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Accuracy of the Multislice CT in Diagnosis of Biliary Tract Obstruction

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Abstract:
Background: The recent implementation of multidetector computed tomography (MDCT) scan and post-processing image reconstruction techniques has facilitated a better visualization of the biliary system. With multiplanar reconstruction technique, the biliary duct anatomy can be displayed in various planes. Moreover, minimal intensity projection technique enables us to depict a small biliary duct and pancreatic duct more clearly. Aim of the study: This study aims to show the accuracy of MDCT in diagnosis of biliary obstruction. Materials and Methods; MDCT cholangiographs of 90 patients with clinically suspected biliary tract obstruction were retrospectively reconstructed and reviewed. The causes of obstruction identified by MDCT were divided into three groups including calculus, benign stricture, and malignancy. Final diagnosis was based on pathological diagnosis or PTC or endoscopic retrograde cholangiopancreatography or follow-up. The MDCT diagnosis and final diagnosis were compared. Results: The sensitivity, specificity, positive predictive value, and negative reductive value of MDCT cholangiography for detection of calculus, benign stricture, and malignancy were 88.8-100%, except for sensitivity and positive predictive value for detection of benign stricture, which were 66.7% and 66.7% respectively. Conclusion; MDCT cholangiography is a fast, noninvasive technique that offers high diagnostic accuracy in evaluation of cause of biliary tract obstruction.

Keywords: *Multidetector computed tomography (MDCT), Biliary tract obstruction (BO). Calculus, Stricture*

1. Introduction

Obstructive Jaundice (OJ) is a common surgical problem that occurs when there is an obstruction to the passage of conjugated bilirubin from liver cells to intestine. (1) OJ is a condition of bile and bile component retention due to extrahepatic or intrahepatic bile duct obstruction. Extrahepatic cholestasis means obstruction of large bile ducts outside the liver due to the formation of gallstones, cyst or malignant tumours. (2)

Many imaging tests have been introduced into diagnosis of suspected biliary obstruction. Traditionally, sonography is the initial imaging technique used. However, its value in the evaluation of the extrahepatic and peripheral intrahepatic ductal lesions is limited. Although conventional CT or MRI results in high spatial resolution of the biliary tract, they do not provide adequate anatomic information of the bile and pancreatic ducts. For this reason, direct cholangiography such as percutaneous transhepatic cholangiography (PTC) or endoscopic retrograde cholangiopancreatography (ERCP) are still used clinically, but they are invasive procedures. (3)

Magnetic resonance cholangiography (MRC) is a non-invasive technique, produces high contrast and high-resolution images of the biliary tree, and also allows evaluation of the solid organs. However, contraindications including patients with cardiac pacemakers, cerebral aneurysm clips or claustrophobia, and those who cannot endure the long examination limit its use. (4)

In the past decade, CT scanning and computer imaging technology have rapidly improved. Multidetector row CT provides exceptional image quality. A detailed image of the structure of the bile duct and the vascular structure of the hepatic hilus can be achieved with thin collimation data and high spatial-resolution multidetector row CT(MDCT). (5)

The recent implementation of MDCT scan and post-processing image reconstruction techniques has facilitated a better visualization of the biliary system. With multiplanar reconstruction technique, the biliary duct anatomy can bde displayed in various planes. Moreover, minimal intensity projection technique enables us to depict a small biliary duct and pancreatic duct more clearly. (6)
The aim of this study is to show the accuracy of MDCT in diagnosis of biliary tract obstruction.

2. Aim of the Study

This study aims to show the accuracy of MDCT in diagnosis of biliary obstruction

3. Patients and Methods

We conducted a prospective study from May 2012 to May 2014 with MDCT study. Onninety patients with clinical and biochemical (increased serum levels of bilirubin and/or alkaline phosphatase) signs suggesting bile duct obstruction referred to the CT unit in National Liver Institute referred from the Hepatology and surgery departments. Subjects were given written, informed consent; and the study protoc all conformed to the ethical guidelines of the 1975 Helsinki Declaration.
Every patient included in the study was subjected to the following:

3.1. History Taking

Full history taking with stress on: patient personal data (age, sex and weight) & patient presenting complaint: jaundice, discoloration of urine and stool (tea color urine or clay stool), weight loss, anorexia, nausea, vomiting, pallor, fatigue, abdominal pain and abdominal swelling. Each patient is asked about the history of the present condition including the onset, course and duration of the presenting complaint and the risk factors (obesity. pregnancy, alcohol intake, inflammatory bowel disease…). The patient is also asked about any relevant past history e.g. (surgical operation).

3.2. Laboratory and Serological Examinations

Routine laboratory investigations were done to all patients that included: complete blood picture, erythrocyte sedimentation rate, bleeding parameters and renal profiles that included blood urea and creatinine.
Special laboratory investigations were done according to the case including serum bilirubin, alkaline phosphatase and serological markers such as carbohydrate antigen 19-9(CA 19-9) and carcinoemberyonic antigen (CEA) were used in cases with obstruction at the level of pancreatic head for diagnosis as well as for assessing prognosis.

3.3. Abdomino-Pelvic Ultrasound

Trans abdominal ultrasound was the initial test. Ultrasonographic examination was done for all patients searching for signs of biliary obstruction. Scanning using 3.5 MHz and 5 MHz sector transducers after an overnight fast. The liver, gallbladder, pancreas, intrahepatic and extrahepatic bile ducts were evaluated. Any additional findings namely, ascites, enlarged lymph nodes were also evaluated.

3.4. Review of all available other imaging studies, the operative data and histopathological reports.

3.5. Multi Detector Computed Tomography

Technique of triphasic CT scan of the liver:
Twenty patients were examined by (Siemens 20 Somatom Definition AS 2010) used in the National Liver Institute and the other thirty patients examined by different outside MDCT machines.
With the following parameters 120 kVp,350 mAs,0.5second tube rotation time,16x1.25mm collimation, pitch of 1.375, 5mm slice thickness for axial images, and 1.25mm reconstruction slice thickness, 1.25mm reconstruction interval.
Patient preparation:

- Fasting for 6 hours before scan.
- No oral contrast was used.
- Creatinine clearance should be>30
- Vigorous Oral hydration.
- Intravenous catheter introduced through antecubital vein.

Patient position:

- The patient lies supine, head first, scanning start from the lung bases down to the inferior border of the liver in all phases except in the porto-venous phase where the scan extends to perineum.

CT scan Protocol

1) Non-contrast phase:
Used for identification of calcifications in the base line study, and in post embolization study: to identify the lipidol deposition in the focal lesions. Then a nonionic contrast agent (300 mg of iodine per mL) was administered intravenously (2 ml /kg), through the intravenous catheter. then the helical acquisition started(8sec) after a threshold level of (140 HU) was reached in the abdominal aorta then the arterial phase acquired(20-30sec) after injection of contrast media, the porto-venous phase acquired (50-60sec) after the injection of contrast media, Lastly the delayed phase acquired (5-10min) after injection of the contrast media.

2) Contrast enhanced phases:
It includes arterial, porto-venous and delayed phases. Diagnosis of the focal hepatic lesion depend on its pattern of enhancement.
Ex; hypervasculer HCC lesions will show typical criteria of enhancement (wash-in at the arterial phase and wash-out at the porto-venous and delayed phases).

Post procedure care:
Vigorous Oral hydration
Reference examinations
The results of MDCT were compared to the final diagnosis reached by histopathology and (or) ERCP and (or) PTC and (or) MRCP. They were confirmed as follows:
ERCP was performed to 23 patients and PTC was performed to 46 patients 1 to 70 days after MDCT. The mean delay time between the ERCP or PTC studies and MDCT was 17 days.
Histopathological study was performed to 15 patients.
MRCP was performed to 14 patients
And one case was confirmed with color Doppler sonography.
Statistical analysis:
By comparing MDCT diagnosis with the final diagnosis obtained from standard references, the diagnostic accuracy of MDCT cholangiography in evaluation of causes of biliary obstruction was presented in terms of sensitivity, specificity, accuracy, PPV and NPV.

4. Results

Our results were tabulated as follows

Level	No	%
Intrahepatic	8	8.8
Hilar level	27	30
Pancreatic including ampullary level and distal CBD	55	61.1
Total	90	100

Table 1: Level of biliary obstruction in the studied 90 patients

Cause	No	%
Benign (n=30)		33.3
Calcular	19	
Benign mass	5	
Benign stricture	6	
Malignant (n= 60)		66.6
Intra hepatic malignant mass	8	
Hilar mass	24	
Pancreatic head mass	16	
Ampullary mass	6	
Malignant stricture	6	
Total	90	100

Table 2: Causes of biliary obstruction in the studied 90 patients Pancreatic and distal CBD lesions were the highest detected while intrahepatic lesions were the least

Causes of obstruction	MDCT diagnosis	Reference test diagnosis
Calcular	16 (84.2%)	19
Benign stricture	4 (66.6%)	6
Benign masses	5 (90%)	5
Malignant obstruction	56 (90%)	60
Total cases	81 (90%)	90

Table 3: The causes of biliary obstruction based on reference examinations and findings on MDCT cholangiography Hilar malignant masses were the highest detected while benign masses were the least

MDCT accurately diagnosed the cause of biliary obstruction in 81/90 patients (90% of patients) and diagnosed calcular biliary obstruction in 16/19 patients (84.2% of patients). It was able to diagnose benign common bile duct strictures in 4/6 patients (66.6% of patients), benign masses in 5/5 patients (100% of patients) and malignant obstructive lesions 56/60 patients (93.3% of patients).

Biliary dilatation	Benign cause	Malignant cause	Total	Percentage to total
Mild	20 (71.4%)	8 (29.6%)	28	31.1
Moderate	6 (20%)	24 (80%)	30	33.3
Sever	4 (12.5%)	28 (87.5%)	32	35.5

Table 4: Degree of biliary dilatation seen on MDCT cholangiography. The degree of biliary duct dilatation caused by malignancies was found to be more severe (87.5%) than that caused by benign strictures (12.5%)

Causes	No	%
Hilar cholangiocarcinoma	19	70.8
Hilar lymphadenopathy	4	16.6
Gall bladder carcinoma	1	
Post anastomotic stricture (Liver Transplant)	2	8.4
Portal bilopathy	1	4.1
Total	27	100

Table 5: Causes of hilar obstruction

The most common cause of biliary obstruction was hilar cholangiocarcinoma were the highest detected while gall bladder carcinoma and portal bilopathy were the least.

Causes	No	%
Pancreatic head carcinoma	16	30.2
Pancreatic adenoma	1	2
Ampullary mass	12	22.6
Lower end CBD obstruction (NO=24)		
*Lower end CBD stone(NO=12)	12	22.6
*Lower end CBD stricture (NO=12)	12	22.6
Benign	6	
Malignant	6	
Total	53	100

Table 6: Causes of biliary obstruction at the level of the pancreas including the ampulla of Vater and distal CBD

	MDCT results		Sensitivity %	Specificity %	Accuracy	PPV	NPV	P. value
Final diagnosis	True +ve	True –ve						
Calcular	16	3	100	84.2	96.7	100	95.9	< 0.01
Benign stricture	4	2	66.7	80.2	92.6	80.2	91.7	
Malignant lesions	56	4	96.8	94.9	95.6	98.2	96.7	
Benign mass	5	0	100	100	100	100	100	
All cases	81	9	98.9	89.8	94.8	94.6	97.6	

Table 7: Statistical analysis of the MDCT ability to diagnose various causes of biliary obstruction

Pancreatic head carcinoma showed the highest incidence while pancreatic adenoma was the least.

The sensitivity, specificity, accuracy, PPV, and NPV of MDCT cholangiography in the diagnosis of calcular obstruction were 84.2, 100%, 96.7%, 100%, and 95.9%, respectively.
The sensitivity, specificity, accuracy, PPV, and NPV of MDCT cholangiography in diagnosis of malignant lesions were 96.8%, 94.9, 95.6 %, 98.2%, and 96.7%, respectively.
The sensitivity, specificity, accuracy, PPV, and NPV of MDCT cholangiography in diagnosis of benign stricture were 66.7%, 80.2%, 92.6 %, 80.2%, and 91.7%, respectively.
The sensitivity and specificity of MDCT in diagnosis of benign masses were 100 %.
MDCT detected all the cases of pancreatic carcinoma and ampullary carcinoma with 100% accuracy.

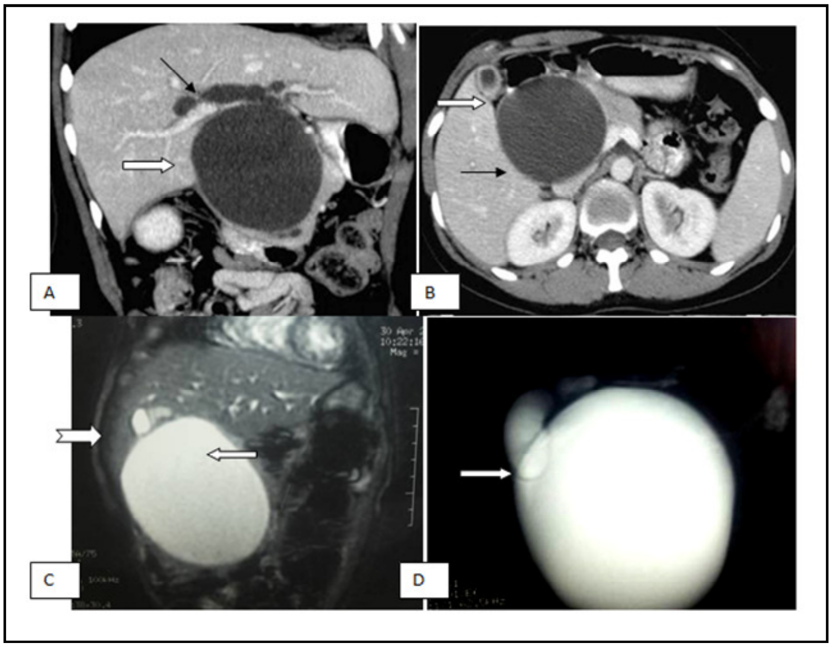

Figure 1

Fig. 1 :A: Axial contrast enhanced CT in the portovenous phase shows moderate IHBRD (black arrow) till a large cystic structure at the course of the common hepatic duct and CBD (open arrow).
B: Axial contrast enhanced CT in the portovenous phase shows the cyst (arrow) and the small GB (open arrow).
C: MRC T2WI shows a large cystic structure at the course of the common hepatic duct and CBD (arrow). The IHBRD appears intimate to the cyst (notched arrow)
D: Curved thick MIP coronal T2WI shows the biliary radicles draining into the cyst (arrow).

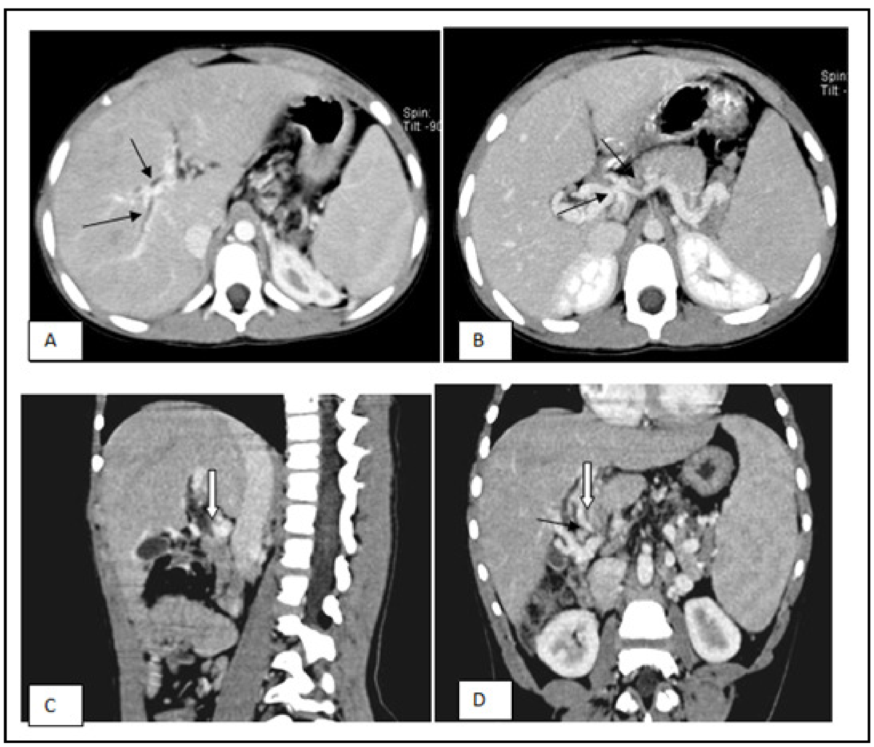

Figure 2

Fig. 2: A: Axial contrast enhanced CT in the portovenous phase shows mild IHBRD (arrows).
B: Axial contrast enhanced CT in the portovenous phase shows prominent multiple venous collaterals at the porta hepatis (arrows).
C: Sagittal oblique contrast enhanced CT in the portovenous phase shows prominent multiple venous collaterals along the course of the ectatic CHD and CBD (open arrow).

D: Coronal oblique contrast enhanced CT in the portovenous phase shows prominent multiple venous collaterals (black arrow) along the course of the ectatic CHD and CBD (open arrow).

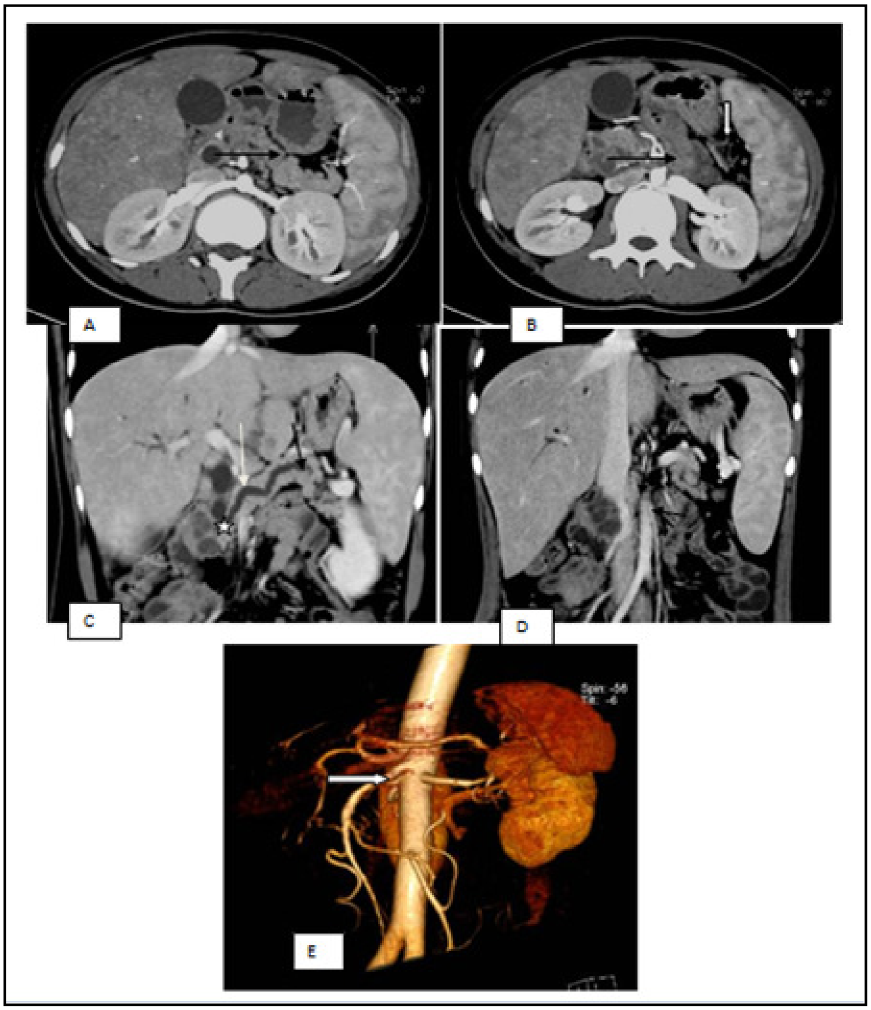

Figure 3

Fig 3: A: Axial contrast enhanced CT in the arterial phase shows dilation of the CBD till its distal end (arrow).
B: Axial contrast enhanced CT in the arterial phase shows a heterogeneous pancreatic head mass (arrow) displacing the SMA (open arrow).
C: Curved multiplanar coronal CT image in the portovenous phase shows a heterogeneous pancreatic head mass (star) dilated pancreatic duct (black arrow), dilated CBD (white arrow) (double duct sign) and moderate IHBRD.
D: MinIP coronal oblique contrast enhanced CT in the portovenous phase shows invasion of the mid portion of the IVC by the mass (arrows).
E: CT arteriography shows no invasion of the SMA but shows its displacement by the mass (arrow).

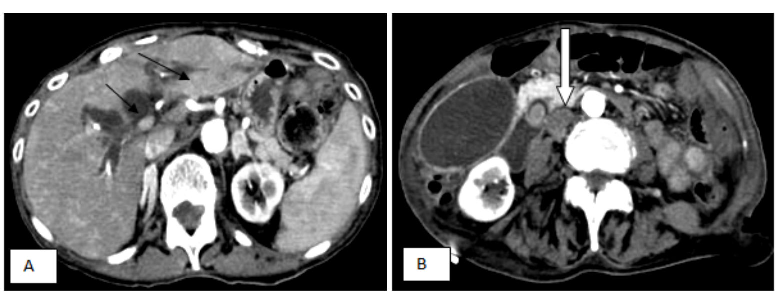

Figure 4

Fig.4: A: Axial contrast enhanced CT in the arterial phase shows moderate IHBRD (black arrow)
B: Axial contrast enhanced CT in the arterial phase shows a stone of low density in the distal end of the CBD (arrow).

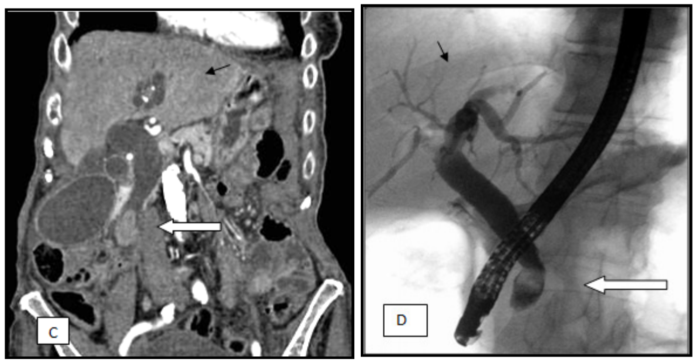

Figure 4

Figure 4-C: Curved multiplanar coronal CT in the arterial phase shows dilatation of the CBD till its distal end where a low density stone is detected (arrow).
D: ERCP shows dilated CBD with a stone at its distal end (open arrow) and IHBRD (black arrows).

5. Discussion

In the evaluation of obstructive jaundice, diagnosing the cause and the level of biliary obstruction is crucial since the choice of the therapy may depend on the cause, the location of obstruction and the extent of the lesion. Hepatobiliary imaging by CT has advanced impressively since the introduction of MDCT scanners in the late 1990s. Over the last few years, the number of detector rows has increased progressively from four, to eight, to 16, and then up to 320 (Kawata et al.,) [(7).]

Advances in MDCT scanners have resulted in an increased capability to detect and characterize various biliary diseases. The advantages of MDCT of the biliary tract are increased speed and reduction of acquisition time and respiratory motion artefacts. Furthermore, the thinner slices of MDCT result in reconstructed data sets with isotropic voxels for MPR and 3-D displays. Straight and curved MPR are especially valuable for visualization and evaluation of the biliary tree, which is typically oriented either perpendicular or tangential to the axial plane (Schindera and Nelson) [(8).] (Romagnuolo et al.) [(9)] reported that with the recent advances in CT, it has become an equal diagnostic tool compared to MRI and MRCP in the diagnosis of cholestasis regarding the presence and level of obstruction with accuracy nearing 100%.

In this study MDCT was able to detect the level of biliary obstruction in all our patients (90 patients) with 100% accuracy. The sensitivity, specificity, accuracy, PPV, and NPV of MDCT in diagnosing the cause of biliary obstruction was 98.9%, 89.8%, 94.8%, 94.6% and 97.6% respectively. This agrees with Zhanga et al. [(3)] who reported that MDCT was accurate in detecting the presence and location of obstruction in 100% of the studied patients and the cause of obstruction was correctly evaluated in 95.7%.

In the present study MDCT was able to diagnose biliary duct stones in 16 out of 19 patients with an accuracy of 84.2%, and there were 3 false negative results. Two patients were found to have black-colored radiolucent calculi in the distal CBD that were removed by ERCP four days later. The 3rd patient showed IHBRD and dilatation of the CBD with smooth narrowing of its distal end and was diagnosed as having a benign stricture. ERCP performed 21 days later showed a small distal common bile duct stone that was extracted. So, the sensitivity, specificity, accuracy, PPV, and NPV of MDCT in the diagnosis of calcular obstruction in our study were 84.2, 100%, 96.7%, 100%, and 95.9%, respectively.

The results reported by Tongdee et al., [(6)] about the sensitivity, specificity, accuracy, PPV, and NPV of MDCT cholangiography in diagnosis of biliary stones were 91.7%, 100%, 96%, 100%, and 92.9%, respectively which are close to our results. Upadhyaya et al., [(10)] reported that usually only 20% of the CBD stones show homogenous high attenuation on CT while 50% of the stones show faint attenuation slightly higher than the surrounding bile and often similar to that of the adjacent soft tissues of the pancreas. Hence, detection of these stones is difficult.

The study by Adedin et al., [(11)] showed that the sensitivity, specificity, accuracy, PPV, and NPV of MDCT in diagnosing choledocholithiasis were 75%, 100%, 96.5%, 100%, and 96.1%, respectively. The results of the study by Kondo et al., [(13)] showed that the diagnostic sensitivity of MDCT for CBD stones varies between 65 and 93%.

The advent of ERCP dramatically changed the diagnosis and treatment of biliary and pancreatic diseases. It currently remains the standard reference for imaging the biliary ducts and the pancreatic duct. PTC as well is particularly useful when proximal pathology is suspected based on previous screening studies. A major drawback of these procedures is their invasive nature which may result in complications (Upadhyaya et al.,). [(10)] It has a failure rate of 3-10% and 0.5-5% complications rate which includes adverse reactions from sedatives, pancreatitis, perforation of the gastrointestinal tract, bleeding, cholangitis, sepsis, and even death (Tongdee et al.,). [(6)]

Five patients with benign lesions in this study showed characteristic diagnostic pictures by MDCT. The first showed a ring enhancing hepatic lesions with related IHBRD that was diagnosed as cholangitic abscess and confirmed with cytological examination and clinical follow up. Two other patients showed a cystic structure along the course of the common hepatic duct and CBD and were diagnosed as choledochal cysts they were confirmed by MRC. Portal bilopathy was diagnosed in one patient. It appeared as marked dilated venous collaterals compressing the CBD and was confirmed by Color Doppler. The last patient had a pancreatic head adenoma that was a well-defined enhancing focal lesion in the pancreatic head with preserved fat planes, no local lymohadenopathy or local vascular invasion. The diagnosis was confirmed by the histopathologic study.

Regarding the detection and classification of common bile duct narrowing, Anderson et al., [13] stated that MDCT with its multiplanar capabilities especially coronal, curved linear and oblique planes made visualization and characterization of the biliary stricture an easier task. They described the CT criteria of a benign stricture as smooth and gradually tapering narrowing of the CBD in a short segment <1cm without a mass.

In the present study, these criteria were seen in four patients. The diagnosis was confirmed by ERCP in three patients while the ERCP findings were inconclusive in the fourth. A biopsy was taken and revealed local malignant infiltration.

The diagnosis of malignant biliary narrowing was made when a mass involving or surrounding the bile duct or when focal nodular biliary wall thickening was present in a long segment (>1cm). Asymmetric narrowing and irregular margin, hyperenhancement of the bile duct wall in the portal phase or abrupt termination of the CBD were other diagnostic signs (Anderson et al.,) [13] In the present study, these criteria were seen in three patients. ERCP and post-operative histopathology confirmed our results.

A correct diagnosis of benign stricture was achieved by MDCT in four out of six patients in this study with a fair sensitivity of 66.7%. This was the same as the result reported by Tongdee et al., [6] that was 66.7%. as well in our study, two patients were misdiagnosed as having malignant strictures. The first had underlying chronic pancreatitis and MDCT showed marked CBD dilatation with abrupt irregular narrowing of the distal CBD. ERCP demonstrated severe irregular narrowing of the distal CBD measuring 0.8 cm in length. The pathological result of punch biopsy from the stricture segment showed chronic inflammation with fibrosis. The second patient had mild left intrahepatic duct dilatation with abrupt irregular bile duct narrowing and hyperenhancement of the left intrahepatic duct wall on MDCT cholangiography and was diagnosed as infiltrative cholangiocarcinoma. However, ERCP showed mild dilatation of the left intrahepatic duct without an obstructive lesion or filling defect and the diagnosis was acute cholangitis. The patient clinically improved after antibiotic treatment and became symptom-free.

Malignant obstruction was correctly diagnosed by MDCT in 56 out of 60 patients in our study. Four other patients with malignant obstruction were incorrectly diagnosed as having benign obstruction. One patient showed smooth tapering of distal CBD and no mass was detected by MDCT. One week later, ERCP showed marked dilatation of the CBD with bulging of its distal end into the duodenum and the pathological diagnosis was infiltrative cholangiocarcinoma. The second patient showed smooth narrowing of distal CBD and the brush biopsy taken through ERCP showed local malignant adenocarcinoma infiltration of the duodenal wall. The other two patients showed metastatic lesions from NHL and breast cancer and they were proved by biopsy taken through ERCP. The sensitivity, specificity, accuracy, PPV, and NPV of MDCT cholangiography in diagnosis of malignant stricture were 96.8%, 94.9, 95.6 %, 98.2%, and 96.7%, respectively and the overall diagnostic accuracy of MDCT cholangiography in evaluation of the cause of biliary obstruction was 90%.

This agrees with Ahmetoglu et al., [20] who reported that the sensitivity and specificity of MDCT cholangiography in diagnosis of malignant biliary obstruction were 94.1% and 94.1%, respectively. The results of Tongdee et al., [6] also showed that the sensitivity, specificity, accuracy, PPV, and NPV of MDCT cholangiography in diagnosis of malignant biliary strictures were 95%, 93.3%, 94%, 90.5%, and 96.6%, respectively.

In our study, MDCT diagnosed twelve patients with ampullary carcinoma. They showed ill-defined soft tissue density masses near the ampulla of Vater with average measuring 17x25x15mm. The lesions showed mild enhancement in the arterial and portovenous phases and moderate to marked dilatation of the intrahepatic bile ducts and the CBD along its course till the ampullary region. Dilatation of pancreatic duct was observed in one patient only. In another patient the lesion showed infiltration of the pancreas and the second part of the duodenum. All the twelve lesions were correctly diagnosed by MDCT so the sensitivity and the accuracy of MDCT in evaluation of periampullary carcinoma were 100%. Upadhyaya et al., [10] also reported that all the sixteen cases of periampullary carcinoma in their study were detected by CT scan. Chang et al., [15] also reported in their study that MDCT showed 91.7% sensitivity in the detection of ampullary masses compared with 20–39% by single slice CT.

In this study, MDCT also correctly diagnosed malignant pancreatic head masses in all 16 patients with an accuracy 100%. It showed low density lesions in 7 patients and heterogeneous lesions in 9 patients in the enhanced pancreas phase with accurate detection of the mass size. Biliary dilatation was moderate in 5 patients and marked in 11 patients. Local vascular invasion was detected in two patients (superior mesenteric vein invasion and PV thrombosis), local lymph node enlargement and distant metastasis were detected in 3 patients with hepatic deposits. Curved multiplanar reformatting gave clear details of the pancreatic duct and the extension of the mass and related duodenal wall invasion and it was of great value in the preoperative assessment of 4 patients. This agrees with Adedin et al., [11] who reported that the sensitivity, specificity, accuracy, PPV, and NPV of MDCT in evaluation of cancer pancreas were 93.3%, 97.6%, 96.5%, 96.3% and 97.6% respectively. And also stated that MDCT is the imaging modality of choice as it provides data on resectability and prognosis of pancreatic carcinoma. It has an accuracy of 99%, positive predictive value of 87% - 100%, and NPV of 100% in the diagnosis and staging of pancreatic cancer and staging. The results of the study by Heller et al., [14] showed that the sensitivity of MDCT in detection of pancreatic head malignant masses approaches 100%.

Salles et al., [16] reported that MinIP by emphasizing hypodense structures, it well shows not only ducts but also emphasizes the variably hypodense ductal adenocarcinoma against the background of more intensely enhancing normal pancreatic parenchyma. Using variable obliquities, the relationship of the tumor to other structures, such as stomach and duodenum, can be easily emphasized to aid for surgical planning.

In our study coronal oblique minimum intensity projection helped to diagnose invasion of the IVC wall in one case. It makes the lesions more defined and easily showed their relation to the surrounding structures.

In the present study, MDCT correctly diagnosed 17 patients out of 19 patients with cholangiocarcinoma. Cholangiocarcinoma lesions were hypoattenuating in 11 cases and were isoattenuating in 6 cases. After intravenous administration of contrast material, 15 lesions remained hypoattenuating during the arterial phase and portal venous phase and showed enhancement during the delayed phase. The other 2 cases showed faint enhancement in the arterial and portal venous phases and showed enhancement in the delayed phase. MDCT was of great value in pre-operative staging of hilar cholangiocarcinoma in 7 patients. It allowed accurate estimation of the vertical and horizontal extension of the tumor. However, the presence of a drainage tube in two patients decreased the detection sensitivity of tumor extension due to strong artifact. MPR and MinIP images combined with conventional axial MDCT images increased the accuracy in staging of hilar tumors in 12 patients.

From the results of our study, we found that the degree of biliary duct dilatation caused by malignant lesions was more severe than that caused by benign strictures, whereas biliary calculi can cause a variable degree of biliary duct dilatation depending on their size. This agrees with Tongdee et al., (6) who found the same result and reported that differentiation between benign strictures and malignancies cannot be based solely on the degree of biliary dilatation, however the presence of severe biliary dilatation without detectable stones should raise the suspicion of malignancy.

In the current study post processing techniques had an additional value in 19 of our patients. They helped us in detecting three patient's bile duct stones. One of these patients showed intrahepatic biliary stones. The axial oblique MinIP images in the plane along the course of the intrahepatic dilated bile ducts clearly delineated the stones more than the axial plane images. Coronal oblique images along the course of the CBD were used in 11 patients having CBD stones. Curved MPR images were useful in two patients having a tortuous course of the CBD.

Curved multiplanar reformatting gave obvious details of the pancreatic duct and the extension of a pancreatic masses in 5 patients with pancreatic carcinoma. Duodenal wall invasion was also detected as well in 3 patients of them. Coronal oblique MinIP clearly defined the lesions and their relation to surrounding structures.

Several authors like Tongdee et al., (6), Ryoo et al., (17) and Kim HC et al., (18) reported that, MDCT using thin-slab MinIP and MPR technique may be feasible as a noninvasive imaging modality that demonstrates useful cholangiographic images. With technical advances in multislice CT and three-dimensional projection techniques. Conventional CT does not provide adequate information inside a biliary stent because the orientation of these ducts is not suitable for axial images.

In our study, on examining the patient with MDCT using the MPR and the variable thin-slab (4–15 mm) MinIP images. The most appropriate oblique plane and the slab thickness were decided according to the lesion and the dilated bile duct including small ampullary, pancreatic malignant lesions and also the small CBD stones. This with Zandrino et al., (44) reported that MDCT using 15-mm-thick, overlapping coronal oblique slabs seems to be a promising diagnostic tool in the assessment of patients with bile duct obstruction. Although a 15-mm slab thickness could encompass the whole biliary tract, small lesions within the mildly or severely dilated bile duct might not be properly depicted in this slab thickness. Also it agrees with Ahmetoglu et al., (70) who reported that MDCT with volume rendering is a promising technique that can be used to reveal the site and cause of biliary obstruction and vascular invasion by a tumor during preoperative evaluation. MDCT cholangiography with volume rendering has some advantages over CT cholangiography with biliary contrast agent, ERCP, and PTC. MDCT cholangiography performed without a biliary contrast agent eliminates the complications related to it.

The biliary tree can be rotated in any orientation so that all the intrahepatic ducts may be viewed, which is not possible on ERCP or PTC. The same data set may be used to produce angiographic images to evaluate vascular invasion by tumors. So MDCT using thin-slab MinIP and MPR provides useful information for diagnosis in patients with biliary obstruction and correlates well with the comparative studies such as MRC, ERC, and PTC. (Kim et al.,) (21)

6. Conclusion

MDCT was found highly specific in differentiating malignant from benign causes of obstruction. In malignant obstruction, it permits one step evaluation of the biliary tree and the surrounding liver, pancreas and lymph nodes with optimal assessment of the lesion location and extension.

MDCT was able to detect the level of biliary obstruction in all 90 patients showing 100% accuracy. The sensitivity, the specificity, accuracy, PPV, and NPV of MDCT in diagnosing the cause of biliary obstruction were 98.9%, 89.8%, 94.8%, 94.6% and 97.6 respectively.

Biliary duct stones were detected by MDCT in 16 out of 19 patients with sensitivity, specificity, accuracy, PPV, and NPV 84.2, 100%, 96.7%, 100%, and 95.9% respectively.

Correct diagnosis of benign stricture was achieved by MDCT in four out of six patients with a fair sensitivity of 66.7%.

The sensitivity, specificity, accuracy, PPV, and NPV of MDCT cholangiography in diagnosis of malignant strictures were 96.8%, 94.9, 95.6 %, 98.2%, and 96.7% respectively.

All the twelve periampulary lesions were correctly diagnosed by MDCT so the sensitivity and the accuracy of MDCT in evaluation of periampullary carcinoma were 100%.

MDCT cholangiography is of great value in pre-operative staging of hilar cholangiocarcinoma. It allows accurate estimation of the vertical and horizontal extension of tumor.

Given its comparable diagnostic accuracy, superior resolution, and availability, we recommend that MDCT could be used as an alternative to MRCP and ERCP for non-invasive imaging of the biliary tree. It represents a valuable supplement to conventional CT imaging of hepatopancreatic disorders that may not be demonstrated in conventional CT images.

6.1. Conflict of Interest

The authors declare no conflict of interest.

7. References

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