

Original Research Article

Study of correlation between pre-operative ultrasonographic findings and difficult laparoscopic cholecystectomy

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ABSTRACT

Background: In laparoscopic cholecystectomy prevention of certain life-threatening complications are dependent on proper patient selection. Some reliable factors to predict difficulty, conversion or complications in laparoscopic cholecystectomy are needed. In the present research attempt was made to study correlation between pre-operative abdominal ultrasonographic findings and difficulty in laparoscopic cholecystectomy.

Methods: Sixty patients above age of 18 years with gall stone admitted for elective laparoscopic cholecystectomy were included. Pre-operative ultrasonographic parameters such as gallbladder wall thickness and size, gallstone mobility, common bile duct (CBD) diameter, size and number of calculi, presence of pericholecystic fluid collection were given score of 0 or 1 based on findings being negative or positive respectively. Total score was correlated to intraoperative difficulty of surgery. Operative findings were graded as difficult laparoscopic cholecystectomy if there were presence of dense peri gall bladder adhesions, difficulty in dissection of Calot triangle, tear of gallbladder, bleeding that hindered visual field, abnormal anatomy of biliary tree and buried or intrahepatic gall bladder.

Results: Pre-operative USG findings such as gall bladder wall thickness and size, impacted and size of gall stones, CBD diameter, presence of pericholecystic fluid collection were significantly associated with difficult laparoscopic cholecystectomy. Gall bladder wall thickness, pericholecystic fluid collection and impacted gall stones were accurate predictors for difficult laparoscopic cholecystectomy. Higher the pre-operative USG score, higher were the percentage of difficult laparoscopic cholecystectomy and conversion to open cholecystectomy.

Conclusions: Pre-operative ultrasonography in the form of the formulated score is a good predictor of difficulty in laparoscopic cholecystectomy.

Keywords: Difficult laparoscopic cholecystectomy, Laparoscopic cholecystectomy, Open cholecystectomy, Ultrasonographic findings, Ultrasonography score

INTRODUCTION

Laparoscopic cholecystectomy has rapidly become the procedure of choice for routine gallbladder removal and is currently the most commonly performed major abdominal procedure worldwide.¹ Retrospective data shows laparoscopic cholecystectomy to be safe and effective, and when compared to open cholecystectomy advantages of laparoscopic cholecystectomy have been

described as, 'obvious and compelling'. These include reduced hospitalization, decreased morbidity, short recovery time, and better cosmesis.²⁻⁵ In addition, studies evaluating physiologic and biochemical responses show minimal change from normality.⁶

Indications for laparoscopic cholecystectomy are the same as for open cholecystectomy which include symptomatic cholelithiasis, with or without complications

and asymptomatic cholelithiasis in patients who are at increased risk for gallbladder carcinoma or gallstone complications.⁷ As laparoscopic cholecystectomy is becoming more widely practiced, certain life-threatening complications are being reported. Prevention of these complications is dependent on proper patient selection, meticulous technique, and necessity to convert to an open procedure when in doubt.

It will be useful to have some reliable factors to predict difficulty, conversion or complications in laparoscopic cholecystectomy. Patients tending towards conversion or complications can then be advised to opt for open surgery beforehand. Hence, an attempt was made to study correlation between pre-operative abdominal ultrasonographic findings and difficulty in laparoscopic cholecystectomy. This can then be a pre-operative tool to predict the need for open cholecystectomy.

METHODS

All patients above age of 18 years and both sexes with gall stone disease admitted between July 2015 and December 2016 for elective laparoscopic cholecystectomy and ready to participate were included after explaining potential advantages, and risks. Patients were also informed about the possibility of on table conversion to open cholecystectomy. Written informed consent of laparoscopic and if required open cholecystectomy was taken for surgery from patient. Permission was obtained from ethics committee and scientific advisory committee of the institution.

Inclusion criteria

- Above age of 18 years and both sexes with gall stone disease
- Admitted for elective laparoscopic cholecystectomy
- ready to participate.

Exclusion criteria

- choledocholithiasis on USG
- patients having comorbid conditions like uncontrolled diabetes mellitus
- uncontrolled hypertension
- hepatic or renal disease
- portal hypertension
- coagulopathies
- chronic obstructive pulmonary disease
- severe cardiac failure
- pregnancy
- obese patients with body mass index (BMI) >30
- jaundice
- cholangitis and patient unfit for general anaesthesia.

Based on a previous study, setting an alpha error at 0.05, and power at 80%, sample size of 60 patients was calculated by a formula.^{6,8}

Following pre-operative ultrasonographic parameters were studied:

- Gallbladder (GB) wall thickness ($\leq 4\text{mm}$ or $>4\text{mm}$ wall thickness)
- Gallstone mobility (gallstone mobile or impacted at neck)
- Gallbladder size (gallbladder contracted with transverse diameter $<5\text{cm}$ or distended with transverse diameter $\geq 5\text{cm}$).⁹
- Common bile duct (CBD) diameter (diameter $<6\text{mm}$ or $\geq 6\text{mm}$).¹⁰
- Size of calculus: Small $<1\text{cm}$ or large $\geq 1\text{cm}$ and number of calculi (single or multiple)
- Presence of pericholecystic fluid collection.

Above ultrasonographic parameters were given score of 0 or 1 based on findings being negative or positive respectively. Total score was calculated considering all six ultrasonographic parameters. Thus, a total score of a minimum of 0 and a maximum of 6 was found. Total score was correlated to intraoperative difficulty of surgery. A cut off score was calculated for prediction of a difficult laparoscopic cholecystectomy.

Operative findings were objectively graded as difficult laparoscopic cholecystectomy if any one of following difficulties was encountered:

- Presence of dense peri gall bladder adhesions.
- Difficulty in dissection of the Calot triangle or a frozen Calot triangle.
- Tear of the gallbladder during dissection with spillage of bile and stones.
- Bleeding that hindered visual field.
- Abnormal anatomy of biliary tree.
- Buried or intrahepatic gall bladder.

General anaesthesia was used in all cases. Laparoscopic cholecystectomy was carried out by standard four port technique. Intra-operatively, careful notes were made about any complications encountered during the procedure and whether laparoscopic procedure was converted to open cholecystectomy and reasons for the same. Pneumoperitoneum was created by insufflating peritoneal cavity with CO₂ gas by using a Veress needle inserted through sub-umbilical port site. Electronic insufflators produced pneumoperitoneum to a pressure of 12-15 mm of Hg. A 10mm trocar was inserted through sub-umbilical incision using rotatory movement and entry into peritoneal cavity was confirmed. Laparoscope was inserted through this cannula and diagnostic laparoscopy was performed visualising gall bladder and abdominal viscera. The next three ports were inserted under vision. Port in epigastrium was 10mm cannula inserted just below the xiphi-sternum below the inferior liver edge. This port was used for dissection of Calot triangle, application of clips, suction-irrigation and for extraction of the gall bladder specimen. Port in mid-clavicular line (5mm) was inserted through right sub costal incision

slightly lateral to the fundus of gallbladder. This was used to pass grasper to manipulate gall bladder (body and neck) for dissection of Calot triangle. Fourth port, 5mm cannula was placed laterally in anterior axillary line at level of the umbilicus.

Patient was placed in a reverse Trendelenberg position with a tilt to the left of approximately 30 degrees for better visualization of the gall bladder. A grasping forceps inserted through fourth port and gall bladder fundus was held and pushed upwards and laterally towards patient's right shoulder viz superolaterally. This opened up the Calot triangle.

Adhesions if any between gall bladder and surrounding structures, were separated by cauterization. After fundus of gall bladder was pushed up and over the liver using atraumatic grasping forceps, further retraction was accomplished by second atraumatic grasping forceps holding gall bladder neck and retracting it laterally to expose Calot triangle for achieving the critical view of safety. Gentle anterior and posterior dissection with straight and curved blunt dissector (Maryland forceps) was continued with alternating infero-lateral and supero-medial retraction of the neck until the gallbladder was dissected away from liver, creating a "window" crossed by two structures, cystic duct and artery. The duct was skeletonised and exposed up to its junction with common bile duct. Once this was achieved, polymer clips were applied on cystic duct and it was divided. Cystic artery was doubly clipped and divided similarly. Gall bladder was lifted from its bed, exposing connective tissue between it and liver. Gall bladder was gradually dissected until completely freed and placed on surface of liver for easy access. Extraction of the dissected gall bladder was done through epigastric port.

Before removing instruments, a thorough check was made of entire abdominal cavity for bleeding from gall bladder bed, portahepatis, adhesiolysed bowel and elsewhere in the abdomen. Any area with clots and blood was thoroughly irrigated and bleeders noted and cauterized. Suctioning of fluid in gall bladder fossa and all dependent parts of abdomen including right sub phrenic, sub hepatic, pelvis and paracolic spaces was done. A tube drain of appropriate size was placed through fourth port in gall bladder fossa in some patients. Closure of 10mm ports with 1-0 or 2-0 absorbable, synthetic, braided polyglactin 910 sutures (Vicryl) and skin closure with 3-0 non-absorbable - synthetic - monofilament nylon sutures (Ethilon) was done.

Postoperative complication like bile leakage, haemorrhage, surgical emphysema, wound infection, pulmonary complications and other complications, if any, were noted. In this study laparoscopic surgery was performed by a unit of surgeons who were well versed with laparoscopic cholecystectomy. Data on categorical

variables is presented as n (% of cases). Data on continuous variables is presented as mean \pm standard deviation (SD) or median (min - max) across two study groups.

Statistical analysis

Statistical significance of difference of categorical variables was tested using chi-square test or Fisher's exact test. Statistical significance of normally distributed continuous variables was tested using independent sample 't' test and for non-parametric data Mann-Whitney U test was used. Measures of diagnostic efficacy indices such as sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy were calculated along with 95% CI for accuracy measure. P-values less than 0.05 were considered to be statistically significant. Data was statistically analyzed using Statistical Package for Social Sciences (SPSS) Version 20:0 (IBM, USA) for MS Windows.

RESULTS

The mean age (SD) of the patients was 43.2 (\pm 12.6) years. Of 60 cases studied, 17 cases (28.3%) were males and 43 cases (71.7%) were females. Twenty out of sixty (33.3%) laparoscopic cholecystectomy surgeries were difficult. Of the 20 difficult laparoscopic cholecystectomy surgeries, gall bladder adhesions, difficult Calot dissection, spillage of bile and stones, bleeding leading to hindering of vision, abnormal biliary tree anatomy and intra-hepatic gall bladder was observed in 95%, 90%, 20%, 25%, 5% and 5 % patients respectively. Of the 20 difficult laparoscopic cholecystectomies, 11 were converted to open cholecystectomy.

As depicted in Table 1, pre-operative USG findings such as gall bladder wall thickness >4 mm, gall bladder size ≥ 5 cm, impacted gall stones, CBD diameter ≥ 6 mm, size of the calculus ≥ 1 cm, and presence of pericholecystic fluid collection were significantly associated with difficult laparoscopic cholecystectomy.

As shown in Table 2, gall bladder wall thickness > 4 mm was the most accurate predictor for a difficult laparoscopic cholecystectomy followed by pericholecystic fluid collection and impacted gall stones. Median pre-operative USG score was 0.72 and 3.00 for non-difficult and difficult laparoscopic cholecystectomy respectively which was statistically significant ($p = 0.001$).

As depicted in Table 3, there was statistically significant difference between pre-operative USG score and difficult or non-difficult laparoscopic cholecystectomy. Higher the preoperative USG score, higher were the percentage of difficult laparoscopic cholecystectomy.

Table 1: Pre-operative ultrasonographic findings and incidence of difficult laparoscopic cholecystectomy.

Ultrasonography parameters	Finding	Laparoscopic cholecystectomy			P value
		Not difficult N (%)	Difficult N (%)	Total N (%)	
GB wall thickness	≤4mm	39 (84.8)	7 (15.2)	46 (100.0)	0.001
	>4mm	1 (7.1)	13 (92.9)	14 (100.0)	
GB size	<5cm	27 (81.8)	6 (18.2)	33 (100.0)	0.006
	≥5cm	13 (48.1)	14 (51.9)	27 (100.0)	
Gall stone mobility	Mobile	40 (76.9)	12 (23.1)	52 (100.0)	0.001
	Impacted	0 (0.0)	8 (100.0)	08 (100.0)	
CBD diameter	<6mm	40 (74.1)	14 (25.9)	54 (100.0)	0.001
	≥6mm	0 (0.0)	6 (100.0)	06 (100.0)	
Size of calculus	<1cm	37 (75.5)	12 (24.5)	49 (100.0)	0.004
	≥1cm	3 (27.3)	8 (72.7)	11 (100.0)	
Pericholecystic fluid collection	No	39 (79.6)	10 (20.4)	49 (100.0)	0.001
	Yes	1 (9.1)	10 (90.9)	11 (100.0)	

Table 2: Diagnostic accuracy of pre-operative USG findings for predicting the difficult surgery.

Ultrasonographic findings	Diagnostic accuracy				
	Sensitivity	Specificity	PPV	NPV	Accuracy (95% CI)
GB wall thickness (>4mm)	65.0	97.5	92.9	84.8	86.7 (78.1 - 95.3)
GB size (≥5cm)	70.0	67.5	51.8	81.8	68.3 (56.6 - 80.1)
Gall stone mobility (Impacted)	40.0	100.0	100.0	76.9	80.0 (69.9 - 90.1)
CBD diameter (≥6mm)	30.0	100.0	100.0	74.1	76.7 (65.9 - 87.4)
Size of calculus (≥1cm)	40.0	92.5	72.7	75.5	75.0 (64.0 - 85.9)
Pericholecystic fluid collection	50.0	97.5	90.9	79.6	81.7 (71.9 - 91.5)

Table 3: Pre-operative USG score and difficult laparoscopic cholecystectomy.

Pre- operative USG score	Laparoscopic cholecystectomy			P value
	Non-difficult N (%)	Difficult N (%)	Total N (%)	
0-1	37 (94.9)	2 (5.1)	39 (100.0)	0.001
2-3	2 (28.6)	5 (71.4)	7(100.0)	
≥4	1 (7.1)	13 (92.9)	14(100.0)	
Total	40 (66.7)	20 (33.3)	60(100.0)	

Table 4: Pre-operative USG score and conversion of laparoscopic cholecystectomy to open cholecystectomy.

Pre-operative USG score	Conversion to open cholecystectomy			P value
	Not required N (%)	Required N (%)	Total N (%)	
0-1	39 (100.0)	0 (0.0)	39 (100.0)	0.001
2-3	6 (85.7)	1 (14.3)	7 (100.0)	
≥4	6 (42.9)	8 (57.1)	14 (100.0)	
Total	51(85.0)	9(15.0)	60 (100.0)	

As shown in Table 4, there was statistically significant difference between pre-operative USG score and conversion of laparoscopic cholecystectomy to open

cholecystectomy. Higher the preoperative USG score, higher were the percentage of conversion to open cholecystectomy. Minor surgical wound infections

occurred in two patients which were managed conservatively with oral antibiotics.

DISCUSSION

The aim of our study was to evaluate pre-operative abdominal ultrasonographic parameters, which could reliably predict chances of difficulty and complications faced during laparoscopic cholecystectomy and to formulate an ultrasonographic score which could be used to predict possibility of complications and the need of conversion to an open procedure. Indian literature lacks studies on predictive use of ultrasonography, unlike western literature.

In the present study, gall bladder wall thickness >4mm, pericholecystic fluid collection, impacted gall stone, common bile duct diameter >5mm, size of calculus >1cm and gall bladder size ≥ 5 cm were found to be the most important ultrasonographic parameters for prediction of difficulty in laparoscopic cholecystectomy.

Conversion rate in laparoscopic cholecystectomy was significantly high as noted in existing literature. Conversion rates in laparoscopic cholecystectomy vary between 1.5 to 19%. Yetkin et al. reported that out of 108 patients, 19 (17.33%) needed conversion to open cholecystectomy.¹¹ Conversion rate of 9.5 % was reported in The United States National Hospital Discharge Surveys, which identified one million patients who underwent cholecystectomy from 2000 to 2005.¹² In present study, 9 of 20 (45%) difficult laparoscopic cholecystectomy cases needed conversion to open procedure. Conversion rate in our study was 9/60 (15%). The relatively high rate of conversion seen in our study can be attributed to multiple attacks of acute cholecystitis suffered in the past by patients before reporting to hospital. This trend is commonly seen all over India.

In present study, there was a significant correlation between gallbladder wall thickness more than 4mm and difficulty faced in laparoscopic cholecystectomy which is comparable to other studies except one study in which, the opposite has been reported.¹³⁻¹⁹ A correlation between the common bile duct diameter and difficulty in laparoscopic cholecystectomy and also conversion to open procedure was observed in our study which was comparable to other studies.^{13,20} Daradkeh et al and Lal et al also reported in their respective studies that both gall bladder wall thickness and common bile duct diameter were the best ultrasonographic parameters to predict difficulty of laparoscopic cholecystectomy.^{13,16}

In the present study, stone impaction at gallbladder neck was a good predictor of difficult laparoscopic cholecystectomy with an accuracy of 80% and a high possibility of conversion to open procedure. This is contrary to the findings in other studies in which stone impaction, was reported to have a moderate correlation.^{13,16} Prime difficulty with stone impacted at

Hartmann pouch is that it hampers holding and maneuvering of the gallbladder neck while dissection. If stones are impacted, gall bladder forms a mucocele due to mucus collection, and gall bladder becomes tense and difficult to hold.

Many studies have reported statistical significance between the size of stones and conversion of laparoscopic cholecystectomy to open cholecystectomy.^{21,22} Authors found the same in present study, but Jansen et al stated that stone size >20 mm was associated with increased risk of conversion.¹⁵ In present study authors have considered 10 mm gall bladder calculus as cut off size. Out of 11 cases that had size of calculus more than 10 mm, 8 cases (72.7%) had difficult laparoscopic surgery and 3 cases (27.3%) did not have difficult surgery. A significantly higher proportion of cases that had higher size of calculus had relatively higher incidence of difficult surgery.

Out of the cases that had difficult laparoscopic cholecystectomy, most commonly encountered cause of difficulty was found to be dense gall bladder adhesions (95%).

In the present study it was found that patients with pericholecystic fluid collection had significant high rates of difficulty. In a study conducted by Nidoni et al, the sensitivity, specificity, positive predictive value and negative predictive value of pericholecystic collection in predicting conversion of laparoscopic cholecystectomy to open surgery were 70%, 91.76%, 33.33% and 98.11% respectively as compared 50.0%, 97.5%, 90.9% and 79.6% respectively in present study.²³ Thus presence of pericholecystic fluid was also a significant predicting factor for difficult laparoscopic cholecystectomy in present study with an accuracy of 81.7%.

Dinkel et al, reported sensitivity, specificity, positive predictive value and accuracy of wall thickening as an indicator of technical difficulties as 66.7%, 94.1%, 84.2%, and 85.3% respectively whereas in present study the sensitivity, specificity, positive predictive value and accuracy (with 95% CI) of gall bladder wall thickness more than 4 mm to predict the difficult surgical outcome were 65.0%, 97.5%, 92.9% and 86.7% (78.1%-95.3%) respectively.²⁴

Many studies have attempted to form a scoring system to predict difficult laparoscopic cholecystectomy, but most of them are complex, use large number of determining factors, and they are difficult to use in day-to-day practice.²⁵⁻²⁸ Many of these scoring systems cannot be applied pre-operatively.²⁶ The score formulated in present study can be applied pre-operatively. It is a simple and purely ultrasonological score with six parameters which were highly predictive of a difficult laparoscopic surgery. Median score of difficult laparoscopic cholecystectomies in this study was found to be 3. In this study patients having a score of more than or equal to 4 had a 92.9%

chance of facing intraoperative difficulties during laparoscopic cholecystectomy and a 57.1% chance of being converted to open cholecystectomy. A significant increase in the percentage of difficult laparoscopic cholecystectomy and conversion to open procedure was observed with an increase in the value of the score. The study has some limitations. The study was conducted on a limited patient population of sixty. Although ultrasound is the best modality for diagnosis of gall stones, it is operator-dependent. A high level of skill and experience is needed to acquire good-quality images and make accurate diagnoses. In this study, although ultrasonography of the abdomen was performed by a team of sonologists who were well versed with it, some degree of deviation of the values of the ultrasonographic parameters was expected. Image quality and accuracy of diagnosis is limited with obese patients, overlying subcutaneous fat attenuates the sound beam and a lower frequency transducer is required (with lower resolution) thus affecting the values considered.

CONCLUSION

This study has shown that pre-operative USG findings such as gall bladder wall thickness >4 mm, gall bladder size ≥ 5 cm, impacted gall stones, CBD diameter ≥ 6 mm, size of the calculus ≥ 1 cm, and presence of pericholecystic fluid collection were significantly associated with difficult laparoscopic cholecystectomy. Gall bladder wall thickness >4 mm was the most accurate predictor for a difficult laparoscopic cholecystectomy followed by pericholecystic fluid collection and impacted gall stones. Higher the pre-operative USG score, higher were the percentage of difficult laparoscopic cholecystectomy and conversion to open cholecystectomy. From these observations, authors conclude that pre-operative ultrasonography in the form of the formulated score is a good predictor of difficulty in laparoscopic cholecystectomy.

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