



Original Research Article

Transabdominal Ultrasonography in Symptomatic Choledocholithiasis – Usefulness in Settings with Limited Resources

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ABSTRACT

Objective: Ultrasonography remains the initial imaging modality in the management of biliary disease. This study is designed to evaluate the accuracy of transabdominal ultrasonography in diagnosing biliary pathology in patients with choledocholithiasis.

Methods: This was a retrospective study of a continuous sample of patients over a period of 3 years ending in January 2016; these patients were referred for endoscopic management of choledocholithiasis to a tertiary care hospital in Colombo, Sri Lanka. Ultrasound reporting was carried out by different consultant radiologists at both the index and the referring hospitals. The findings of endoscopic retrograde cholangiograms were compared with the ultrasound scan (USS) results.

Results: A total of 247 patients were included in the study. USS was 97.4% accurate in detecting intrahepatic duct dilatation (IHDD). Stone counts and the location of stone(s) in the USSs correlated strongly with the number of stones delivered during endoscopic removal and their location in cholangiograms ($P < 0.001$). The difference in mean diameter of the common bile duct (CBD) of patients with choledochal cysts (CCs) (18.57 mm) and of patients without them (12.39 mm) is statistically significant ($P < 0.001$). At 14.5 mm, the negative predictive value for a CC is 99.02%.

Conclusion: Ultrasonography is a reliable tool in predicting IHDD, stone count, and the location of stones in the biliary tree, particularly in a resource-poor setting. A CBD diameter of 14.5 mm in transabdominal ultrasound scan can be used as a cutoff for predicting extrahepatic CC.

Keywords: Ultrasonography in choledocholithiasis, Intrahepatic duct dilatation, Choledochal cyst, Common bile duct

INTRODUCTION

The accuracy of transabdominal ultrasonography (TAUS) scan in detecting gallbladder stones is well established, with high sensitivity (85%–95%) and 100% specificity.^[1-3] However, its appropriateness in the diagnosis of common bile duct stones (CBDS) and other pathologies of the biliary tree is unclear. TAUS was found to be only 80% sensitive and 87.5% specific for the detection of CBDS in one small-scale study.^[4] More advanced imaging modalities such as magnetic resonance cholangiopancreatography (MRCP) or an endoscopic ultrasonography

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(EUS) are often used for the detection and confirmation of pathologies of the biliary tree; however, TAUS remains the first line of investigation when any biliary pathology is suspected. Moreover, the American Society of Gastroenterology guidelines for the management of choledocholithiasis recognizes ultrasonographic detection of CBDS as a very strong predictor and a dilated bile duct as a strong predictor for finding CBDS.^[5]

Endoscopic retrograde cholangiopancreatography (ERCP) is considered the gold standard in diagnosing any biliary pathology. However, due to the procedure's invasive nature and potentially serious complications, ERCP has lost its place as a diagnostic tool.^[6] On some compelling occasions, the decision to offer ERCP is based solely on the ultrasound scan (USS) report, particularly in settings, where EUS and MRCP are not available or unaffordable. Thus, knowledge of the predictive capacity of TAUS findings is useful in the initial planning of treatment, as it enables better communication between the medical team and the patient. Moreover, it can indicate what to expect in each case before ERCP is undertaken. The present study was designed to identify the accuracy of TAUS in detailing the clinically important characteristics of CBDS and biliary pathologies in patients with choledocholithiasis.

METHODS

This was a retrospective study involving patients referred to a single surgical unit, a Sri Lankan tertiary care center for hepatopancreaticobiliary disease and management of CBDS, from all parts of the country. Patients who underwent ERCP for the 1st time and as their primary treatment modality were included in the sample, while those who underwent ERCP following other biliary interventions and patients who underwent follow-up studies were excluded. The study period lasted 3 years, from January 2013 to January 2016. Data were collected from the ERCP database and patient records. Informed and written consent was obtained from all patients before the collection of data.

Reporting of the TAUS included in this study was carried out by several consultant radiologists. When two or more USS reports were available, the data from the first scan were considered. Intrahepatic duct dilatation (IHDD) was defined as bile ducts having a diameter >40% of the diameter of the adjacent portal vein tributary or ducts larger than 2 mm.^[7] The maximum diameter of the common bile duct (CBD) was considered to be the CBD diameter, and the stone number indicated in the USS was categorized into four groups (one, two, three, and three or more stones). CBD dilatation is defined as a maximum CBD diameter of >6 mm.^[7] Supraduodenal, retroduodenal, and infraduodenal CBD are considered as proximal, mid, and distal CBD, respectively. ERCP findings were traced from the ERCP

database and reconfirmed with patient records. Photographs of the cholangiograms before any intervention, which are saved for reference, were traced from the database for all patients [Figures 1 and 2]. The TAUS details were cross-checked with the details of the cholangiograms, and the Todani classification of biliary cysts was used to characterize choledochal cysts (CCs).^[8]

RESULTS

Initially, a continuous sample of 312 patients who underwent endoscopic treatment for choledocholithiasis was selected;

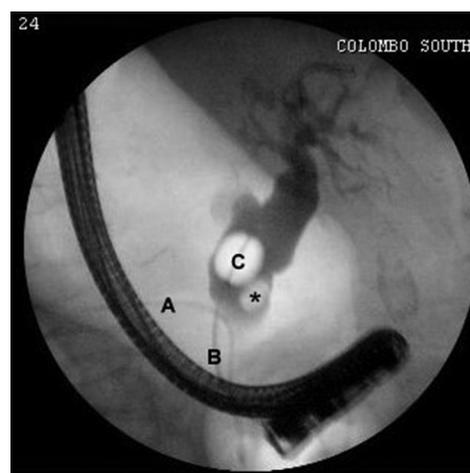


Figure 1: Cholangiogram of a 62-year-old male patient presented with a distal common bile duct (CBD) stone (*) causing CBD dilatation and intrahepatic duct dilatation. Prophylactically inserted pancreatic duct stent (A) after accidental cannulation of the pancreatic duct, balloon catheter (B) with the inflated bulb (C) are also seen.

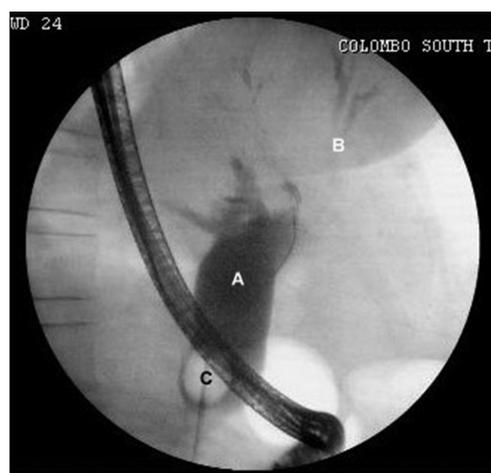


Figure 2: Occlusive cholangiogram of a 42-year-old female patient with Type 1 choledochal cyst complicated with choledocholithiasis. Largely dilated common bile duct (A) without intrahepatic duct dilatation (B) and bulb of the balloon catheter (C) are seen.

the number was reduced to 247 due to inadequacy of data. The mean age of the study population was 53.6 years (age range 15–85), and the male-to-female ratio was 1:1.23. The mean age was 58.8 years (standard deviation [SD] 11.2) for males and 50 years (SD 13.9) for females. The difference between the mean ages of males and females was statistically significant ($P < 0.001$). As to symptoms, 145 patients (58.7%) presented with obstructive jaundice, 62 (25.1%) with cholangitis, 35 (14.2%) with upper abdominal pain or biliary colic, and 5 (2%) patients underwent ERCP following gallstone pancreatitis. The mean time gap between the onset of symptoms and the USS was 2 days, with a range of 1–4 days. Thirteen consultant radiologists were involved in USS reporting.

IHDD and CBD dilatation

IHDD was reported in USS in 239 (94.5%) patients, of whom 233 (92.1%) were confirmed by cholangiogram to have IHDD. USS was 97.4% sensitive but only 70% specific for the diagnosis of IHDD. The positive predictive value for IHDD was also 97.5%, and the positive likelihood ratio was 3.25. CBD dilatation was noted in 230 patients in USS and confirmed with ERCP in 220 patients, for a sensitivity of 95.6% and a specificity of 72.9%.

Stone count

Details of the USS and ERCP findings regarding the number of stones detected appear in Table 1. The Spearman coefficient of correlation was very strong (0.949) and highly significant ($P < 0.001$).

Stone location

The results regarding the location of stone(s) in the biliary tree in USS and ERCP are shown in Table 2. The Spearman coefficient of correlation was strong (0.701) and highly significant ($P < 0.001$).

CC

Using ERCP, 21 patients in the sample were diagnosed as having CCs, all of which were Todani type 1 (9 with type 1A and 12 with type 1B). However, USS raised the possibility of a CC in only eight of these patients. The mean CBD diameter of patients with CCs indicated by USS was 18.57 mm (SD 3.3), whereas the mean diameter of those without CC features was 12.39 (SD – 1.9). The difference between the two means was strongly significant ($P < 0.001$). The strength of association was checked for various diameter cutoffs using receiver operating characteristic (ROC) curves, which demonstrated that the CBD diameter showed excellent accuracy in predicting the existence of CCs.

Table 1: Comparison of USS findings and ERCP diagnosis as to number of stones.

Stone count in USS	Stone count in ERCP				Total
	1	2	3	Multiple	
1	118	2	0	1	121
2	4	21	1	8	34
3	0	0	0	1	1
Multiple	0	2	4	85	91
Total	122	25	5	95	247

ERCP: Endoscopic retrograde cholangiopancreatography,
USS: Ultrasound scan

Table 2: Location of stone (s) according to USS and ERCP.

Location of stone (s) using USS	Location of stone (s) using ERCP				Total
	Intrahepatic	Proximal	Mid	Distal	
Intrahepatic	2	0	0	0	2
Proximal	0	16	3	0	19
Mid	0	1	56	4	61
Distal	0	5	35	125	165
Total	2	22	94	129	247

ERCP: Endoscopic retrograde cholangiopancreatography,
USS: Ultrasound scan

Table 3: Sensitivity and specificity at different CBD diameters.

USS CBD diameter (mm) predicting CC	Sensitivity	Specificity
7	1	0
8.5	1	0.039
9.5	1	0.095
10.5	1	0.156
11.5	1	0.294
12.5	1	0.528
13.5	0.952	0.68
14.5	0.905	0.874
15.5	0.762	0.965
16.5	0.667	0.983
17.5	0.667	0.996
18.5	0.524	1
19.5	0.429	1
21.5	0.19	1
23.5	0.095	1
25	0	1

USS: Ultrasound scan, CBD: Common bile duct, CC: Choledochal cyst

What the information in ROC curve proves is that the CBD diameter found in USS is a diagnostic test of good discriminatory ability for CCs. Table 3 uses coordinates from the ROC curve to find a suitable CBD diameter cutoff value for the prediction of CCs. Smaller diameters have high sensitivity but poor specificity, while greater diameters have

poor sensitivity and high specificity. The cutoff diameter of choice (14.5 mm) offers a good balance of sensitivity and specificity.

CBD strictures

Nine (3.6%) patients were diagnosed with CBD strictures by ERCP, only two of whose USS results suggested CBD strictures. However, there were not enough data to further analyze any correlation in this regard.

DISCUSSION

Ultrasonography is a highly operator-dependent mode of investigation, so it is very difficult to design studies to standardize its findings. Including USS reports from 13 independent radiologists in this study have helped to minimize subjectivity. However, having to include TAUS reports of different radiologists is also considered as a limitation of this study as this increase the variability in the skills and experience of them. All consultant radiologists were certified radiologists in the board of study for radiology in Postgraduate Institute of Medicine, University of Colombo, Sri Lanka. Since outcome prediction is more relevant at the beginning of a clinical encounter, this study considered the first USS when more than one report was available. This also maximized homogeneity because only few patients had more than one TAUS. Excluding patients who had previously undergone biliary interventions confine the results to patients with virgin biliary trees.

Knowledge of the strengths and limitations of TAUS in choledocholithiasis is important in patient management. The reported accuracy of TAUS in detecting CBDS in suspected choledocholithiasis has varied in different studies.^[9-11] From the results of the present study, it is evident that USS is highly accurate in identifying the number and location of stones, two important features that can influence the management plan. However, the stone count in TAUS was less accurate with multiple stones despite its overall excellent accuracy. Similarly, TAUS was less accurate in identifying the location of proximal stones. The possibility of stone migration between the interval between TAUS and ERCP could explain this discrepancy. These two limitations should be kept in mind when managing patients using only TAUS. This also contradicts with the common perception of TAUS being less accurate in visualizing the distal CBD due to the obscuration by bowel gas.

IHDD, which is always a reliable marker of biliary obstruction, can be very accurately detected with TAUS. Properties of stones are known to affect the outcome of endoscopic clearance; large, impacted, multiple, or intrahepatic stones are considered difficult to extract.^[12,13] The ability to identify patients with difficult stone characteristics

in the initial TAUS enables their early transfer to centers with the appropriate expertise, and more advanced modalities like laser lithotripsy can be used to clear those stones. Moreover, the endotherapeutic team can be better prepared to manage difficult cases with expert personnel and equipment when the difficulty can be predicted with TAUS characteristics.

Only a few studies have been conducted to assess the accuracy of USS in detecting CCs. In a review, transabdominal USS had variable sensitivity (71%–97%) for CC diagnosis.^[14] The diagnosis of a CC requires demonstration of the continuity of the cyst with the biliary tree so that it can be differentiated from other intrabdominal cysts. This is difficult with TAUS alone due to its limited precision in visualizing the extrahepatic biliary tree.^[15] Moreover, the vast majority of patients with symptomatic choledocholithiasis have a dilated CBD. TAUS thus has very limited capacity in diagnosing CCs, necessitating more advanced imaging modalities.

According to the present study, a maximum CBD diameter of 14.5 mm can be used to predict, with a sensitivity of 90.5% and a specificity of 87.4%, the presence of a CC. Because the CBD diameter is an objective measurement, operator dependency is eliminated to a significant extent. The distinction between a dilated CBD due to distal obstruction by CBDS and a CC complicated with stone formation can be sorted out early by applying this finding, which essentially triggers a change in the management plan. The CBD diameter given in the USS can thus be used to reliably predict CC, although TAUS is inferior to other imaging modalities in sensitivity and specificity for CC diagnosis. However, this finding cannot be generalized to all CCs, as the present study did not include intrahepatic and other rare types of CCs. This finding is also limited to patients with CCs complicated with choledocholithiasis.

CBD diameter is known to increase with age,^[16,17] although this age-related increase in diameter was not found in patients with choledocholithiasis in a study conducted by Karamanos *et al.*^[18] Therefore, these cutoff values for the prediction of CC can be safely used without a correction for the advancing age. These findings can only be applied when the maximum diameter used is the CBD diameter, not the diameter at the hilum. Because IHDD and CBD dilatation in ERCP is a subjective finding, it is difficult to standardize the results of this study.

In Sri Lanka, TAUS remains the first-line imaging modality in investigating patients with a biliary pathology. In all tertiary care hospitals and in many secondary care hospitals, a consultant radiologist is available to provide this service. Sri Lanka has three MRI machines in government hospitals to date. In Colombo south teaching hospital, in which this study was carried out, no MRI machine is available up to date to provide MRCP for patients, despite being a premier center for hepatobiliary diseases. Few private hospitals offer

MRCP as the standard imaging for all indicated patients. The government hospitals at the moment in Sri Lanka cannot provide MRCP for all indicated patients. Often, management decisions are made, solely on the findings of TAUS. However, with rapidly growing economy and developing health-care system, MRCP will soon be available more readily to Sri Lankan patients. Outcomes of this study are useful in managing patients in health-care setups with similar availability of resources.

CONCLUSION

In settings with limited resources, where EUS and MRCP are not readily available, clinicians must depend heavily on TAUS. Since limited data are available in literature for the usefulness of TAUS in CBDS, the results of this study are of particular value to resource-poor centers. The results of this study demonstrate that TAUS is a reliable tool to infer the presence of IHDD. Moreover, the number and location of CBDS can be predicted accurately with TAUS. This is useful in the decision-making process before endotherapeutic procedures. As to extrahepatic Type I CCs, the CBD diameter given in TAUS can be used to predict their presence, at a CBD diameter cutoff of 14.5 mm.

Ethics approval

Ethics approval for the conduct and publication of this study was obtained from the Ethics Review Committee of the Faculty of Medical Sciences, University of Sri Jaywardenepura, Nugegoda, Sri Lanka (Ref. number 32/15).

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the journal. The patient understands that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

WSLD, TKW, BDG, and AAP designed the study. WSLD and BKD carried out the data collection and statistical analysis. WSLD wrote the manuscript. AAP, TKW, and MMD revised and restructured the manuscript. All authors read and approved the final manuscript.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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