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Role of MRCP and Diffusion Weighted Imaging in Diagnosis of Extrahepatic Biliary Stricture

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ABSTRACT

Background: A non-invasive and secure alternative to existing unreliable diagnostic techniques is magnetic resonance cholangiopancreatography (MRCP) and diffusion weighted imaging (DWI), which may be used to examine biliary strictures and image the biliary tree.

Objectives: This study's primary goal was to assess how well DWI to MRCP in detection of level and differentiation of causes of extra-hepatic biliary stricture **(**benign or malignant**).**

Patients and methods: South Valley University's Qena University Hospital served as the site of this cross-sectional investigation. This research comprised 30 individuals who were healthy enough for an MRI test between January 2021 and January 2022 and who had obstructive jaundice that was either known to exist or was clinically believed to exist.

Results: In the studied patients, MRCP correctly diagnosed 16 cases out of 19 cases as benign stricture according to histopathology with three false negative malignant strictures. DWI correctly diagnosed 18 cases out of 19 cases as benign stricture according to histopathology with one false negative malignant stricture. Sensitivity, specificity, PPV, NPV and accuracy of MRCP in comparison with histopathology was 100%, 84.21%, 78.57%, 100% and 90% respectively. Sensitivity, specificity, PPV, NPV and accuracy of DWI in comparison with histopathology was100% ,94.74% , 91.67% , 100% and 96.6% respectively.

Conclusion: DWI greatly enhances the diagnosis accuracy for identifying benign and malignant biliary strictures and is superior to MRCP in the identification and characterization of biliary obstructing disorders.

Keywords: DWI, MRCP, Benign stricture, Malignant stricture.

INTRODUCTION

Both surgeons and endoscopists value accurate approaches for identifying the source of biliary stricture in patients with obstructive jaundice. Cholangiocarcinoma or a benign stricture may cause biliary stricture. Many imaging methods were used to diagnose the cause of biliary stricture. As example, ultrasound is widely accessible, non-invasive, and inexpensive investigation with no need for ionizing radiation. But it is quite operator-dependent [(1)]. However, MRCP and DWI are a non-invasive and secure replacement for other unreliable diagnostic techniques that include the biliary tree imaging and examining biliary stricture.

Additionally, MRCP offers the following benefits. It is quick, without problems, radiation, or the need for a contrast agent [(2)].

The utilization of parallel acquisition approaches to shorten scan times and enhance spatial resolution, as well as the utilization of various MRI sequences, have proven to be of great value in identifying the causes of biliary stricture with the ongoing advancement and enhancement of MRI hardware and software [(3)]. MRCP sequences, which is a heavily T2-weighted turbo spin-echo (TSE). This is new mode of MR sequences provide clear projectional images. These new, quick, high capacity MRCP sequences are the best diagnostic method as it is very highly accurate in diagnoses of pancreato- biliary diseases [(4)].

Diffusion-weighted imaging (DWI) is a method that assesses tissue cellularity and cellular membrane integrity while measuring the Brownian motion of water. DWI is now being utilized more often in a variety of therapeutic settings. Although, DWI has garnered more attention and is the subject of multiple studies, it has shown highly promising results in the identification of various causes of biliary diseases, especially in separating benign from malignant origins [(3)].

As investigation images of the DWI and MRCP for the etiology of the extra hepatic biliary stricture was done, the gold standard of the research is endoscopic retrograde cholangiopancreatography (ERCP) and histology. Patients' diagnoses and follow-up were further verified by ERCP or histopathology. Results of both MRCP pictures and DWI were computed, and comparing the values of sensitivity, specificity, accuracy, positive predictive value, and negative predictive value [(5)].

This research sought to determine the use of MRCP and DWI in determining the severity and underlying causes of extra-hepatic biliary stricture.

PATIENTS AND METHODS

At South Valley University at Egypt's Qena University Hospital, this prospective cross-sectional research was conducted. The sample size was 30 patients between January 2021 and January 2022.

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Inclusion criteria:
All patients with obstructive jaundice.

Exclusion criteria:
Patients who decline inspection or have metallic prosthetics that are not MRI compatible or who feel claustrophobic.

Methods:
Full history taking (all patients with obstructive jaundice) and clinical examination, abdominal ultrasonography (dilated extra hepatic biliary ducts), laboratory assessment (routine laboratory investigation CBC, liver function test and urine analysis), MRCP T1, T2-weighted imaging, and DWI (examining the signal strength of the lesions on DWI utilizing b = 500, 1000 and 1500 s/mm^2).

Ethical approval:
All patients were informed about the procedure and ensured to remain anonymous. All patients gave their informed permission.

The research received clearance from the South Valley and patient groups as well as the Medical Ethics Council of Qena University Hospital. This study also received approval from the Faculty of Medicine at South Valley University in Qena, Egypt. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Magnetic resonance cholangiopancreatography
With the use of MRI and the noninvasive imaging method known as MRCP, the pancreatic and biliary ducts may be seen clearly without the need of contrast. It is particularly effective for diagnosing strictures, dilatation, and filling defects greater than 3 mm in suspected biliary illness [(6)]. Similar to ERCP, MRCP has a great estimated sensitivity and specificity for determining the severity and shape of biliary strictures. It has high sensitivity rate up to 87% for stricture detecting and a specificity of 94% for determining the degree of stricture development. Additionally, several investigations have shown that it has the same sensitivity for both extra hepatic and intrahepatic strictures [(7)].

Patients who have a suspected hilar occlusion benefit more from MRI/MRCP, which may map the biliary tree in addition to finding the stricture and sometimes revealing a tumor (Figure 1). When doing an ERCP for biliary drainage and making efforts at tissue identification using biliary brushings, this knowledge is helpful [(8)].

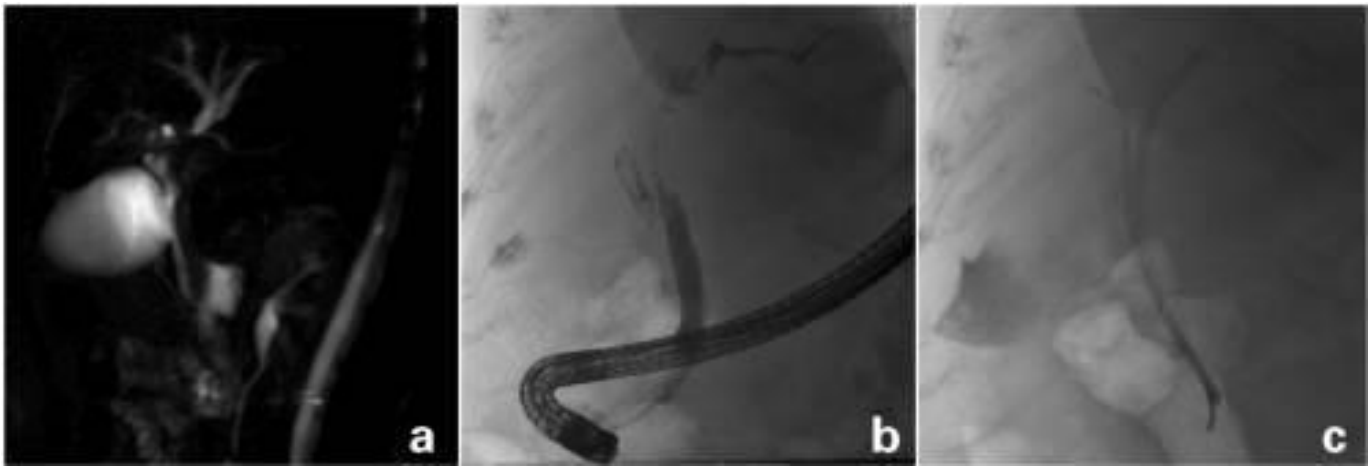


Figure (1): Patient with obstructive jaundice. (a) MRCP showed a hilar stricture and proximal biliary dilatation. (b) ERCP in the same patient before and (c) after placement of two plastic biliary stents [(8)].

Due to its capacity to give amazing soft-tissue contrast and to highlight the intricate architecture of the bile ducts and their lumen, a biliary MRI protocol paired with MRCP has been frequently employed for the examination of perihilar cholangiocarcinomas [(9)].

Diffusion weighted imaging (DWI)

The unhindered, continuous Brownian motion of water molecules is known as diffusion. Interactions with cell membranes and macromolecules modify and restrict the molecular diffusion of water in biological tissues [(10)].

DWI creates picture contrast without the utilization of exogenous contrast agents by using variations in the mobility (diffusion) of water molecules in extracellular and intracellular fluid as well as vascular fluids.

Cellularity, the integrity of the cell membrane, and lipophilicity are negatively correlated with diffusion. Diffusion is shown to be restricted (or hindered) in tissues with high cellularity, like tumors. In tissues with little cellularity or damaged cell membranes, like cysts and necrotic tissues, diffusion is relatively unrestricted or unhindered [(10)].

DWI has recently been suggested as a viable addition to traditional MRI for separating focused benign lesions from malignant lesions in the pancreas and liver. The combined picture set of DWI and MRCP was shown to have a considerably greater diagnostic accuracy for identifying a distal biliary stricture than MRCP alone [(11)].

Statistical Analysis

With the aid of the IBM SPSS software package version 20.0, records were fed into the computer and evaluated (IBM Corp., Armonk, New York).

Number and percentage were utilized to express qualitative data. The normality of the dispersion was examined utilizing the Kolmogorov-Smirnov test.

The range (minimum and maximum), mean, standard deviation, median, and interquartile range were employed to characterize quantitative data (IQR).

The significance of the findings was assessed at the 5% level.

RESULTS

30 cases were included with a mean age of 65.6 years and mean BMI of 28.6 kg/m^2.

There was male predominance (60%) and females were 40% **(table 1).**

Table (1): Distribution of investigated instances based on demographic information (n = 30)

	No.	**%**
Sex		
Male	18	60.0
Female	12	40.0
Age (years)		
Min. – Max.	45.0 – 88.0	
Mean ± SD.	65.60 ± 12.06	
Median (IQR)	67.0(56.0 – 76.0)	
BMI (kg/m^2)		
Min. – Max.	26.0 – 32.0	
Mean ± SD.	28.60 ± 1.81	
Median (IQR)	28.50(27.0 – 30.0)	

As regards **MRCP** findings, 53.3% showed benign stricture (16 cases) and 46.7% had malignant stricture (14 cases) as shown in t**able (2)**.

Table (2): Distribution of investigated instances based on MRCP (n = 30)

MRCP	**No.**	**%**
Benign stricture	16	53.3
Malignant stricture	14	46.7

As regard **DWI** findings, 40% showed benign stricture (19 cases) and 60% had malignant stricture (12 cases) (**Table 3)**.

Table (3): Distribution of investigated instances based on DWI (n = 30)

DWI	**No.**	**%**
Benign stricture	**18**	**60.0**
Malignant stricture	**12**	**40.0**

As regards **Histopathology** findings 36.7% showed benign stricture (19 cases) and 63.3% had malignant stricture (11 cases) as shown in t**able (4).**

Table (4): Distribution of investigated instances based on Histopathology (n = 30)

Histopathology	**No.**	**%**
Benign nature of the stricture	19	63.3
Malignant nature	11	36.7

In the studied patients, **MRCP** correctly diagnosed 16 cases out of 19 cases as benign stricture according to histopathology with 3 false negative malignant strictures **(**Table 5).

Table (5): Agreement (sensitivity, specificity and accuracy) for MRCP (n= 30)

MRCP	Histopathology				Sensitivity	Specificity	PPV	NPV	Accuracy
	Benign (n = 19)		Malignant (n = 11)						
	No.	%	No.	%					
Benign	16	84.2	0	0.0	100.0	84.21	78.57	100.0	90.0
Malignant	3	15.8	11	100.0					
χ^2 (p)	19.850*(<0.001*)								

χ2: Chi square testFE: Fisher Exact p: p-value for connection of distinct categories
*: Statistically substantial at p ≤ 0.05 PPV: Positive predictive value NPV: Negative predictive value

In the studied patients, **DWI** correctly diagnosed 18 cases out of 19 cases as benign stricture according to histopathology with one false negative malignant stricture. **Table (6)**

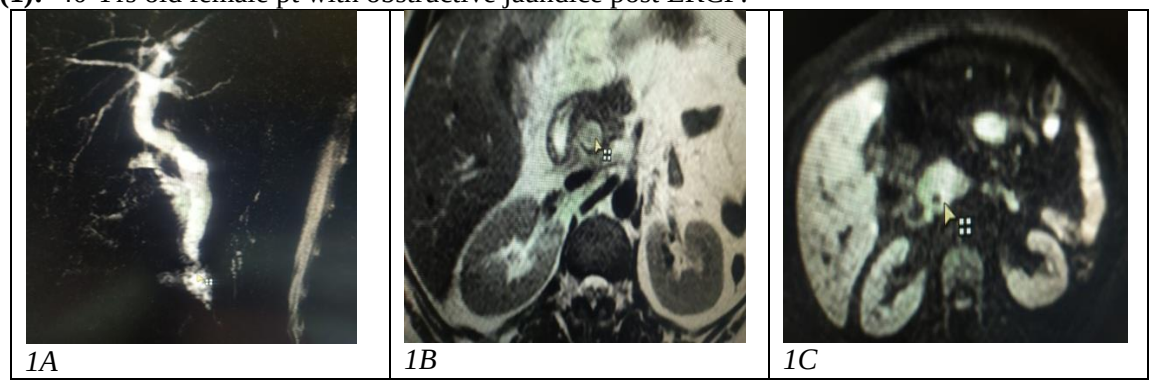
Table (6): Agreement (sensitivity, specificity and accuracy) for DWI (n = 30)

DWI	Histopathology				Sensitivity	Specificity	PPV	NPV	Accuracy
	Benign (n = 19)		Malignant (n = 11)						
	No.	%	No.	%					
Benign	18	94.7	0	0.0	100.0	94.74	91.67	100.0	96.67
Malignant	1	5.3	11	100.0					
χ^2 (^{FE}p)	26.053*(<0.001*)								

χ2: Chi square testFE: Fisher Exact p: p-value for connection of distinct categories. *: Statistically substantial at p ≤ 0.05

CASES

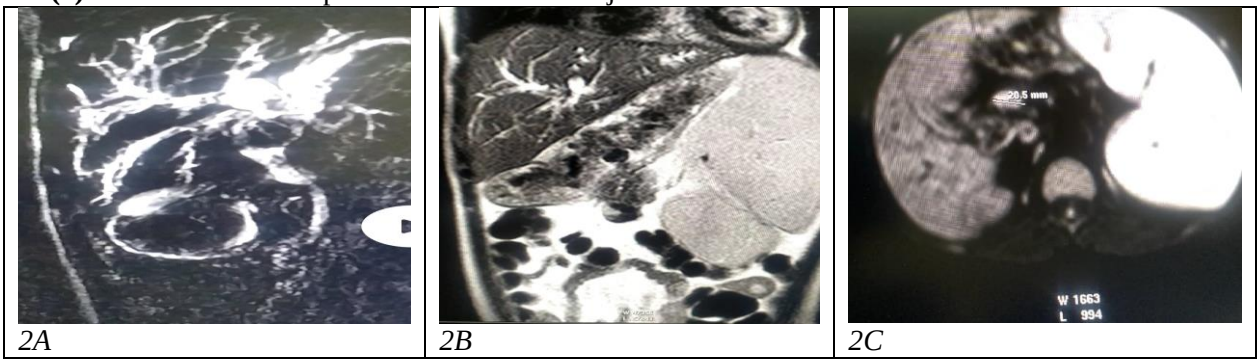
Case No. (1): 40 Yrs old female pt with obstructive jaundice post ERCP.



1A *1B* *1C*

Figure (2): A) MRCP showed dilated intrahepatic ducts and CBD with smooth tapering stricture impressive benign nature. B) T2WI showed dilated CBD. C) DW showed isointense stricture with no restriction. Histopathology: Benign nature.

Case No. (2): 20 Years old male patient with obstructive jaundice

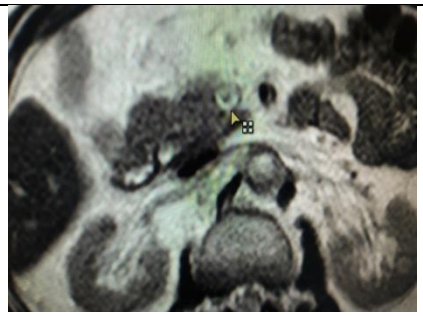


2A *2B* *2C*

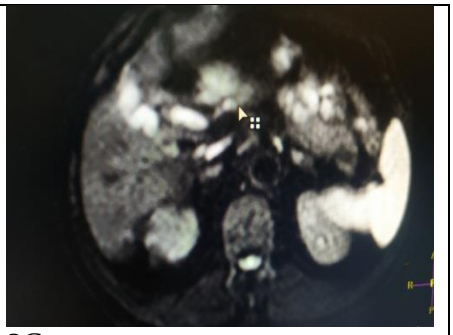
Figure (3): A) MRCP showed marked dilated intrahepatic ducts and CBD with few stenotic segments with smooth cut off impressive benign strictures. B) T2WI showed few stenotic segments involving intrahepatic ducts. C) DW showed isointense stricture no restriction. **Histopathology:** Benign nature**.**

Case No. (3): 48 Years old male patient with weight loss and obstructive jaundice

3A



3B



3C

Figure (4): A) MRCP showed dilated CBD with smooth narrowing impressive benign stricture. B) T2WI showed hyperintense irregular stricture. C) DW showed restricted diffusion. Histopathology: Malignant nature.

DISCUSSION

The biliary system is affected by a broad range of diseases, which are usually divided into benign and malignant ailments. Determination of the location, cause, degree of the problem, and any associated consequences by using biliary tract imaging [(12)]. MRCP may offer indirect indications of a malignant lesion, such as abnormality of the inner borders and sudden stenosis, with shouldering of the edge indicating cholangiocarcinoma, while a short segment with normal margin and symmetric narrowing implies a benign etiology. T2-weighted MR (T2WI) scans may discriminate between benign and malignant disease. A hyperintense mass-like lesion indicates the presence of malignancy [(13)].

Diffusion weighted imaging (DWI) may provide extra functional information on the change of tissue cellularity caused by disease processes, which can be used to supplement the morphological information provided by traditional MRCP. The cellularity of the tissue and the integrity of the cell membrane directly influence the degree of limitation to water molecule diffusion. Water molecule mobility is more constrained in tumors with higher cellularity than in tumors with less cellularity [(14)].

The main objective of this research was to examine the efficiency of MRCP and diffusion weighted imaging in identifying the level and causes of extra-hepatic biliary stricture. South Valley University's Qena University Hospital served as the site of this cross-sectional investigation. The research had 30 patients with obstructive jaundice in the duration between Aprils 2021till April 2022.

As regards demographic data of the studied group. 30 cases were included with a mean age of 65.6 years and mean BMI of 28.6 kg/m^2. There was male predominance (60%) and females were 40%. Our findings were consistent with the research of **Elkholy *et al.*** [(15)] as their study was performed in 34 (68%) men and 16 (32%) women, with a mean age of 61.52 ± 10.45 years.

As regards MRCP finding, 53.3% showed benign stricture and 46.7% had malignant stricture. In the study of **Maarouf *et al.*** [(16)] 4 out of 6 instances of cholangitis (of which 2 were mistakenly identified as cholangiocarcinoma), 7 out of 9 instances of strictures distal to bile duct stones, and 17 out of 23 instances of malignant cholangiocarcinoma strictures were accurately detected by MRCP. Thus, 11 out of 15 instances of benign biliary strictures were accurately detected by MRCP. In light of this, the total MRCP accurate diagnosis rate was 73.6% (28/38). **Rabie *et al.*** [(17)] demonstrated that conventional MRCP properly identified 30 benign patients and incorrectly identified two instances as malignant strictures; one case was ambiguous. Furthermore, 23 out of 26 malignant cases were accurately identified by MRCP; three instances were incorrectly identified as benign strictures. As a result, 53/60 cases were correctly diagnosed at a rate of 88.33% overall.

As regards DWI findings, 36.7% showed benign stricture, 63.3% had malignant stricture. In the study of **Rabie *et al.*** [(17)] All 34 benign patients were accurately identified by DWI/ADC, as were 24 malignant instances. However, two cases were incorrectly classified because of the modest size of the lesion in these two cases. As a result, 58/60 cases were correctly diagnosed, with an accuracy rate of 96.67%.

Our results showed that by using ROC curve, sensitivity, specificity, PPV, NPV and accuracy of MRCP in comparison with histopathology was 100%, 84.21%, 78.57%, 100% and 90% respectively. Sensitivity, specificity, PPV, NPV and accuracy of DWI in comparison with histopathology was 100%, 94.7%, 91.6%, and 100% % 96.7% respectively. While in the study of **Rabie *et al.*** [(17)], the total accuracy rate was 98.33% (59/60), with 34 benign cases and 25 malignant tumors accurately detected by the combination of MRCP and DWI. MRCP has an 88.46% detection sensitivity and an 88.24% diagnostic specificity. The diagnosing sensitivity and specificity for DWI,

however, were 92.31% and 100%, respectively. Therefore, the addition of DWI to the traditional MRCP technique results in an improvement in sensitivity and specificity and a variation in the final diagnoses in 5 out of 60 patients (8.3%).

CONCLUSIONS

DWI greatly enhances the diagnosing accuracy for identifying benign and malignant biliary strictures and is superior to MRCP in the identification and characterization of biliary obstructing disorders.

Conflicts of Interest: no conflicts of interest.

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