Original Research Article

Comparative study of diagnostic accuracy of magnetic resonance cholangiopancreatography (MRCP) with ultrasonography in choledocolithiasis with post endoscopic retrograde cholangio-pancreatography (ERCP) correlation

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Abstract

Background: Choledocolithiasis may be classified into primary and secondary forms. Primary choledocolithiasis denotes de novo formation of stones, often made of calcium bilirubinate within the ducts.

Materials and Methods: The present prospective comparative study was conducted in the Department of Radio Diagnosis and Imaging, SMHS hospital, Government medical college srinagar. Patients admitted or attending OPD in SMHS hospital with suspected obstructive jaundice or who were known case of obstructive jaundice were included in the study. The study was performed on all patients after written informed consent was acquired from them. The study was carried out over a period of 24 months from August 2014 to July 2016.

Results: Total 70 patients were selected for this comparative study after taking informed consent. Among 70 patients 50 patients were found to have choledocolithiasis. Rest 20 patients were found to

have obstructive jaundice due to causes other than choledocolithiasis. Out of 70 patients 40 (57%) patients were female and 30 (43%) patients were male.

Conclusion: USG is inexpensive, non-invasive modality for choledocolithiasis, however has low sensitivity for detecting distal CBD calculi.

Key words

MRCP, ERCP, USG, Choledocolithiasis.

Introduction

Obstructive jaundice or surgical jaundice is due to obstruction to the flow of bile e.g., stone, stricture or tumor [1], characterized by increase billirubin and abnormalities of alkaline phosphatase [2]. Choledocolithiasis may be classified into primary and secondary forms. Primary choledocolithiasis denotes de novo formation of stones, often made of calcium bilirubinate within the ducts [3]. Migration of the stones from the gall bladder to the common bile duct constitutes secondary choledocolithiasis [4]. Whereas primary choledocolithiasis is relatively rare outside endemic regionsecondary choledocholithiasis is quite common [5], representing the worldwide distribution of gall stone disease. Bile duct stones are found in 8% to 18%of patients with symptomatic gall stones [6].

Multiple non-invasive and invasive methods have been used for the diagnosis of calculi in the bile duct. Sonography is often used as the first line imaging modality in patients with suspected choledocolithiasis [7]. However sonography of the common bile duct is particularly limited by operator dependence. MRCP provides excellent anatomic details and contrast resolution [8], also without use of ionizing radiation [9, 10]. Magnetic Resonance Cholangiopancreatography (MRCP) uses signal produced by fluid within ducts that can create images of the biliary system and pancreatic ductal system. Unlike Endoscopic Retrograde Cholangio-Pancreatography (ERCP) and PTC studies, no extrinsic contrast is necessary [11].

Endoscopic Retrograde Cholangio-Pancreatography (ERCP) is a technique that combines the use of endoscopy and fluoroscopy and is used for diagnosis and treatment of choledocolithiasis. Through the endoscope, the endoscopist can inject radiographic contrast into the ducts in the biliary tree and pancreas so they can be seen on X-rays [12]. ERCP can provide clear images of the hepatobiliary and pancreatic ducts.

The common bile duct is formed near the porta hepatis, by the junction of the cystic and common hepatic ducts. It is usually between 6 and 8 cm long. Its diameter tends to increase somewhat with age but is usually around 6 mm in adults. It descends posterior and slightly to the left, anterior to the epiploic foramen, in the right border of the lesser omentum. It lies anterior and to the right of the portal vein and to the right of the hepatic artery. It passes behind the first part of the duodenum with the gastroduodenal artery on its left, and then runs in a groove on the superolateral part of the posterior surface of the head of the pancreas. It lies anterior to the inferior vena cava and is sometimes embedded in the pancreatic tissue. The duct may lie close to the medial wall of the second part of the duodenum or as much as 2 cm from it. Even when it is embedded in the pancreas, a groove in the gland marking its position can be palpated behind the second part of the duodenum. As it lies medial to the second part of the duodenum; the common bile duct approaches the right end of the pancreatic duct. The ducts enter the duodenal wall together, and usually unite to form the hepatopancreatic ampulla. Rarely the common bile duct and pancreatic duct drain into the duodenum separately.

For evaluation of hepatobilliary system ultrasonography is noninvasive, inexpensive, and readily available modality for assessment. It is usually the first modality used in the diagnosis of patients with biliary – related symptoms. Ultrasonography findings are usually accurate in the diagnosis of gallbladder stones, but CBD stones are missed frequently. On the other hand, CBD dilation is identified accurately, with up to 90% accuracy. CT scan findings are fairly accurate in the detection of biliary tree obstruction and ductal dilatation, both intrahepatic and extrahepatic with 75-90% sensitivity in detection of CBD stones [2]. MRCP is a noninvasive tool with 97% accuracy, 92% sensitivity, and 100% specificity. It is improving with the advent of new sequences in imaging of the CBD. Cost, inconvenience, and limitations (e.g., obesity, presence of metal objects, e.g., pacemakers) are some of its disadvantages. Cholangiography remains the criterion standard for the detection of CBD stones. In the past, intravenous cholangiography was the only available method for assessing the biliary tree, but the results had poor accuracy and sensitivity, not to mention major concerns with allergic reactions [9]. Intravenous cholangiography became obsolete with the introduction of endoscopic retrograde cholangiopancreatography (ERCP) and peructaneous transhepatic cholangiography (PTC).

The aim and purpose of this study was to choose one method which is both reliable and causes no or minimum harm to the patients. Patients with suspected choledocholithiasis were reviewed with USG and MRCP, the results then correlated with ERCP/ post intervention findings and finally the accuracy, sensitivity and specificity of USG, MRCP and ERCP in detecting choledocolithiasis was ascertained.

Materials and methods

The present prospective comparative study was conducted in the Department of Radio Diagnosis and Imaging, SMHS hospital, Government medical college srinagar. Patients admitted or attending OPD in SMHS hospital with suspected obstructive jaundice or who were known case of obstructive jaundice were included in the study. The study was performed on all patients after written informed consent was acquired from them. The study was carried out over a period of 24 months from August 2014 to July 2016. A total of 70 patients who were divided into two subgroups as follows:

- Patients with common bile duct stones at USG
- Patients without common bile duct stones at USG, and comprising two subgroups
    - MRCP positive for calculus
    - Negative USG & MRCP

The armamentarium used had the specifications as under.

- 1.5 tesla **SIEMENS MS (AVENTO) & 3 Tesla** installed in SMHS hospital, with workstation and software.
- USG machine of **Phillips iU 22** (transducer –2.5-12 MHz)
- USG machine of **SIEMENS Pro 300 premium** (transducer –-2.5- 12 MHz)

The data were analyzed using a prescription as a unit. The primary analysis included all prescription who satisfied the inclusion criteria. Data were entered into an Excel Sheet database (MS Office Excel 2000; Microsoft Corporation, Redmond, WA, USA). The Data was analyzed using Minitab 16.1.1 version of statistical software.

Results

Total 70 patients were selected for this comparative study after taking informed consent. Among 70 patients 50 patients were found to have choledocolithiasis. Rest 20 patients were found to have obstructive jaundice due to causes other than choledocolithiasis. Out of 70 patients 40 (57%)

patients were female and 30 (43%) patients were male. Age of the patients was between 11 to 87 years with mean age 49 years. The patients presented with overlapping symptoms of upper abdominal pain, jaundice, clay colored stool, tea colored urine, fever , Nausea, vomiting and weakness. On physical examination patients were found to have icterus, right upper quadrant tenderness, hepatomegaly, anemia and Fever .In many of the patients most of the clinical findings were overlapping.

All the patients were initially worked up with ultrasound examination using supine and left lateral decubitus approach. Tissue harmonic imaging was used for better visualization. Scanning done for search of dilatation of IHBRs, presence of cholelithiasis, dilation of CHD, CBD, presence of CBD stone, other factors causing choledocolithiasis, pancreatitis or any other complicating factors. All the patients underwent MRCP examination. Heavily T2 weighted single shot FSE sequences and thick slab high resolution 3D MRCP sequences were done with secondary reformation. Subsequently all the patients underwent ERCP and size, location, number of stones was assessed. Any other causes of obstruction were assessed.

Findings in USG, MRCP and ERCP were compared and correlated. We calculated the sensitivity, specificity, PPV, NPV and other relevant statistical parameters. Summary result of our study is tabulated are in **Table - 1**. Results from **Table - 1** showed that the ERCP had a highest specificity of 100% in comparison to the USG and MRCP. Table also shows that USG had lowest sensitivity of 48% in comparison to the MRCP and ERCP.

Table – 1: Sensitivity and specificity.

Test	Sensitivity	Specificity	PPV	NPV
USG	48%	90%	92.3%	40.9%
MRCP	93%	95.2%	97.8%	86.9%
ERCP	100%	100%	100%	100%

Subgroup analysis

Group A (Patients in whom CBD calculus was detected on USG)

Out of 70 patients with history of obstructive jaundice. Choledocolithiasis was detected in 24 patients on USG. Ultrasound diagnosed 13 cases of calculi in the proximal CBD, 10 in the middle CBD and 3 in the distal CBD. Ultrasound also detected abnormalities other than choledocolithiasis of which 3 cases were Choledococeles, 5 CBD masses, 4 GB masses and 2 liver masses. Ultrasound could not identify Common bile duct calculus in 26 patients (26 false negative patients). The reason for false negativity was influenced by factors such as the size and site of stones, patient's body habitus and presence of overlying bowel gas. There were 2 false positive patients.

The sensitivity, specificity, positive and negative predictive values of ultrasonography in detecting CBD stones in the present study were: Sensitivity = 48%, Specificity= 90%, Positive predictive valve = 92%

Negative predictive valve = 40.9%.

Group B (USG negative, MRCP and ERCP positive for calculus)

46 patients were positive for choledocolithiasis on MRCP. MRCP diagnosed 13 cases of calculi in the proximal CBD, 23 cases in the middle CBD and 10 cases in the distal CBD. MRCP also detected other various abnormalities of which 3 cases were choledococele, 9 were CBD masses, 4 GB masses and 2 liver masses. There was one false positive on MRCP. The cause of the false positive finding on MRCP was mistaking a

prominent ampullary sphincter for a lower bile duct stone. MRCP could not identify calculus in 4 patients (Four false negative patients). The false negative diagnosis had occurred, due small distal calculus at the level of Ampulla of vater and others were due to lack of contrast between the calculus and adjacent structures. The sensitivity, specificity, positive and negative predictive values of MRCP in detecting CBD stones in the present study were: Sensitivity = 97.8%, Specificity = 82.8%, Positive predictive valve = 92%, Negative predictive valve = 95%.

Group C (USG negative, MRCP negative, ERCP positive)

ERCP detected calculi in 50 patients. This was subsequently confirmed with per operative and post-operative follow ups. On ERCP calculi were seen in proximal CBD in 13 cases, 26 cases in the middle CBD and 11 cases in the distal CBD. ERCP identified calculi in 4 patients in whom MRCP was negative. ERCP also detected other abnormalities of which 3 cases were of choledochocele and 9 were of CBD masses. ERCP was successful in all patients with a maximum of three attempts. ERCP was associated with several complications, including pancreatitis, hemorrhage, perforation and cholangitis.

The sensitivity and specificity values of ERCP in detecting CBD stones in the present study was: Sensitivity = 100%, Specificity = 100%, Positive predictive valve = 100%, Negative predictive valve = 100%.

The sensitivity, specificity, positive and negative predictive value for ERCP was 100% even for small (1-5 mm) bile duct stones in our study.

Discussion

Ultrasonography (USG) and Magnetic resonance cholangiopancreatography (MRCP) are non-invasive study to determine billiary duct pathology. ERCP is an invasive modality for evaluation of biliary duct abnormalities. ERCP is a technique that combines the use of endoscopy and fluoroscopy and is used for diagnosis and treatment of choledocolithiasis. Through the endoscope, the endoscopist can inject radiographic contrast into the ducts in the biliary tree and pancreas so they can be seen on X-rays [12]. ERCP can provide clear images of the hepatobiliary and pancreatic ducts. Previously many authors have reported use of such procedures as F. Regan, et al. prospectively evaluated 23 patients with suspected bile duct calculi using HASTE MR cholangiography and compared that imaging technique with endoscopic retrograde cholangiography and sonography [13].

In the present study 70 patients were recruited based on clinical and hematological evidence of obstructive jaundice suspected to be due to choledocolithiasis. All the patients were assessed with USG, MRCP and ERCP; Standard statistical parameters like sensitivity, specificity, PPV, NPV were used to determine the diagnostic accuracy of both the tests and comparison done between them.

ERCP is highly accurate in diagnosing CBD stones and showed 100% sensitivity and specificity in detecting choledocolithiasis. However it was invasive procedure associated with few complications.

Overall sensitivity and specificity of USG was low in comparison to MRCP and ERCP. Multiple non-invasive & invasive methods have been used for the diagnosis of calculi in the bile duct. Sonography is often used as the first line imaging modality in patients with suspected choledocolithiasis [7]. However sonography of the common bile duct is particularly limited by operator dependence. However, in proximal CBD calculi, USG was good with high sensitivity and specificity comparable to that of MRCP and ERCP. For MRCP the calculated overall sensitivity, specificity, PPV and NPV were almost comparable to that of ERCP and definitely

better than USG study in detection of choledocolithiasis. It was also found to be free of operator dependence [14].

MRCP is also non-invasive study without use of contrast or ionizing radiation which provides excellent anatomic details of pancreatico-biliary system and provides three dimensional assessment. MRCP shows high sensitivity and specificity in detection of choledocholithiasis in comparison to USG despite use of modern harmonic imaging. MRCP shows very high positive predictive value and also negative predictive value. Adamek, et al. conducted a study in the department of medicine, in Ludwigshafen, Germany. To assess the diagnostic accuracy of MRCP and endoscopic retrograde cholangiopancreatography (ERCP) and to determine whether MRCP may help to prevent unnecessary interventional procedures [15]. In other similar study Stiris MG, et al. performed a study in Department of Radiology, Aker Hospital, University of Oslo, Norway, to compare MR cholangiopancreatography (MRCP) vs. endoscopic retrograde pancreatography (ERCP) in patients with suspected common bile duct (CBD) stone disease. It was found that the sensitivity was 87.5% and the specificity 94.4%, respectively. The positive predictive value was 96.6% and the negative predictive value was 81.1% [16].

MRCP also shows a very high sensitivity in detection of distal CBD stones which is obscured by bowel gas preventing proper visualization by USG. MRCP can be used in obese and echo poor subjects. There is no operator dependence. Limitations of MRCP are cost, relative unavailability and patients incompatible with standard MRI protocol.

The value of MRCP is also high in comparison to conventional ultrasound examination supporting this study. The results of the current study showed that MRCP as a suitable modality for evaluating patients with obstructive jaundice due to its non-invasive nature and good sensitivity and specificity. MRCP is also a non-invasive study without use of contrast or ionizing radiation which provides excellent anatomic details of pancreatico-biliary system and provides three dimensional assessments. MRCP shows high sensitivity and specificity in detection of choledocolithiasis in comparison to USG despite use of modern harmonic imaging. MRCP shows very high positive predictive value and also negative predictive value. MRCP also shows a very high sensitivity in detection of distal CBD stones which is obscured by bowel gas preventing proper visualization by USG. MRCP can be used in obese and echo poor subjects. There is no operator dependence. Limitations of MRCP are cost, relative unavailability and patients incompatible with standard MRI protocol. ERCP is highly accurate in diagnosing CBD stones. It has very high sensitivity and specificity in detection of CBD calculi. However ERCP is invasive and inconvenient for the patient requiring sedation and contrast and also is associated with complications when compared to USG and MRCP.

It thus becomes obvious that another diagnostic modality should replace ERCP for diagnosis of choledocolithiasis, which should have similar sensitivity, specificity and accuracy as ERCP, but fewer complications. This study shows that MRCP has a diagnostic accuracy which is almost similar to ERCP in the diagnosis of choledocolithiasis. Hence MRCP can be used as a primary tool for detecting or excluding CBD stones non invasively and without use of contrast media and ionizing radiation.

Conclusion

USG is inexpensive, non-invasive modality for choledocolithiasis, however has low sensitivity for detecting distal CBD calculi. It has moderate sensitivity and specificity for mid CBD calculi and high sensitivity and specificity for proximal CBD calculi.

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