Surgical Endoscopy (2020) 34:1868–1875
https://doi.org/10.1007/s00464-019-07268-x

DYNAMIC MANUSCRIPT

The impossible gallbladder: aspiration as an alternative to conversion

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Received: 5 December 2018 / Accepted: 12 November 2019 / Published online: 25 November 2019

Abstract

Background Laparoscopic cholecystectomy is the standard of care for symptomatic gallstone disease but when laparoscopic removal proves impossible the standard advice is to convert to open surgery. This jettisons the advantages of laparoscopy for a procedure which surgeons no longer perform routinely, so it may no longer be the safest practice. We hypothesised that gallbladder aspiration would be a safer alternative when laparoscopic removal is impossible.

Methods A retrospective analysis was performed of all laparoscopic cholecystectomies attempted under one surgeon's care over 19 years, and the outcomes of gallbladder aspiration were compared with the standard conversion-to-open procedure within the same institution.

Results Of 757 laparoscopic cholecystectomies attempted, 714 (94.3%) were successful, while 40 (5.3%) were impossible laparoscopically and underwent gallbladder aspiration. Interval cholecystectomy was later performed in 34/40 (85%). Only 3/757 (0.4%) were converted to open. No aspiration-related complications occurred and excessive bile leakage from the gallbladder was not observed. During this time 1209 laparoscopic cholecystectomies were attempted by other surgeons in the institution of which 55 (4.55%) were converted to open and 22 (40%) had procedure-associated complications. There was a significant difference in the mean (±SEM) post-operative hospital stay between laparoscopic gallbladder aspiration [3.12 (±0.558) days] and institutional conversion-to-open cholecystectomy [9.38 (±1.04) days] ($p < 0.001$), with attendant cost savings.

Conclusion Laparoscopic gallbladder aspiration is a safe alternative to conversion when inflammation makes cholecystectomy impossible laparoscopically, especially in the sickest patients and for surgeons with limited open surgery experience. This approach minimises morbidity and permits laparoscopic cholecystectomy in the majority after a suitable interval or referral of predicted difficult cases to specialist hepatobiliary centres.

Keywords Damage-control · Gallbladder aspiration · Conversion-to-open · Cholecystectomy

Cholecystectomy is the standard of care for symptomatic gallstone disease and the vast majority of operations can be safely completed laparoscopically with faster patient recovery, less pain and a shorter hospital stay than open surgery [1–3]. Identification of the contents of Calot's triangle and visualisation of the 'critical view of safety' are mandatory prior to clipping and dividing the cystic artery and duct and completion of the cholecystectomy laparoscopically [4]. Conventional wisdom, hitherto, has been that when dense inflammation obscures the normal anatomy the operation should be completed as an open cholecystectomy [5–9], hence the reported incidence of conversion-to-open cholecystectomy ranges from 3.9% to over 20% [6–10].

Laparoscopy provides many advantages over open surgery such as magnification, unrestricted illumination, enhanced working-space through gas insufflation and the ability of all operating room personnel to follow the progression of the procedure. These advantages are jettisoned for a procedure with no magnification and poorer illumination, where the first assistant struggles to see the key steps and

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s00464-019-07268-x) contains supplementary material, which is available to authorised users.

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nobody else can participate; and above all, it is a procedure in which the operating surgeon may have limited experience [7, 11–13]. While "convert to open" was prudent advice at the outset of the laparoscopic era, when all surgeons were experienced with open cholecystectomy, this approach may no longer be supportable in an era when newly qualified surgeons and trainees have had limited exposure to open cholecystectomy. Because the modern trainee has the opportunity to see few open cholecystectomies and to participate in even fewer [14–16], it seems imprudent to advise converting to an unfamiliar operation when the anatomy is obscured by inflammation or adhesions to adjacent organs, often in the oldest and sickest patients, and with more complicated cholecystitis.

Many surgeons aspirate the liquid contents of the gallbladder prior to conversion-to-open surgery or prior to placing an indwelling cholecystostomy drain [7]. Aspiration of the gallbladder with antibiotic instillation and the placement of a sub-hepatic drain were introduced as a damage-limitation option at the beginning of this experience, scheduling a second-look laparoscopic procedure for when the inflammatory process had subsided, usually after 6 weeks. This paper, spanning most of the laparoscopic era, reports on one unit's experience using this approach.

Patients and methods

Study design

This descriptive study identified all patients who underwent surgery for cholelithiasis in a single hospital from 1st November 1998 to 30th June 2017. Connolly Hospital, Dublin, is a Level III general hospital serving a mixed urban–rural catchment population of approximately 370,000. A retrospective analysis of all laparoscopic cholecystectomies attempted under the care of one surgeon was conducted and the outcomes of gallbladder aspiration for the impossible gallbladder were compared with the standard conversion-to-open procedure performed by other surgeons within the same institution and with the literature.

Unit policy for the management of the complications of cholelithiasis

The policy of this unit is to treat biliary colic with analgesics and arrange elective interval surgery. Acute cholecystitis is treated with intravenous antibiotics, scheduling laparoscopic cholecystectomy electively at an interval of at least 6 weeks after the inflammation has subsided. Failure to improve or clinical deterioration is treated by radiologically guided percutaneous cholecystostomy or emergency laparoscopic cholecystectomy, as dictated by the clinical circumstances. A pre-operative diagnosis of empyema, especially in patients with multiple co-morbidities, mandates percutaneous cholecystostomy by the interventional radiology team as the treatment of choice [17]. Patients with suspected choledocholithiasis undergo magnetic resonance imaging of the biliary tract (MRCP), and those with choledocholithiasis undergo endoscopic retrograde cholangiography (ERC) and duct clearance prior to laparoscopic cholecystectomy.

When laparoscopic cholecystectomy is attempted and the contents of Calot's triangle are found to be obscured by inflammation or the gallbladder is inseparable from the surrounding organs and dissection is considered unsafe or impossible, our policy is to perform laparoscopic gallbladder aspiration only, and to schedule laparoscopic cholecystectomy following patient recovery at least 6 weeks after the inflammation has subsided.

Description of the laparoscopic gallbladder aspiration procedure [video 1]

During laparoscopic cholecystectomy, if the 'critical view of safety' is obscured by inflammation, or the gallbladder is friable or adherent to an adjacent viscus and safe progression is considered impossible, further dissection ceases. Rather than converting to open surgery the contents of the gallbladder are aspirated using an 18G laparoscopic needle (DTR Medical, Swansea, UK) which is passed via a 5-mm port to puncture the gallbladder and aspirate its liquid contents. The gallbladder is punctured directly, rather than transhepatically, close to the fundus; all pus or bile is aspirated and sent for culture and the gallbladder decompressed. Once the drainable contents have been aspirated an antibiotic solution (gentamicin, 80 mg in 20 ml of normal saline 0.9%) is infused into the gallbladder. The puncture site is inspected to ensure that there is no bleeding and there is no undue leakage. A thin trickle of the gentamicin solution, sometimes slightly bile-stained, may be seen to emanate from the puncture site but this rapidly ceases as the puncture site closes.

A closed-suction drain is placed in the sub-hepatic space in all cases to drain any blood or bile leakage that might occur. When the dissection site has been satisfactorily reviewed, the abdomen is desufflated and the port sites closed. The abdominal drain is usually removed within 24 h or sooner if the patient is considered for day-case discharge. The patient is discharged on oral antibiotics, usually on the first post-operative day.

Stones impacted in the cystic duct are not addressed at the initial operation.

Post-aspiration management

All patients are scheduled for clinical review at least 6 weeks after discharge. At clinic review patient's symptoms are

re-assessed and laparoscopic cholecystectomy is planned if clinically indicated. Patients with multiple co-morbidities may be offered surveillance rather than immediate surgery. Patients who decline surgery will be followed up in the clinic. For those patients where difficulties are anticipated at subsequent surgery a referral to a specialist hepatobiliary (HPB) centre is considered.

At second laparoscopy circumstances dictate whether laparoscopic cholecystectomy is possible, whether conversion is the most appropriate option or whether further aspiration is indicated.

Study inclusion/exclusion criteria

All patients presenting for laparoscopic cholecystectomy under the care of the senior author were included in the study. Patients who presented with choledocholithiasis that failed duct clearance at ERC and who underwent open cholecystectomy for exploration of the common bile duct were excluded. Also excluded were patients who were referred for ultrasound-guided percutaneous cholecystostomy because they failed to settle on conservative therapy and were considered too sick for subsequent surgery [17]. Patients with a pre-operative diagnosis of gallbladder or bile duct malignancy were referred to a tertiary HPB centre, and thus did not appear in our study.

Management by other surgeons in the hospital

There were five other surgeons in the hospital who followed conventional guidelines and converted to open surgery when laparoscopic removal proved impossible. These patients' data were also retrospectively recruited and their demographics examined. Conversion-to-open rates, morbidity and length of stay were documented and compared with the gallbladder aspiration cohort.

Data collection and analysis

Patient demographics, date and type of procedure(s)—whether aspirated or converted, and the grade of the operating surgeon were retrieved from the theatre database. The duration in the operating department was retrieved, which included the time for administration, the duration of induction, and the operating time and the time of leaving the recovery unit. Finally, the duration of hospital stay was also retrieved from the hospital in-patient enquiry (HIPE) system. Given the case-mix between elective and emergency admissions and the absence of an emergency operating room, the post-operative rather than overall duration of stay was considered the most robust measure of the impact of the procedure. Since this is a public hospital, many patients' stay was prolonged for non-surgical reasons.

Once collected, data were cross-referenced and independently validated by three researchers. STROBE guidelines for reporting observational studies were adhered to [18]. Approval by our Institutional Ethics committee was sought formally, guidelines for data protection followed, and statistical analysis was performed on a de-identified dataset.

Data were analysed using SPSS version 21 (IBM Corporation) and the R statistical programming language and environment (R Foundation for Statistical Computing, Vienna, Austria). P values were all two-tailed, and the alpha level of significance was set at 0.05. The incidence and/or prevalence is shown as a percentage. The t test and χ^2 test were used for testing comparison. ANOVA was used to test multivariate analysis between groups; post hoc correlations were calculated with the Bonferroni and Dunnett's T3 test, and correction utilised for multiple comparisons.

Results

Patient demographics

During the study period 757 patients were admitted for laparoscopic cholecystectomy under the care of one surgeon. Of these, 714 (94.3%) underwent successful cholecystectomy on first attempt; 40 (5.3%) patients underwent 'damage-control' laparoscopic gallbladder aspiration, and three (0.4%) were converted to open cholecystectomy. A mean of 40.4 laparoscopic cholecystectomies and 2.16 'damage-control' gallbladder aspiration procedures were performed per annum.

Laparoscopic cholecystectomy

Of 714 patients who underwent laparoscopic cholecystectomy on first attempt, 553 (78%) were female, and 175 (25%) were performed as an emergency procedure. The mean age (± SD, range) at time of operation was 47.3 (± 16.0, 16–91) years (Table 1). Seventy-two patients (10%) were aged 70 years and older when undergoing laparoscopic cholecystectomy.

Laparoscopic gallbladder aspiration

Of 40 patients who had laparoscopic gallbladder aspiration, 31 (78%) underwent emergency procedures. Males were more likely to undergo 'damage-control' laparoscopy, performed in 17/178 (9.5%) males versus 23/576 (4.0%) females ($p = 0.002$).

The mean (± SD; range) age of patients undergoing laparoscopic gallbladder aspiration was older at 54.4 (± 16.6, 21–83) years than the laparoscopic cholecystectomy group at 47.34 (± 16.0, 16–91) years ($p = 0.003$). Ten of the 40

Table 1 Patient demographics

	Lap chole group ($n=714$)	Damage-control group ($n=40$)	Lap-to-open group ($n=3$)	Entire study cohort ($n=757$)
AGE: mean (±SD, range)	47.3 (±16.0, 16–91)	54.4 (±16.6, 21–83)	63.4 (NA, 45–76)	47.8 (±16.12, 16–91)
>70 (*n*, %)	72 (10.1%)	10 (25%)	1	83 (11%) ($p<0.05$)
Male	161 (22.5%)	17 (42.5%)	2	180 (23.8%)
Female	553 (77.5%)	23 (57.5%)	1	577 (76.2%) ($p<0.001$)
Emergency	175 (24.5%)	31 (77.5%)	2	208 (27.5%)
Elective	539 (75.5%)	9 (22.5%)	1	549 (72.5%) ($p<0.001$)

(25%) gallbladder aspiration patients were over 70 years of age compared with just 72/714 (10%) laparoscopic cholecystectomy patients ($p=0.013$).

Laparoscopic converted to open cholecystectomy

Only three patients aged 46, 70, and 76, two of whom were male, were converted to open cholecystectomy at the initial laparoscopy attempt. The latter two patients underwent conversion-to-open as an emergency procedure early in this study (Table 1).

Further procedures after gallbladder aspiration

Of the 40 patients who had gallbladder aspiration, 35 (88%) subsequently underwent attempted further operative intervention; 28 (70%) underwent successful laparoscopic cholecystectomy, and 3 (7.5%) required conversion-to-open procedure on the second attempt at laparoscopic cholecystectomy, while 3 (7.5%) patients had a second laparoscopic gallbladder aspiration. Of these latter three, one had a subsequent successful laparoscopic cholecystectomy, a second patient underwent conversion-to-open on the third admission, and a third patient opted for conservative management. One patient underwent open cholecystectomy in another institution. Of the original 40 patients, six (15%) were treated expectantly because of co-morbidities or patient preference.

Duration in the operating theatre

The mean ± SD (range) duration in the operation theatre (including administration and induction) for the laparoscopic gallbladder aspirations was 108 ± 38 (45–135) min, compared with 135 ± 38 (50–320) min for normal laparoscopic cholecystectomy ($p=0.19$).

Duration of hospital stay

Pre-operative duration of hospital stay *Laparoscopic cholecystectomy cohort* The median (range) pre-operative duration of stay for all laparoscopic cholecystectomy patients ($n=714$) was 0 (0–33) day. The median (range) pre-operative duration of stay for emergency laparoscopic cholecystectomy patients ($n=175$) was 3 (1–14) days and was greater than for the 539 elective patients which was 0 (0–33) day ($p=<0.01$).

Gallbladder aspiration cohort For the gallbladder aspiration cohort (n=40; elective and emergency), the median (range) pre-operative duration of stay was 2 (0–32) days. The median (range) pre-operative duration of stay for the elective damage-control cohort ($n=9$) was 0 (0–2) day, while the median pre-operative stay for the emergency aspiration cohort ($n=31$) was 3 (0–32) days ($p=0.668$).

Post-operative duration of hospital stay *Laparoscopic cholecystectomy cohort* The median (range) duration of post-operative stay for all laparoscopic cholecystectomies ($n=714$) was 0 (0–105) day reflecting a shift in policy toward day-case elective surgery. Same-day discharge was achieved in 207 of 714 (29%) laparoscopic cholecystectomies; a further 193 (27%) were discharged after overnight observation, and a further 150 (21%) were discharged between 24 and 48 h. The remaining 164 (23%) had a post-operative inpatient stay greater than 48 h of which 17 (2.4%) had a stay greater than 7 days (Table 2).

Of the 539 elective laparoscopic cholecystectomies, 207/539 (38%) were day-case procedures and a further 193/539 (36%) were discharged within 24 h. The mean ± SD (range) post-operative duration of stay for elective laparoscopic cholecystectomy was 1.3 ± 4.6 (0–105) days.

Of the 175 emergency laparoscopic cholecystectomy procedures, 27/175 (15%) patients were discharged within 24 h post-operatively (of which three were discharged on the same day) and a further 56/175 (32%) were discharged

Table 2 Duration of hospital stay between different groups

Discharge time interval	Damage-control procedure ($n=40$)	Laparoscopic cholecystectomy ($n=714$)
Same-day discharge	4 (10%)	207 (29%)
Discharged within 24 h	12 (30%)	193 (27%)
Discharged between 24 and 48 h	8 (20%)	150 (21%)
Post-operative in-patient stay > 48 h	16 (40%)	164 (23%)
In-patient stay > 7 days	8 (20%)	17 (2.4%)

There was no difference between the mean pre-operative duration of stay of the emergency damage-control cohort and the emergency laparoscopic cholecystectomy patients ($p=0.67$)

between 24 and 48 h. The median (range) post-operative duration of stay for emergency laparoscopic cholecystectomy was 3 (0–87) days.

Laparoscopic gallbladder aspiration cohort Of the 40 gallbladder aspiration procedures, four (10%) were discharged as day-case procedures; a further 12 (30%) were discharged within 24 h, and a further 8 (20%) between 24 and 48 h. Therefore, 24/40 (60%) were discharged within 48 h. The median (range) duration of stay for the index procedure for the laparoscopic gallbladder aspiration patients was 2 (0–24) days.

Of the 40 gallbladder aspiration patients, 31 (78%) underwent emergency procedures, which was reflected in the post-operative mean (range) duration of stay of 5 (0–24) days. The mean (range) post-operative duration of stay for the elective damage-control cohort patients was 2 (0–10) days.

The combined/overall median (range) duration of time spent in hospital (inclusive of the index admission and re-admission days) for the aspiration cohort was 5.5 (0–24) days.

Post-operative duration of stay after emergency laparoscopic gallbladder aspiration The mean post-operative length of stay for emergency gallbladder aspiration (5 days) was the same as the emergency laparoscopic cholecystectomy cohort (5 vs. 3.6 days; $p=0.47$).

Cholecystectomy data from within the institution

There were 1209 laparoscopic cholecystectomies performed by other surgeons within the institution during this period, of which 55 (4.55%) were converted to open when laparoscopic removal was considered unsafe or impossible.

Duration of post-operative stay

The mean (±SEM) post-operative length of stay for conversion-to-open procedure was 9.38 (± 1.04) days. The mean length of stay for laparoscopic gallbladder aspiration was significantly shorter than laparoscopic cholecystectomy converted to open ($p<0.001$). Indeed, when the post-operative length of stay for the index and interval admissions were summated for patients undergoing gallbladder aspiration and subsequent 'second-look' laparoscopic cholecystectomy, the mean (± SEM) post-operative length of stay was 3.94 (± 0.76) days, which was significantly shorter than conversion-to-open ($p=0.003$) but did not differ statistically from uncomplicated laparoscopic cholecystectomy ($p=0.182$).

Complications

Complications of laparoscopic cholecystectomy

Of the 714 patients who underwent successful laparoscopic cholecystectomy, 17 (2.4%) patients had post-operative stay of greater than 7 days. Of these, nine had a prolonged post-operative stay due to an acute setting (two admitted with acute pancreatitis secondary to cholecystitis), or co-morbidities, and eight patients developed post-operative complications, such as lower respiratory tract infection (three patients), and one each with acute pancreatitis complicated by sepsis, urinary retention requiring urologic intervention, post-operative hematoma, and a post-operative cardiac event. Two patients required admission to the intensive care unit (ICU), one who developed post-operative ileus and acute respiratory distress, and the other patient due to extensive co-morbidities. There were one bile duct injury, repaired primarily, and one mortality from multiple organ failure secondary to sepsis and other morbidities at 105 days.

Complications of gallbladder aspiration

Of the 40 patients who underwent the damage-control aspiration procedure, 32 (80%) patients had a post-operative hospital stay of 7 days or less. The duration of stay was reflective of their acute presentation because the majority of these underwent damage-control procedure in an acute setting (31/40, 78%). One patient had a complication secondary to the presence of co-morbidities, which was managed successfully. Otherwise, no complications relating to the procedure were recorded in this subgroup. In particular, excessive bile leakage was not observed in this series.

Eight of the 40 patients (20%) had a stay of greater than 7 days. Of those, three had an extended hospital stay complicated by the presence of co-morbidities. A further four had complications directly related to their post-operative recovery; two with urinary retention with acute kidney injury and one each with a cardiac event and a pleural effusion. One patient had an extended hospital stay due to acute pancreatitis, complicated by sepsis and acute kidney injury requiring 5 days of ITU care; this patient subsequently underwent successful cholecystectomy (laparoscopic converted to open procedure).

Complications of institutional conversion-to-open surgery

Of the 55 patients who underwent conversion-to-open cholecystectomy in the institution, 22 (40%) had procedure-associated complications. Of those, five patients developed lower respiratory tract infection, three had wound infection, two had intra-abdominal collection, a further two had common bile duct injury requiring repair, and the following complications were documented in one patient each: wound dehiscence, incisional hernia, haematuria, ventricular fibrillation, urinary tract infection, and sepsis. In four cases, the nature of post-operative complications was not specified.

Experience of operating surgeon

There is a strong emphasis on surgical training in our surgical firm, reflected in the fact that 522/714 (73%) of laparoscopic cholecystectomies and 30/40 (75%) of laparoscopic gallbladder aspiration procedures were recorded as having a surgical trainee as the primary operating surgeon overseen by a consultant surgeon. Conversely, all 3/3 laparoscopic conversion-to-open cholecystectomies were performed by the consultant surgeon, assisted by a trainee. Of the 55 conversion-to-open operations performed by other surgeons in the institution, 48 (87%) were performed by a consultant and seven performed by a trainee assisted by a consultant, or one open cholecystectomy performed by a senior trainee every 2 years.

Discussion

This study found that when the gallbladder is impossible to remove laparoscopically because Calot's triangle is obscured by inflammation or the gallbladder is adherent to nearby organs, the simple expedient of gallbladder aspiration is a safe and effective alternative to conversion. It satisfies the time-honoured principle of "ubi pus, ibi evacua" and acts as a bridge to safer surgery when inflammation has subsided. Almost all cholecystectomies can then be performed laparoscopically, with reduced morbidity and a shorter hospital stay, or the patient can be referred to a hepatobiliary (HPB) unit if difficulty is anticipated.

At the outset of the laparoscopic era, surgeons were skilled in open cholecystectomy and were encouraged to revert to open surgery if laparoscopic cholecystectomy was deemed unsafe [5, 6, 9]. Now surgeons skilled at laparoscopic cholecystectomy may have limited experience in open cholecystectomy. Sirinek et al. reported that surgeons in training in the US performed on average 85 laparoscopic cholecystectomies but only 3.6 open cholecystectomies during their training over the past decade [14]. A recent publication from the UK and Ireland [15] reported that just 21.8% of elective laparoscopic cholecystectomies were performed by a trainee, and only 3.3% of operations were converted to open. This suggests that the number of open procedures performed by trainees was very small [14–16]. As trainees have little opportunity to perform open cholecystectomy it seems essential to promote a safer alternative when laparoscopic cholecystectomy proves impossible.

The Tokyo guidelines advise that when laparoscopic cholecystectomy is impossible surgeons should perform conversion-to-open, fundus-first cholecystectomy, partial cholecystectomy or cholecystostomy as the bailout options when difficulty is encountered [19–23], but each has its shortcomings. Fundus-first and partial cholecystectomies are very challenging even for an experienced surgeon. Complications were reported in 13% of patients after cholecystostomy including bile leakage, tube dislodgement, and sub-hepatic collection, with two mortalities [24]. A meta-analysis of subtotal cholecystectomy for patients with dense inflammation in Calot's triangle reported more frequent incidence of bile leakage and sub-hepatic collections when compared to total cholecystectomy [25].

Conversion-to-open surgery comes at the cost of increased duration of surgery, prolonged hospital stay and the potential for complications [26–29]. The rates of conversion-to-open vary to over 15% and are greatest in patients operated on as an emergency [15, 30]. A study of the registry of all patients (58,697) undergoing cholecystectomy in Nordrhein Westphalia during the period 2010–2014 reported that 77.3% had evidence of inflammation of which 26.6% had empyema [30]. When there was inflammation without empyema, the conversion rate was 5.8% with a mortality rate of 1.2% (or 1 in 83 patients), but when there was empyema the conversion rate increased to 15.3% with a mortality rate of 2.8% (or 1 in 36 patients). These mortality rates were described by the authors as "alarming" [30]. The overall mortality rate when there was inflammation was 1.66% (or 1 in 66 patients undergoing surgery) which is almost 10 times greater than mortality rates reported from a region where cholecystectomy is performed mostly electively where the conversion rate is only 3.3% and the mortality rate is only 0.2% [15]. It is difficult to escape the inference that the

mortality rate was directly related to the conversion-to-open rate and its inherent complications.

The concept of 'damage-control' surgery arose from military experience with exsanguinating haemorrhage [31, 32]. Aspirating the gallbladder in this context can be seen as a damage-control procedure with little risk: bile leakage at the needle drainage site has not been a problem as the inflamed gallbladder wall is thickened which helps to seal the wall, and in all cases the sub-hepatic vacuum drain was removed the next morning. The patient's physiologic status can be improved before interval laparoscopic surgery or referral to a specialist service. Alternatively, surgery may be deferred indefinitely in patients with co-morbidities who remain asymptomatic. Our outcomes validate this approach because no patient in the aspiration cohort suffered a major complication or mortality.

Undoubtedly, there is a role for conversion-to-open surgery, but when this should be performed and by whom deserves greater consideration [12]. Trainee surgeons should be familiar with the entire range of options for patients presenting with gallstone disease depending on the presentation and the status of the patient with emphasis on patient safety. When Calot's triangle is obscured during dissection, or in units where the percutaneous options are unavailable, the surgeon should be experienced in the simplest and safest of operative alternatives. The majority of laparoscopic cholecystectomies in our study (73%) were performed by trainees, as were the majority of damage-control laparoscopic gallbladder aspirations (75%). Trainees must be reassured that simply aspirating the gallbladder is not "an admission of failure" but rather a damage-control option which will allow a laparoscopic cholecystectomy to be performed safely when the inflammation has subsided.

In conclusion, while the vast majority of cholecystectomies can be safely completed laparoscopically, some will prove impossible—especially if unanticipated inflammation obscures the critical view of safety. The currently advocated default options are not straightforward, especially for surgeons with limited experience, and are associated with significant morbidity. We advocate the simple expedient of gallbladder aspiration which avoids the need for conversion and its attendant physiological costs. It provides a bridge to a later laparoscopic surgery when the inflammation has subsided or an opportunity to refer to an HPB centre if future difficulties are anticipated.

Authors contributions Due to a long time span of the study and frequent rotations of surgical trainees, the study was carried out over several years, involving several authors who performed data collection and drafting of the manuscript at various stages of this study. Their contribution is acknowledged by their authorship (BDD, PPH, TNT, TA, MPM, EG). NK carried out the literature search, data collection and analysis, and wrote the paper. GAB gave statistical advice, supervised data analysis, contributed to writing the paper, and commented on the manuscript drafts. DVW carried out the literature search and contributed to data analysis and to writing the section on Methodology. TNW was the consultant in charge of the unit, had the original idea for the paper, formulated the study protocol, and supervised the writing of the paper. All the authors were asked to offer advice and comments on various drafts of the paper. The final version of the manuscript was revised by all the authors prior to its submission.

Funding No funding was sought nor obtained for the conduct of this study.

Compliance with ethical standards

Disclosures The authors (N Kharytaniuk, GA Bass, BD Dumbrava, PP Healy, D Viani-Walsh, TN Tiwary, T Abassi, MP Murphy, E Griffin, TN Walsh) declare to have no competing interests.

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