ORIGINAL ARTICLE

Predictive Factors For Choledocholithiasis In Patient Undergoing Cholecystectomy in Ibn Sina Specialized Hospital From 1/1/2019 - 1/1/2020

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Abstract:

Background: Choledocholithiasis constitutes the main aetiology of non-malignant biliary obstructions. The prevalence of CBD stones in patients with symptomatic gallstones varies but probably lies between 8 % and 20%. Failure to detect CBD stones leads to potentially life-threatening complications such as cholangitis, pancreatitis or obstructive jaundice. ERCP, MRCP and Intraoperative cholangiography have high sensitivity in detecting CBDS but its routine use is associated with increased complications, costs and operating room time. In this study we felt a need for useful predictive factors to predict patients having choledocholithiasis so that these modern interventions can be selectively utilized, and to determine the patients who need CBD exploration during cholecystectomy.

Patient and Methods : Data was collected from consecutive patients diagnosed with cholelithiasis and choledocholithiasis by clinical presentations, ultrasonography and liver function tests at Ibn Sena Hospital, then CBD stone confirmed by definitive testing for choledocholithiasis (ERCP, MRCP or common bile duct [CBD] exploration). These clinical, biochemical and radiological findings were considered as predictive factors and analysed retrospectively.

Results:A total of 72 patiens satisfied our inclusion criteria. Of those, 86% (n=62) had CBD stone, and 14% (n=10) did not have CBD stone. Several variables were

analysed and showed that total bilirubin, ALP, AST, ALT, dilated CBD>6mm and visible CBD stone on ultrasonography were significantly associated with choledocholithiasis ($p<0.05$). Then four predictive factors (total bilirubin, ALP, dilated CBD > 6mm and visible CBDS on ultrasonography) were used to build a simple scoring system.

Conclusion:our results showed that abnormal liver function tests, multiple gallbladder stones, dilated CBD more than 6mm and visible CBD stone in ultrasonographic were statistically significant for detection of choledocholithiasis. Also we suggest a simple scoring system as a predictor for CBD stones.

Introduction:

Choledocholithiasis or common bile duct stones (CBDS) constitute the main aetiology of non-malignant biliary obstructions. The quoted prevalence of CBD stones in patients with symptomatic gallstones varies but probably lies between 8 % and 20% [(1)]. The ratio of women to men with CBD stone is 0.89:1, although the prevalence of gallbladder stone is higher in women than in men (1.22:1) [(2)]. The incidence of gallstones increases with increasing parity, and biliary sludge is formed in approximately 30% of pregnant women; 1-3% of these pregnant women with biliary sludge form gallstones [(3,4)]. Similarly ,gallbladder disease is found in 5-8% of young women but in 25-30% of women over 50 years of age [(5)]. Thus, risk factors for gallstones include biological factors such as increasing age, female gender and pregnancy.[(6)]

Common bile duct stones are associated with a significant number of hospital admissions, readmissions, and potentially life- threatening complications such as Cholangitis, acute pancreatitis, obstructive jaundice, and even fatal complications. The obstructive jaundice secondary to the presence of lithiasis in the CBD are the most common clinical presentations of CBDS [(7)]. Therefore, clinicians should aim to maximize the recognition of choledocholithiasis while minimizing unnecessary endoscopic retrograde cholangiopancreatography (ERCP), which carries up to a 15 % risk of post ERCP pancreatitis, as well as the risks of postsphincterotomy hemorrhage, cholangitis, perforation, and anesthesia-induced adverse events [(8, 9)].

Diagnosis of choledocholithiasis is not always straight forward and clinical evaluation and biochemical tests are often not sufficiently accurate to establish a

firm diagnosis. Common bile duct stones may be discovered preoperatively, intraoperatively or postoperatively. The standard preoperative workup for patients presenting with symptoms attributable to cholelithiasis includes liver function tests, and abdominal ultrasound. These tests, combined with clinical examination and history, constitute the entire workup for most patients. Abnormalities in these tests may suggest the presence of choledocholithiasis, abdominal ultrasound and liver function tests (LFT) are used routinely to predict CBD stones. Elevated serum bilirubin and alkaline phosphatase typically reflect biliary obstruction but these are neither highly sensitive nor specific for CBD stones. Excepting obvious jaundice, a raised GGT level has been suggested to be the most sensitive and specific indicator of CBD stones. A value of greater than 90 U/L has been proposed to indicate a high risk of choledocholithiasis. However, laboratory data may be normal in as many as a third of patients with choledocholithiasis, warranting further evaluation of the CBD by imaging studies to clarify the diagnosis [(10)].

In order to help select from the various diagnostic and therapeutic options, patients may be classified preoperatively into high, moderate or low risk groups. The high risk (> 50% risk) group includes those patients with obvious clinical jaundice or cholangitis, choledocholithiasis or a dilated CBD on ultrasonography. Patients with a history of pancreatitis or jaundice, elevated preoperative bilirubin and alkaline phosphatase levels or multiple small gallstones carry a moderate (10%-50%) risk of choledocholithiasis. Patients with large gallstones, without a history of jaundice or pancreatitis and with normal liver function tests are considered unlikely to have CBD stones and therefore at low risk (<5%)[(11-13)].

Today, laparoscopic cholecystectomy (LC) is considered as the gold standard for treatment of cholelithiasis. However, a surgeon needs to rule out the presence of choledocholithiasis and treat the problem if present. Historically, exploration of the CBD was recommended in patients with a history of jaundice or pancreatitis, operative findings of multiple gallbladder stones, single-faceted stone, dilated CBD and palpable stone in the bile duct. Observance of these criteria for CBD exploration led to a significant proportion of unnecessary CBD explorations, and a patient suffered complications like prolong T-tube drainage and biliary stricture [(14)]. To avoid these complications, intraoperative cholangiography (IOC) was introduced which meant the availability of a portable X-ray machine and increased operative time of 30 ±10 min [(15)]. Now endoscopic retrograde

cholangiopancreaticography (ERCP) gradually replaced IOC as a preferred investigation for detection of choledocholithiasis [16]. The major advantage was its therapeutic role in clearing the CBD off stone and achieving drainage by stent insertion. However, when used as a diagnostic investigation alone, the risks of complications like pancreatitis, cholangitis and iatrogenic injuries were unacceptable.The development of magnetic resonance cholangiopancreaticography (MRCP) and endoscopic ultrasonography (EUS) have provided a safe alternative for detecting CBD stones. The use of endoscopic retrograde cholangiopancreatography (ERCP) as a diagnostic tool should be minimised as it carries considerable risk (5–10%) of post-procedural complications: acute pancreatitis (1.3–6.7%), bleeding (0.7–2%), acute cholangitis (0.5–5%), duodenal perforation (0.3–1%) [17,18]. Recently, the American Society for Gastrointestinal Endoscopy (ASGE) published a guideline for patients who are planned to undergo ERCP for suspected CBDS. According to this guideline, in patients with symptomatic gallbladder stone, very strong (CBDS on transabdominal ultrasonography (US), clinical ascending cholangitis or total bilirubin > 4 mg/dL), strong (dilated CBD > 6 mm on US with gallbladder in situ and total bilirubin level of 1.8–4.0 mg/dL) and moderate (abnormal liver biochemical test other than bilirubin, age more than 55 years and clinical findings of biliary pancreatitis) predictive factors have been proposed. Patients who have any of very strong or two of the strong predictors are defined to have a high risk for CBDS and preoperative ERCP has been recommended in these patients. Patients without any predictive factor are defined to have low risk and in these patients laparoscopic cholecystectomy is recommended without further investigation. The remaining patients are defined to have intermediate risk and in these patients confirmation of the stone is recommended according to the clinical preference, either preoperative (endoscopic ultrasound (EUS) or magnetic resonance cholangiopancreatography (MRCP)) or intraoperative (laparoscopic intraoperative cholangiography (IOC)). It is noticed that adverse events occur more often in patients with low risk of choledocholithiasis [18]. Therefore the best possible patient selection for ERCP procedure is needed. However, because the unnecessary CBD exploration, and the cost, the limited availability of these investigations and it is complication, in this study we felt a need for useful predictive factors to predict a patients having a high risk of choledocholithiasis so that these modern interventions can be selectively utilized [19].

Patient and Methods:

Data was collected from consecutive patients diagnosed with cholelithiasis and choledocholithiasis by clinical presentations, ultrasonography and liver function tests at Ibn Sena Hospital which were satisfying our inclusion criteria (Age > 18 years, patient with cholelithiasis and choledocholithiasis, or symptoms that could suggest suspected choledocholithiasis, procedural indications of pancreatitis, ascending cholangitis, biliary dilatation, and abnormal liver function test results). Then clinical presentations (biliary colic, jaundice, itching, dark urine, pale stool, acute pancreatitis and ascending cholangitis), LFT (Total bilirubin, ALP, AST and ALT) and ultrasonographic findings (dilated CBD > 6mm, visible CBD stone and number of gallbladder stone) were analyzed retrospectively by using SPSS computer program version 25. Chi square, Student *t* test and descriptive statistic will be used when appropriate. The p value will be considered significant if ≤ 0.05.

Results:

A total of 72 patients in Ibn Sina specialized hospital diagnosed as cholelithiasis and choledocholithiasis by ultrasonography and liver function tests, then confirmed by either MRCP or ERCP, all of them satisfied the inclusion criteria. Of all patients, 86% (n=62) confirmed to have CBD stone, and 14% (n=10) did not have CBD stone.

The age range was from 26 to 90 years [mean age of 52.26 ±13.9]. Male were 26% (n=19) and female were 73% (n=53), and male to female ratio was 1:3 (Figure 1.3).

We studied different presentations of CBD stone as predictive factors. Of those 72 patients, there was 63% (n=46) who presented with biliary colic, 84.8% (n=39) of them with CBD stone and 15.2% (n=7) without CBD stone. 33% (n=24) of total patients presented with itching, 87.5% (n=21) of them with CBD stone and 12.5% (n=3) without CBD stone. 66% (n=48) presented with jaundice, 89.6% (n=43) of them with CBD stone and 10.4% (n= 5) without CBD stone. A 76% (n=55) presented with dark urine, 92.7% (n=51) of them with CBD stone and 7.3% (n=4) without CBD stone, it had statistically significant ($p < 0.05$). 36% (n=26) presented with pale stool, 88.5% (n=23) of them with CBD stone and 11.5% (n=3) without CBD stone. There was only 5% (n=4) patients who

presented with pancreatitis, and all of them had CBD stone. Also there was only 4% (n=3) patients who presented with cholangitis, and all of them had CBD stone (Table 1.3).

There were 70% (n=51) patients who had total bilirubin level more than 2mg/dl, 92.2% (n=47) of them with CBD stone and 7.8% (n=4) without CBD stone. 30% (n=21) had total bilirubin level less than 2mg/dl, 71.4% (n=15) of them with CBD stone and 28.6% (n=6) without CBD stone, it had statistically significant ($p<0.05$). The mean of total bilirubin was 4.9 ± 5.77 (Table 2.3, Figure 2.3).

There were 61.1% (n=44) patients who had ALP level more than 150 IU/L, 95.5% (n=42) of them had CBD stone and 4.5% (n=2) without CBD stone. 39.9% (n=28) had ALP level less than 150 IU/L, 71.4% (n=20) of them with CBD stone and 28.6% (n=8) without CBD stone, it had statistically significant ($p<0.05$). The mean of ALP level was 282.6 ± 179.22 (Table 2.3, Figure 3.3).

A 52.8% (n=38) patients had AST level more than 40 IU/L; all of them had CBD stone. And 47.2% (n=34) had AST level less than 40 IU/L, 70.6% (n=24) of them had CBD stone and 29.4% (n=10) without CBD stone, it had statistically significant ($p<0.05$). The mean of AST was 54.08 ± 51.805 (Table 2.3, Figure 4.3).

The ALT level was more than 40 IU/L in 43.1% (n=31) patients, 96.8% (n=30) of them with CBD stone and 3.2% (n=1) without CBD stone. And it was less than 40 IU/L in 56.9% (n=41), 78% (n=32) of them with CBD stone and 22% (n=9) without CBD stone, it had statistically significant ($p<0.05$). The mean of ALT was 51.89 ± 74.83 (Table 2.3, Figure 5.3).

There were 73.6% (n=53) had a visible common bile duct stone on ultrasonography, 94.3% (n=50) of them with CBD stone and 5.7% (n=3) without CBD stone. 26.4% (n=19) had no visible CBD stone on ultrasonography, 63.2% (n=12) of them with CBD stone and 36.8% (n=7) without CBD stone, it had statistically significant ($p<0.05$) [figure (6)]. Of 72 patients 88.9% (n=64) had dilated common bile duct more than 6 mm, 92.2% (n=59) of them had CBD stone and 7.8% (n=5) without CBD stone. 11.1% (n=8) had a normal CBD diameter, 37.5% (n=3) of them had CBD stone and 62.5% (n=5) without CBD stone, it had statistically significant ($p<0.05$) (Table 3.3).

There were 58.3% (n=48) had multiple gall stones on ultrasonography, 89.6% (n=43) of them with CBD stone and 10.4% (n=5) without CBD stone. 19.4% (n=14) had solitary gall stone, 85.7% (n=12) of them with CBD stone and 14.3%

(n=2) without CBD stone. 13.9% (n=10) had sludge on ultrasonography, 70% (n=7) of them had CBD stone and 30% (n=3) without CBD stone. The number of gall stones was statistically significant ($p<0.05$) (Table 3.3).

These statistically significant predictive factors were used to develop scoring system. Total bilirubin, ALP, dilated CBD and visible CBD stone on ultrasonography were included in scoring system. Analysis of each predictive factor showed 92.9% positive predictive value (PPV) for total bilirubin, 95.5% PPV for ALP, 92.2% PPV for CBD diameter > 6 mm and 94.3% PPV for visible CBD stone on ultrasonography. Each of these factors was given a score of 1. The scoring system was applied to all total patients. The scoring system was studied by assessing the positive and negative predictive values for diagnosing choledocholithiasis as shown in (Table 4.3).

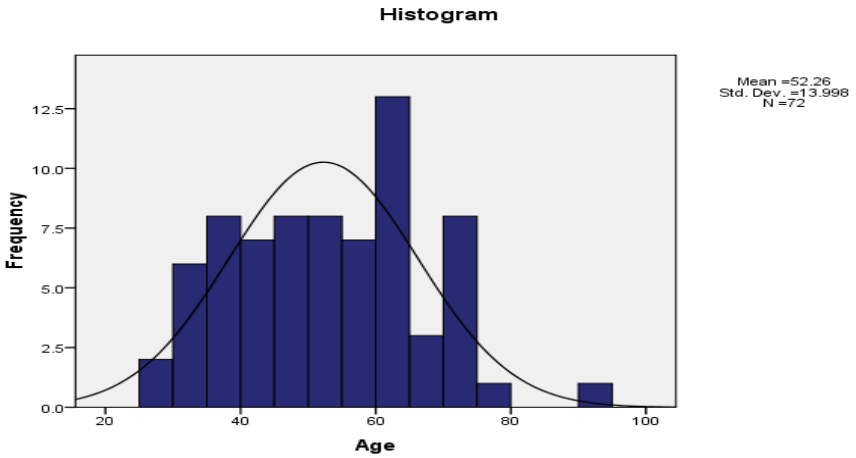

Figure (1.3): histogram showing age of patient (n=72)

Table (1.3): Clinical presentations

	Presence of CBD stones		Total from 72	P value
	Yes	No		
Biliary colic	39 84.8%	7 15.2%	46	.670
Jaundice	43 89.6%	5 10.4%	48	.234
Itching	21 87.5%	3 21.5%	24	.813
Dark urine	51 92.7%	4 7.3%	55	.003
Pale stool	23 88.5%	3 11.5%	26	.670
Pancreatitis	4 100%	0 0%	4	.416
Cholangitis	3 100%	0 0%	3	.484

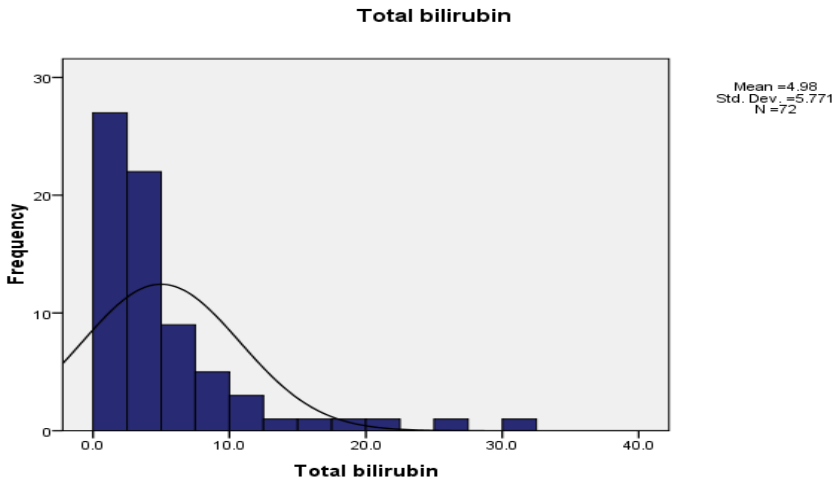

Figure (2.3): histogram of total bilirubin (n=72)

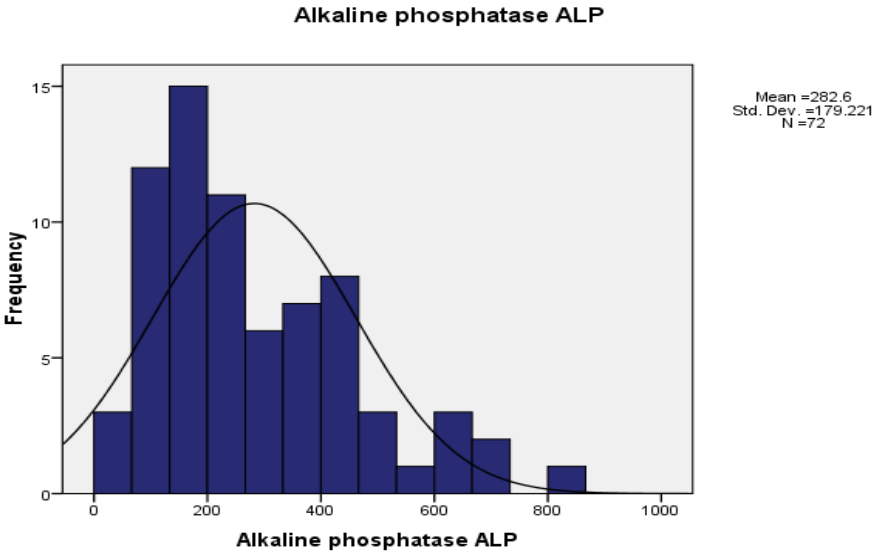

Figure (3.3): histogram of alkaline phosphatase

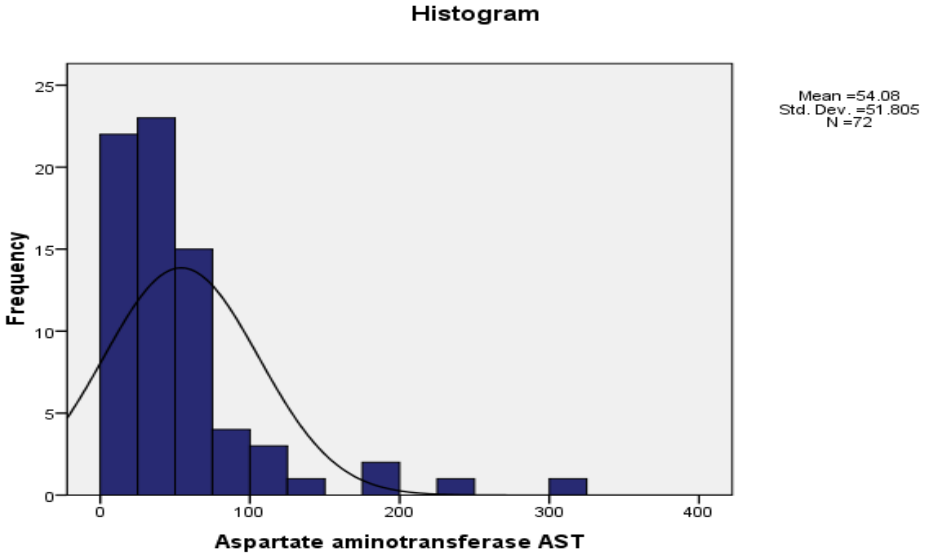

Figure (4.3): histogram of aspartate aminotransferase

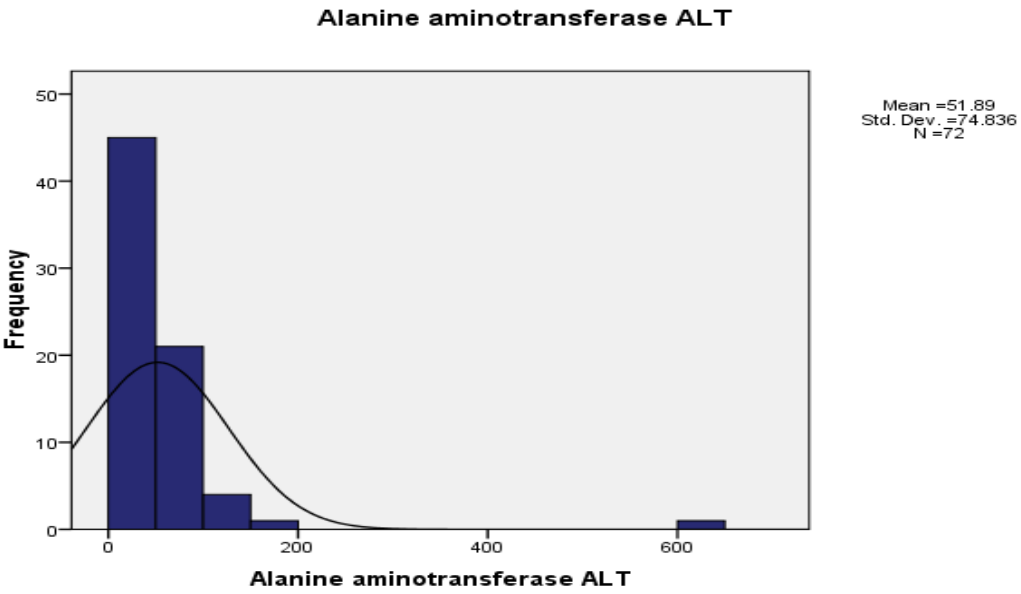

Figure (5.3): histogram of alanine aminotransferase

Table (2.3): Association of liver function tests with choledocholithiasis(n=72)

	Presence of CBD stones		Total from 72	P value
	Yes	No		
Bilirubin	47 92.2%	4 7.8	51	.01
ALT	30 96.8%	1 3.2%	31	.01
AST	38 100%	0 0%	0	.000
ALP	42 95.5%	2 4.5%	44	.004

Table (3.3): Association of Ultrasonographic findings with choledocholithiasis

		Presence of CBD stones		Total from 72	P value
		Yes	No		
CBD diameter of > 6mm		59 92.2%	5 7.8%	64	.000
Visible CBD stone		50 94.3	3 5.7	53	.001
Number of CBD stones	Solitary	12 85.7%	2 14.3%	14	
	Multiple	43 89.6%	5 10.4%	48	
	Sludge	7 70%	3 30%	10	.04

Table (4.3): Performance characteristics of scoring system

Score	Patients with CBD stone	Patients without CBD stone	PPV for CBD stone(%)	NPV for CBD stone(%)
0	0	2	0%	100%
1	2	4	33.3%	66.7%
2	14	2	87.5%	12.5%
3	18	2	90%	10%
4	28	2	100%	0%

Discussion:

Due to limited availability of ERCP, EUS, Intraoperative cholangiogram and MRCP in Sudan along with their complications and cost, we attempted to achieve a more reasonable and safer approach for patients suspected to suffer from CBD stone. Then we studied the performance of different predictive factors for CBD stone in our population including the presentations, liver function test and ultrasonographic findings. Then we suggested a simple scoring system for predicting a possible diagnosis of choledocholithiasis in patients with cholelithiasis especially those planed for cholecystectomy.

In our study the mean age was 52.26 ±13.9 and male to female ratio was 1:3. A study conducted by Bilal O. Aljiffry et al in Saudi Arabia showed that the age had statistically significance for prediction of CBD stone and they included it in their scoring system for detection of CBD stone [(20)]. Barkun An el at showed that age plays a significant role in predicting CBD stone, and the prevalence of gallstone increases with age [(12)]. Our results similar to study of Anas Kadah el at, they divided their total patients into two groups according to presence of CBD stone, the mean age of groups A and B were 52.6 ± 19.5 and 63.1 ± 19.6 years, respectively and it is statistically significance [(21)]. On contrast, Ausra Aleknaite et al, showed that the mean age of their total patients was 65.2 ± 17.9, mean age of patients with CBD stone was 66.3 ± 17.7 and mean age of patients without CBD stone was 63.3 ± 18.1, and they reveal that patient's age and sex distribution did not show differ statistical significance [(22)]. Also in study conducted by Michele Grande et al, revealed that mean age was 52 ± 15.3 years which is similar to our study [23]. Frederic Part et al, showed that The prevalence of CBD stone was shown to increase from 14% in patients less than 70 years old, to 32% in patients over 70 years old in a group of patients referred for EUS to rule out CBD stone [(24)].

Bivariate analyses of the presentations for choledocholithiasis in our study (jaundice, biliary colic, itching, dark urine, pale stool, pancreatitis and cholangitis) were not statistically significant ($p < 0.05$), acute pancreatitis and cholangitis had 100% PPV in our study but they were not statistically significant because there was small study sample. Ausra Aleknaite et al showed that jaundice, acute biliary pancreatitis and cholangitis were statistically significant [(22)]. Megan A. Adams et al, found that biliary pancreatitis had a sensitivity of 41.7% and specificity of

68.9% in diagnosing choledocholithiasis, with over all accuracy of 58.9% [25]. Huiqin He et al showed that acute pancreatitis decreased the likelihood for choledocholithiasis in definitive test [26]. In study conducted by Saurabh Sethi et al, Univariate logistic regression analysis was carried out to test the association between the eight variables used for ASGE stratification and the presence of stone at ERCP. Suspected ascending cholangitis (OR=1.9), bilirubin values between 1.8 mg/dl and 4 mg/dl (OR=1.7), elevation in liver enzymes (OR=2.1), and choledocholithiasis seen on pre-ERCP imaging (OR=3.6) were found to be significant predictors for the presence of stones at ERCP [27]. In study Rodrigo M. Narvaez-Rivera et al, multivariable logistic regression analysis showed that the presence of ascending cholangitis and the absence of biliary pancreatitis (OR 3.23; 95% CI, 1.81-5.77; $p < 0.001$) were independently associated with the presence of a stone on ERCP. The occurrence of biliary pancreatitis was a strong protective factor for the presence of a retained CBD stone (OR 0.30; 95% CI, 0.17-0.55; $p < 0.001$) [28].

In our study the total bilirubin, alkaline phosphates (ALP), aspartame aminotransferase (AST) and alanine aminotransferase (ALT) were significantly associated with choledocholithiasis ($p< 0.05$). In study conducted by Bilal O. Aljiffry et al, showed that the ALP, ALT and total bilirubin were significantly correlated with the CBD stone [20]. Our study was similar to study conducted by Sheshang U. Kamath et al, which showed that on bivariate analysis, total bilirubin >2 mg/dl, amylase >90 IU/L, ALP > 190 IU/L, and AST and ALT > 40 IU/L were significantly associated with choledocholithiasis ($p < 0.05$) [19]. Large prospective study by Videhult et al, analyzed these biochemical parameters in cohort of patients with symptomatic cholelithiasis which found ALP and total bilirubin to predict choledocholithiasis [29]. In study conducted by Ming-Hsun Yang et al, found that gamma glutamyle transferase (GGT), ALP, total bilirubin, ALT and AST were significantly associated with choledocholithiasis. And after multivariate analysis of five biochemical predictors, the GGT appeared to be the most powerful independent predictor, with an odds ratio of 3.20. ALP and total bilirubin were also independent predictors [30]. W. K. Peng et al studied the role of LFT in evaluating CBD stone in patients with cholelithiasis. Using several cut-off levels, γ-glutamyl transpeptidase (GGT) had the highest specificity, positive predictive value and negative predictive value, comparable to a scoring system that combined all LFTs. Bilirubin was the least specific and predictive. Also

represented a one in three chance of CBD stones when the GGT level was above 90 units/l and a one in 30 chance when the level was less than 90 units/l [31]. Alejandro L. Suarez et al, found that in multivariable logistic regression analysis revealed that a bilirubin level higher than 4 mg/dl [odds ratio 4.85; 95 % confidence interval (CI) 1.82–12.92] and a stone visualized on US (odds ratio 6.4; 95 % CI 1.50–27.3) were independently associated with the presence of a stone on ERCP, EUS, MRCP, or IOC [32]. Mohammad Zare et al, found that mean of AST. ALT, ALP and total and direct bilirubin had no significant differences between two study groups. In logistic regression analysis, after entering into the model only CBD diameter (OR: 20; P=0.00) and elevated serum level of ALT (OR: 2; P=0.04) were remained into the model and were known as independent predictor of cholelithiasis. Elevated level of liver enzymes had not main role in CBD diagnosis and ERCP had no to perform for suspicious CBD stone only with elevated liver enzyme and even with normal ultrasonography findings [33].

The results of our study showed that dilated CBD more than 6 mm, visible CBD stone and number of gallstones on ultrasonography were statistically significant for choledocholithiasis. In study conducted by Bilal O. Aljiffry et al, showed that the presence of a CDB acoustic shadow during ultrasonography and CBD diameter of > 10mm were significantly correlated with choledocholithiasis [20]. Evaluation of different criteria in study conducted by Ausra Aleknaite et al showed that dilated CBD and presence of CBD stone on ultrasonography were stronger predictors than elevated total bilirubin [22]. Megan A. Adams et al revealed that the presence of a stone on ultrasonography had sensitivity of 21.8%, specificity of 93.5 and an accuracy of 63.4% in diagnosing choledocholithiasis [25]. CBD width by ultrasonography in study conducted by Anas Kadah et al, were statistically significant in univariate and multivariate analysis [21]. Michele Grande, MD et al, showed that number of gallbladder stones and CBD diameter (mm) were statistically significant [23]. In retrospective study conducted by Ufuk B. Kuzu et al, according to the American Society for Gastrointestinal Endoscopy (ASGE) found that all very strong and strong predictors were found to be significantly higher among patients who had CBD stone, detection of CBD stone by ultrasonography and dilated CBD were observed to be independent risk factors associated with the existence of CBD stone [34]. Maffalda Sousa et al, included patients in their study with gallbladder in situ and with cholecystectomy. They showed that the ASGE criteria true positive rate was similar between patients with

and without cholecystectomy. The prevalence of choledocholithiasis on ERCP was 71% in cholecystectomized and 70% in non-cholecystectomized. In addition, both the presence and the diameter of the CBD stone were predictors of positive ERCP in both groups. In contrast, the diameter of the CBD was predictor of positive ERCP only in non-cholecystectomized patients [(35)]. Multivariate logistic regression analysis in study conducted by Saurabh Sethi et al was done to test the association between eight predictor variables used for ASGE stratification and the presence of stone at ERCP. Only the presence of choledocholithiasis on imaging studies (OR: 3.98; 95% CI2.3–6.8; P<0.01), and bilirubin values between 1.8mg/dl and 4mg/dl (OR: 1.9; 95% CI 1.0–3.4; P=0.04) were found to be independent predictors of stones at ERCP [(27)]. In study Rodrigo M. Narvaez-Rivera et al, multivariable logistic regression analysis showed that a CBD > 6 mm (OR 2.21; 95% CI, 1.20-4.10; p = 0.011) and CBD stone visualized on transabdominal US (OR 3.33; 95% CI, 1.48-7.52; p = 0.004) were independently associated with the presence of a stone on ERCP [(28)].

In our study we used most significant predictive factors to develop a simple scoring system. Total bilirubin, ALP, dilated CBD and visible CBD stone on ultrasonography were included in the score. In study conducted by Bilal O. Aljiffry et al, the scoring system were developed from predictive factors such as the presence of CBD acoustic shadow during ultrasonography, a CBD diameter of > 10 (mm), ALP > 200 IU, ALT > 220 IU, elevated serum bilirubin level and a male age of > 50 years [(20)]. Sheshang U. Kamath et al, build a scoring system consisting of four factors: dilated bile duct on ultrasonography > 6 mm, total bilirubin > 2mg/dl, ALP > 190 IU/L, AST > 40 IU/L. Each of these predictors was given a score of 1 [(19)]. N. Menezes et al showed that multivariate analysis of age, sex, jaundice, ascending cholangitis, transaminases, CBD diameter and CBD stone in ultrasonography were statistically significant and used for a predictive scoring system for choledocholithiasis. The overall sensitivity and specificity of this score were 82% and 80%, respectively [(36)]. Jingjing L. Sherman et al, developed a score consist of CBD diameter, GGT, ALP, and total bilirubin A score of 0 had negative predictive value (NPV) of 100% for CBD stones (P <.001). Scores of 1 and 2 had NPV of 81% and 83%, respectively. A score of 3 had NPV of 60%. A score of 4 had PPV of 67% (P = .002). A score of 5 had PPV of 100% (P <.001). The overall accuracy of the scoring system was 88% [(37)].

This study has several limitations. First, GGT which has been considered by

previous studies as an important predictor of choledocholithiasis was not assessed in our study. Second limitation that we did not validate our findings in an independent validation cohort. Third, we observed a delay in the time between the patient's diagnosis and the time of ERCP, and these delays may theoretically increase the possibility that CBD stones were passed before ERCP, and thereby increase the number of negative ERCP results. The last limitation is the small sample size and lack of proper diagnostic techniques.

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