Association of Gallbladder Wall Thickness on Preoperative Ultrasonography with Intraoperative Difficulty in Laparoscopic Cholecystectomy

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Abstract: _Background: Gallstone disease is common in adult population. Untreated, itcan cause acute cholecystitis, cholangitis, obstructive jaundice and acute pancreatitis.Laparoscopic cholecystectomy is the procedure of choice for management of symptomatic gallstones for its minimal invasiveness, less pain and early recovery. However, it at times becomes difficult requiring conversion to open cholecystectomy. Risk factors associated withdifficult surgery areelderly, males, attacks of acute cholecystitis, obesity, abdominal scar and ultrasonographic findings i.e. thickened gallbladder wall, pericholecystic collection, impacted stone etc. It is difficult to predicteasy or difficult surgery preoperatively, although an important aspect of planning laparoscopic surgery to determine need for longer hospitalization or more intensive postoperative care.This observational study was undertaken to estimatethe association of gallbladder wall thickness on preoperative ultrasonography with intraoperative difficulty in laparoscopic cholecystectomy._ _Methods: All patients of either gender undergoing elective laparoscopic cholecystectomy at tertiary care teaching hospital were included and evaluated by preoperative ultrasonography. Intra-operative findings were noted based on the criteria defined in the study._ _Results: A hospital based prospective, observational study was conducted and 200 patients evaluatedfor association of gallbladder wall thickness on preoperative ultrasonography with intraoperative ease/difficulty in laparoscopic cholecystectomy. 85 (42.5%) had easy Laparoscopic Cholecystectomy and 115 (57.5%) had difficult Laparoscopic Cholecystectomy. Association with pericholecystic collection and stone impaction was also studied._

Keywords: Gallstone disease, Gallbladder wall thickness, Laparoscopic cholecystectomy, Ultrasonography

1. Introduction

Gallstone disease is a global health problem with prevalenceof 3-20% in general population worldwide. Most patients are asymptomaticand detected incidentally with ultrasonography during evaluation for unrelated medical conditions.

Laparoscopic cholecystectomy (LC) has become the gold standard for surgical treatment of gallbladder disease. A shorter hospital stay, less postoperative pain, faster recovery, better cosmesis and lower cost are some of the advantages of LC over open surgery.[1, 2]

Although few may require conversion to open cholecystectomy (OC).[3]

On the basis of radiological findings, preoperative information indicating higher possibility of intra-operative complications necessitating conversion to open surgery will aid surgeon preparedness for surgery. It might also help to accurately identify individual patient risk for conversion and can result in more accurate preoperative counselling, improved operating room scheduling and efficiency, stratification of risk for technical difficulty and appropriate team assignment. It may improve patient safety by minimizing time to conversion and better mental preparation of surgeons and patients towards the procedure.

Conversion is related to patient factors, surgeon factors and equipment failure factors but most are converted because of difficulty in delineating the anatomy clearly or complications arising during the procedure.[4] Conversion can be elective or enforced, when the surgeon is forced to convert to open surgery because of the onset of a major or a life threatening intra-operative complication. Evidence of the reporting literature indicates that the outcome of patients is not influenced adversely by elective conversion, however, the morbidity is higher in those requiring enforced conversion.[5] Conversion should not be considered a technical failure but, rather, accepted as a better surgical practice, when indicated.

Ultrasonography is the initial imaging method for diagnosis and evaluation of the biliary system, as it is widely available, safe, innocuous and non-expensive. This method allows detailed real-time study of the gallbladder, besides evaluation of other findings that contribute to the final diagnosis, thus avoiding unnecessary cholecystectomies and their complications.[6] USG has emerged as the preferred test for evaluation of patients with suspected cholelithiasis or cholecystitis.[7] Detection of gallstone on basis of ultrasonography, has been able to reach reliability in greater than 90% of symptomatic patients. Measurement of gallbladder wall thickness by ultrasound is accurate to within 1 mm in 93% of patients.[8] Gallbladder wall thickness greater than 3mm is suggestive of cholecystitis in some, but not all literature reports. There are several clinical reports in the literature where relationship between preoperative ultrasound gallbladder wall thickness and the technical difficulty of a LC is well established.[9]

The normal gallbladder wall should measure less than 3mm. While a thickened gallbladder wall is one sign of

cholecystitis (acute cholecystitis, chronic cholecystitis, acalculous cholecystitis, xanthogranulomatous cholecystitis, adenomyomatosis cholecystitis), there are number of other states which can lead to this finding as well; e.g. normal contracted gallbladder, gallbladder carcinoma, hypoalbuminemia, alcoholic liver disease, increased portal venous pressure, acute viral hepatitis, heart failure, renal disease, ascites etc.

The current study is aimed at evaluating the preoperative ultrasonographic findings and their association as possible risk factors for conversion of LC to OC in a tertiary care set-up.

2. Material and Methods

A hospital based prospective observational analytical study was been undertaken at a tertiary care hospital from June 2017 to October 2019 with a target of analysing 200 cases. Considering a confidence level of 95% and confidence interval of 7 the number of patients in our study to achieve statistical significance is 196. This was calculated by SurveySystem (http://www.surveysystem.com/sscalc.htm#one).

The Survey System ignores the population size when it is "large" or unknown. Population size is only likely to be a factor when you work with a relatively small and known group of people (e.g., the members of an association). Hence a sample size of 200 patients was considered adequate for our study.

The study group comprises patients of symptomatic gallstone disease planned for elective Laparoscopic Cholecystectomy at a tertiary care teaching hospital

Inclusion Criteria: All admitted cases of either gender undergoing elective laparoscopic cholecystectomy.

Exclusion Criteria: Emergency cases and cases of laparoscopic cholecystectomy converted to open cholecystectomy due to equipment failure.

Criteria Foreasy/Difficult Laparoscopic Cholecystectomy
Easy: Time taken <60 min
              No bile/stone spillage
              No injury to duct/artery
Difficult: Time taken >60 min
              Bile/stone spillage
              Injury to duct/artery
              Conversion to open (if any)

Inter-group statistical comparison of distribution of categorical variables was tested using Chi-Square test or Fisher's exact probability test for 2 x 2 contingency table as a univariate analysis. All the results are shown in tabular as well as graphical format.

p-values less than 0.05 are considered to be statistically significant. All the hypotheses were formulated using two tailed alternatives against each null hypothesis (hypothesis of no difference). The entire data is statistically analysed using Statistical Package for Social Sciences (SPSS ver 21.0, IBM Corporation, USA) for MS Windows.

3. Results

Of 200 cases studied, 85 (42.5%) cases had easy Laparoscopic Cholecystectomy and 115 (57.5%) cases had difficult Laparoscopic Cholecystectomy.

Incidence of intra-op difficulty in the study group

Intra-op difficulty status	No. of cases	% of cases
Easy	85	42.5
Difficult	115	57.5
Total	200	100%

3.1 Distribution of Incidence of intra-op difficulty according to ultrasound findings

The distribution of incidence of difficulty was significantly higher among the group of cases with wall thickness ≥4mm compared to group of cases with wall thickness <4mm **(p<0.001).**

The distribution of incidence of difficulty was significantly higher among the group of cases with PC collection compared to group of cases with no PC collection **(p<0.05).**

The distribution of incidence of difficulty was significantly higher among the group of cases with impacted stone compared to group of cases without impacted stone **(p<0.01).**

Distribution of Incidence of intra-op difficulty according to ultrasound findings

Findings	Laparoscopic Cholecystectomy						P-value
	Easy (n=85)		Difficult (n=115)		Total (n=200)		
	N	%	N	%	N	%	
Wall thickness							0.001***
<4mm	80	54.8	66	45.2	146	100.0	
≥4mm	5	9.3	49	90.7	54	100.0	
PC collection							0.021*
Yes	0	0.0	7	100.0	7	100.0	
No	85	44.0	108	56.0	193	100.0	
Impacted stone							0.003**
Yes	3	13.0	20	87.0	23	100.0	
No	82	46.3	95	53.7	177	100.0	
P-value by Chi-square test. P-value<0.05 is considered to be statistically significant. *P-value<0.05, **P-value<0.01, ***P-value<0.001.							

Distribution of Incidence of intra-op difficulty according to ultrasound findings

Incidence of intra-op difficulty according to ultrasound findings
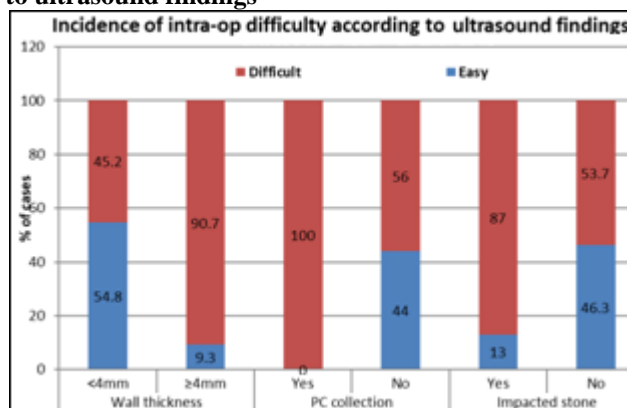
4. Discussion

A hospital based prospective, observational study was conducted with 200 patients to evaluate the association of gallbladder wall thickness on preoperative ultrasonography with the intraoperative ease/difficulty in laparoscopic cholecystectomy.

Ultrasonography has proven to be a reliable and accurate diagnostic examination for biliary tract disease. In addition, information related to contracted gallbladder or distention, presence of pericholecystic fluid, a sonolucent intraluminal layer, and the diameter of the common duct are also good predictors of difficulties preoperatively.

The thickened and contracted gallbladder is difficult to dissect due to dense adhesions withsurrounding structures and in Calot's triangle. Pre-operative abdominal ultrasonographic parameters, which could reliably predict chances of difficulty and complications faced during laparoscopiccholecystectomy are valuable.

In the present study, of 200 cases studied, 85 (42.5%) cases had easy Laparoscopic Cholecystectomy and 115 (57.5%) cases had difficult Laparoscopic Cholecystectomy. This is similar to the studies of Chindarkar H et al[10] and Reddy SVR et al[11].

Chindarkar H et al[10] study assessing the correlation between pre-operative abdominal ultrasonographic findings and difficulty in laparoscopic cholecystectomy found twenty out of sixty (33.3%) laparoscopic cholecystectomy surgeries were difficult.

Reddy SVR et al[11] retrospective study reported thickness of the gallbladder being more than 3 mm a significant factor. Presence of pericholecystic fluid was also found to be an independent risk factor for conversion.

In the present study, the distribution ofincidence of difficulty was significantly higher among the group of cases with wall thickness ≥4mm compared to group of cases with wall thickness <4mm (p<0.001). The distribution of incidence of difficulty was significantly higher among the group of cases with PC collection compared to group of cases with no PC collection (p<0.05). The distribution of incidence of difficulty was significantly higher among the group of cases with impacted stone compared to group of cases without impacted stone (p<0.01).

This is in concordance to the studies of Nachnani J et al[12], Majeski J[13], Reddy SVR et al[11], Ali Rizvi SA et al[14]and Chindarkar H et al[10].

Nachnani J et al[12] study observed thickened gallbladder wall was a significant factor in ultrasonographic finding of acute cholecystitis.

Majeski J[13] study on preoperative ultrasound measurement of gallbladder wall thickness showed that a preoperative gallbladder ultrasound evaluation for symptomatic cholecystitis, which documents a thick gallbladder wall (3 mm) with calculi, is a clinical warning for the laparoscopic surgeon of the potential for a difficult laparoscopic cholecystectomy procedure which may require conversion to an open procedure.

Reddy SVR et al[11] retrospective study estimating the risk factors for conversion observed gallbladder thickness over 3mm in 57.9% of the patients which was significant.

Ali Rizvi SA et al[14] prospective study observed gallbladder wall was found to be greater than 3 mm in 36% of patients with acute calculus cholecystitis and greater than 3 mm in 76% of patients with chronic cholecystitis. The mean gallbladder wall thickness was 2.8mm, maximum wall thickness6mm, and the minimum was 1.8 mm. 98out of 298 patients had gallbladder wall thickness greater than 3mm by preoperative sonography and 48 (50%) of these had difficulty in dissection and 10 (20%) of these patients required conversion.

Chindarkar H et al[10] study observed pre-operative USG findings such as gallbladder wall thickness >4 mm, gallbladder size ≥5cm, impacted gallstones, CBD diameter ≥6mm, size of the calculus ≥1cm, and presence of pericholecystic fluid collection were significantly associated with difficult laparoscopic cholecystectomy. Gallbladder wall thickness>4 mm was the most accurate predictor for a difficult laparoscopic cholecystectomy followed by pericholecystic fluid collection and impacted gallstones. 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).

It was observed in the present study ultrasonographic findings like gallbladder wall thickness, pericholecystic fluid collection, impacted stone are significant and independent determinants of difficult Laparoscopic Cholecystectomy (P-value<0.05l).

5. Conclusion

Preoperative ultrasound examination of the gallbladder is a good predictor of difficult cholecystectomy and should be used pre-operatively as a forecasting tool. The presence of wall thickness more than 3 mm, can give an idea of the potential difficulty and surgeon should be well prepared accordingly. The most valuable assessment that ultrasound can provide is gallbladder wall thickness, gallbladder size, common bile duct diameter, common bile duct stones, and any abnormal anatomy of the biliary tract.

An accurate preoperative diagnostic tool is mandatory for planned surgery to provide information for the selection of the most appropriate approach and to avoid intra -operative difficulties. It appears that gallbladder wall thickening is the best predictor for difficulty during cholecystectomy.

6. Conflicts of Interest

The authors declare no conflict of interest.

7. Disclosures and Funding

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