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Original Research Article

Evaluation of effect of cholecystectomy on common bile duct diameter using ultrasonography and liver function test: a prospective study

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ABSTRACT

Background: Different factors influencing the post cholecystectomy CBD diameter have been implicated. Ultrasound has emerged as a diagnostic imaging method of choice for liver and extrahepatic biliary system. In order to differentiate the diagnosis of asymptomatic bile duct dilatation, one needs to perform either MRCP or ERCP, which are both expensive and/or invasive test. Therefore, it is necessary to understand the physiological changes in bile duct after cholecystectomy to reduce unnecessary testing for early detection of bile duct lesions.
Methods: 100 cases of gall stone disease undergoing cholecystectomy in the department of surgery were studied. Pre operative and Post operative Ultrasound whole abdomen with focus on CBD diameter and Liver function test were done, Post operative data was collected on 10th day and again after 3 months. The data was compiled, compared and analysed.
Results: The mean preoperative diameter was 4.12 mm, postoperatively, the mean diameter of the CBD in early follow up period i.e. at 10th day and at 3 months, was found to be 4.75 and 5.14 mm respectively. The difference between mean preoperative and mean postoperative (10th day follow up) diameter was found to be 0.63 mm ($p<0.01$). The difference between mean preoperative and mean postoperative (3 months follow up) diameter was found to be 1.02 ($p<0.01$) mm, both statistically significant.
Conclusions: Significant compensatory dilatation does occur in common bile duct diameter after cholecystectomy in most of the patients.

Keywords: Cholecystectomy , CBD diameter, USG Abdomen

INTRODUCTION

The evolution of the common bile duct diameter following cholecystectomy has been a matter of considerable scientific debate in the surgical, radiological and sonographic literature for several decades. Many of the scientist, who worked on this subject initially did not find any considerable changes in the CBD diameter after cholecystectomy. Different factors influencing the post cholecystectomy CBD diameter have been implicated. Ultrasound has emerged as a diagnostic imaging method of choice for liver and extrahepatic biliary system. Structure details down to a millimeter are available. Post operative immediate viewing of changing structure is a characteristic feature of ultrasound.[1] The normal range of CBD size depends on age. Siegel stated that in infancy the normal CBD size should be <2 mm, <4 mm in childhood, and <7 mm after adolescence.[2]

As abdominal ultrasonographic exams are frequently performed, bile duct dilatations are incidentally found in gallbladder resected patients. When bile duct dilatation is discovered in asymptomatic patients, it is often difficult to differentiate whether it is the physiological change of gallbladder resection or the early findings of bile duct lesions. In order to differentiate the diagnosis of

asymptomatic bile duct dilatation, one needs to perform magnetic resonance cholangiopancreatography or endoscopic retrograde cholangiopancreatography (ERCP), which are both expensive and/or invasive tests. Therefore, it is necessary to understand the physiological change of the bile duct after cholecystectomy to reduce unnecessary testing for the early detection of bile duct lesions.

Although stones in the common bile duct can often be missed by ultrasound, the size of the common hepatic duct can be measured quite easily. After a hypothesis suggested by Oddi in 1887, many studies reported that the physiological dilatation of the bile duct after cholecystectomy was due to the disappearance of the gallbladder's reservoir function. However, the frequency and degree of bile duct dilatation after gallbladder resection are reported differently. In addition, since most of the reported studies were based on the western population, it is assumed that these results may be different in the eastern population, who frequently show anomalous union of pancreaticobiliary duct (AUPBD) and a high incidence of bile duct stones. However, there have only been a few studies reported thus far.[3]

Apart from the general assessment of liver function, LFTs are generally used postoperatively as an indicator of duct obstructions and iatrogenic injuries. The sensitivity of liver function tests in predicting biliary obstruction has been shown to be high. The predictive value of ALP has been accepted, and large values of this enzyme in particular raise the possibility of CBD stones.[4]

In this study, ultrasound has been made investigating tool for measuring CBD diameter before and after cholecystectomy. The biliary tract is the excretory system of the liver and includes intrahepatic and extrahepatic biliary duct system. Disorders of liver and extrahepatic biliary system influence each other. Any pathology of this system may alter anatomical architecture and biochemical processes.

Clinical trend is to refer to all biochemical determination that reflect hepatic diseases as '"liver function tests". However, estimation of the ability of the liver to excrete an endogenous load can be done by testing bilirubin levels (total and conjugated) and Alkaline phosphatase.

A group of biochemical determination are of great help in the recognition of hepatic disease and any extrahepatic biliary disorders (i.e. Serum bilirubin, SGOT, SGPT, Serum Alkaline Phosphatase).

The main purpose of this study was to find out if there is CBD dilatation after cholecystectomy and to differentiate between physiological and pathological dilatation of CBD using Ultrasononography and Liver Function test.

METHODS

This study was conducted in the department of surgery in a Medical College in North India.

This was an observational prospective study.

A prospective study was conducted in 100 cases of gall stone disease undergoing Cholecystectomy in the Department of Surgery. Patients underwent pre-operative USG whole abdomen with focus on extra-hepatic CBD diameter and liver function test. Patients again underwent USG whole abdomen with focus on CBD diameter and Liver function test after cholecystectomy on 10th day and 3 months. Both data were collected, compiled, compared and analysed.

Statistical analysis

Statistical Paired 't' test and unpaired 't' test was done to compare and analyse the results statistically.

Paired students 't' test

X=mean of the difference between and after the effects of a factor, SE(X)= Standard error of mean, SE(X)= SD upon N

Unpaired "t" test

T= X1 –X2 upon SE(x1-X2)

Where: X1= mean of 1st sample, X2= mean of 2nd sample, Se(X1-X2) standard error of the difference between two means, SE (X1-X2) = SD square 2 upon n 1 +SD square 2 upon n2, SD1 – Standard deviation of 1st sample, SD2 – Standard deviation of 2nd sample

RESULTS

In this study, there were 20 patients (15 females and 5 males) in the age range of 21-30 yrs.

Table 1: Comparison of mean pre-operative and mean post-operative 10th day diameter of CBD.

Time	No. of pts	Mean±SD	Mean diff±SD	SE	T	P	Sig
Pre-op	100	4.12±1.42	0.63±0.74	0.104	6.05	<0.01	HS
Post-op (10th day)	100	4.75±1.52					

28 patients (24 females and 4 males) were in the age range of 31-40 years. 21 patients (16 females and 5 males) were in the age range of 41-50 years. 22 Patients (19 females and 3 males) were in the age range of 51-60 years. 8 patients (6 females and 2 males) were in the age range of 61-70 years. 1 patient (male) fell in the age range of 71-80 years.

Out of the total of 100 patients, 20 were males and 80 were females depicting a male female ratio as 1:4.

Gall bladder disease (cholelithiasis) was well represented between the age range of 31-50 years as 70 of the patients belonged to this age range.

Table 2: Comparison of mean pre- operative and mean post- operative (10th day) serum bilirubin.

	No. of patient	Mean± SD	Mean Diff	SE	T	P	Significance
Pre-op	100	0.814±0.406	0.06	0.018	0.3259	>0.01	No
Post-op (10th day)	100	0.820±0.409					

Paired students 't' test

Table 3: Comparison of mean pre- operative and mean post- operative (10th day) serum alkaline phosphatase

	No. of patient	Mean±SD	Mean diff.	SE	T	P	Significance
Pre-op	100	8.25±2.37	0.25	0.156	1.603	>0.01	No
Post-op	100	8±2.27					

Paired students 't' test

Table 4: Comparison of mean preoperative and mean postoperative 3 month diameter of CBD.

Time	No. of pts	Mean±SD	Mean diff±SD	SE	T	P	Sig
Before op	100	4.12±1.42	1.02±1.19	0.168	6.07	<0.01	HS
Post-op (3 months)	100	5.14±1.92					

Paired students 't' test

The difference between mean pre-operative and mean post-operative (10th day follow up) diameter was found to be 0.63 (p<0.01) mm which is statistically significant.

The difference between mean pre-operative and mean post-operative (10th day) serum bilirubin was found to be 0.06 mg% (p = 0.7452 i.e. >0.01) which is not statistically significant.

The difference between mean pre-operative and mean post-operative (10th day) serum Alkaline Phosphatase was found to be 0.25 KA units (p = 0.1121 i.e. >0.01) which is not statistically significant.

The difference between mean preoperataive and mean postoperative (3 months follow up) diameter was found to be 1.02 mm (P<0.01) which is statistically significant.

Table 5: Comparison of mean pre-operative and mean post-operative (3 months) serum bilirubin.

	No. of patient	Mean ± SD	Mean Diff	SE	T	P	Significance
Pre-op	100	0.814±0.406	0.072	0.033	2.1920	>0.01	No
Post-op (3 months)		0.886±0.512					

Paired students 't' test

Table 6: Comparison of mean pre- operative and mean post- operative (3 months) serum alkaline phosphatase.

	No. of patient	Mean±SD	Mean diff.	SE	T	P	Significance
Pre-op	100	8.250±2.367	0.018	0.075	0.2402	>0.01	No
Post-op (3 months)	100	8.232±2.396					

Paired students 't' test

Table 7: Difference of pre-operative and post-operative (3 months) diameter in relation to age.

No. of patients	Mean age	Difference in CBD size (mm)
86	43.04	<3
14	47.5	3 or >3

The difference between mean pre-operative and mean post-operative (3 mths) serum bilirubin was found to be 0.072 mg% (p = 0.0307 i.e. >0.01) which is not statistically significant.

The difference between mean pre-operative and mean post-operative (3 months) seum Alkaline Phosphatase was found to be 0.018 KA units (p = 0.8107 i.e. >0.01) which is not statistically significant.

86 patients of the mean age 43.04 years (range 21-74 years) showed change of less than 3mm increase in CBD diameter at 3 months follow up after cholecystectomy while 14 patients of the mean 47.5 years (range 29-65 years) showed common bile duct dilatation of the order of 3 or more than 3 mm after 3 months of cholecystectomy.

Table 8: Standard error and significance.

Difference in CBD size (mm)	No. of patient	Mean Age±SD	Diff.	SE	T	P	Significance
<3	86	43.05±13.13	4.45	3.731	1.1936	>0.01	No
3 or >3	14	47.5±11.69					

Unpaired "t" test was used to calculate standard error. The P value came out to be 0.2355 (p>0.01) which is not significant.

Table 9: Difference of size of CBD between pre operative and post operative (3 months) measurements.

Difference of size of CBD (Range) mm	No. of patients
0.0	28.00
0.1-1.0	28.00
1.1-2.0	14.00
2.1-3.0	12.00
3.1-4.0	10.00
Decreased in size (0.7-1.1)	8.00

28 of the patients had no change in diameter of common bile duct. 28 patients showed post cholecystectomy CBD dilatation ranging from 0.1-1.0 mm. 14 patients showed post cholecystectomy CBD dilatation ranging from 1.1-2.0 mm. 12 patients showed post cholecystectomy CBD dilatation ranging from 2.1-3.0 mm. 10 patients showed post cholecystectomy CBD dilatation ranging from 3.1-4.0 mm. 8 patients showed decrease (range 0.6-1.1 mm) in common bile duct diameter after cholecystectomy.

DISCUSSION

Ultrasonographic evalution of CBD caliber has been a matter of interest for several decades however available data are not univocal.

One of the first to investigate whether biliary ducts dilate after cholecystectomy was Oddi. In 1887 he cholecystectomised 3 dogs and found that the common bile duct becomes dilated after cholecystectomy (Qvist).[5] In 1917 Judd and Mann drew a similar conclusion from studies in cats and dogs. Subsequently it was felt that this phenomenon also occurs in man. Many scientists felt that such dilatation is pathological and is indicative of biliary tract disease. Others, however, felt that this diameter is purely physiological because of following reasons:

- Common bile duct begins to act as a reservoir of bile in the absence of the gall bladder.
- Common bile duct gets inflamed, dilated and fibrotic due to previous passage of the stone and does not regain back its original caliber.

Many investigators have done a variety of studies in order to establish the status of common bile duct following cholecystectomy.

Following are the main studies which in their own way gives knowledge of the effects of cholecystectomy on CBD diameters.

Sandweiss et al reported the radiological findings in 100 patients and concluded that common bile duct does not necessarily dilate as a compensatory mechanism following cholecystectomy.[6]

Don et al concluded that it seems justifiable to assume that physiological dilatation of the duct after cholecystectomy is not the usual course of events in man.[7]

Wise and Colleagues reported that post cholecystectomy dilatation of the common bile duct did not occur unless obstruction was present.[8]

Qvist showed that in most cases the duct was unchanged before and after cholecystectomy. In a few cases there was negligible dilatation.[5]

Quesne and Whiteside found no evidence that the common bile duct becomes dilated after cholecystectomy.[9]

Longo et al found that common bile duct does not dilate significantly after cholecystectomy.[10]

Edmunds et al found that bile duct does not dilate usually after cholecystectomy and even if dilatation occurs it is not significant.[11]

Graham et al studied the size of ommon hepatic duct in post cholecystectomy patients and found that the common hepatic duct generally does not dilate following the removal of gall bladder.[12]

Mueller et al described the capacity of the common bile duct to distend and collapse over a short period.[13]

Kaude et al measured the common bile duct diameter in 600 cases ultrasonographically before and after cholecystectomy.[14] The conclusion was that there was no further increase in the duct diameter after cholecystectomy.

Niederau et al in their large cross sectional ultrasonographic study, have detected significantly higher common bile duct diameters in post cholecystectomy patients.[15]

Co et al evaluated the bile duct diameter using high resolution CT and found that mean diameter of common bile duct after cholecystectomy was larger.[16]

Chung et al concluded after performing ERCP in 43 patients that there is small but significant rise in bile diameter after cholecystectomy.[17]

Hunt and Scott in the prospective ultrasonographic study suggested a strong trend to minor dilatation of CBD diameter after cholecystectomy.[18]

Farrell et al in a study of 100 cases after cholecystectomy found that there was dilatation of common bile duct after cholecystectomy.[19]

Bucceri et al found no significant change in common bile duct caliber even after 24 months of operation.[20]

Feng and Song studied 234 patients to determine the effect of cholecystectomy on common bile duct width and found that the bile duct dilatation was statistically significant.[21] He concluded that there is small but significant increase in CBD width after cholecystectomy.

Hammarstorm et al strongly supported the opinion that there is a significant compensatory dilatation in bile duct diameter after cholecystectomy.[22]

Going through the plethora of above literature, it is clear that there are studies both for and against the opinion that common bile duct dilates after cholecystectomy.

The present study on 100 patients admitted to the Department of Surgery of Rajindra Hospital, Patiala, with cholelithiasis clearly showed that common bile duct dilates after cholecystectomy in most of the patients.

The diameter of the normal common duct, as shown on ultrasound, has been the subject of some debate with reports ranging from 1-4 mm (Cooperberg) to 8 mm (Koeningsberg).[23]

Ultrasonographically measured normal CBD diameter is 2-7 mm (Diseases of the liver and biliary system, Sherlock S)

Bucceri et al found in their experience after measuring in 100 healthy subjects that range of normality for CBD size is 0.20 to 0.60 cm or (2-6 mm).[20]

In present study 94 of the patients had common bile duct diameter 2-7 mm pre-operatively which is a normal range of CBD diameter on ultrasonography. A few had CBD diameter more than 7 mm.

Parulekar gave the mean diameter of the common bile duct, as measured by ultrasonography was to be 4.1 mm in normal subjects.[24]

Wedmann et al gave the mean pre-operative common bile duct diameter to be 4.6 mm.[25]

The mean average preoperative diameter in the present study was 4.12 mm (range 2 to 8.1 mm).

Wedmann et al studied the effects of cholecystectomy on common bile duct diameter in 32 patients with chronic cholecystectitis and cholelithiasis.[25] They found the preoperative median diameter to be 4.6 which increased to 5.3 mm (median) post –operatively after 27 to 39 months ($p<0.05$). The difference between preoperative and post operative diameter was 0.7 mm which he considered was significant.

Hunt and Scott observed that mean diameter increased from 3.95 mm before to 4.48 mm, 5 years after surgery and the difference was 0.5 mm.[18]

Feng and Song found in their study, the average mean diameter of the common bile duct before cholecystectomy to be 5.9 mm which increased to 6.1 mm after cholecystectomy. The difference of 0.2 mm was statistically significant.[21]

Hammarstrom et al found in their study that there is significant compensatory increase in the bile duct diameter following cholecystectomy. The preoperative mean diameter was 5.6 which increased to 7.1 after cholecystectomy. The difference was 1.5 mm.[22]

In the present study, the mean preoperative diameter was 4.12 mm, postoperatively, the mean diameter of the CBD in early follow up period i.e. at 10th day and at 3 months, was found to be 4.75 and 5.14 mm respectively.

The difference between mean preoperative and mean postoperative (10th day follow up) diameter was found to be 0.63 ($p<0.01$) mm which is statistically significant.

The difference between mean preoperative and mean postoperative (3 months follow up) diameter was found to be 1.02 ($p<0.01$) mm which is statistically significant.

Wedmann et al showed postoperative diameter increased in 32% cases, decreased in 9% of cases and remained same in 59% of cases.[25]

Feng and Song showed postoperative common bile duct diameter increased in 47% cases, decreased in 26% cases and remained same in 27% of cases.[21]

Present study showed postoperative common bile duct diameter in 64% cases, decreased in 8% cases and remained same in 28% of cases.

Regarding the liver function tests of the patients 94% of the patients showed normal levels of serum biirubin, 96% of the patients had normal values of SGPT, 100% patients had normal values of SGPT, 100% showed normal values of serum alkaline phosphatase and 96% of the patients had shown normal values of total serum proteins. Biochemically, virtually, all the patients were proved to be without any liver or extrahepatic biliary disorder.

In the present study the ratio of SGOT to SGPT is 1.25 to 1.

Chopra and Griffin proved that false positive elevations in serum glutamic oxaloacetic transaminase levels have been reported in patients when levels are determined by calorimetric assay.[26]

CONCLUSION

Significant compensatory dilatation does occur in common bile duct diameter after cholecystectomy in most of the patients.

The dilatation is purely compensatory and physiological as there was no evidence of any other pathology in the common bile duct.

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