative photos of two stay stitches and appropriate longitudinal CBD incision suitable for giant stone extraction

Discussion

Our study revealed that cholelithiasis and choledocholithiasis with intraoperative difficulties is more common in the female population 77.9% and the ratio account is (3:1). As found in the international

literature Nakeeb et al. reported the ratio of female to male for gallstone disease intraoperative difficulties was (4:1), (3). This result goes similarly with findings of Festi et al. who revealed that gallstone disease intraoperative difficulties was more frequent in females with multiple stones up to (23.5 per 1000) than in males (3.2 per 1000), (5). In addition, our statistical findings support the female sex as a factor for predicting intraoperative difficulties in open cholecystectomy. This disagreed with some authors in the literature as they showed the risk of difficult cholecystectomy to be increased in males due to delayed medical attention (26). The mean age for difficult open cholecystectomy was noticed in our study to be more common between 45-60 years, which represents 35.6% of the cases. This was in agreement with the results of other studies that proposed an advanced age more than sixty years raising the risk of intraoperative difficulties related to elderly patients who have a long history of gallbladder diseases with recurrence of acute attacks progressing into continuous fibrotic adhesions at Calot's triangle. Also, the gallbladder dysfunction and bile lithogenicity are predisposing factors known to increase with advanced age and contribute to difficult open cholecystectomy (3). Modes of clinical presentation were recorded in this study. The most common presenting complaint in our patients was recurrent epigastric and right hypocondrial pain with dyspepsia in 68.4%, followed by jaundiced sclera in 31.6%. These findings were in agreement with the literature that reported the most common complaints to be right hypocondrial pain in 81% and jaundice in 74% of the cases. In abdominal examination, we discovered positive Murphy's tenderness in right hypochondrium in all patients (100%). This signify ongoing sub-acute inflammation in long-standing cholecystitis which leads to high risks like bleeding from surrounding tissues (27). The demographic details of this study clearly indicate the predominance of gallstone disease and choledocholithiasis with intraoperative difficulties in females with mean Body mass index (BMI) of the obese category (>30 kg/m2) seen in 59.3% and detected hypercholesterolemia in 32% of the cases. These agreed with the literature that reported obese women who had an increased hepatic secretion of cholesterol can have gallstones and difficult cholecystectomy that is associated with unclear anatomy related to fatty infiltration of Calot's triangle (13). Also, another study had noted the same results and concluded that a BMI more than >40 kg/m2 was statistically significant for predicting intraoperative difficulties in open approach and made a rapid decision for LC conversion (18). Moreover, diabetes mellitus has been diagnosed in 4.3% of the cases. This is similar to the results of the international literature as they showed diabetes mellitus is significantly associated with intraoperative difficulties from advanced forms of recurrent chronic cholecystitis. Also, it increased the wall thickness of the gallbladder due to poor glycemic control, autonomic neuropathy, frequent bacterobilia and diabetic microangiopathy (13, 28). There are debates in the international literature for preoperative evaluation of intraoperative difficulties that is associated with cholelithiasis and choledocholithiasis without specific laboratory or radiological findings. This reason prompted researchers to seek for early diagnostic tests to detect these difficulties preoperatively. In this study, TUS showed cholelithiasis in all patients (100%) and detected a dilated CBD caliber more than 8 mm in 31.6 % of the cases. This revealed that TUS is highly sensitive and accurate for gallstones detection but less for the CBD stones. Costi et al. found the same findings in his study as he stated that the sensitivity of TUS for detection of gallstones and CBD stones was 80–100% and 70–90%, respectively (29). Also, TUS was showed an increased GB wall thickness more than 0.4 cm with multiple stones in 43.1% and single stone in 25.3% of patients. These goes with literature showing that a thickened GB wall more than 4 mm predict intraoperative difficulties that significantly increase its risks, hospital stay and need of LC conversion (21). Hence, there was recommendation of the usage of preoperative TUS as a screening procedure for difficult cholecystectomy either in open or laparoscopic approach (30). All patients underwent preoperative MRCP for equivocal results on TUS and to predict preoperative difficulties that related to planed open cholecystectomy ± CBD exploration. Moreover, our study showed that MRCP had successfully detected impacted multiple gallstones inside the Hartmann's pouch in 68.4%. Also, it revealed stones in the contracted thick gallbladder wall complicated with multiple stones in CBD in 31.6% of the cases. These similarly goes in agreement with other studies that revealed multiple gallstones increased surgeon's difficulty and impacted stone in neck of the gallbladder raised up the LC conversion rate (25, 31). The literature reported that MRCP has an excellent overall sensitivity of 95% and a specificity of 97% for accurate demonstration of variable sizes of CBD stones. Hence, when the open approach of fundus-first cholecystectomy has been planned, it is useful to perform preoperative MRCP with TUS for diagnosis of all difficult cases that has association with long-standing cholecystitis with scleroatrophic gallbladder and choledocholithiasis to identify the distorted anatomy within the Calot's triangle and avoidance of bile duct injuries in the future (23, 24). Our patients who were diagnosed with long-standing cholelithiasis with intraoperative difficulties represented 68.4% of the cases and required an open fundus-first cholecystectomy. Also, 31.6% of the patients have both cholelithiasis and choledocholithiasis associated with obstructive jaundice and intraoperative difficulties. They were planned for open technique of fundus-first cholecystectomy with CBD exploration ended by choledocho-dudeunostomy in 25.3% and T-tube biliary drainage in 6.3% of the cases. Moreover, we reported intraoperative difficulties including a contracted intra-hepatic gallbladder in 62.1%, redundant elongated gallbladder in 37.9%, difficult dissection related to distorted anatomy within the Clot's triangle in 53.4% and severe omental adhesions between the gallbladder and surrounding viscera in 46.6% of the patients. An extensive revision in the literature was done. We found no relevant surgical studies that reported the patterns of intraoperative difficulties for open cholecystectomy. In addition, there is no accepted universal grading for difficult cholecystectomy. Furthermore, our results go similar to findings of studies noticed dense adhesions of the gallbladder with surrounding viscera in 56.2% of the cases and concluded it's the most common cause of difficult cholecystectomy leading to LC conversion in both genders (12, 20). We observed bleeding from the liver bed during difficult open cholecystectomy with high incidence in patients who

have recurrent acute attacks on chronic cholecystitis. Extensive revision of published studies in the literature was done and a few findings focused on the incidence, mechanisms and intraoperative treatment of bleeding from the liver bed during an open approach of difficult cholecystectomy. Hence, in this study, an intraoperative bleeding from the liver bed after the usage of fundus-first cholecystectomy represented the form of bloody oozing in 59.3% of the cases. Also, our findings disagreed with results of other studies that reported the form of actual bleeding from liver bed in 39% of the patients with open cholecystectomy and 47% in laparoscopic approach (32, 33). Most of our patients had acute attacks on chronic cholecystitis with shrunken fibrotic gallbladder due to alteration of local anatomy from pericholecystitis and subsequent loss of the cleavage plane between the gallbladder and hepatic bed when attempting surgical dissection leading to injury of the vessels traversing between them. Sahu et al. have reported an incidence of various vascular anomalies in 7.7% of the cases discovered during surgical dissection of the gallbladder from liver bed (34). These vessels reported in previous studies particularly at cirrhotic livers where an increased portal pressure lead to collaterals development and raises the possibility of uncontrolled hemorrhage with requirement of direct packing pressure for five minutes, vascular clamps and diathermy cauterization that halt the hemorrhage. If these methods failed, then dissection and repair by oversewing or ligation of the bleeding vessels will be helpful in the bleeding control (35). Our study revealed a variability in the operative time of open cholecystectomies facing intraoperative difficulties. Most of the patients had 120 minutes of operative time reported in 40.7%. This is because available expert surgeons were requested for these difficult cases to use the fundus-first technique. Also, we found no statistical analysis for operative time of difficult open cholecystectomy in most published studies of the literature. Hence, our results similarly go with findings of the literature that observed an increased operative time associated with high frequency of LC conversion. Moreover, operative time of cases exceeding 120 minutes means a significant predictive of difficulty and the actual intraoperative causes were an obscured distorted anatomy of Calot's triangle and regional dense omental adhesions observed particularly in the cases of long-standing cholecystitis ± CBD stones (36). Due to the approach of open fundus-first cholecystectomy, the mortality rate in this study was zero. Our results are consistent with literature that reported zero mortality rate for a difficult gallbladder surgery (37). Furthermore, our findings disagreed with another study that revealed perioperative mortality of 11.5% for open cholecystectomy with difficulties (38). Finally, we revealed a short time postoperative hospital stay for our patients with difficult open cholecystectomies ± CBD exploration approached by the fundus-first method. These results were in agreement with the Danish National Guidelines for the Treatment of Gallstones which showed that postoperative stay within the hospital below three days with no re-admission is an indicator of successful cholecystectomy without morbidities and assist in reduced expenditure of health care providers (39). The main strength of this current study is applicability of fundus-first method in an elective setting of difficult open cholecystectomies in the developing countries where availability of laparoscopic cholecystectomy facilities is beyond the reach of poor patients for avoidance of bile duct injuries and intraoperative bleeding.

Conclusions

There is a need for appropriate therapeutic and preventive strategies in healthcare systems for safe dealing with difficult cholecystectomy. Unclear anatomy due to severe inflammatory dense adhesions at Calot's triangle and CBD stones are leading factors for difficult fundus-first laparoscopic cholecystectomy. Hence, we humbly recommend an open approach of fundus-first cholecystectomy as safe surgical option to reduce the incidence of bile duct injuries and intra-operative bleeding.

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This research did not receive any specific fund.

Conflict of Interest

No conflict of interest

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Statement of Ethics:

Our research complies with the guidelines for human studies and was conducted ethically in accordance with the World Medical Association Declaration of Helsinki. Ethical approval was obtained from the local Research Ethics Committee of Faculty of Medicine and Health Sciences, Omdurman Islamic University on the committee meeting number (109) on Thursday 13th December 2018. A written informed consent was obtained from all participants to participate in the study.

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