Scholars Journal of Applied Medical Sciences (SJAMS) **ISSN 2320-6691 (Online)**
Sch. J. App. Med. Sci., 2014; 2(3A):891-898 **ISSN 2347-954X (Print)**

(An International Publisher for Academic and Scientific Resources)
www.saspublishers.com DOI: 10.36347/sjams.2014.v02i03.001

Research Article

Assessment and Correlation of Technical Difficulties and Conversion to Open Procedure During Laparoscopic Cholecystectomy by Preoperative Ultrasonography

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Abstract: Laparoscopic cholecystectomy is now the gold standard for the treatment of gall stone disease and ultrasonography is the most common imaging study performed for biliary tract disease. The various pre-operative parameters in literature for predicting difficult laparoscopic cholecystectomy are reported. The present study was conducted to look for some predictive factors on ultrasonography of gallbladder that can give surgeon some idea about the potential difficulty and complications that may be encountered during the course of laparoscopic cholecystectomy. This study was conducted on patients undergoing laparoscopic cholecystectomy in Department of General and Laparoscopic Surgery at Dr. S. N. Medical College Jodhpur, India. In this study we have included 146 patients of all age groups and both sex, in which four ultrasonic parameters for predicting difficult laparoscopic cholecystectomy were analyzed. All patients included in the study were undergone detail history and clinical examination. Pre-operative ultrasound was done for all patients .The selected patients were then told about the procedure and written informed consent was taken. Patients were also informed about the conversion to open cholecystectomy. In our study a strong statistical correlation was found between pre-operative ultrasound and difficulty in the laparoscopic cholecystectomy. The study shows that preoperative ultrasound can predict operative difficulty for laparoscopic cholecystectomy to a good extent. Pre operative ultrasonography can also aid in recognition of cases where an open cholecystectomy should be considered and the patient counselled preoperatively.
Keywords: Cholelithiasis, Ultrasonography, Cholecystectomy, Laparoscopy.

INTRODUCTION

Laparoscopic Cholecystectomy (LC) has gradually replaced open cholecystectomy for the treatment of symptomatic gall stone disease. Cholecystectomy is the most common procedure performed on the biliary tract and the second most common major abdominal operation performed today. Ultrasonography is the most common screening test for cholecystitis and cholelithiasis. It is easy, non invasive, safe and a highly accurate imaging technique that can also detect associated lesions of the liver, pancreas, common bile duct (CBD) and kidneys. It detects gallstones with accuracy of more than 95%. Over the past years, removal of the gall bladder by open surgery has been the primary mode of therapy for gallstone diseases.

In 1882, Carl Langenbuch performed the first open cholecystectomy for gallstone disease [1]. The pain associated with a long incision and its effect on the post operative chest complications and also various wound complications of traditional open cholecystectomy added to the morbidity of this procedure. In 1987,105 years later, Phillipe Mouret performed the first laparoscopic cholecystectomy in Lyon, France [2]. Disadvantages of laparoscopic cholecystectomy are the known complications like injury to common bile duct, bowel, iliac vessels etc costly equipment, high conversion rates (10-50%) in

acute cholecystitis, difficulty in management of simultaneous common bile duct stones and limitation of facility to the tertiary health care centres [3].

The present study was conducted to look for some predictive factors on ultrasonography of gallbladder that can give surgeon some idea about the potential difficulty and complications that may be encountered during the course of laparoscopic cholecystectomy.

MATERIALS AND METHOD

This study was conducted on patients undergoing laparoscopic cholecystectomy in Department of General and Laparoscopic Surgery at Dr. S.N.Medical College Jodhpur, India. Institutional ethical committee approval had been taken prior to the study.

Inclusion criteria

Patients of all age group and both sex with symptomatic Gall stone disease was included in study.

Exclusion criteria

Patients with Common bile duct stone, jaundice or abnormal liver function test, acute cholecystitis, acute pancreatitis, known carcinoma gall bladder, peritonitis, cholangitis, biliary enteric fistula, portal hypertension and contraindication to laparoscopic surgery.

Ultrasonography

The ultrasonography was done on Diasonics Spectra Colour Doppler Ultrasound on B mode, gray scale, and real time scan with 3.5 MHz probe.

Equipment used for laparoscopic cholicystectomy

It includes video equipment, laparoscopic instruments used in conventional laparoscopic cholecystectomy, energy source- endocoagulators and diathermy unit (monopolar/ bipolar) and stop watch.

Methodology

All patients included in the study were undergone detail history and clinical examination. All routine investigation including liver function test and coagulation profile were done. Pre-operative ultrasound was done for all patients and following criteria was assessed:

- Gallbladder wall thickness---more than or less than 4 mm.
- Stone impacted at neck of gallbladder or not.
- Volume of gallbladder-contracted or not.
- CBD size---more than or less than 6mm.
- Any evidence of acute cholecystitis and acute pancreatitis.

The selected patients were then told about the procedure and written informed consent was taken. Patients were also informed about the conversion to open cholecystectomy.

Technique of Laparoscopic Cholecystectomy

The patient was kept in supine position. Operating surgeon stood on the left side of the patient with second assistant by the side of him handling telescope and first assistant on the right of the patient. The patient was catheterised to decompress the urinary bladder and Ryle's tube was put to decompress the stomach. Pneumoperitoneum was created by insufflating the peritoneal cavity with CO_2 gas by open hassan's technique. Electronic insufflator produces pneumoperitoneum to a pressure of 12-15 mm of Hg at a rate of 1 to 1.5lit/min. The telescope with the camera mounted was then inserted through the cannula. We have used the Karl Stroz triple chip camera and Karl stroz laparoscope 0^0. The next three cannulas were then inserted under direct vision. One in the epigastrium (2^{nd}),one in the mid clavicular line (5mm) at the fundus of the gallbladder and the third in the anterior axillary line (5mm) at the level of the umbilicus. The patient was then made in the reverse Trendlenberg position with right side up approximately 30^0 to horizontal. Gallbladder fundus was now held with atraumatic forceps and the organ was pulled to the right and upwards, forwards and to the patient's right shoulder. Dissection was carried out with the two handed technique in which surgeon held the tissues under tension with the left hand and right hand held the scissors and did the dissection. Cystic duct and artery was dissected and separated [figure 1]. The cystic duct was then exposed up to junction with common duct and then cut between two clips (Fig. 2). The cystic artery was then isolated, clipped and cut between the clipped. The gallbladder was then dissected away from the gallbladder fossa using electrocautery. The organ was extracted through the subumbilical port with cannula being retracted ahead of it. The sub umbilical fascial opening and skin was then closed with non-absorbable sutures.

Fig. 1: Calot's Triangle with dissected cystic duct and artery

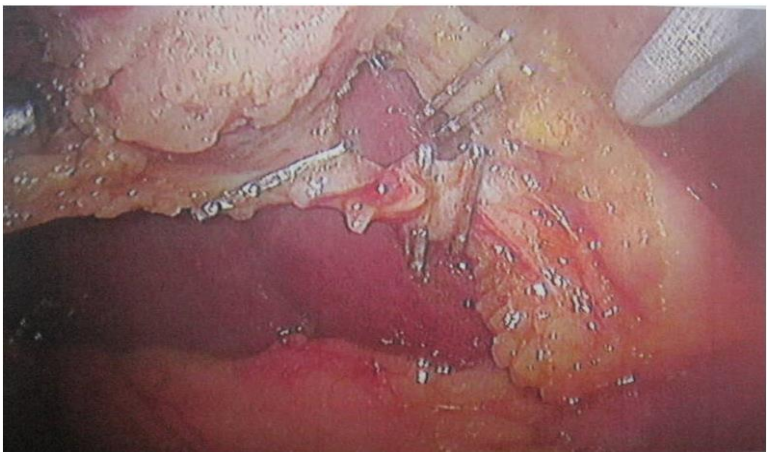

Fig. 2: Clipped cystic duct and artery

Intra-operatively following criteria's were assessed:

- Duration of surgery from the insertion of Verres needle to the extraction of gallbladder, More than or less than 90 minutes.
- Total time taken to dissect the calot'triangle, more than or less than 20 minutes.
- Total time taken to dissect gallbladder from gallbladder bed, more than or less than 20 minutes.
- Spillage of bile and stone present or not.
- Tear of gallbladder present or not.
- Any other complication during surgery.

RESULTS

The study was conducted in a total of 146 patient's age between 17 to 75 years. After proper evaluation and assessment, all patients were undergone laparoscopic cholecystectomy.

Age Distribution

The mean age of the study is 40 years. The age group of the patients ranged from 17 to 75 years. The maximum incidence is seen in the age group of 30- 35 years.

Sex distribution

The female to male ratio is 2.8: I. The above sex distribution shows that the gall bladder diseases have a higher frequency in females than in males in all age groups.

Gall bladder wall thickness

The mean gall bladder wall thickness in the study is 2.8mm.The maximum gall bladder wall thickness is 6mm and minimum is 1.8mm.There were 20 patients with gall bladder wall thickness more than 4mm.

Contracted gall bladder

There were 22 patients (15.1%) with contracted gall bladder. The remaining 124 patients had either gallbladder of normal volume that is approx 50ml or more. The mucocele gall bladders were also included in the study.

Stone impacted at the neck of Gall bladder

There were 22(15.1%) patients with gall stone impacted at the neck of gall bladder or Hartman's pouch. The rest of the 124 patients had mobile gall stones (85%).The patients with gall bladder full of stones with no mobility of the stones due to gallbladder

being totally packed with stones was taken as stone impacted at the neck of gall bladder.

Common bile duct dilatation more than 6mm

There were only five patients with common bile duct diameter more than 6mm.This could be due to the reason because the patients with common bile duct stones were excluded from the study.

Prediction of the difficult cases on Ultrasonography

The total number of cases predicted to be difficult on ultrasonography was 42 patients (28.8%).The remaining 104 cases (71.2%) were predicted to be easy.

Total number of difficult laparoscopic surgeries

The total number of laparoscopic cholecystectomies attempted was 146 out of which 48(32.9%) were difficult on surgery. The remaining 98(67.1%) cases were easy on laparoscopic cholecystectomy.

Conversion to open cholecystectomy

Out of total 146 cases 34(23.3%) cases were converted to open procedure. In the remaining 112 cases the laparoscopic cholecystectomy was completed successfully (including the difficult cases which were not converted to open cholecystectomy).The various reasons for conversion were dense adhesions in the calot's triangle, tear of cystic artery, dense adhesions of the gallbladder with the surrounding viscera that is colon and omentum. One of the cases was converted as it turned out to be carcinoma gallbladder.

Correlation of ultrasonographic prediction and difficulty in performing laparoscopic cholecystectomy (Table 1) The number of cases predicted to be difficult on ultrasonography was 42 patients out of which 34 were difficult on surgery while 8 cases were easy. The cases predicted to be easy on ultrasonography were 104 out of which 90 cases were actually easy while 14 cases turned out to be difficult on surgery.

Sensitivity of ultrasonographic prediction= (a/a+c) x 100 = 70.83%

Specificity of ultrasonographic prediction= (d/b+d) x 100 = 91.84%

Positive predictive value (of cases to be difficult on ultrasonography) = (a/a+b) x 100 = 80.95%

Negative predictive value (of cases to be easy on ultrasonography) = (d/c+d) x 100 = 86.54%

Percentage of false negative= (c/a+c) x 100 = 29.17%

Percentage of false positive tests= (b/b+d) x 100 = 8.16%

Pearson's correlation co-efficient = 0.65

Correlation of the ultrasonographic prediction and conversion to open procedure (Table 1)

Sensitivity of ultrasound to predict the conversion to open procedure was=(e/e+g)x100= 76.47%. Specificity (h/f+h) x100= 85.71%,

positive predictive value= (e/e+f)x100= 61.90%.

Percentage of false negative was (f/e+g) x100= 23.52%.

Percentage of false positive tests was (f/f+h) x100=14.28% and

Pearson's correlation co-efficient was 0.58

Correlation between the gall bladder wall thickness and difficulty in the laparoscopic surgery (Table 2)

Sensitivity of gall bladder wall thickness to predict difficulty in laparoscopic surgery was 37.5%, Specificity 97.95%, Positive predictive value 90%, Negative predictive value 76.19% and Pearson's correlation co-efficient was 0.36.

Correlation between the gall bladder wall thickness and conversion to open cholecystectomy (Table 2)

Sensitivity of gallbladder wall thickness to predict the conversion to open cholecystectomy was 41.18%, Specificity 94.64%, Positive predictive value 70%, Negative predictive value 84.12%, and Pearson's correlation co-efficient 0.44.

Correlation of the gall bladder contraction and difficult cholecystectomy (Table 3)

Sensitivity of contracted gall bladder to predict the difficult laparoscopic cholecystectomy was 33.33%, Specificity 93.88%, Positive predictive value 72.73%, Negative predictive value 74.19%, and Pearson's correlation co-efficient was 0.36.

Correlation of the gall bladder contraction with the conversion to the open cholecystectomy (Table 3)

Sensitivity of contracted gall bladder to predict difficult laparoscopic cholecystectomy was 41.67%, Specificity 89.28%, Positive predictive value 45.45%, Negative predictive value 80.64% and Pearson's correlation co-efficient was 0.22.

Correlation of the Impaction of stone in the gall bladder neck with the difficult laparoscopic cholecystectomy (Table 4)

Sensitivity of stone impaction at the neck of gall bladder to predict difficult laparoscopic cholecystectomy was 41.67%, Specificity 97.96%, Positive predictive value 90.91%, Negative predictive value 77.42 and Pearson's correlation co-efficient was 0.52.

Correlation of the impaction of stone at the neck of gall bladder and conversion to open procedure (Table 4)

Sensitivity of the impaction of stone at the neck of gall bladder and conversion to open cholecystectomy was 41.17%, Specificity 92.86%, Positive predictive

value 63.64%, Negative predictive value 83.87% and Pearson's correlation co-efficient was 0.4**.**

Multiple regressions Table for difficult laparoscopic surgery (Table 5)

Shows the maximum correlation of the difficult laparoscopic cholecystectomy with the combined ultrasonographic parameters next best correlation is shown by impaction of stone at the neck of gall bladder, followed by gall bladder wall thickness and contracted gall bladder.

Multiple regressions for the conversion to open procedure (Table 6)

Best correlation is shown by the combined ultrasonographic prediction followed by impaction of stone at the neck of gall bladder, gall bladder wall thickness and contracted gall bladder.

Table 1: Correlation of ultrasonographic prediction with difficulty in performing laparoscopic cholecystectomy and conversion to open procedure

	NOCs*difficult on surgery	NOCs found to be easy during surgery	NOCs converted to open surgery	NOCS not converted to open surgery	Total
Total NOCs which were predicted difficult on ultrasound	34(a)	8(b)	26(e)	16(f)	42
Total NOCs which were predicted easy on ultrasound	14(c)	90(d)	8(g)	96(h)	104
Total	48	98	34	112	146

*NOCs= number of cases

Table 2: Correlation of gall bladder wall thickness with difficulty in the laparoscopic surgery and conversion to open surgery

	NOCs difficult on surgery	NOCs found to be easy during surgery	NOCs converted to open surgery	NOCS not converted to open surgery	Total
Total NOCs with GB wall thickness >4mm	18	2	14	6	20
Total NOCs with GB wall thickness<4mm	30	96	20	106	126
Total	48	98	34	112	146

Table 3: Correlation of contracted gall bladder with difficulty in the laparoscopic surgery and conversion to open surgery

	NOCs difficult on surgery	NOCs found to be easy during surgery	NOCs converted to open surgery	NOCs not converted to open surgery	Total
Total NOCs with contracted GB	16	6	10	12	22
Total NOCs without contracted GB	32	92	24	100	124
Total	48	98	34	112	146

Table 4: Correlation of the impacted stone at gall bladder neck with difficulty in the laparoscopic surgery and conversion to open surgery

	NOCs found difficult on surgery	NOCs found easy on surgery	NOCs converted to open surgery	NOCs not converted open surgery	Total
Total NOCs with stone impacted at GB neck	20	2	14	8	22
Total NOCs without impaction of stone at GB neck	28	96	20	104	124
Total	48	98	34	112	146

Table 5: Multiple regression tables for difficult laparoscopic surgery

Variable	Correlation (r)	(r^2)	Significance (t)	p Value
Gall bladder wall thickness	0 .484465	0.234706	4.666348	0.000014
Impaction of stone at the neck of gall bladder	0.520343	0.270757	5.134323	0.000002
Contracted gall bladder	0.357317	0.127676	3.223624	0.001913
Combined ultra-sonographic prediction	0.650358	0.422966	7.214078	0.000000

Table 6: Multiple regressions for the conversion to open procedure

Variable	Correlation (r)	(r^2)	Significance (t)	p Value
Gall bladder wall thickness	0.440317	0.193879	4.132328	0.000097
Impaction of stone in the neck of gall bladder	0.402100	0.161685	3.700495	0.000421
Contracted gall bladder	0.220907	0.048800	1.908546	0.060364
Combined Ultra-sonographic prediction	0.580620	0.337119	6.009017	0.000000

DISCUSSION

Cholecystectomy remains the gold standard for the treatment of the gallstone disease. The classical open cholecystectomy is performed through 10 to12 cm incision either from the kocher's subcostal incision or through the upper right paramedian incision. Few of the disadvantages of the classical open cholecystectomy were increased post operative pain, presence of an ugly scar and increased recovery time as compared to laparoscopic cholecystectomy. Laparoscopy has seen maximum progress in the past decade. The laparoscopic cholecystectomy has now become the gold standard for the treatment of symptomatic gall stones [4]. Laparoscopy can be difficult in dense adhesions and distorted anatomy. The various features that increase the technical difficulties are adhesions in the calot's triangle (the hepatic artery, common bile duct and cystic duct), distorted anatomy, empyema of gall bladder, contracted gall bladder, Mirrizi's syndrome, previous upper abdominal operations and acute cholecystitis. The conversion rates in various studies range from 1.5% to 35% [5-9]. In this study we have included 146 patients in which four ultrasonic parameters for predicting difficult laparoscopic cholecystectomy were analyzed. The various pre-operative parameters in literature for predicting difficult laparoscopic cholecystectomy are: Gall stone size [10-13]. Gall bladder wall thickness [10,13],Gall bladder volume [10,12,13], Number of stones [10,12,13], Common bile duct size [10-13], and stone impaction in the neck of gall bladder [10]. Of these parameters only gall bladder wall thickness, common bile duct diameter, contraction of gall bladder and stone impaction shows the maximum correlation with the difficult laparoscopic cholecystectomy and/or conversion of laparoscopic cholecystectomy to open procedure. In our study a strong statistical correlation was found between pre-operative ultrasound and difficulty in the laparoscopic cholecystectomy. Out of the 42 cases predicted to be difficult on ultrasonography, 34 cases were difficult on surgery and out of 34 cases 26 cases were converted to open procedure, giving a positive predictive value of 80.95% for difficult cases on laparoscopic cholecystectomy, which is in agreement with the earlier studies [10-12,14,15]. There is one study by Carmody *et al*. [16]. that shows that there is no correlation between the ultrasonographic findings and difficult laparoscopic Cholecystectomy. Difficult dissection secondary to adhesions was the most common cause for the difficult laparoscopic cholecystectomy and/or conversion to open cholecystectomy in our study. The other causes of conversion to open cholecystectomy distorted anatomy like sessile gall bladder, abnormally short cystic duct which lead to conversion to open cholecystectomy. The intraoperative complications that occurred were tearing of cystic artery leading to bleeding; tear of gall bladder with spillage of stones and bile, tear of cystic duct, bleeding from the liver. No major common bile duct injury occurred in our series. Out of the four ultrasonic parameters studied common bile duct diameter more than 6mm, the number of cases in our study was not enough to give a significant statistical value. This is due to the reason that the patients with common bile duct stones were not included in the study. Gallbladder wall thickness is one of the ultrasonic parameter most extensively studied for the gallstone disease. Gall bladder wall thickness can be most accurately measured with a high degree of accuracy with ultrasonography. 95% of patients have sonographic wall measurements that correlate to within 1mm with the measurements taken at the time of surgery [17]. It is generally agreed that a sonography/pathologic wall thickness of 3mm constitutes the upper limit of normal and may serve as a

demarcation between thin walled and thick walled gall bladder [18].

In our study we have taken an arbitrary wall thickness cut off as 4mm (that a gall bladder wall thickness more than 4mm were predicted to be difficult gallbladder), of the 146 cases studied 20 patients had gall bladder wall thickness more than in our study, out of which 18 cases were difficult on surgery and 14 cases out of 18 had to be converted to open procedure. The positive predictive value of the gall bladder wall thickness is 90% for predicting the difficult laparoscopic cholecystectomy though the sensitivity of the test is only 37.5% for predicting the difficult laparoscopic cholecystectomy. The pearson's correlation co-efficient is 0.36 for difficult predicting difficult laparoscopic cholecystectomy. Stone impaction at the neck is another parameter that shows a good predictive value. Out of the 22 cases with the stone impaction at the neck 20 cases were difficult on surgery and 14 out of 20 cases were converted to open procedure. The reason for the difficulty was the impacted stone caused the gall bladder changed into the mucocoele and also the impaction of the stone at the neck causes difficulty in holding the gall bladder during dissection for retraction leading to difficult surgery. The impaction of the stone on ultrasonography is seen by conducting the ultrasonography in supine and reclining/erect position the mobile stone will slide towards the fundus of the gall bladder. The fallacy of the test is in predicting the impaction in the neck of a gall bladder full of gall stones and the contracted gall bladder in which the stones will not move even if they are not impacted in the neck. The contracted gall bladder is another important predictive factor for difficult laparoscopic cholecystectomy. The contracted gallbladder is usually a non-functioning gallbladder after repeated attacks of cholecystitis with dense adhesions with the surrounding structures.In our study there were 22 contracted gallbladder out of which 16 cases were difficult on surgery and 10 cases out of 16 were converted to open cholecystectomy. The positive predictive value of ultrasonography considering all the four parameters included together is 80.95%.The sensitivity of the prediction is 70.83% and specificity of the ultrasonographic prediction is 91.84%.The negative prediction value of the ultrasonography is 86.54%(that is the prediction of ultrasonography to predict the easy laparoscopic cholecystectomy).The pearson's correlation coefficient is 0.65. The various surgical parameters taken for assessing the operative technical difficulty namely the time taken for surgery more than 90min and time taken to dissect the calot's triangle and gallbladder bed more than 20 minutes is well calculated. The laparoscopic cholecystectomy in expert hands should not take more than 45 to 50min [10-12]. The tear of gall bladder and spillage of stones occurs in laparoscopic cholecystectomy in which there are dense adhesions with the surrounding structures and usually the tear occurs during dissection. Our policy was to convert the laparoscopic cholecystectomy to open cholecystectomy if there is no progress in dissection of the calot's triangle for more than 20-30min.This probably accounts for the high conversion rates in our study. Another reason for high conversion rate could be due to reason that our patients usually are from the low socioeconomic group and come to seek medical advice only after years of neglect of the disease and after repeated attacks of acute cholecystitis. Since these surgeries were done by surgeons experienced in laparoscopic surgery of our institution therefore the learning curve statistics do not apply to this study.

The study shows that preoperative ultrasound can predict operative difficulty for laparoscopic cholecystectomy to a good extent. Pre operative ultrasonography can also aid in recognition of cases where an open cholecystectomy should be considered and the patient counselled preoperatively. The impaction of stone at the neck of gallbladder followed by the gallbladder wall thickness and contracted gallbladder were the most accurate predictors of the potential operative difficulty and conversion to open procedure.

CONCLUSION

From this study it can be concluded that pre-operative ultrasonography is a good predictor of difficulty in laparoscopic cholecystectomy in majority of the cases and should be used as a screening procedure. It can help surgeon to get an idea of the potential difficulty that he can face in that particular patient. The most valuable assessment the ultrasound can give is gall bladder wall thickness, gall bladder size, CBD diameter and CBD stones and any abnormal anatomy of the biliary tract if present. Thick gall bladder wall is a finding which may show that more adhesions may be found during surgery. Common bile duct dilatation may give an idea about the possibility of common bile duct stones. Contracted gall bladder is usually a non functioning gall bladder due to repeated attacks of acute cholecystitis.

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