Langenbeck's Archives of Surgery (2024) 409:271
https://doi.org/10.1007/s00423-024-03459-w

RESEARCH

The Rationale of sub-hepatic drainage on a specialist biliary unit: a review of 6140 elective and urgent laparoscopic cholecystectomies and bile duct explorations

Haitham Qandeel[1,7] · Israa Hayyawi[2] · Ahmad H. M. Nassar[3,4] · Hwei J. Ng[5] · Khurram S. Khan[4,6] · Subreen Hasanat[1] · Haneen Ashour[1]

Received: 6 June 2024 / Accepted: 23 August 2024

Abstract

Background Drains are used to reduce abdominal collections after procedures where such risk exists. Using abdominal drains after cholecystectomy has been controversial since the open surgery era. Universally accepted indications and agreement exist that routine drainage is unnecessary but the role of selective drainage remains undetermined. This study evaluates the indications and benefits of sub-hepatic drainage in patients undergoing laparoscopic cholecystectomy (LC) and bile duct exploration (BDE) in a specialist unit with a large biliary emergency workload.

Methods Prospectively collected data from 6,140 LCs with a 46.6% emergency workload over 30 years was reviewed. Demographic factors, pre-operative presentations, imaging and operative details in patients with and without drains were compared. Sub-hepatic drains were inserted after all transductal explorations, subtotal cholecystectomies, almost all open conversions and 94% of LC for empyemas. Adverse or beneficial postoperative drain-related outcomes were analysed.

Results Abdominal drains were utilised in 3225/6140 (52.5%). Patients were significantly older with more males. 59.4% were emergency admissions. Preoperative imaging showed thick-walled gallbladders in 25.2% and bile duct stones or dilatation in 36.2%. At operation they had cystic duct stones in 19.8%, acute cholecystitis, empyema or mucocele in 28.4% and operative difficulty grades III or higher in 59%. 38% underwent BDE, 5.4% had fundus-first dissection and the operating times were longer (80 vs.45 min). Drain related complications were rare; 3 abdominal pains after anaesthetic recovery settling when drains were removed, 2 drain site infections and one re-laparoscopy to retrieve a retracted drain. 55.8% of 43 bile leaks and 35% of 20 other collections in patients with drains resolved spontaneously.

Conclusions The utilisation of drains in this study was relatively high due to the high emergency workload and interest in BDE. While drains allowed early detection of bile leakage, avoiding some complications and monitoring conservative management to allow early reinterventions, the study has identified operative criteria that could potentially limit drain insertion through a selective policy.

Keywords Abdominal drain · Subhepatic · Laparoscopic cholecystectomy · Laparoscopic bile duct exploration · Subtotal cholecystectomy · Fundus first dissection

✉ Ahmad H. M. Nassar
Ahmad.Nassar@glasgow.ac.uk; Anassar@doctors.org.uk

1 Hashemite University, Zarqa, Jordan

2 Inverclyde Royal Hospital, Greenock, Scotland

3 Golden Jubilee National Hospital, Glasgow, Scotland, UK

4 School of Medicine, Dentistry & Nursing, University of Glasgow, Glasgow, Scotland, UK

5 Royal Alexandra Hospital, Glasgow, Scotland, UK

6 Department of Upper GI Surgery, University Hospital Hairmyres, NHS Lanarkshire ML6 0JS, Scotland, UK

7 Laparoscopic Biliary Service, University Hospital Monklands, Lanarkshire, Scotland

Published online: 05 September 2024

Introduction

Routine drainage of the sub-hepatic space after elective uncomplicated laparoscopic cholecystectomy is not indicated [1] and is not encouraged [2–6]. Some authors suggested that abdominal drainage in such cases may increase morbidity without significant benefits and should be avoided [7–14]. A meta-analysis was unable to show any drain benefits except following LC for acute cholecystitis, cholangitis, or pancreatitis or when significant intraoperative morbidity occurred [2,15]. Nadeem et al. [7] maintain that drains do not prevent the occurrence of intra-abdominal abscesses. This policy on uncomplicated LC is evidence based and is consistent with the practice in the current study.

In the absence of guidelines, the use of abdominal drains after difficult LCs is subject to the judgement of the operating surgeon. There is published data on the specific indications for drains such as increased risk of bleeding, intraoperative gallbladder perforation, after repair of iatrogenic injury to other organs [8] and when subtle bile staining of the liver bed may suggest a missed hepatocystic or subvesical duct, increasing the risk of bile leakage. Difficult dissection due to acute cholecystitis and fibrous adhesions increase the risk of bleeding while an abnormal cystic pedicle, aberrant biliary anatomy, or suspicion of a minor biliary leak indicate subhepatic drainage [16,17] to reduce post-operative morbidity. It was pointed out, however, that drain placement does not guarantee the prevention of postoperative bile collections, bleeding, or bile peritonitis and may not always contribute to therapeutic interventions in such cases [18].

In the absence of conclusive evidence for sub-hepatic drainage after complicated LC, the primary aim of this study was to evaluate the indications for drainage in a large series on a specialist biliary unit and the factors that may contribute to decision making. The secondary aims were to assess the extent to which drains may be beneficial and whether any drain-related morbidity was encountered.

Methods

Prospectively collected data from 6,140 LC performed by a single surgeon (AHMN) or his trainees under direct on-table supervision over 30 years was reviewed. Data on patient demographics, type of admission, clinical presentation, radiological findings, operative difficulty grading, operative time, peri-operative complications, re-admissions and mortality were recorded and maintained on a computerised database (Datbase3 then Microsoft Access).

This biliary firm managed, by protocol, all referrals with biliary emergencies within the hospital and occasionally received inter-hospital transfers. The unit adopts a policy of intention to treat during the index emergency admission and single session laparoscopic management of bile duct stones.

Operative technique and strategies for difficult LC

LC is carried out using a four port technique in the American position with modified open access through an 11–12 mm infraumbilical port and three 5 mm epigastric, subcostal and right flank ports. Adhesiolysis, if required, is limited to the minimum needed to clear the port sites and sweep bowels away from the operating field. The cystic pedicle is dissected using a blunt “duckbill dissector” (Karl Storz, Tutlingen, Germany), having abandoned the diathermy hook after the first few cases.

The infundibular approach was employed in the early part of the series before a policy of routinely seeking to display the critical view of safety (CVS) was adopted. Once the anatomy of the Calot’s triangle was clear or the CVS was displayed the neck of the gallbladder was ligated using 2 – 0 absorbable suture. The cystic duct was incised, a cholangiography catheter (Cook Medical INC, USA) within a cholangiography cannula (Karl Storz, Tutlingen, Germany) was inserted and an intraoperative cholangiography (IOC) was obtained. The main bile ducts were defined and CBD stones excluded before ligating and dividing the cystic duct. The use of metal clips to secure the cystic duct and artery was abandoned in 1997. Gallbladder separation was then carried out using the “duckbill dissector”. If gallbladder perforation occurred any spilled bile or stones were collected and irrigation of the subhepatic space carried out. The gallbladder is usually removed through the umbilical port site and the fascial incision closed under vision using a 5 mm scope at the epigastric port. A careful second look of the gallbladder bed and the space lateral to the liver is conducted. The decision to use a drain was dictated either by predetermined factors e.g. bile duct exploration through a choledochotomy, the operative finding of empyema or perforation of the gallbladder externally or into the liver parenchyma, when a risk of bleeding or bile leakage was anticipated, e.g. after suturing a wide cystic duct or in the rare event of resorting to subtotal cholecystectomy (Table 1).

If a decision to use a drain was made it was inserted through the right flank port and positioned in the subhepatic space under-vision. The drains used were 14 Fr suction tube drains but larger bore drains were utilised occasionally when indicated e.g. oozing from the gallbladder bed requring haemostatic material, suturing a wide cystic duct stump expected to result in some bile leakage and the presence of extracholecystic or gallbladder bed abscess. Most drains were removed on the first postopearive day if there was nothing other than remnants of irrigation fluid. Should there be evidence of bile or blood in the drain it was left

Table 1 Indications and factors influencing the decision to use abdominal drains

Criteria	
Strong indications	• BDE via choledochotomy
	• Bowel requiring repair; cholecystoenteric fistula, anastomosis due to bowel or bile duct injury or bilioenteric bypass
	• Subtotal cholecystectomy or suturing wide/inflammed cystic duct
	• Abscess : extracholecystic or into liver parenchyma
Relative indications	• Acute/Empyema/Pancreatitis with pericholecystic phlegmon
	• Excess irrigation fluid after lengthy choledochoscopy
	• Operative rupture of gallbladder
	• Significant haemostasis of gallbladder bed needed with use of any haemostatic material

until that was no longer a concern. Following choledochotomies, drains were left until the drainage fluid was clear of bile and the usual clinical indicators of drain removal were otherwise followed in other cases. The amount of drainage fluid was not recorded in this study.

Further analysis of operative details associated with individual LC difficulty grades was carried out to identify specific factors that influenced the decision to insert drains. This would help exclude patients where it is possible to apply a selective policy aiming at reducing the rate of draiange.

SPSS® Statistics 17 was used for statistical analysis. Two-tailed Student T-test was used to calculate the p value for continuous data. Chi-square with Pearson uncorrected used for categorical data. The level of statistical significance was set at $P < 0.05$.

was obtained from all patients with specific emphasis on the specialisation of the unit with regards to the management of suspected bile duct stones. The database was registered as a clinical audit and ethical approval was not required for this retrospective analysis as the management protocols were in line with the recommendations of national and international societies.

Results

Just over half the patients 3225/6140 (52.50%) received sub-hepatic drains. The median age was 55 years and 65.8% were female. Compared to the patients who had no drains this group had significantly more males (34.1% vs. 17.7%). Emergency admissions occurred in 46.6% of the patients in the whole series. Those who had drains inserted were significantly more likely to have been emergency admissions (59.4% vs. 32.4%).

Demographic and preoperative data comparison between the two groups is shown in Table 2.

Patients who were found to have contracted or thick walled gallbladders on ultrasound scanning were more likely to have drains inserted at operation (25.2% vs. 7%, $p < 0.001$). The finding of bile duct stones or dilatation on preoperative imaging signified a higher incidence of bile duct explorations. 36.2% of these patients had drains inserted and only 9.2% had no drains. (Table 3).

The use of drains was significantly more in patients who required division of adhesions around the gallbladder, hepatic flexture or duodenum. There were also significant associations between certain intra-operative findings; cystic duct stones, dilated cystic ducts and filling defect on Intra-operative cholangiography and the eventual utilisation of abdominal drains. As would be expected abdominal drainage is likely to be resorted to when acutely inflamed (including 92% of patients with gallbladder empyema) or contracted gallbladders were encountered. In this study 44.5% of those with drains had acute cholecystitis, empyema, mucocele or a contracted gallbladder. Patients with

Table 2 Demographic data, type of admission and clinical presentations

Characteristic	Abdominal drainage $N = 3225$ (%)	No drainage $N = 2915$ (%)	P value	OR (95% CI)
Gender*	1099 (34.1%)	516 (17.7%)	**< 0.001**	2.400 (2.129–2.705)
Male	2123 (65.8%)	2392 (82.1%)		
Female				
Median age (years)	56 (IQR 43–68)	47 (IQR 35–58)	0.214	
Admission**	1917 (59.4%)	944 (32.4%)	**< 0.001**	3.055 (2.752–3.393)
Emergency	1308 (40.6%)	1968 (67.5%)		
Elective				
Clinical presentation				
Acute pain	1287 (39.9%)	766 (26.3%)	**< 0.001**	1.863 (1.672–2.077)
Acute cholecystitis	526 (16.3%)	69 (2.4%)	**< 0.001**	8.038 (6.220–10.388)
Acute pancreatitis	283 (8.8%)	213 (7.3%)	**0.035**	1.220 (1.014–1.469)
Jaundice and/or Cholangitis	1063 (33%)	256 (8.8%)	**< 0.001**	5.107 (4.405–5.920)
Suspected CBD stones	1637 (50.8%)	660 (22.6%)	**< 0.001**	3.522 (3.153–3.935)

* 10 not recorded ** 3 not recorded CBD = Common bile duct

Table 3 Pre-operative imaging in patients with or without abdominal drains

Findings	Abdominal drainage $N=3225$ (%)	No drainage $N=2915$ (%)	P value	OR (95% CI)
Ultrasound scan	2609 (80.9)	2347 (80.5)	0.703	1.025 (0.903–1.164)
Multiple stones	337 (10.4)	363 (12.5)	**0.014**	0.820 (0.701–0.960)
Single stone	82 (2.5)	61 (2.1)	0.243	1.221 (0.873–1.707)
Other pathologies	218 (6.8)	144 (4.9)	**0.003**	1.395 (1.123–1.733)
None				
Gallbladder thick / contracted / mucocele	813 (25.2)	203 (7)	**< 0.001**	4.503 (3.825–5.302)
No sign of inflammation	2412 (74.8)	2712 (93)		
Bile duct stones / dilatation on ultrasound / MRCP / ERCP / CT scan	1168 (36.2)	269 (9.2)	**< 0.001**	5.585 (4.834–6.454)

MRCP = Magnetic resonance cholangiopancreatography, ERCP = Endoscopic retrograde cholangio pancreatography, CT = Computed Tomography

Table 4 Intra-operative findings in relation to abdominal drainage

Findings	Abdominal drainage $N=3225$ (%)	No drainage $N=2915$ (%)	P value	OR (95% CI)
Adhesiolysis	2519 (78.1)	1401 (48.1)	**< 0.001**	3.856 (3.452–4.307)
Gallbladder	1127 (34.9)	154 (5.3)	**< 0.001**	9.631 (8.063–11.504)
Hepatic felxture	1988 (61.6)	867 (29.7)	**< 0.001**	3.796 (3.413–4.223)
Duodenum	575 (17.8)	233 (8)	**< 0.001**	2.498 (2.125–2.935)
Distal				
Calot's Triangle difficulty	1940 (60.2)	548 (18.8)	**< 0.001**	6.521 (5.803–7.328)
Cystic duct stone	639 (19.8)	396 (13.6)	**< 0.001**	1.572 (1.371–1.802)
Cystic duct wide	668 (20.7)	165 (5.7)	**< 0.001**	4.354 (3.642–5.206)
Gallbladder: Acute/ Empyema/Mucocele	917 (28.4)	229 (7.9)	**< 0.001**	4.660 (3.991–5.442)
Gallbladder: contracted	520 (16.1)	177 (6.1)	**< 0.001**	4.597 (3.736–5.657)
Cholecystectomy Difficulty Grade*‡	1321 (41)	2493 (85.5)	**< 0.001**	0.117 (0.103–0.133)
I or II	1904 (59)	421 (14.5)		
III, IV or V				

* 1 not recorded ‡ Nassar Cholecystectomy Scale

drains were significantly more likely to have a Nassar difficulty grade III or higher (Table 4).

Drains and bile duct explorations

Drains were routinely used in all 455 transcholedochal explorations. Only 769/992 (77.5%) of transcystic explorations had drains. However, the decision to use abdominal drains in patients undergoing transcystic explorations was mostly related to the removal of multiple or impacted bile duct stones, Mirizzi Syndrome or where the cystic duct was wide and had to be secured with sutures or loops. Drains were also utilised after choledochoscopy to make sure that excess irrigation fluid is removed, thus avoiding any postoperative collections. Choledochoscopies were performed in 1021 (16.6%) of this series, including all 455 choledochotomies and 566 (57%) of transcystic explorations. Abdominal drains in 178/3225 (5.5%) patients was unrelated to the transcystic exploration but to the condition of the gallbladder; namely the presence of acute cholecystitis, empyema of the gallbladder or difficult cystic pedicles (Nassar difficulty grades III to V cholecystectomies).

Drains and salvage cholecystectomies

All 16 open conversions of 1447 bile duct explorations were in the drainage group. Drains were inserted after 93.6% of fundus-first cholecystectomies (Table 5) and in all the rare (11/6140) subtotal cholecystectomies. The use of drains was also considered mandatory when the cystic duct stump was secured with sutures due to a wide cystic duct, an inflammed pedicle or when a longitudinal cystic duct incision was needed to remove a large impacted stone (6 patients).

Drains and complications

The presence of drains did not affect the rate of wound infection. 29 (0.9%) patients with drains and 28 (1%) in those without drains developed umbilical wound infections ($p=0.95$). Certain groups of complications were analysed in relation to the presence of drains to evaluate the whether drain utilisation had potential benefits as follows.

Postoperative bile leaks Occurred in 45 patients; 0.7% of whole series and 1.3% of those who had drains. 20 of these occurred from the choledochotomy following direct transductal exploration with no ill effects as they had mandatory

Table 5 Operative techniques and criteria related to utilising abdominal drainage

Technique	Abdominal drainage $N=3225$ (%)	No drainage $N=2915$ (%)	P value	OR (95% CI)
LC with bile duct exploration, total	1224 (38)	223 (7.6)	**< 0.001**	7.550 (6.466–8.816)
LC & choledochotomy	455 (14.1)	0	**< 0.001**	-
LC & TCE plus acute/empyema/mucocele	178 (5.5)	22 (0.8)	**< 0.001**	7.682 (4.919–11.998)
Gallbladder operative perforation	782 (24.2)	336 (11.5)	**< 0.001**	2.457 (2.137–2.824)
Fundus first dissection	174 (5.4)	9 (0.3)	**< 0.001**	18.415 (9.405–36.056)
Median Length of Surgery (minutes)	80 (IQR 60–110)	45 (IQR 35–60)	**0.001**	
Conversion	28 (0.9)	1 (0.003)	**< 0.001**	25.521 (3.470–187.693)

LC = Laparoscopic cholecystectomy, TCE = Transcystic exploration

prophylactic sub-hepatic drains for potential bile leaks. Bile leakage occurred before drain removal in 16; 10 settling spontaneously, 3 requiring ERCP and 3 needing relaparoscopy (due to mistaken removal of T-Tube and T-Tube retraction into abdomen, the drain having had protective function until reintervention was arranged). 4 occurred after drain removal and all required reinterventions via percutaneous drains (PCD) in 2 and ERCPs in 2. Of 12 undergoing transcystic duct exploration 10 leaks occurred while drain was still in situ; 8 settling spontaneously, 1 with ERCP and 1 with PCD. 2 occurred after drain removal; 1 settled and 1 needed ERCP. 11 patients had postcholecystectomy bile leakage. 9 still had their drains (6 settled, 1 PCD, 1 ERCP and 1 relaparoscopy) and 2 occurred after drain removal needing relaparoscopy and ERCP. Thus, the protective benefits of drains were early detection and spontaneous resolution in 24 patients (55.8%). 7 of the 8 patients who had bile leaks after drain removal required reintervention. The details of bile leakage in this series have previously been published in this journal [19].

Only two bile duct injuries occurred in this series (0.03%). One transection of the common hepatic duct and one of the right hepatic duct were recognised intraoperatively, confirmd by cholangiography, stents were inserted in the ducts, the cut edges were marked with sutures and abdominal drains were inserted. The two patients were transferred to a liver surgery unit on the same day for biliary reconstruction and long term follow up was satisfactory.

Abdominal collections, other than bile, occurred in 20 patients; 6 after cholecystectomy for empyema, 6 after choledochotomy, 2 after transcystic ductal exploration, 4 following uncomplicated cholecystectomies and 2 after complex cholecystectomies. These resulted in various septic collections at various intervals; settling conservatively in 8 patients, requiring guided percutaneous drainage in 8, requiring relaparoscopy for bleeding or abdominal collections in 2 and relaparotomy for peritonitis in 2 patients.

The presence of drains caused complications in only six patients (0.18%). One drain retracted into the abdomen and needed to be retrieved using relaparoscopy, two drain site infections occurred and 3 had significant unexplained pain in the recovery room, disappearing when the drains were removed. This was not drain site pain but significant intraabdominal pain not responding to adequate analgesia. It alarmed the nursing and junior staff, lead to suspected bleeding or bile leakage not manifesting in the drain and required attendance by a consultant to exclude an intraabdominal event.

2915 (47.5%) did not have drains and 80 had operative or postoperative complications (2.74%). Of the 5 patients who had PCBL (0.17%) all needed readmission and reinterventions; including 3 percutaneous drainage, 2 ERCPs and 3 relaparoscopies. These patients required a mean 3 hospital episodes and 21.6 days in hospital. One patient had a gallbladder bed haematoma resulting in readmission but settled conservatively. 10 patients required readmission due to abdominal and shoulder pains with a mean hospital stay of 4.4 days. Wound infections occurred in 28 patients, 3 requiring readmissions. The rest of the complications were unrelated to whether or not a drain was used.

The morbidity rate, Clavien-Dindo Classification of complications and postoperative outcomes are detailed in Table 6.

Detailed analysis was conducted of the operative findings of patients records to identify those where specific reasons for drainage, other than bile duct exploration, were recorded in LC difficulty grades I (44), II (76) or III (51). Transcystic basket trawling of the CBD due to equivocal cholangiographies was carried out in 15, 45 and 27 respectively. Significant division of distant omental or bowel adhesions was needed in 8, 10 and 9, hepatocystic or subvesical accessory ducts were ligated or sutured in 8,4 and 6, liver biopsies, cirrhosis or deroofing of larger liver cysts in 8,3 and 7 and other indications were encountered in 5, 14 and 6.

Table 6 Postoperative morbidity and outcomes in relation to utilising abdominal drainage

Technique	Abdominal drainage $N=3225$ (%)	No drainage $N=2915$ (%)	P value	OR (95% CI)
Morbidity	341 (10.5)	78 (2.7)	**< 0.001**	2.038 (2.264–3.811)
Clavien-Dindo Classification Grade I Grade II Grade IIIa Grade IIIb Grade IVa Grade V	101 151 49 16 14 10	18 49 7 3 1 0	**< 0.001** **< 0.001** **< 0.001** **0.006** **0.002** **0.003**	5.203 (3.143–8.613) 2.873 (2.073–3.981) 6.409 (2.899–14.172) 4.840 (1.409–16.626) 12.705 (1.670-96.677) -
Reoperations	18 (0.6)	3 (0.1)	**0.002**	5.448 (1.603–18.514)
Postoperative ERCP***	55 (1.7)	8 (0.27)	**< 0.001**	6.305 (2.998–13.258)
Readmissions	161 (5)	41 (1.4)	**< 0.001**	3.683 (2.604–5.209)
Median total hospital stay	6* days (IQR 3–10)	2** days (IQR 1–5)	**< 0.001**	-
Mortality	10 (0.3%)	0	**0.003**	-

LC = Laparoscopic cholecystectomy, TCE = Transcystic exploration

* Available in 78.6%, available** in 68.5%, For all episodes *** for complications, investigation or retained stones, excluding those for recurrent stones later in the series.

No specific reason for drain insertion was recorded in 1094 which would have adjusted the rate of drainage to 34.7% (2131/6140).

Discussion

Bugiantella et al. [2] demonstrated that sub-hepatic drainage did not reduce the incidence of abdominal collections, wound infection, postoperative pain or the mortality rates after uncomplicated LC. Picchio et al. [15] performed another meta-analysis to assess whether drains had a role in reducing complications after LC. They concluded that it is reasonable not to insert drains when a dry operating field was evident at the end of the procedure as there was no evidence drains contributed to reduction of complications. However, this evidence did not apply to emergent LC. Gurer et al. [17] found no relationship between the presence of a drain and postoperative fluid collections. As less sub-hepatic fluid accumulated when no drain was used, it was unnecessary to place drains in patients without complications. In a randomised study, Bostanci et al. [18] suggested that routine use of prophylactic sub-hepatic drains in elective LC offered no benefit. They recommended selective drainage instead.

This study included a significant proportion of emergency LC as well as bile duct explorations which was not the case in most of these reports. Our results support the conventional practice of using drains when the surgeon may be concerned about potential bile leakage or bleeding. In our series, although there was a lower threshold for using drains, these had definite indications such as common bile duct exploration through a choledochotomy, occasional subtotal cholecystectomy, empyema of the gallbladder or following open conversion (some conversions having also undergone transcholedochal ductal explorations). 77% of patients undergoing transcystic bile duct explorations had drains inserted although the decision was not directly related to the exploration in most cases. In two fifths of the transcystic explorations the insertion of drains was to ensure no cystic duct leakage as a result of oedema of the ampulla or potential retained stones.

The presence of drains may prevent the potential development of symptoms and signs of bile leakage in some patients who develop post operative sub-hepatic or intra-abdominal collections. Although these can be shown by sonography or CT scan and then interventionally drained with good results, they may only be detected after symptoms have developed thus delaying any reintervention. The presence of a drain helps timely detection of bile leaks or bleeding and may limit the consequences of such events by avoiding reinterventions. In our series controlled drainage also allowed the optimisation of the timing of reinterventions when these were necessary rather than force emergency procedures.

In 40 of 45 patients the appearance of bile leaks or post LC bleeding through the drains made the team aware of the complication, allowed close monitoring of the amount and nature of the drain content, optimised the utilisation of cross sectional imaging and guided the decision on whether to continue with expectant management or to proceed with percutaneous, endoscopic or surgical intervention. A significant number settled completely on conservative management. These included 13 of 25 patients who developed postcholecystectomy bile leakage and 13 of 20 patients who had bile leakage following choledochotomy bile duct explorations. These leaks were controlled and limited by the drains and were managed without reintervention. The only five patients who developed postcholecystectomy or post-bile duct exploration bile leaks and required reintervention (3 relaparoscopies and two percutaneous drainage of collections) had had no drains inserted at the time of surgery.

The CholeS study [20] compared this series to national data from UK hospitals with drainage rates of 52% and 18% respectively. This was the result of this series having statistically significant higher numbers of emergency procedures (32% vs. 16%), higher cholecystectomy difficulty grades (35% vs. 30%) and more bile duct explorations (21% vs. 3%) than the CholeS study.

We have previously suggested liberal selective use of sub-hepatic drains in patients undergoing LC for Mirizzi Syndrome or for complicated empyemas [21,22]. We also consider abdominal drainage mandatory following choledochotomy to avoid bile leakage and to remove residual irrigation fluid after choledochoscopic exploration, thus reducing the risk of postoperative collections. On the other hand, the study showed that avoiding abdominal drainage is possible, even in patients with relative indications for drain insertion. Patients with no drains included 219 who underwent transcystic explorations (7.5%); including 91 involving choledochscopies, 362 patients (12.4%) with acute cholecystitis, empyema, mucoceles or contracted gallbladders and 463 (12.4%) who had other criteria of difficulty grades III and IV.

Some authors reported increased postoperative pain and hospital stay in patients with sub-hepatic drains after elective uncomplicated LC. On the other hand, many studies comparing LC with and without sub-hepatic drain found no significant differences in the visual analogue scale with respect to abdominal and shoulder pain, nausea, and vomiting 6,9 However, Vafaei et all conducted a randomized clinical trial and suggested that abdominal drainage leads to significantly less postoperative shoulder pain [23] .

The incidence of wound infection in some studies was found to be significantly higher in patients where drains were used [3,9]. However, a meta-analysis concluded that the use of drains has no effect on wound infection [2]. A randomized trial showed no statistical difference in the rate of wound infections with and without sub-hepatic drains [10]. Similarly, our study demonstrated no correlation between the presence of a drain and the wound infection rate.

Georgiou et al. [11] and Sharma et al. [12] found that postoperative pulmonary complications were similar in patients with and without drains. Although the pulmonary complications rate in our study was higher with drains this seemed to be related to clinical presentations and operative findings.

Limitations

This study is limited by the fact that it cannot be compared with others addressing abdominal drainage after LC on account of the large percentage of emergent cholecystectomy (59.4%, Table 2), resulting in difficult cholecystectomies graded III to V in 59% (Table 4). However, it is the first study addressing abdominal drainage in a series with a large number of bile duct explorations. Our service model is that of a specialist referral unit with a large biliary emergency workload, a policy of index admission surgery in all comers who are fit for surgery and single session laparoscopic management of bile duct stones [24,25]. There was subsequently a low threshold and a high incidence of sub-hepatic drain utilisation for specific indications summarised in Table 1. The series also spanned three decades and it could be argued that the utilisation of drains may have evolved subject to increasing experience and technical improvements. However, the incidence of drain usage over the three decades was 49.7%, 51.1% and 54.9% suggesting a similar case mix and specific indications rather than individual bias. Although the decision to insert a drain is dependent on the experience and judgement of the operating surgeon the presence of one or more indications should weigh in favour of placing a sub-hepatic drain. It is agreed, however, that elective and uncomplicated LC do not routinely justify using drains. Careful intraoperative consideration of the indications to use drains avoided drainage in 12.4% of patients undergoing transcystic exploration of the bile duct and a similar proportion of patients with acute gallbladder pathology. A stricter selective policy, could also have avoided drains in 87.4% of grade I LC and 84.8% of grade II who had no bile duct explorations and 68.3% of Grade III patients who had no ductal explorations or acute cholecystitis. Such a policy could have resulted in reducing the rate of abdominal drainage by one third from 52.5 to 34.7%.

Conclusions

The rate of utilisation of drains in this study is relatively high due to the high workload of biliary emergencies and bile duct exploration. Certain preoperative criteria have associations with the decision to insert drains. While some operative findings will be paramount in determining sub-hepatic drain utilisation after LC, careful selection is advocated to avoid drainage whenever possible even in some patients undergoing transcystic bile duct exploration and those with operative findings suggesting acute gall bladder pathology. In the specialist setting, while having specific principles, the decision to insert drains is guided by the surgeon's judgement. Drains can help to control bile leakage or other collections in order to avoid their complications, optimise the need for cross-sectional imaging and facilitate the potential for conservative management thus reducing the need for remedial reinterventions.

Author contributions HQ: analysis of data, initial draft, review of final manuscript. EH: analysis of data, presentation of work, review manuscript. AN: generating clinical material, maintaining database, analysis of results, processing of tables, editing manuscript. HN: developing the draft and reviewing final manuscript. verifying statistics. KK: main

statistical work and formatting tables, editing final manuscript. SH: literature review, obtaining and summarising references, drafting tables, reviewing manuscript. HA: literature review, obtaining and summarising references, reviewing manuscript.

Funding None.

Data availability No datasets were generated or analysed during the current study.

Declarations

Competing interests The authors declare no competing interests.

References

1. Satinský I, Mitták M, Foltys A, Dostalík J (2003) Subhepatic drainage in laparoscopic cholecystectomy–a necessity or an overused tradition? Rozhl Chir 82(8):427–431
2. Bugiantella W, Vedovati MC, Becattini C, Canger RCB, Avenia N, Rondelli F (2014) To drain or not to drain elective uncomplicated laparoscopic cholecystectomy? A systematic review and meta-analysis. J Hepatobiliary Pancreat Sci 21(11):787–794. https://doi.org/10.1002/jhbp.127
3. Bangash TH (2018) Post operative wound infection in uncomplicated laparoscopic cholecystectomy with and without a drain. Pakistan Armed Forces Med J 68(5):1393–1397
4. Shamim M (2013) Routine sub-hepatic drainage versus no drainage after laparoscopic cholecystectomy: Open, Randomized, Clinical Trial. Indian J Surg 75(1):22–27. https://doi.org/10.1007/s12262-012-0452-5
5. Chauhan HHR, Vaishnav UG (2016) A comparative study to evaluate the outcome of routine use of drain verses no drain after laparoscopic cholecystectomy: a tertiary care teaching centre experience. Int J Surg 3(1):330–335. https://doi.org/10.18203/2349-2902.isj20160254
6. Marwah S, Pandey S, Jangra MS, Sing H, Singla P, Sing J (2015) Subhepatic drain has no role after uncomplicated laparoscopic cholecystectomy: a prospective randomized double blind study. Hell J Surg 87(6):458–464. https://doi.org/10.1007/s13126-015-0257-7
7. Nadeem F, Khan MR, Naz FU (2019) Comparison of mean pain scores for the patients with sub hepatic drainage to those without it after elective uncomplicated laparoscopic cholecystectomy. Pakistan J Med Sci 35(1):226
8. Sharma A, Mittal S (2016) Role of routine subhepatic abdominal drain placement following uncomplicated laparoscopic cholecystectomy: a prospective randomised study. J Clin Diagn Res JCDR 10(12):PC03
9. Usman M, Saleem K, Hayat S (2019) Laparoscopic cholecystectomy; early postoperative outcomes of laparoscopic cholecystectomy with and without subhepatic drain insertion. Prof Med J 26(4):563–566. https://doi.org/10.29309/TPMJ/2019.26.04.3364
10. El-Labban G, Hokkam E, El-Labban M, Saber A, Heissam K, El-Kammash S (2012) Laparoscopic elective cholecystectomy with and without drain: a controlled randomised trial. J Minim Access Surg 8(3):90–92. https://doi.org/10.4103/0972-9941.97591
11. Georgiou C, Demetriou N, Pallaris T, Theodosopoulos T, Katsouyanni K, Polymeneas G (2011) Is the routine use of drainage after elective laparoscopic cholecystectomy justified? A randomized trial. J Laparoendosc Adv Surg Tech A 21(2):119–123. https://doi.org/10.1089/lap.2010.0003
12. Sharma A, Gupta SN (2016) Drainage versus no drainage after Elective Laparoscopic Cholecystectomy. Kathmandu Univ Med J (KUMJ) 14(53):69–72
13. Rathi PK, Shaikh AR, Kella N, Behan RB (2011) Laparoscopic cholecystectomy without the use of drain in selected cases. J Liaquat Uni Med Heal Sci 10:117–120
14. Ruiz-Tovar J, Ortega I, Santos J et al (2012) Is there any indication for inserting a drain in elective laparoscopic cholecystectomy? Cir Esp 90(5):318–321
15. Picchio M, Lucarelli P, Di Filippo A, De Angelis F, Stipa F, Spaziani E (2014) Meta-analysis of drainage versus no drainage after laparoscopic cholecystectomy. JSLS J Soc Laparoendosc Surg. ;18(4)
16. Tzovaras G, Liakou P, Fafoulakis F, Baloyiannis I, Zacharoulis D, Hatzitheofilou C (2009) Is there a role for drain use in elective laparoscopic cholecystectomy? A controlled randomized trial. Am J Surg 197(6):759–763. https://doi.org/10.1016/j.amjsurg.2008.05.011
17. Gurer A, Dumlu EG, Dikili E, Kiyak G, Ozlem N (2013) Is a drain required after laparoscopic cholecystectomy? Eurasian J Med 45(3):181–184. https://doi.org/10.5152/eajm.2013.37
18. Bostanci MT, Saydam M, Kosmaz K, Tastan B, Bostanci EB, Akoglu M (2019) The effect on morbidity of the use of prophylactic abdominal drain following elective laparoscopic cholecystectomy. Pakistan J Med Sci 35(5):1306–1311. https://doi.org/10.12669/pjms.35.5.291
19. Nassar AHM, Ng HJ Risk identification and technical modifications reduce the incidence of post-cholecystectomy bile leakage: analysis of 5675 laparoscopic cholecystectomies. Langenbecks Arch Surg 2021 407(1): 213–223. https://doi.org/10.1007/s00423-021-02264-z
20. Griffiths EA, Hodson J, Vohra RS et al (2019) Utilisation of an operative difficulty grading scale for laparoscopic cholecystectomy. Surg Endosc 33(1):110–121. https://doi.org/10.1007/s00464-018-6281-2
21. Nassar AHM, Nassar MK, Gil IC, Ng HJ, Yehia AM (2020) One-session laparoscopic management of Mirizzi syndrome: feasible and safe in specialist units. *Surg Endosc*. Published online. https://doi.org/10.1007/s00464-020-07765-4
22. El Zanati H, Nassar AHM, Zino S, Katbeh T, Abdellatif A (2020) Apr-Jun Gall Bladder Empyema: Early Cholecystectomy during the Index Admission Improves Outcomes. JSLS. ; 24(2): e2020.00015. https://doi.org/10.4293/JSLS.2020.00015
23. Vafaei F, Kamely A, Nouri G, Teshnizi SH, Shokri A (2020) Effect of utilizing a drain on Shoulder Pain in Laparoscopic Cholecystectomy. A Randomized Clinical Trial. Indian J Surg Published Online. https://doi.org/10.1007/s12262-020-02474-7
24. Nassar AHM, Ng HJ, Ahmed Z et al (2020) Optimising the outcomes of index admission laparoscopic cholecystectomy and bile duct exploration for biliary emergencies: a service model. Surg Endosc. https://doi.org/10.1007/s00464-020-07900-1
25. Nassar AHM, Ng HJ, Katbeh T, Cannings E (2022) Conventional Surgical management of bile Duct stones. A service model and outcomes of 1318 laparoscopic explorations. Ann Surg 276(5):e493–e501. https://doi.org/10.1097/SLA.0000000000004680