The Role of Ultrasound and Magnetic Resonance Imaging in the Diagnosis of Obstructive Jaundice

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ABSTRACT:

BACKGROUND:

Evaluation of jaundiced patients should include proper history and examination, laboratory investigation and imaging investigations (non invasive like U\S, CT and MRI or invasive like ERCP and PTC).

AIM OF STUDY:

The aim of this prospective study is to evaluate the role of U\S and MRI-MRCP in patients with obstructive jaundice in clinical practice.

METHODS:

This is a prospective study performed on 80 patients (42 female and 38 male) with an average age of 53 years presented with obstructive jaundice for whom abdominal ultrasound (U\S) and magnetic resonance imaging (MRI) and magnetic resonance cholangiopancreatography (MRCP) performed in the departments of radiology in Al-Kadhemiyyah teaching hospital and Specialized surgical hospital and Baghdad teaching hospital from October 2003 to October 2005. The final diagnosis was found by endoscopic retrograde cholangiopancreatography (ERCP) and \or surgery and confirmed by histopathology.

RESULTS:

The most common cause of obstructive jaundice in our study was tumors (41.25%) followed by common bile duct stones (36.25%) then benign strictures (13.75%), hydatid cyst (6.25%) & finally choledochal cyst (2.5%). In this study, MRI-MRCP could differentiate surgical from medical jaundice in all cases, while U\S could differentiate surgical from medical jaundice in 91.25% of cases. MRI-MRCP correctly defines the level of obstruction in all cases (100%).While U\S correctly define the level of obstruction in only 86.2 % of the total cases. MRI-MRCP correctly suggests the most possible cause of obstruction in 96.25% of cases. While U\S correctly suggests the most possible cause in only 36.2 %.

CONCLUSION:

So that U\S, as a screening modality is useful to confirm or exclude biliary dilatation & to choose patients for MRCP examination. MRI-MRCP is a useful non-invasive and essential method in the preoperative evaluation of patients with obstructive jaundice. In addition MRI-MRCP was superior to U\S or ERCP in studying the extent & staging of malignant lesions.

KEYWORDS: Ultrasound, MRI, MRCP, Obstructive jaundice.

INTRODUCTION:

MRI-MRCP becomes the standard technique of non-invasive investigation of the biliary tree to visualize ductal dilatation, strictures as well as intraluminal filling defects. [1] U\S is usually used as the initial investigation in patients suspected of obstructive jaundice & can be used for follow up imaging after treatment. It is non-invasive, lacks radiation exposure & widely available. [2] Disadvantages of MRI include; being not widely available, expensive, can not be done in claustrophobic patients or with aneurysm clips or cardiac pacemakers. Fluid collections external to the biliary & pancreatic ducts, such as ascites, may obscure the region of interest or Generate motion related artifacts [3]. Patient motion may also degrade image quality; this is a great problem in pediatric patients. Other disadvantage is lack of interventional procedures & that it could not be performed in patients with metallic implants. Open magnets provide the most direct access for interventions, but most are currently limited to lower field strengths (typically 0.2–0.3 Tesla) with low signal to noise ratio. [4] **Normal measurements;**

The intrahepatic bile ducts should be 2 mm or less in normal patients. The internal diameter of the extrahepatic duct is generally 5 mm or less. The internal diameter of the extrahepatic duct dilates with age. A reasonable rule to follow is to allow 1 mm of internal diameter of the bile duct for each decade after 50 years. A 7 mm bile duct is considered normal in a 70 years old patient. [5].

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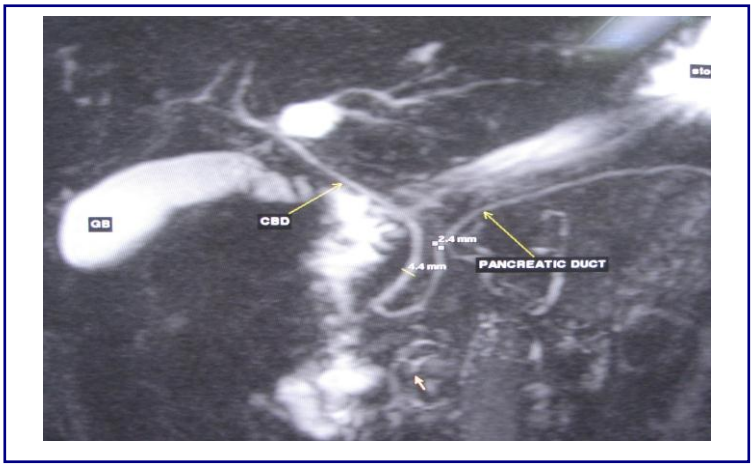


Figure 1: shows the normal biliary tree as appear on MRCP.

PATIENTS AND METHODS:

Eighty patients [42 females and 38 males, with age range between (20-85 years) and an average age of 53 years] with clinical & biochemical features of obstructive jaundice who presented between October 2003 to October 2005 were enrolled in this study. This study was carried out in Al-Kadhemiyyah teaching hospital, Specialized Surgical hospital and Baghdad hospital in medical city teaching hospital. Data collection regarding (patient age, sex, address and specific imaging findings) were obtained in each case and recorded on a special protocol form. All these patients had been examined by ultrasound and MRI-MRCP. The final diagnosis was found by ERCP and \or surgical findings and confirmed by histopathology. **Ultrasound examination:** The examination was done using Siemens Versa Pro of 3.5 MHz transducer. No special preparation was needed apart from fasting overnight. Careful scanning of the entire course & caliber of the duct system whenever possible helps to trace the extent of the duct dilatation & to localize the level of obstruction. Water was sometimes drunk to improve visualization. The examination was done by two radiologists. **MRI examination:** The examination was done using Philips 1.5 Tesla Gyroscan ACS-NT 3000 superconductive type with a useful aperture of 61 cm. We check the patients for any contraindications. No special preparation was needed. A body coil was used for the examination. Conventional MRI of the upper abdomen was done including T1 and T2 with or without fat suppression technique. I.V. contrast medium was given, if required (Gadolinium DTPA in a dose of 0.1 mmol\Kg as a bolus). MRI-MRCP images were reviewed at the diagnostic workstation and on hard copy films by 2 expert radiologists.

RESULTS:

Forty-two patients from the 80 cases were subsequently submitted to ERCP. While the remaining 38 patients subsequently underwent open surgery. Figure 2 shows the age distribution. Figure 3 shows the distribution of the study sample by gender.

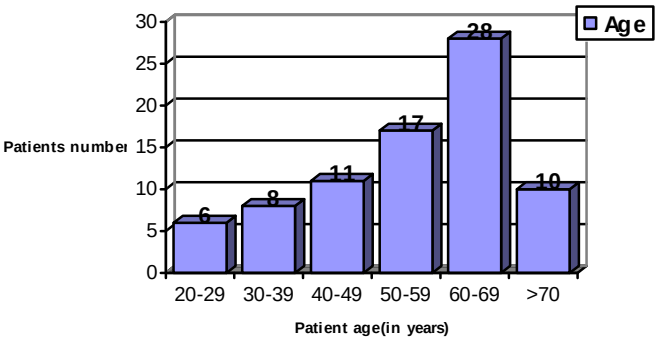


Figure 2- Age distribution

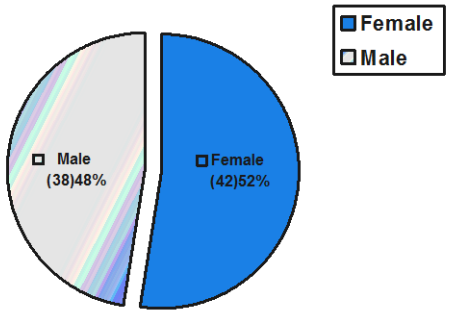


Figure 3- Gender distribution (number in brackets representing Patients number)

Detection of ductal dilatation:

As shown in table.1; eighty patients were found to have ductal dilatation on MRI-MRCP. U\S diagnosed 73 out of these 80 patients.

Table 1; Detection of ductal dilatation by both modalities

Modality	Intrahepatic biliary dilatation	CBD Dilatation	Both CBD & intrahepatic biliary dilatation
U\S	12	15	46
MRI	12	6	62

Detection of the level of obstruction:

As shown in table.2, U\S was able to detect the level of obstruction in 86.2 % of cases. MRI-MRCP was able to give a correct level of obstruction in all cases.

Table 2; Delineation of the level of obstruction by U\S & MRI

Level of obstruction	No. of cases	U/S (no. of patients)	MRI (no. of patients)
Porta hepatis	9	9	9
Proximal CBD	8	4	8
Distal CBD	63	56	63
Total	80	69	80

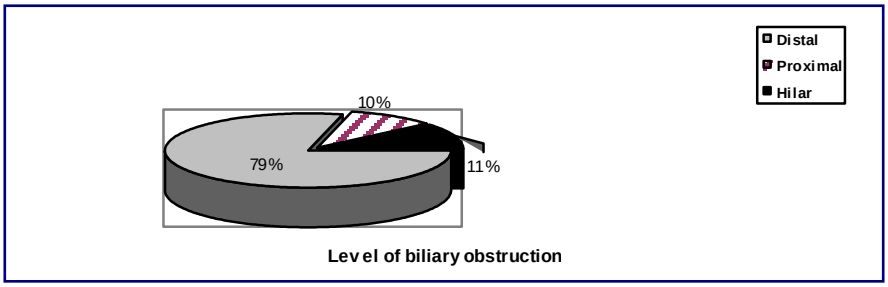
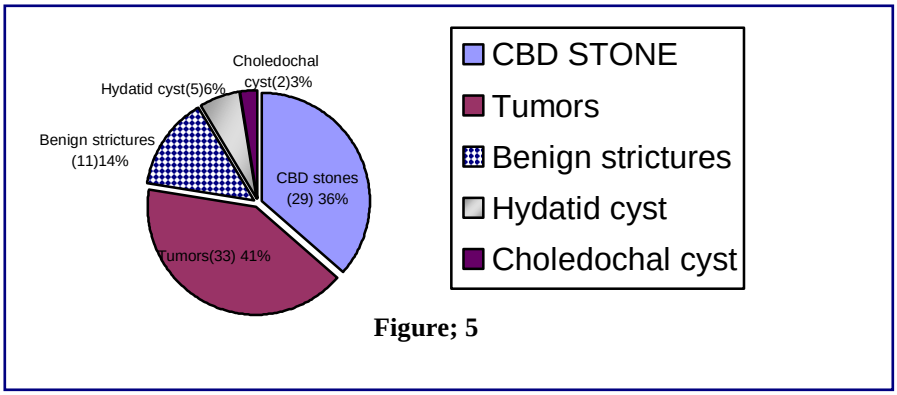


Figure.4 shows the frequency of each level of obstruction.

Detection of the cause of obstruction:

On the bases of surgical findings &\or ERCP findings with histopathological confirmation, the final diagnosis was as follow: (as shown in figure.5).



Figure; 5

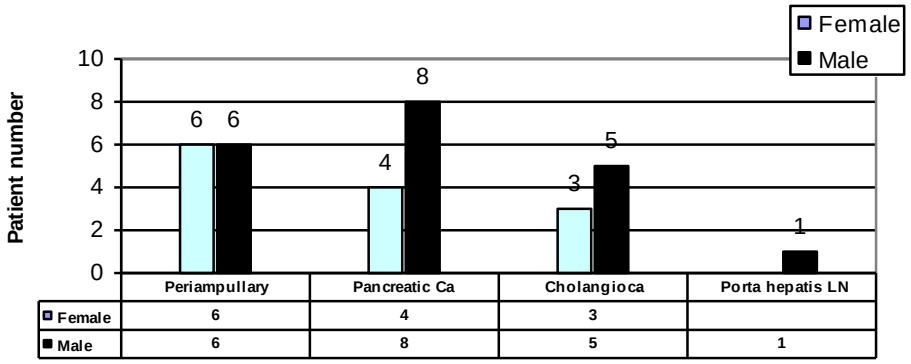
As shown in table-3, MRI-MRCP suggests the correct diagnosis in 77 out of 80 cases. U\S was able to suggest the possible cause in 30 out of 80.

Table3: shows delineation of causes of biliary obstruction by both modalities

Causes of obstruction	No. of patients	U\S(no. of patients)	MRI (no. of patients)
CBD stones	29	11	29
Tumors	33	12	30
Benign strictures	11	1	11
Hydatid cyst	5	4	5
Choledochal cyst	2	2	2
Total	80	30	77

Tumors obstructing the pancreaticobiliary tree:

In our series, 33 cases diagnosed as tumors. (As shown in figure 6)



Figure; 6

The most common tumors (The most common cause of obstructive jaundice in our study) in our study were pancreatic head tumor & periampullary tumors. The age ranges between 24-85 years. They were 20 male & 13 female. MRI-MRCP suggested the correct diagnosis in 30 out of 33 cases with tumors (one case of Ca head pancreas diagnosed as chronic pancreatitis by MRI & 2 cases of ampullary tumors diagnosed as CBD stones by MRI).

Choledocholithiasis: Twenty nine out of 80 patients proved to have a CBD stones. The age ranges between 25-75 years. They were 10 male & 19 female. U\S diagnosed 11 patients out of 29 cases with CBD stones, while MRI-MRCP correctly diagnosed the presence of CBD stones in all cases but there are 2 false positive cases of CBD stones that proved to be ampullary tumors.

Benign strictures: *Six patients proved to have postoperative stricture (3 male & 3 female). All of them with previous history of cholecystectomy. Their age ranges between 31-70 years. *Four patients proved to have chronic pancreatitis causing CBD stricture with one false positive diagnosis with chronic pancreatitis that was proved later to be a pancreatic carcinoma. Their ages range between 35-70 years. *One female patient has sclerosing cholangitis. Her age was 21 years. U\S could not reach a specific diagnosis in these cases except one case of a benign stricture due to chronic pancreatitis, while MRI-MRCP correctly diagnoses all cases.

Hydatid cyst: Five patients out of 80 proved to have hepatic hydatid cysts. Their age ranges between 20-68 years. U\S detects 4 of them while MRI correctly diagnoses all cases.

Choledochal cyst: Two cases out of 80 proved to have choledochal cysts. Their age ranges between 26-35 years. U\S and MRI-MRCP correctly diagnose the two cases. Both choledochal cysts are type one choledochal cysts.

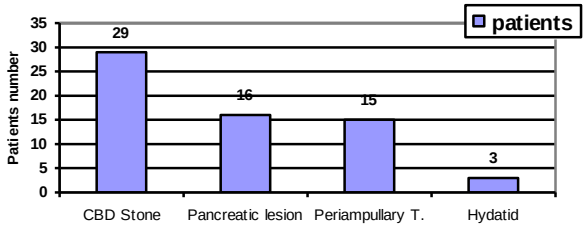


Figure 7: Shows the causes of distal biliary obstruction

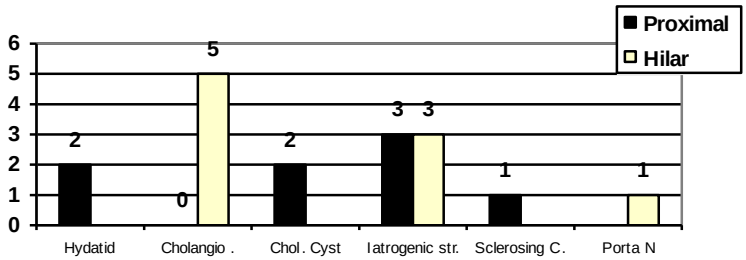


Figure 8:Shows the causes of proximal & hilar biliary obstruction

Table 4: Causes of obstructive jaundice, sensitivity, specificity, accuracy, NPV & PPV of both modalities

Cause	Modality	Sensitivity	Specificity	Accuracy	NPV	PPV
Tumors	U\S	36.3%	80.7%	73.75%	68.1%	70.0%
	MRI	90%	97.8%	95%	93.8%	96.7%
CBD stones	U\S	37.9%	96.2%	77.2%	73.9%	84.6%
	MRI	100%	96.2%	100%	100%	93.5%
Benign stricture	U\S	One case was correctly detected (chronic pancreatitis)				
	MRI	100%	98.5%	98.7%	100%	91.6%
Hydatid cyst	U\S diagnosed 4 out of 5 & MRI diagnosed all cases correctly					
Choledochal cyst	U\S & MRI diagnosed the two cases correctly					

Table- 5 Comparison between U\S & MRI findings in the detection of the parameters of obstructive jaundice

Parameter	Total number	U\S (No. of patients)	MRI (No. of patients)	Overall accuracy	
				U\S	MRI
Dilatation	80	73	80	93.7 %	100 %
Level of obstruction	80	69	80	88.7 %	100 %
Causes of obstruction	80	30	77	37.5 %	96.2 %

DISCUSSION:

Detection of ductal dilatation: In our study, 7 patients have normal measurements of CBD diameter on U\S, but on MRCP, the CBD was mildly dilated & this could be explained by intermittent obstruction and also because the measurements were regarded as borderline measurements by U\S and this turned to be mildly dilated on MRCP. These differences could be explained as follows:

1. The site of measurement may differ between both modalities as U/S may not visualize the most distal part of CBD (due to overlying gas or mass?) while MRCP define the whole duct.
2. US is operator dependent so operators differ in measuring outer or inner outline of CBD while MRCP is not operator dependent.
3. Timing difference between both examinations in few days may reveal borderline on U/S to be mildly dilated on MRI.

In this study, U\S could differentiate surgical from medical jaundice with 91.25% sensitivity while MRI-MRCP sensitivity was 100%. Our U\S results were comparable to the findings of Abbas (1999) [6] and that of Dixit et al (1993) [7] & higher than what is reported by Salazar et al (1993) [8]. While Rigauts et al (1992) found that U\S successfully differentiated obstructive from non-obstructive jaundice with 96% sensitivity [9]. Our MRI results are similar to what is mentioned by Al-Janabi A. (2002). [10] and Mendler et al 1998[11].

The level of obstruction: In our study, MRI-MRCP was correct in defining the level of obstruction in all cases. While U\S was correct in 69 cases out of 80 patients (constituting 86.2 % of cases).

Pavone et al in 2000 reported that the accuracy of MRCP in diagnosing the presence of obstruction ranges between 91-100%, where as the level of obstruction could be correctly evaluated in 85-100% of cases that approximates our results. [12].

While the level of obstruction was identified by MRI in 94 % of cases by Koennigsberg et al and Ferucci. [13,14]. Our results in MRI are comparable to a study done by Al-Janabi (2002) [10].

Our U\S results are higher than what is reported in studies done by Sherlock et al in 1998 & Honickman et al (1983), the site of obstruction could be determined (by U\S) in only 27% of the total sample. [15,16] U\S was unable to demonstrate the level of obstruction in 12 of cases because of excessive bowel gases, obesity & previous operations.

In a study done by Kammona (1995) they showed that U\S correctly identified the level of obstruction in 92.8 % [17].

Defining the most possible cause of obstruction;

Table4. Shows the sensitivity , specificity and accuracy of U\S and MRI in defining the possible cause of biliary obstruction.

Our U\S results are similar to what is reported by Sherlock et al in 1998 [15] and Honickman et al (1983). [16]. our results in MRI are similar to Yousif [18] and Pavone [19].

Pancreaticobiliary tumors:

In our study, U\S detects 12 out of 33 cases of tumors. On the other hand, MRI-MRCP suggests the correct diagnosis in 30 out of 33 cases with tumors. Our MRI results are similar to the results of studies done by Lomas et al in 1999, [20] and by Yousif [18] & Pavone et al in 1998. [19] Regarding U\S, in a study done by Nesbit [21] in 1987, U\S detects 47% of cases of cholangiocarcinoma that approximates our U\S results. While Hann et al (1995) reported that U\S detected 87% of Klatskin tumor [22].

In these studies, the study sample was larger than our study sample & special attention focused on bile duct tumors. In our study, in most of the cases of peri ampullary tumors, U\S and MRI-MRCP gave a suggestion of this possibility but did not image a definite mass because the tumor is small.

This is similar to what is reported by Muttarak in 2001 [2] and by Semelka et al in 1997. [23]

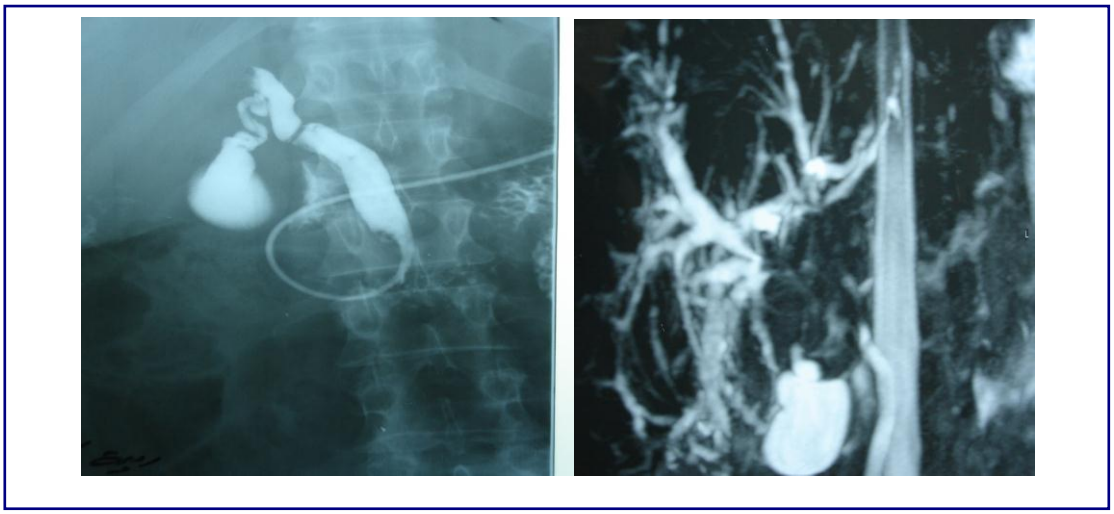


Figure9: A case of Klatskin tumor as seen on ERCP & MRCP

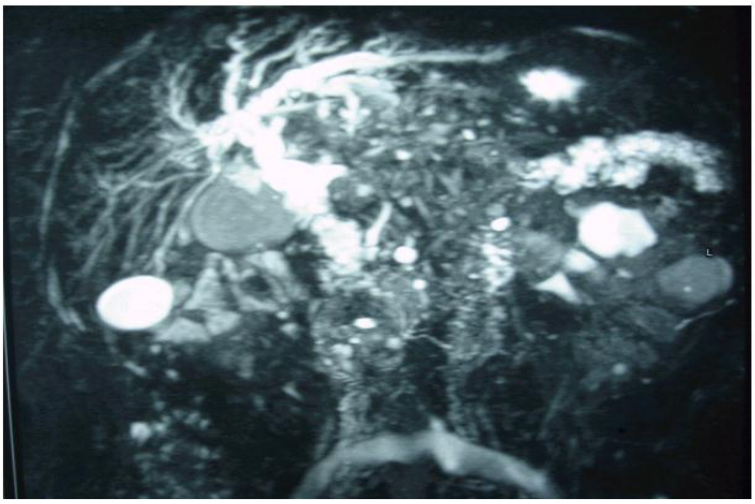


Figure 10: acase of infiltrative cholangiocarcinoma as seen by MRCP.

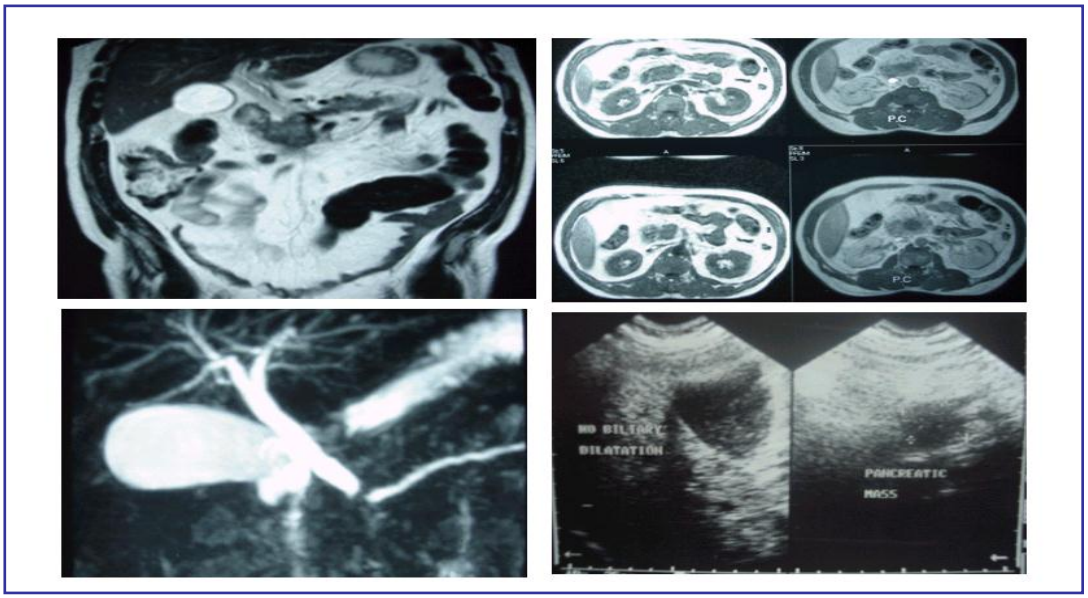


Figure 11: pancreatic head tumor as shown by coronal T2 axial enhanced T1 W1 and MRCP (shows dilatation of both CBD and pancreatic ducts) and by U\S (shows a hypoechoic pancreatic head mass with sludge in the GB).

Choledocholithiasis:

In our series, U\S detects 11 out of 29 cases, where as MRI-MRCP detects all cases but with 2 false positive cases. Our MRI results are comparable to the findings of Al-Janabi 2002[10] and Yousif 2001 [18] and Isomoto et al 1998 [24]. Where as Varghese et al in 1999 reported that MRCP was better than U\S in the detection of CBD stones with sensitivity, specificity and accuracy were 91 %, 98 % & 97 % respectively [25]. Our U\S results approximate what is reported by Varghese et al in 1999[25].

Our U\S results are lower than what was reported by Kammona (1995) [17] & Rigauts et al (1992) with a sensitivity of 71.4% & specificity of 91% [9].

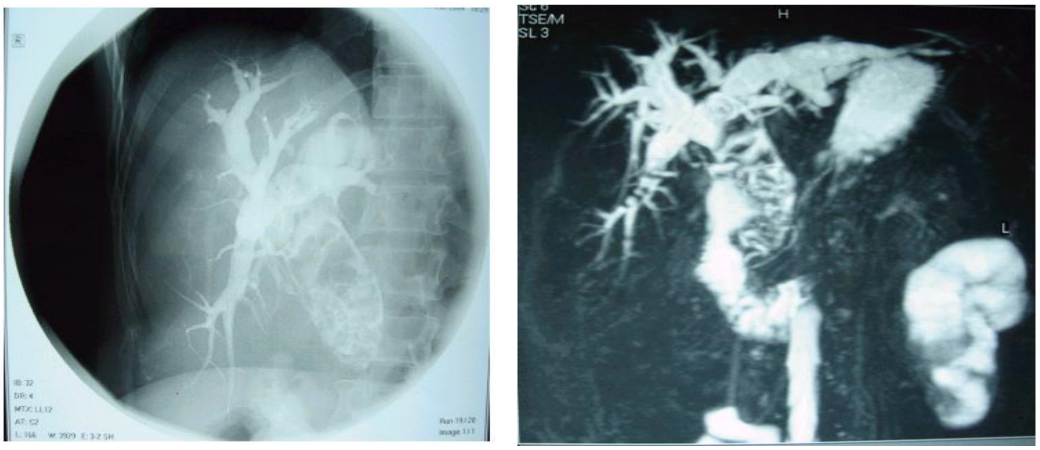


Figure 12: shows multiple CBD stones filling the hugely dilated CBD as seen in the MRCP and PTC .

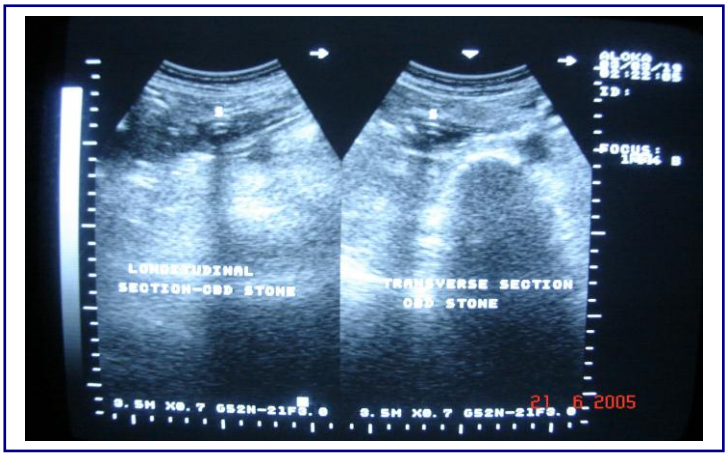


Figure 13: U\S scan show an echogenic CBD stone with distal acoustic shadowing

Benign CBD strictures:

In our study, 6 out of 11 patients with benign CBD strictures, proved by ERCP & surgery to have postcholecystectomy strictures. U\S did not detect the strictures while MRI-MRCP detected all cases correctly. Our U\S results are lower than what was reported in a study done by Abbas (1999) where they detect 4 out of 9 cases with postoperative strictures [6]. In our study, 4 out of 11 cases with benign bile duct strictures due to chronic pancreatitis proved by surgery. U\S detected only one of these cases, while Abbas in 1999[6] detected 3 out of 5 cases in their series.

On the other hand, our MRI results are comparable to a study done by Lomas et al 1999[26] and Al-Janabi 2002 [10]. In a study done by Soto et al, a sensitivity & specificity of 75 & 69 % was detected respectively for the detection of bile duct stricture due to chronic pancreatitis. [3]

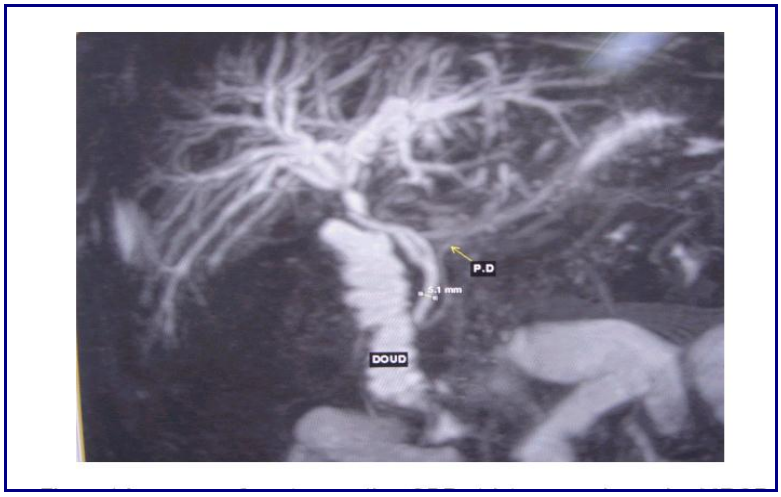


Figure 14: a case of post-operative CBD stricture as shown by MRCP.

Primary sclerosing cholangitis:

We have one case of sclerosing cholangitis in our sample; this case has been missed by U\S (where there were non specific bile duct wall thickening and increased periductal echogenecity) but was correctly detected by MRI-MRCP. In a study done by Paul Angulo et al, MRCP had an overall diagnostic accuracy of more than 90 % in the detection of primary sclerosing cholangitis. [27].

Hydatid cyst:

Intra biliary hydatid rupture is a rare event, but an incidence of 16 % has been reported from Iraq. (1) In our study, U\S detects 4 out of 5 cases with hydatid cyst in the liver, while MRI MRCP has detected all cases correctly.

One case of hydatid cyst has been missed by U\S because the internal echogenecity was of the solid looking type & there is no great difference in its echogenecity with the surrounding liver parenchyma , in addition to being located near the dome of the diaphragm where we need a good cooperation with The patient in taking deep inspiration & stop breathing & our patient was elderly & not cooperating.

Our U\S results approximate what is reported by Abbas 1999 [6]. It is important to combine MRI with MRCP in cases of complicated, ruptured hydatid cyst which is also proved in a study done by Osilouridis et al 2001[28].

Choledochal cysts:

In our study, U\S & MRI-MRCP detect 2 out of 2 cases. U\S is particularly valuable in the diagnosis of choledochal cyst & is discussed by Frank et al in 1981[29] & is the initial method of evaluation as found in a study done by OH Kim et al.

[30] MRI-MRCP detects 2 out of 2 cases that is similar to that obtained by a study of Celso Matos 1998 . [31] & Al-Janabi 2002 [10] and Yousif S. 2001[18]. Differences in the U\S results between different studies could be attributed to the fact that U\S is operator dependant, patient dependant and machine dependant.

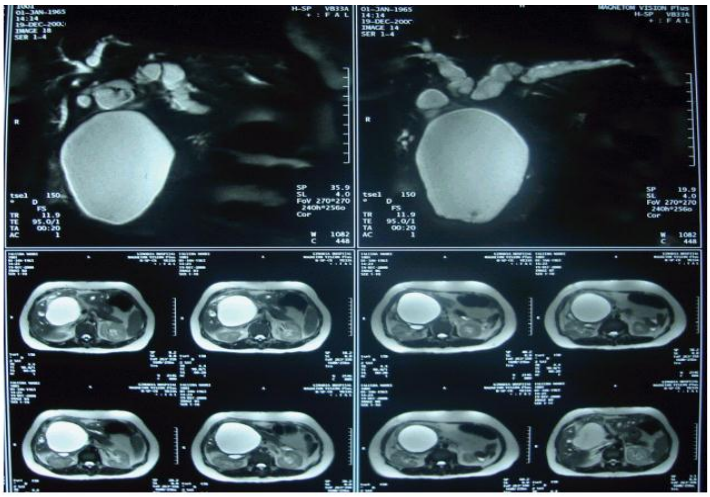


Figure15: Choledochal cyst as shown by MRI and MRCP.

CONCLUSION:

1. Although U\S provides good information about the presence and level of biliary obstruction, it does not suggest the possible cause in many cases. So U\S is regarded as the initial examination, which provides a guide to choose patients for MRI examination.

2. MRI-MRCP is a sensitive non-invasive technique in the detection of the presence of biliary obstruction in addition to defining its level and cause.

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