Title: Is cystic artery lymph node excision during laparoscopic cholecystectomy a marker of technique?

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ABSTRACT

Background: In order to minimize bile duct injury, experts suggest dissection during laparoscopic cholecystectomy (LC) should be performed lateral the lymph node (LN). This study aims to determine whether the frequency of excision of the LN is related to patient factors, disease severity or surgical difficulty.

Methods: All LC performed or supervised by one surgeon were identified from a prospective database. Presence of the LN was retrospectively determined by reviewing the gallbladder histology report.

Results: The LN was identified in 10.4% of 1332 cholecystectomies. American Society of Anaesthesiologists class 3 was associated with a lower rate of LN excision compared to class 1 (OR 0.36; $p = 0.049$) as was the presence of a senior surgical trainee (OR 0.18; $p < 0.001$). Rate of LN excision was independent of patient demographic and clinical characteristics, including indication for cholecystectomy, conversion to open, gallbladder perforation, cholangiography, bile duct exploration and overall surgical difficulty.

Conclusions: The frequency with which the LN is excised during LC by the one surgeon is independent of the majority of clinical and surgical factors and may represent a surrogate marker of surgical technique. Whether this is related to the rate of bile duct injury remains to be determined.

INTRODUCTION

Major bile duct injury (BDI) during laparoscopic cholecystectomy (LC) is a rare event (0.47% of cholecystectomies¹). Surgeons utilise anatomical land marks, anatomical exposure and intraoperative imaging to avoid BDI. A review of population-based studies assessing the relationship between IOC and major BDI highlighted that all studies identified IOC use as a likely marker for disease severity and/or surgical technique.¹ Retrospective analysis of the role of IOC is therefore hampered by the lack of administrative codes for disease severity and surgical technique. Recent expert opinion² recommends surgeons dissect the hepatobiliary triangle lateral to the cystic artery lymph node (LN) in order to minimize the rate of BDI.

We postulate a surgeon's rate of cystic artery LN excision during LC may therefore represent a marker of surgical technique. The closer the surgeon dissects to the gallbladder (and thus away from the bile duct), the less frequently the LN would be excised. Because LC is typically performed for a benign condition, excision of the node overlying the cystic artery is not medically necessary i.e. it is incidental.

If a surgeon's rate of LN excision can be shown to be independent of patient factors, indication for surgery, disease severity and operative difficulty, it could represent a marker of surgical technique. This would make the ratio a useful research tool. In addition, a given surgeon's LN excision ratio could be used a quality assurance measure for laparoscopic

cholecystectomy as the frequently used measures (bile duct injury or 30 day readmission) are inadequate.

The lead author has prospectively maintained a comprehensive intraoperative grading system for disease severity and technical difficulty as proposed by Nasser et al. over 20 years ago³ but has remained largely unknown⁴. Analysis of this database was performed to determine whether the frequency of lymph node excision during laparoscopic cholecystectomy is a marker of surgical technique, similar (but inverse) to the concept of number of nodes excised during colorectal cancer surgery⁵ or the rate of inadvertent parathyroidectomy during thyroidectomy.⁶

The limitations of the dataset are such that it cannot determine what the acceptable frequency of LN excision should be or the relationship between the rate of LN excision and bile duct injury.

MATERIALS AND METHODS

This prospective clinical case series includes all cholecystectomies commenced laparoscopically in Queensland, Australia, between June 2006 and September 2016 by the lead author (APW) or a surgical trainee under his supervision. At commencement of the study, the lead author (APW) was beyond the 30 LC learning curve (171 independent LC out of 431 performed during surgical training).⁷ Permission for the study was obtained from Metro South Health Human Research Ethics Committee and Logan Hospital Site Specific Authority. The presence of the LN was retrospectively determined by reviewing the

histology report of the resected specimen. Specimens were not re-reviewed for the purposes of this study. The pathologist was not requested to specifically look for the LN. The unstructured non-synoptic pathology report was always validated by a consultant pathologist. Recognition of the LN in the pathological specimen was taken to be synonymous with LN excision.

A standard 4 port American position laparoscopic cholecystectomy was routinely performed at one of four general peri-urban hospitals.⁸

Demographic information collected included age, sex, weight, height, and body mass index. Clinical characteristics recorded included the date of surgery, previous supra-umbilical laparotomy, previous Endoscopic Retrograde Cholangio Pancreatography (ERCP), American Society of Anaesthesiologists (ASA) class, type of gallstone history (typical biliary colic/consistent with biliary colic/atypical/asymptomatic/acute) and level of surgical trainee. Following each LC the lead author (APW) prospectively recorded intraoperative features including: gallbladder perforation, spillage of gallstones, attempted IOC, drain placement, conversion to open, bile duct exploration, and all components of the Nassar Classification of disease severity³.

In 1995 Nassar and colleagues published an intraoperative grading system for disease severity and technical difficulty. The four aspects covered overall difficulty, gallbladder appearance, cystic pedicle appearance, and adhesions. The details of the categories are listed in Supporting Tables 2, 3, 4. Operative difficulty was determined from a composite

score of disease severity. Whether the LN was identified intraoperatively was not prospectively recorded.

Summary statistics are presented as frequency (percentage) for categorical variables. The association between demographic and clinical patient characteristics and LN excision was investigated using logistic regression analysis. First univariable analyses were undertaken, then multivariable analyses with patient age and sex, level of surgical trainee, and year included as covariables. Effect estimates are presented as odds ratios (OR) with 95% confidence intervals (95% CI). Analysis was conducted using Stata statistical software v13.1 (StataCorp, College Station, TX, USA).

RESULTS

Between June 2006 and September 2016, 1332 cholecystectomies were commenced laparoscopically by the lead author or a doctor under his supervision. The LN was identified by the pathologist in 138 (10.4%) specimens.

Patient and operation characteristics

Demographic characteristics are presented in Supporting Table1. 77.3% of patients were women. Only 13.8% of patients had a normal Body Mass Index ($18 - 25\text{kg/m}^2$). 71.5% of cholecystectomies were graded easy or normal. Three patients had a cholecysto-choledochal fistula. One patient with gangrenous cholecystitis was diagnosed with incidental gallbladder carcinoma - LN was not identified.

In logistic regression models, ASA class 3 was consistently associated with a lower rate of LN excision compared to ASA 1 (OR 0.36; $p = 0.049$ on multivariable analysis). There was an inconsistent association between year of surgery and LN excision. The lower rate of LN excision on univariable analysis during 2015 - 2016 compared to 2006 - 2008 (OR 0.43; $p = 0.015$) disappeared on multivariable analysis, while the higher rate of excision during 2009 – 2010 remained significant on multivariable analysis (OR 3.51; $p < 0.001$).

Type of biliary history

LN excision was not associated with whether the LC was for typical biliary symptoms, symptoms consistent with biliary colic, atypical symptoms, absence of symptoms or acutely for pancreatitis, choledocholithiasis or cholecystitis as demonstrated in Supporting Table 1.

Intraoperative features

Lower rate of LN excision was observed when a senior surgical trainee was present during the surgery (OR 0.31; $p < 0.001$ univariable analysis) compared to presence of a non-trainee. The magnitude of this effect increased on multivariable analysis (OR 0.18; $p < 0.001$). Details are presented in Table 1. LN excision was independent of the overall level of difficulty as presented in Table 2. During this time the lead author (APW) commenced 14 cholecystectomies as an open procedure (e.g. imaging suspicion of carcinoma, trauma laparotomy, ERCP duodenal perforation or unable to achieve laparoscopy) – the LN was identified in 7.1% (1/14; OR 1.46; $p = 0.718$).

Disease severity

Nassar grade gallbladder appearance (Supporting Table 2) did not affect the rate of LN excision. Simple adhesions to the gallbladder (Supporting Table 3) were associated with a higher rate of LN excision on univariable (OR 1.47; $p = 0.054$) and multivariable analysis (OR 1.50; $p = 0.048$). A fibrosed cystic pedicle was possibly associated with a lower rate of LN excision (univariable OR 0.43; $p = 0.073$) but this effect disappeared on multivariable analysis (OR 0.56; $p = 0.233$) as shown in Supporting Table 4.

Hospital differences

The LN was identified in 2 patients who underwent LC at one of three smaller hospitals (2.6%) - almost all 78 LC were performed by the lead author. The LN was identified in 136 (10.8%) of the remaining 1254 LC which were performed at a teaching hospital. The difference in the rate of LN excision was significant (OR 0.21; $p = 0.019$).

Biliary complications

Of the 11 patients with a bile leak, one had the LN excised (9.09%; OR 1.14; $p = 0.900$). The site of bile leak was unknown in 6 patients (5 had a drain placed during cholecystectomy and 1 underwent Computed Tomography guided percutaneous drainage). 5 patients underwent re-laparoscopy with the location of bile leak being at the choledochotomy closure (3), gallbladder fossa (1) and liver trauma away from gallbladder fossa (1). There were no inadvertent biliary tree excisions - one patient underwent hepaticojejunostomy for an intraoperatively recognised Type 4 Mirizzi Syndrome.

DISCUSSION

The rate of cystic artery lymph node excision during laparoscopic cholecystectomy was independent of the majority of patient factors and degree of surgical difficulty. The relatively constant rate with which the LN was excised (10.4% of 1332 consecutive cholecystectomies) suggests a given surgeon (perhaps subconsciously⁹) commences dissection of the hepatobiliary triangle in the same location every time irrespective of the state of the gallbladder. The rate of LN excision may thus represent a simple yet relatively robust marker of one component of surgical technique.

One part of the standardized method for LC proposed by Connor et al calls for dissection “close to the gallbladder and lateral to the cystic node”, in order to reduce the prevalence of bile duct injury.² One of the supporting references cited¹⁰ does not specifically mention the sentinel lymph node of the gallbladder (Lund’s or Mascagni’s lymph node) while the other suggests the surgeon coagulates and divides “several small vessels and lymphatics bridging the gap between the cystic duct and artery”¹¹. We were unable to find other literature to support this expert recommendation.

It is currently unreported under what circumstances surgeons dissect medial or lateral to the LN (which is not always visible as it is deep to the peritoneum). Some may dissect medial to the LN (and thus closer to the bile duct) as this is prior to cystic artery bifurcation and may thus facilitate quicker surgery. Under other circumstances e.g. acute cholecystitis with Mirizzi 1, the surgeon may choose to commence dissection as lateral as possible thus dividing multiple cystic artery branches and not excising the lymph node.

If in one surgeon's practice the cystic artery lymph node yield is the same irrespective of the indication for surgery and appearance of the gallbladder (e.g. elective, gangrene, empyema, shrunken fibrotic gallbladder, bile duct exploration), it suggests the lymph node ratio is a marker of technique i.e. how the surgeon approaches dissection of the hepatobiliary triangle rather than a marker of gallbladder disease severity i.e. what the gallbladder looks like. If the lymph node ratio was to vary depending on the pathological state of the gallbladder it may indicate the original recommendation is too simplistic or that the author's surgical technique needs to improve. It is this distinction the study aims to achieve.

On multivariable analysis only three out of 19 variables were associated with a lower rate of LN excision (presence of a senior surgical trainee, ASA class 3 and spillage of gallstones). Only one factor increased the rate of LN excision (presence of simple adhesions to the gallbladder). Three of these factors relate in some way to surgical technique: cholecystectomy on an ASA 3 or 4 patient would almost always be performed by the lead author and not the trainee (irrespective of seniority), a senior trainee is more likely to have better manual dexterity and follow direction; division of omental adhesions to the gallbladder may result in wider opening the gallbladder peritoneum resulting in more medial dissection. Gallbladder perforation was associated with a lower rate of LN excision possibly because a disrupted gallbladder may make pathological examination more difficult. Because in this study the rate of LN excision was not independent of every variable studied, it cannot be considered a perfect marker of surgical technique.

Publications referring to the cystic artery lymph node are limited and nonspecific.^{12,13} Some make no mention of the node^{10,14} but are incorrectly cited as if they did^{2,15}. In a 2003 opinion article, Kunasani and Kohli proposed the LN “be used as a reliable medial endpoint of the dissection” of the hepatobiliary triangle.¹⁶ Mistakenly, Timoney et al in 2014 claim to introduce the LN as a “novel landmark” to improve LC safety.¹⁷

Typically, the cystic artery travels through the hepatobiliary triangle (82% in a recent literature review¹⁸). The superficial branch runs subserosally on the left of the gallbladder, while the deep branch runs in the gallbladder fossa before reanastomosing with the superficial branch.¹⁸ Skandalakis states “lymph node of Calot (*sic*) usually lies just superficial to the position of the cystic artery in the cystic triangle, and can be a good guide to finding and ligating it....node lies in the angle formed by the cystic and common hepatic ducts”.¹⁹ Whether the cystic artery lymph node is uniformly present is unknown. Qamar et al macroscopically intraoperatively identified the LN in 53% of LC (160/300).¹⁵ The node was presumed absent in the remainder. The node was always on top of the cystic artery (i.e. superficial) – in 59% it was anterior and in 41% behind the artery.¹⁵

The strengths of the study are its prospective nature, large number of consecutive patients operated on by the one surgeon and the prospective recording of comprehensive Nassar disease severity and technical difficulty. There is no selection bias because open, laparoscopic converted to open and laparoscopic cholecystectomies performed by the one surgeon all had broadly similar rates of LN excision (7.1%, 5.3%, 10.4% respectively).

This study has significant limitations: Nassar classification has not been independently validated; pathologists may vary in their pursuit of this clinically irrelevant LN in a benign specimen; and the lead author's database does not specify who (surgeon or trainee) dissected the hepatobiliary triangle. Nassar et al reported 78.5%³ of their laparoscopic cholecystectomies being "easy or normal" – not dissimilar to the 71.5% in this series. The pathologist's attentiveness to the presence of the LN is likely to be uniformly distributed throughout the study period, and consequently recorder bias is unlikely to be present. The last issue is likely to be skewed to the more difficult operations having been performed by the lead author. Importantly, when the cholecystectomy was performed by the trainee, it was under the instruction and supervision of the lead author.

Given the rarity of bile duct injury, our sample size is too small to determine the relationship between bile duct injury and rate of lymph node excision – this was not our intention. Bile leaks are reported for completeness but are mostly not relevant to the discussion as the majority were likely from the gallbladder fossa and three were at the choledochotomy closure site following laparoscopic choledochotomy and exploration. The LN was identified in 9.1% of patients with a bile leak which is similar to the overall rate of LN excision in this study.

Prospectively confirming the relationship between LN yield and surgical technique rather than disease severity will be difficult due to the Hawthorne effect.²⁰ The observer effect refers to the situation where an individual changes their normal practice in response to their awareness of being observed i.e. during a prospective study surgeons may actively look for the lymph node and leave it behind. Therefore a crucial component of confirming whether a

given surgeon's LN ratio is a marker of surgical technique would be to demonstrate that the ratio varies between surgeons. Just as there is an inadvertent rate of parathyroidectomy during thyroidectomy⁶, there may be an unavoidable rate of cystic artery LN excision during laparoscopic cholecystectomy. This rate remains to be established and may be lower or greater than the 10.4% observed in this study. The results of this study are not definitive and will need to be confirmed by other surgeons. Subsequent studies will need to determine whether there is inter-surgeon variability. A much larger database is required to assess the relationship between a surgeon's rate of bile duct injury and lymph node excision.

CONCLUSIONS

Results from a long term prospective surgical database suggest the rate of cystic artery lymph node excision during laparoscopic cholecystectomy is relatively constant and may be a marker of surgical technique rather than surgical difficulty or disease severity. A much larger sample size is required to establish whether the rate of cystic artery lymph node excision is related to frequency of bile duct injury. Confirmation of our findings would justify expert opinion that when dissecting the gallbladder the surgeon needs to avoid excessive medial dissection so as not to risk the bile duct.

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DISCLOSURE STATEMENT

This paper has not been submitted before or in parallel and has not been presented.

APW developed the idea for the study, collected data and prepared the initial manuscript.

SM and APW performed literature review. RW performed the statistical analysis. All authors contributed to manuscript revision, rewrites and approved the final version.

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AP Wysocki, S Murphy and RS Ware have nothing to declare and have no financial disclosures.

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Tables

	Frequency	Proportion LN present % (n)	Univariable Odds Ratio LN present (95% CI); P value	Multivariable Odds Ratio LN present (95% CI); P value
Completed laparoscopically	1313	10.43% (137)	1.00 (Reference)	1.00 (Reference)
Converted to open	19	5.26% (1)	0.48 (0.06 – 3.60); 0.743	0.56 (0.07 – 4.31); 0.579
GB not perforated	819	10.99% (90)	1.00 (Reference)	1.00 (Reference)
GB perforated	513	9.36% (48)	0.84 (0.58 – 1.21); 0.342	0.83 (0.57 – 1.22); 0.339
No stone spillage	1123	11.04% (124)	1.00 (Reference)	1.00 (Reference)
Stone spillage	209	6.70% (14)	0.58 (0.33 – 1.03); 0.061	0.55 (0.30 – 0.99); 0.047
No drain	1215	10.37% (126)	1.00 (Reference)	1.00 (Reference)
Drain placed	117	10.26% (12)	0.99 (0.53 – 1.85); 0.969	1.09 (0.56 – 2.11); 0.805
IOC not attempted	795	9.81% (78)	1.00 (Reference)	1.00 (Reference)
IOC attempted	537	11.17% (60)	1.16 (0.81 – 1.65); 0.424	1.07 (0.74 – 1.54); 0.712
No Bile Duct Exploration	1250	10.40% (130)	1.00 (Reference)	1.00 (Reference)
Bile Duct Exploration	82	9.76% (8)	0.93 (0.44 – 1.98); 0.853	0.77 (0.36 – 1.67); 0.514
Non-trainee	380	13.16% (50)	1.11 (0.76 – 1.63); 0.583	0.74 (0.45 – 1.21); 0.233
Junior trainee	626	11.98% (75)	1.00 (Reference)	1.00 (Reference)
Senior trainee	326	3.99% (13)	0.31 (0.17 – 0.56); <0.001	0.18 (0.08 – 0.38); <0.001

Table 1. Clinical factors and cystic artery Lymph Node excision

LN: Lymph Node; GB: Gallbladder; IOC: Intra Operative Cholangiogram; CI: Confidence Interval

	Frequency	Proportion LN present % (n)	Univariable Odds Ratio LN present (95% CI); P value	Multivariable Odds Ratio LN present (95% CI); P value
I: easy	265	9.06% (24)	1.21 (0.75 – 1.96); 0.440	1.06 (0.64 – 1.77); 0.810
II: normal	688	10.76% (74)	1.00 (Reference)	1.00 (Reference)
III: difficult	352	11.08% (39)	1.25 (0.73 – 2.14); 0.412	1.21 (0.69 – 2.14); 0.502
IV: very hard	27	3.70% (1)	0.39 (0.05 – 2.97); 0.361	0.35 (0.04 – 2.78); 0.321

Table 2. Nassar grade overall difficulty and cystic artery Lymph Node excision

LN: Lymph Node; N/A: Not Applicable as no LN excision in the category; CI: Confidence Interval

Figure Legends

N/A

List of Supporting Information

Tables x4

Figures

N/A

Supporting Information

	Frequency	Proportion LN present % (n)	Univariable Odds Ratio LN present (95% CI); P value	Multivariable Odds Ratio LN present (95% CI); P value
Overall	1332	10.36 % (138)		
Female	1030	10.10% (104)	1.00 (Reference)	1.00 (Reference)
Male	302	11.26% (34)	1.13 (0.75 – 1.70); 0.561	1.24 (0.80 – 1.91); 0.803
Age <30 years	303	13.20% (40)	1.24 (0.79 – 1.95); 0.346	1.35 (0.85 – 2.14); 0.200
Age 30 – 45 years	436	10.78% (47)	1.00 (Reference)	1.00 (Reference)
Age 45 – 60 years	334	8.38% (28)	0.76 (0.47 – 1.24); 0.275	0.77 (0.47 – 1.27); 0.300
Age >60 years	259	8.88% (23)	0.80 (0.48 – 1.36); 0.416	0.73 (0.42 – 1.25); 0.252
Typical biliary colic	508	10.04% (51)	1.00 (Reference)	1.00 (Reference)
Consistent with biliary colic	437	9.84% (43)	0.98 (0.64 – 1.50); 0.919	1.03 (0.66 – 1.60); 0.902
Acute cholecystitis	250	10.80% (27)	1.08 (0.66 – 1.78); 0.746	0.93 (0.56 – 1.54); 0.783
Acute pancreatitis	70	10.00% (7)	1.00 (0.43 – 2.29); 0.992	0.79 (0.34 – 1.85); 0.581
Obstructive jaundice	22	13.64% (3)	1.41 (0.40 – 4.95); 0.587	1.18 (0.33 – 4.23); 0.799
Atypical history	31	19.35% (6)	2.15 (0.84 – 5.49); 0.109	1.90(0.72 – 5.04); 0.196
Asymptomatic gallstones	14	7.14% (1)	0.69 (0.09 – 5.38); 0.723	0.97 (0.12 – 8.00); 0.979
2006 - 08	314	9.55% (30)	1.00 (Reference)	1.00 (Reference)
2009 - 10	233	14.16% (33)	1.56 (0.92 – 2.64); 0.097	3.51 (1.88 – 6.56); <0.001
2011 - 12	251	12.75% (32)	1.38 (0.82 – 2.35); 0.229	1.40 (0.82 – 2.39); 0.220
2013 - 14	255	12.16% (31)	1.31 (0.77 – 2.23); 0.319	1.16 (0.66 – 2.04); 0.610
2015 - 16*	279	4.30% (12)	0.43 (0.21 – 0.85); 0.015	0.91 (0.43 – 1.90); 0.799
No prior laparotomy	1281	10.46% (134)	1.00 (Reference)	1.00 (Reference)
Prior upper laparotomy	51	7.84% (4)	0.73 (0.26 – 2.05); 0.549	0.82 (0.28 – 2.39); 0.714
No preoperative ERCP	1322	10.36% (137)	1.00 (Reference)	1.00 (Reference)
Preoperative ERCP	10	10.00% (1)	0.96 (0.12 – 7.64); 0.970	1.14 (0.14 – 9.41); 0.901

ASA 1	489	11.66% (57)	1.00 (Reference)	1.00 (Reference)
ASA 2	734	10.35% (76)	0.88 (0.61 – 1.26); 0.474	1.00 (0.67 – 1.49); 0.993
ASA 3	103	4.85% (5)	0.39 (0.15 – 0.99); 0.048	0.36 (0.13 – 1.00); 0.049
ASA 4	6	0.00% (0)	N/A	NA
BMI <18	6	0.00% (0)	N/A	NA
BMI 18 – 25	184	13.04% (24)	1.00 (Reference)	1.00 (Reference)
BMI 25 - 30	332	9.64% (32)	0.71 (0.40 – 1.25); 0.235	0.68 (0.38 – 1.22); 0.193
BMI 30 – 40	464	9.27% (43)	0.68 (0.40 – 1.16); 0.156	0.63 (0.37 – 1.09); 0.103
BMI > 40	112	15.18% (17)	1.19 (0.61 – 2.33); 0.606	1.15 (0.57 – 2.31); 0.691

Supporting Table 1. Patient factors and cystic artery Lymph Node excision

LN: Lymph Node; ERCP: Endoscopic Retrograde Cholangio Pancreatography; ASA: American Society of Anaesthesiologists class; BMI: Body Mass Index (kg/m²); N/A: Not Applicable as no LN excision in the category; * until September 2016; CI: Confidence Interval

	Frequency	Proportion LN present % (n)	Univariable Odds Ratio LN present (95% CI); P value	Multivariable Odds Ratio LN present (95% CI); P value
I: floppy not adherent	825	9.45% (78)	1.00 (Reference)	1.00 (Reference)
Ila: packed with stones	210	11.43% (24)	1.24 (0.76 – 2.01); 0.392	1.33 (0.81 – 2.20); 0.260
IIb: mucocoele	49	14.29% (7)	1.60 (0.69 – 3.67); 0.271	1.66 (0.71 – 3.89); 1.16
IIla: acute	100	13.00% (13)	1.43 (0.76 – 2.68); 0.263	1.24 (0.65 – 2.37); 0.510
IIIb: contracted fibrous	71	11.27% (8)	1.22 (0.56 – 2.63) ; 0.619	1.36 (0.61 – 3.05); 0.449
IIlc: attached to bile duct	10	20.00% (2)	2.39 (0.50 – 11.47); 0.275	2.15 (0.44 – 10.60); 0.347
IVa: empyaema	18	16.67% (3)	1.92 (0.54 – 6.76); 0.313	2.31 (0.62 – 8.59); 0.211
IVb: gangrene	42	7.14% (3)	0.74 (0.22 – 2.44); 0.617	0.66 (0.19 – 2.26); 0.505
IVc: completely obscured	7	0.00% (0)	N/A	N/A

Supporting Table 2. Nassar grade gallbladder appearance and cystic artery Lymph Node excision

LN: Lymph Node; N/A: Not Applicable as no LN excision in the category; CI: Confidence Interval

	Frequency	Proportion LN present % (n)	Univariable Odds Ratio LN present (95% CI); P value	Multivariable Odds Ratio LN present (95% CI); P value
I: clear thin	316	12.34% (39)	1.00 (Reference)	1.00 (Reference)
II: fatty	863	10.43% (90)	0.83 (0.55 – 1.23); 0.352	0.75 (0.48 – 1.16); 0.194
IIIa: arterial variant	25	8.00% (2)	0.62 (0.14 – 2.72); 0.695	0.71 (0.16 – 3.19); 0.652
IIIb: ductal variant	15	6.67% (1)	0.51 (0.06 – 3.93); 0.518	0.52 (0.06 – 4.13); 0.534
IIIc: fibrosed	105	4.76% (5)	0.36 (0.14 – 0.93); 0.034	0.43 (0.16 – 1.17); 0.098
IV: impossible	8	12.50% (1)	1.01 (0.12 – 8.47); 0.989	1.24 (0.14 – 10.94); 0.848

Supporting Table 3. Modified Nassar grade cystic pedicle appearance and cystic artery Lymph Node excision

LN: Lymph Node; N/A: Not Applicable as no LN excision in the category; CI: Confidence Interval

	Frequency	Proportion LN present % (n)	Univariable Odds Ratio LN present (95% CI); P value	Multivariable Odds Ratio LN present (95% CI); P value
I: none/minor	697	9.04% (63)	1.00 (Reference)	1.00 (Reference)
II: simple	409	12.71% (52)	1.47 (0.99 – 2.16); 0.054	1.51 (1.01 – 2.25); 0.044
IIIa: dense	75	8.00% (6)	0.88 (0.37 – 2.10); 0.765	0.96 (0.39 – 2.35); 0.923
IIIb: duodenum	109	11.01% (12)	1.24 (0.65 – 2.39); 0.511	1.15 (0.59 – 2.27); 0.677
IIIc: colon	12	8.33% (1)	0.91 (0.12 – 7.20); 0.933	1.15 (0.14 – 9.50); 0.895
IVa: wrapping	27	14.81% (4)	1.75 (0.59 – 5.22); 0.315	1.71 (0.54 – 5.42); 0.360
IVb: duodenum difficult	3	0.00% (0)	N/A	N/A

Supporting Table 4. Nassar grade adhesions and cystic artery Lymph Node excision

LN: Lymph Node; N/A: Not Applicable as no LN excision in the category; CI: Confidence Interval