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Comparative Study between Intra-Operative Ultrasound and Endoscopic Ultrasound for the Diagnosis of Extra Hepatic Cholestasis

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Abstract: Background: There is an immense difference between causes of obstructive jaundice and it is necessary to assess the presence, the type of obstruction pre-operatively as ill-shosen procedure can lead to high morbidity and mortality. During biliary surgery, in both lithiasis and tumors, endoscopic ultrasound (EUS) and intraoperative ultrasound (IOUS) were used due to their great advantage. **Objectives:** The primary objective was to evaluate the impact of EUS and IOUS in changing the plan of management of obstructive jaundice; therefore, their impact on the surgical strategy. **Patients and Methods:** Aprospective cross sectional study which was conducted in the department of surgery, Theodor Bilharz Research Institute (TBRI) & AL-AZhar University Hospital from 2017 to 2019 consisting of 40 patients (15 calcular cases, 25 malignant cases) with history of obstructive ejaundice each patient; will undergo preoperative EUS and IOUS then the results of both to be evaluated. **Results:** Group A preoperative EUS co-ordinance with intraoperative diagnosis was (93.3) %, while The IOUS co-ordinance was 100% with 100% Sensitivity and 100% specificity for both. Group B malignant 45 % was the co-ordinance with pre-operative diagnosis. The IOUS co-ordinance with intraoperative diagnosis was 88 %; the P-Value is <0.001. The result is significant at p=≤0.05. **Conclusion:** In this study, comparative study between EUS and IOUS revealed that, the correct diagnostic identification, reached by IOUS, has allowed to: select patients with cancer really resectable, detect accurately CBD stones. It consumesless time and performed easily by an adequately trained surgeon.
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1. Introduction

It is normal but daunting radiological issue to determine obstructive jaundice. The purpose of the imaging is to diagnose biliary obstruction by defining intra- and extra-hepatic biliary channels to delineate the obstruction level [1].

Benign or malignant can be the causes of obstructive jaundice. The surgical jaundice can be caused by bile duct obstruction, such as gallstones, strictures, periampullary carcinoma and cancer of the pancreatic head [2]. The most common malignancy is the cancer of the pancreas, while choledocholithiasis is the most common benign cause [3].

For assessing obstructive jaundice, a variety of imaging modalities are available, include trans-abdominal ultrasound (US), endoscopic retrograde cholangiopancreatography (ERCP), endoscopic ultrasound (EUS), percutaneous cholangiopancreatography (PTC), and cholangiopancreatography of magnetic resonance (MRCP), computed tomography (CT) [4]. The various modalities of imaging are categorized into direct and indirect techniques. The latter are more aggressive, with ERCP and PTC being included. Although more sensitive (90%) and specific (98%), they are restricted to intrinsic biliary tree evaluation and can not identify the extra-hepatic pathologies which trigger obstruction. Both procedures have the key advantage of being able to tissue biopsy and perform interventions such as biliary drainage, stenting and stone removal. They are, however, at higher risk of complications such as bleeding, perforation or bile leakage. In addition, the skills needed and their availability is limited [5]. Indirect techniques are used more commonly because they give negligible procedural risks and also allow pancreatic biliary malignancies to be staged. In

addition to ultrasonography, new indirect modalities such as cholangiopancreatography of magnetic resonance (MRCP) (with solid organ MR), endoscopic ultrasonography (EUS) and cholangiography of helical CT (hCTC) (with CT) are now available. They offer enhanced image quality and diagnostic capabilities to allow surgeons to detect the better therapeutic option to reduce morbidity and mortality in patients with obstructive jaundice [6].

Trans-abdominal-ultrasonography remained the initial imaging method of choice in the assessment of suspected biliary obstruction because it is non-invasive, cheap and readily available. Sonographic scanning of the bile ducts was successfully used as a screening test to differentiate between medical and surgical jaundice with 90 percent accuracy [7]. Although it is well adapted to delineate the common hepatic duct and proximal CBD, one of its major limitations is the evaluation of distal CBD and pancreas, which are often obscured in about 30-50 percent of patients by overlying gases distention of bowel [8]. The limited ability to identify biliary pathologies limits its use to a preliminary imaging analysis to direct the further imaging modality or intervention to be applied [9].

Endoscopic ultrasound (EUS) blends endoscopy and US to accurately delineate pancreatic and biliary tree. This uses ultrasonic waves of higher frequency compared to traditional US waves (3.5 MHz vs. 20 MHz) and enables clinical tissue biopsy through EUS-guided fine needle aspiration (EUS-FNA) [10]. EUS overcomes the limitation of visualization of distal CBD by transabdominalsonography. It is very effective to diagnose CBD stone with a total accuracy of 96% compared to 63% transabdominalsonography sensitivity, esp. For tiny stone less than 5mm (or stone with non-dilated biliary radicals [11]. it also detects small resectable pancreato-bilary mass for high sensitivity (93-100%) [12]. Limitations include lack of expertise, echoendoscopic availability, need for conscious sedation [13]. EUS is very effective in identifying the cause of extra-hepatic obstruction with a sensitivity of 97% and a specificity of 88% in comparison with ERCP's and intraoperative cholangiography (IOC) [14].

Magnetic Resonance Cholangiopancreato-graphy (MRCP) considered as an accurate, non-invasive diagnostic modality for delineating the biliary and pancreatic ducts [15]. In more than 50 percent of patients, it eliminates the need for a potentially high risk, invasive intervention procedure. Such findings made many clinicians to recognize MRCP as the biliary imaging gold standard. Unlike EUS, MRCP can't detect stones of less than 5 mm in diameter. MRCP is an expensive choice requiring interpretation expertise; this approach may not always be readily available [16].

Intraoperative ultrasound is one of the most significant diagnostic tools in abdominal pathology. The new intraoperative probes, both for laparoscopic and open surgery, allowed the advancement of intraoperative cancer staging, which was long studied only by TC and MRI. Via direct contact with the tissue, the surgeon may determine the patient's operability and pancreatic cancer respectability through IOUS and LIOUS [17]. In the abdominal cavity, IOUS was initially used to treat cholelithiasis and choledocholithiasis [18]. Results of Laparoscopic intraoperative ultrasound versus intraoperative cholangiography to detect choledocholithiasis, were with a sensitivity of 96% and a specificity of 100%, and the benefits of time saved and lack of radiation, intraoperative ultrasound can be a superior diagnostic tool compared to IOC. [19].

Probes of different shapes and frequencies are available today. The probes used, should be easy to use and sterilize. The standard technique to examine the pancrease intraoperatively involves a direct apply of the probe over the pancreatic head. Intraoperative ultrasound is useful in assessing the cancer resectability by examining the portal vein in order to evaluate its course, caliber and potential infiltration. It also scans the hepatic peduncle and its components, the gallbladder, superior mesenteric vessels, the large abdominal vessels and the loco-regional and para-aortic lymph nodes [20].

Aim of the Work

The primary aim of this study to evaluate the impact of EUS and IOUS in changing the plan of management of obstructive jaundice; therefore, their impact on the surgical strategy and/or any additional information obtained from EUS and IOUS was defined as follows: (i) no value, (ii) additional information regarding tumor localization, (iii) additional information regarding vascular contact or (iv) the ability to waive surgery. The secondary objective was to compare the EUS and IOUS assessment with the operative assessment, including the radicality of the resection. The tertiary objective was to evaluate the assessment of vascular involvement; therefore, both the preoperative imaging results including EUS and the IOUS assessment of vascular contact were compared with the operative examination, which is the current gold standard. The contact between the tumor and any vessel was evaluated, in particular, contact between the tumor and the superior mesenteric vein (SMV), including the portal vein (PV) and its confluence.

2. Patients and Methods

A prospective study which was conducted in the department of surgery, Theodor Bilharz Research Institute (TBRI) & Al-Azhar University Hospital,

consisting of Fourty patients (all patients with history of obstructive jaundice) from June 2017 to June 2019.

Patients suspected of having bile duct obstruction were included in the study based on their history, physical examination and laboratory test results. The study was carried out by:-

The initial data including history, physical examination and assessment of laboratory markers of cholestasis.

Transabdominal ultrasonography to detect heterogeneity of the common bile duct content, and visualize the gallbladder, hepatic hilum and head of the pancreas.

Examination of the pancreas and biliary tree using endosonography, always prior to surgery. All patients signed informed consent to all the planned diagnostic procedures.

They were divided into two groups according to the cause:-

Group A benign (15 patients) diagnosed as calcular obstructive jaundice and are subjected (after EUS) to either laparoscopic CBD exploration or laparoscopic cholecystectomy with IOUS & IOC.

Group B malignant (25 patients) diagnosed as periampullary carcinoma including cancer head of pancreas & ampullary carcinoma subjected to Whipple operation (open method).

2 patients were subjected to diagnostic laparoscopy 1st due to doubtful respectability according to preoperative investigations.

Each patient was subjected to pre-operative EUS and IOUS before proceeding then the procedure was completed whatever.

The results of EUS and IOUS to be truly evaluated, especially with experienced hands.

As regard EUS: The EUS investigation was performed with the Olympus GF-UM 160 system using frequencies of 5, 7.5, 12 and 20 MHz. patients had to fast for at least 6h before the procedure. According to their immediate clinical condition, the patients were pre-treated with single dose midazolam (1-3 mg IV) and butylscopolamine (20 mgIV). During EUS investigation, the duodenum and EUS probe balloon were instilled with gas-free water to obtain as clear an ultrasound image as possible. The common bile duct was investigated from two basic positions. In the first - apical - position, the EUS probe is located at the apex of the duodenal bulb. The second position, from the region of the papilla of Vater, enables examination of a larger portion of the common bile duct. When interpreting EUS images, the common bile duct diameter was measured with a cursor in its proximal and distal halves, the presence of heterogeneous contents in the common bile duct was assessed and the condition of the papilla of Vater was determined. The head of the pancreas was examined from the apex of the duodenal bulb, from the region in the descending duodenum opposite the papilla of Vater and distally from the region below the papilla of Vater. The contact between the any mass and vessels was evaluated, in particular, contact between the tumor and the superior mesenteric vein (SMV), the portal vein (PV) and its confluence. Evaluation of CBD for any apparent filling defect mass (extension and resectability), stones (including number, site and size) within the CBD, the loco-regional and para-aortic lymph nodes were also examined.

As regard IOUS: The IOUS machine is a linear real-time mode-B ultrasound using high frequency (5 and 7.5 MHz) sterile probes of different shapes. A lower frequency, 5 MHz, used for a larger, steatotic, or cirrhotic liver. The machine can be adjusted by the operating room nurse in the presence of a radiologist.

Group A

All patients are diagnosed as calcular obstructive jaundice and are subjected (after EUS) to either CBD exploration or cholecystectomy with IOUS & IOC.

1) The gallbladder is seen by placing the probe on the adjacent surfaces of segments IV and V, the main bile duct junction through the surface of segment IV while the intrahepatic ducts are screened 2) For The extrahepatic supra-pancreatic common duct visualization transverse and sagittal scan through the liver by caudally tilting the probe progressively over the surface of segment IV this may require the flooding of the area with saline.

3) One can also lift the inferior surface of segment IV and apply the probe to the surface of the hepatoduodenal ligament. Since the common duct is not exactly vertical but has a curved shape (oblique to the left with a concavity to the right), one has to modify the inclination of the probe on the surface of the hepato-duodenal ligament.

4) The intra-pancreatic portion of the common duct is the most difficult to visualize down to the papilla of Vater. A Kocher maneuver can be helpful. The mean duration of the IOUS depends on operator experience: at present, a complete diagnostic examination of the biliary tree takes an extratime of about 10 minutes.

U.S. scanning can determine the diameter of the bile ducts at any point, detect any stones (site, number, and size), stent if present, mud or any anatomical abnormalities; findings are compared to those of IOC & real-time activity.

Laparoscopic method

With the transducer over segment five, first identify the gallbladder. This is a brief view to see shadowing gallstones sludge, cholesterolosis, polyps or thickening from acute inflammation evaluating the proximal biliary tree

1) The liver can be lifted to directly visualize the hepatoduodenal ligament and the junction with the cystic duct with a rotating clockwise/counterclockwise motion until the bile duct is identified. The non-vascular nature of the common bile duct can also be confirmed with Doppler or color Doppler imaging.

2) Next, we proceed distally to the intrapancreatic common bile duct. Transduodenal view, the tip of the probe is deflected laterally and downward over the duodenum.

Group B:

Scanning technique for malignant pancreatic operations

The diagnostic approach for tumors of the bile ducts & pancreas consists mainly in determining the local spread of these tumors, discovery of hepatic metastases, invaded lymph nodes and vascular elements.

1) Begin contact scanning on the anterior liver surface and start the scan by identifying the intrahepatic vasculature. Find the junction of the three hepatic veins with the vena cava at the superior most portions of the liver "rabbit ears", each hepatic vein is followed peripherally to its terminal branches. Next, reevaluate each vein in the longitudinal (sagittal) plane.

A typical view of the hepatic hilum is acquired by contact scanning along the inferior aspect of the liver to the patient's right of the falciform ligament in the transverse plane. The bifurcation of the portal vein is seen just distal to the termination of the main portal vein.

2) The systemic survey of the hepatic parenchyma follows next, seeking evaluation for diffuse and focal abnormalities.

Lymph node invasion in our experience, we found that no morphologic criteria are available to establish the difference between inflammatory and neoplastic lymph nodes.

3) Then, the pancreas can be explored through the adjacent structures of the stomach, duodenum. and gastro-cholic ligament, or by placing the probe directly on the surface of the gland after incision of the gastro-cholic ligament.

Disappearance of the interface between the tumor and the external aspect of the venous wall, intraluminal tumoral invasion of the vessel or presence of thrombosis & tumor mass shown as a filling of the lumen, are the strict criteria of vascular involvement.

The superior mesenteric vein appears surrounded by the uncinate process. 3-5 mm lateral to this and below the vein runs the superior mesenteric artery (between vein and aorta). In this area the pancreas is less, thick, being about 1.2-1.7 cm. On transverse scan the splenic vein appears very clearly as it courses the length of the body to the tail of the pancreas.

Pancreatic carcinoma presents as a heterogeneous, poorly echoic mass with irregular contours.

If starting with diagnostic laparoscopy

1) Through the epigastric port, Systematic scanning of the liver should start with identification of standard landmarks and of the liver parenchyma.

2) It can also be useful to position the probe on the underside of the liver, particularly on the right lobe. Visualisation of the portal structures can be aided by inserting the probe through the infraumbilical port and placing it on the hepatoduodenal ligament.

3) Then, the pancreas can be explored through the adjacent structures After complete US examination the procedure was completed whatever the result of the IOUS was, according to preoperative plan & real time exploration & dissection.

Statistical analysis

Data collected throughout history, basic clinical examination, laboratory investigations and outcome measures coded, entered and analyzed.

3. Results

Results: Benign group A

In our study 15 patients admitted to TBRI and Al-Azhar Hospital during the period from 2016 to 2018, all patients have history of jaundice (100%) were subjected to pre EUS, IOUS and IOC. laparoscopic cholecystectomy with IOUS and IOC was completed in 100% of the patients (15 patients). Patients were 11 females **(73.3%)** and 4 males **(16.7%)** with mean age of **53.26±12.9** years old (range 28-73 years old).

Patient's history: All patients have history of jaundice (100%) which was relieved by clearance in 3 cases by ERCP (20%) and, 12 of cases by CBD exploration.

Table (1): Intra-operative assessment with comparative study between EUS, IOUS and IOC regarding operative time, CBD diameter and visualization of CBD.

			EUS	IOUS	IOC	P value
Operative time (mean±SD) (min)			20.0 ± 4.22	13.6 ± 3.51	14.60 ± 1.326	0.083
CBD diameter (mm) mean + SD (Range)			12.00 ± 4.22	12.80 ± 3.16	7.010 ± 0.7162	0.414
Visualization of CBD	**Proximal 2/3**	**%**	100%	100	100%	
	Distal 1/3	**%**	100%	80 / 100 %	100%	

Table (2): Comparative study between EUS, IOUS and IOC in detection of CBD stone.

	EUS	IOUS	IOC
True negative	**3 cases**	**4 cases**	**4 cases**
True positive	**11 cases**	**11 cases**	**11 cases**
False negative	**No**	**No**	**No**
False positive	**1 case**	**No**	**No**
Sensitivity	**100%**	**100%**	**100%**
Specificity	**75%**	**100%**	**100%**
Accuracy	**93.3%**	**100%**	**100%**

Table (3): Comparative study between CT, EUS and IOUS in detection of locot-regional and para-aortic LNS.

	Sensitivity	Specificity	+VE predictive	-VE predictive	Accuracy
CT	**95.7%**	**100.0%**	**100.0%**	**100.0%**	**96.0%**
EUS	**87.0%**	**100.0%**	**100.0%**	**50.0%**	**88.0%**
IOUS	**87.0%**	**50.0%**	**95.2%**	**50.0%**	**84.0%**

Table (4): Comparative study between CT, EUS, IOUS and operative finding in detection of vascular invasion.

	Sensitivity	Specificity	+VE predictive	-VE predictive	Accuracy
CT	**100.0%**	**68.0%**	**22.2%**	**100.0%**	**68.0%**
EUS	**100.0%**	**82.7%**	**33.3%**	**100.0%**	**84.0%**
IOUS	**100.0%**	**87.0%**	**40.0%**	**100.0%**	**88.0%**

Co-ordinance of preoperative EUS with IOUS, IOC and intraoperative diagnosis was 14 cases (93.3) %, while the cause of dicoordinance was one case diagnosed as having CBD stone and explaned as may be passed stone. 12 cases (80%) diagnosed as having chronic calcular cholecystitis and 3 cases (20%) had a history of acute calcularcholecystitis.

Preoperative US show CBD diameter more than 8 mm in 11 cases (73.3%) & CBD stone in 8 cases. Preoperative **ERCP** failed to detect the cause of calcular obstructive jaundice in 4 cases (diagnosed as 2 cases CBD stricture and 2 cases passed stone preoperatively) and also had its fallacies in detecting the number of stones in two cases. (Accuracy 86.6%) **MRCP** failed to detect the cause of calcular obstructive jaundice in 1 case (Accuracy 93.3%).

Operative time: ¬***EUS timing:*** mean time of **20.0min. ± 4.22.** ***IOUS Timing:*** Which was the time after identification of cystic duct and artery with mean time of 13.6min**. ± 3.51**(3-25)**.** ***IOC Timing:*** Which was the time After IOUS till clipping of proximal part of cystic duct, with mean time of **14.60 ± 1.326 (5-30).**

Adequate visualization of biliary tree & its contents: ¬***IOUS:*** Proximal 2/3 of CBD visualized in 15 cases **(100%),** Distal 1/3 of CBD visualized in 14 cases **(93.3%)** and 25 cases after transcystic injection of saline **(100%).** ***EUS:*** Proximal 2/3 of CBD visualized in 15 cases **(100%)**, Distal 1/3 of CBD visualized in 15 cases **(100%).** ***IOC:*** Proximal 2/3 of CBD visualized in 15 cases **(100%)**, Distal 1/3 of CBD visualized in 15 cases **(100%).**

Detection of CBD stone: ¬***IOUS:*** True negative in **4 cases**, True positive in **11 cases**, there is no false negative cases and no false positives cases with **100%** Sensitivity and **100%** Specificity. ***EUS:*** True negative in **3 cases**, True positive in **11 case**s, there is no false negative cases and false positive in one case with **100%** Sensitivity and **75%** Specificity. ***IOC:*** True negative in **4 cases**, True positive in **11 cases**, there is no false negative cases and no false positives cases with **100%** Sensitivity and **100%** Specificity.

Intraoperative complications: ¬EUS: No complications occurred. IOUS: No intraoperative complications. IOC: Bile leak from cystic duct while cannulation in 15 cases.

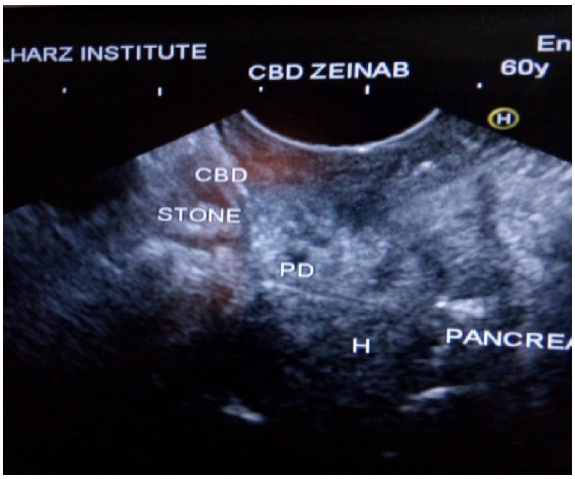

Figure (1): by IOUS, Distal CBD stone.

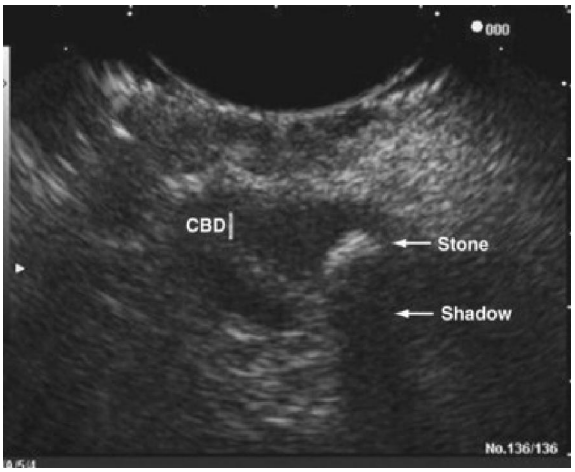

Figure (2): by EUS, Distal CBD stone.

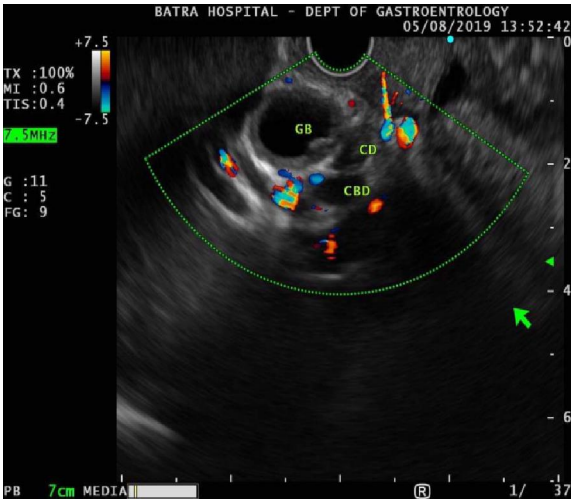

Figure (3): by EUS, view of GB, Cystic duct and CBD.

Post operative assessment: There is no post-operative complication in the form of obstructive jaundice (missed CBD stone) or iatrogenic biliary injury (bile leakage).

Malignant group B

During the study period, patient observations were performed in 25 surgical explorations. The research aimed to assess the impact of IOUS on surgical strategy, preoperative imaging correlation (CT and EUS), IOUS and operational findings of vascular assessments and resectability.

Among 25 patients (16 male, 9 female) with mean age 62y dragged in our study, all patients were subjected to pre EUS, 2 patients have been exposed to a laparoscopic intraoperative ultrasound (LIOUS); 23 patients have been exposed to an intraoperative ultrasound (open method) (IOUS). In 85% of cases the average value of CEA and CA19.9 were elevated.

- Among 25 patients in our study: all patients had obstructive jaundice; 22 of them suffered of typical pancreatic pain. Actually in Our clinical records, after the performance of IOUS exam, 23 patients were eligible to perform a Whipple operation. Three patients exposed to LIOUS then converte d to open. Complete tumor resection done in 23 patients, failed resection in 2 patients was: (one patient) due to vascular invasion and the other one due to direct invasion to peritoneal carcinosis, So45 % was the co-ordinance with pre-operative diagnosis.
- The preoperative diagnosis performed with CT failed to detect 20%(5 patients) with irresectable tumor invasion, detect 22 patients with enlarged suspected loco-regional lymph nodes and one patient with para-aortic LNs. In 96%(24 patients) EUS can detect the tumor, 20 patients with enlarged suspected loco-regional lymph nodes and one patient with para-aortic LNs **(The size of lymph node greater than 1cm, hypoechoic echogenicity, distinct margins, and round shape have been proposed as the criteria of metastatic lymph nodes).** In 100% (25 patients) IOUS can detect the tumor, 21 patients with enlarged suspected loco-regional lymph nodes and 2 patients with para-aortic LNs.
- **The IOUS detect 5** (20 %) patients with local or vascular invasion (with **87.0%specificity** & **100.0% sensitivity**). **EUS detect 6**(24 %) patients with local or vascular invasion (with **8 2.7% specificity** & **100.0% sensitivity**).
- Average for The Mean time for EUS was **21.8750 + 2.58775**min. IOUS procedure was**16.8421 + 4.77567min.** CT procedure was **25.0000+.00000min.** The Mean time for the whole operation was **6.7h±** 54 min.

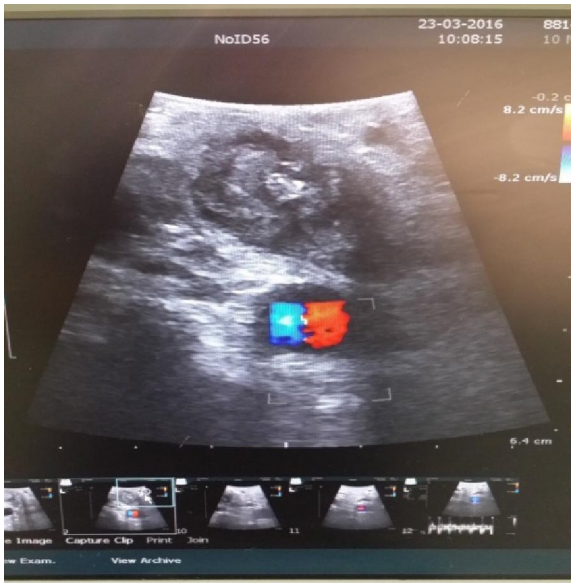

Figure (4): By IOUS, ampillary mass infiltratingduodenal wall, abutting SMV, PV and PV confluence and encroached on the distal CBD.

In **four patients** there was a tumoral encroachment of **the portal vein** but with line of cleavage; **one patients** showed a tumoral encroachment of **IVC**; **2** of them showed a tumoral encroachment of the **superior mesenteric vein** with signs of omental cancer; 23 patients had some central positive loco-regional lymph-nodes which could be detected by CT exam.

Our study shows that there was highly statistically significant increase in the diagnostic accuracy of EUS and IOUS in the diagnosis of the distal versus proximal CBD stricture with (p value<0.001). There were no cases of intraoperatory deaths.

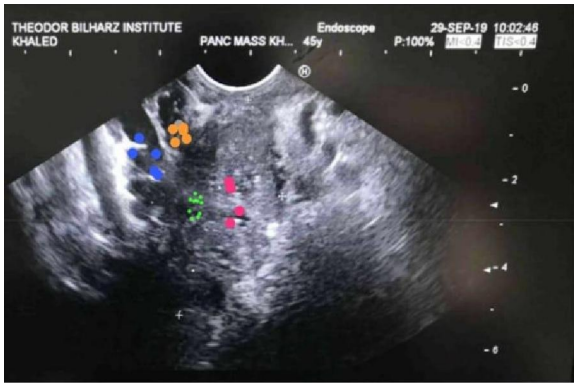

Figure (5): by EUS, pancreatic head mass infiltrating duodenal wall, encasing SMV, PV and PV confluence and encroached on the distal CBD. **Dots: -Pink** (pancreatic head mass), **yellow** (CBD), **blue** (portal vein), **Green** (infiltrated site of SMA).

4. Discussion

This study aimed to evaluate the role of EUS versus IOUS compared with other imaging modality in the diagnosis of causes of extra-hepatic obstructive jaundice.

Next, the effect of the IOUS assessment on the technique of surgical procedure was examined.

This study is a cross sectional study conducted into 40 patients presented with obstructive jaundice.

The patients were subdivided into two groups:

Group (A): included 15 patients who had calcular O.J.

Group (B): included 25 patients had malignant O.J.

All patients in group A and B subjected to EUS and IOUS.

In this study, most patients were in their third to sixth decades of life with mean age of all patients were (57±11.8) years with female predominance (58.8%) and mean age of patients of group B **malignant O.J.** and patients of group **Acalcular O.J**. (**57.0±13.9** vs **53.26±12.9**) years respectively, with female predominance in **group A** compared to group B were (**73.3**% vs. 48%) respectively, among malignancy single most common cause is carcinoma head of pancreas (76%) and among benign causes choledocholithiasis is most common cause (100%), 60% cases are more than 50 yrs age.

These results are in agreement with ***Heinzow et al.*** [21] who comparatively analysis the role of ERCP, EUS, IDUS, and CT in predicting malignant bile duct strictures, with median age (64) range (20-90) years with male predominance (54%), in our study male predominance in group B (52%).

In contrast with ***Moura et al.*** [22] who study the role of EUS FNA versus ERCP for tissue diagnosis of suspect malignant biliary strictures, there was female predominance (52%) with median age were (63) and range (41-86) years.

In our study, all patients were complaining of jaundice with no history of previous biliary surgery (100%). Itching in patients in group B (**malignant O.J.**) and patients of group **A (calcular O.J**.) were (48% vs 33.33%), abdominal pain and night fever in patients in group Band patients of group A were (88 % vs 86.6%), (24% vs 20%) respectively and there was statistically significant increase in patients in group A than in group Bin clinical presentation as regard jaundice, itching and weight loss.

These results were consistent with the study conducted by **Weilert et al.,** [23] who select patients presented with jaundice (100%). However there was no abdominal pain in all patients.

Mahaboobkhan et al. [24] reported that there were (53%) had the complaints of the obstructive jaundice and (40%) had abdominal pain.

In our study EUS, IOUS and CT determine site of cause of malignant CBD stricture with sensitivity and accuracy (96%, 100% and 80%) respectively.

This results in agreement with***(Ćwik, Solecki, & Wallner, 2014)***[25] *who* reported that The sensitivity and specificity of IOUS was determined in the range of 90-96% and sometimes even close to 100% for detection of site of pancreatic tumor. Also in agreement with ***Sun et al.*** [26] who reported that IOUS had a sensitivity of 92-93%, an average of 95% for detection of site of pancreatic tumor.

In comparison with **Wang and his colleagues** who reported that, in the patients with indeterminate diagnosis from CT, EUS had a sensitivity and accuracy of 87 and 92%, respectively [27].

Also in agreement with **DeWitt and colleagues,** In 25 patients recommended for surgery who reported that the sensitivity of EUS for detecting a pancreatic mass was 98 % [95 % CI, 91–100 %]; the sensitivity for CT was 86 % [CI, 77–93 %] [28].

In our prospective surgical explorations, IOUS was of significant clinical value in 61% of the procedures by providing additional information at an early stage during the exploration. The vascular contact (or lack of contact) was correctly assessed with IOUS in 89% of the procedures, a 15% increase compared with the preoperative imaging.

This results in agreement with ***Kolesnik et al.*** [29] who reported that the IOUS assessment changed the surgical strategy in 30%.

The current study found that the specificity and reliability of EUS, IOUS in the diagnosis of malignant vascular invasion (82.7% and 84%) for both (87% and 88%) was equally sensitive (100%) and more precise and accurate than CT 68%.

This results in agreement with ***Sun*** [30] *who* reported that the sensitivity, specificity, and accuracy of EUS for malignant vascular invasion ranged from 42 to 91%, 89 to 100%, and 40 to 100%, respectively.

This also results in accordance with **Grzegorz et al.,** [31] which reported a significant advantage of IOUS tolerance, precision and accuracy in the diagnosis of malignant invasion of portal vein flow compared to CT, IOUS accuracy was 89.7 percent compared to an average of 64.1 percent for CT.

The current study showed that the sensitivity, specificity, PPV, NPV, and accuracy of CT in nodal staging (95.7%, 100%, 100%, 100%, and 96%) are higher than EUS and IOUS with specificity, PPV, NPV, and accuracy (100%, 100%, 50%, and 88%) (50%, 95.2%, 50%, and 80%) respectively.

This leads to conflict with **DeWitt et al.,** [28] who contrasted EUS with vascular compliance surgical results and reported that EUS was lower than CT for tumor staging accuracy (67% vs. 41%; $p<0.001$) but comparable for nodal staging accuracy (94% vs. 47%; $p > 0.2$).

This also results in agreement with **Sun** [30] who indicated that EUS sensitivity ranged from 28% to 92% for the diagnosis of metastatic lymphadenopathy in pancreatic cancer.

Group A benign

Among the symptomatic gallstones typically originating from the gallbladder, the prevalence of CBD stones varies from 8% to 18%.4 Upon initial medical and laboratory evaluation, diagnostic tests of these cases include a variety of imaging methods such as US, MRCP, EUS, CT, ERCP, intraoperative US and intraoperative cholangiography [32]. All of these modalities have strengths, drawbacks and disadvantages of their own. The IOUS is less invasive than the cholangiography. It is done repeatedly in most situations, without any damage to the biliary tree [33].

In our study, the sensitivity was 100% in LIOUS, EUS and IOC while the specificity was 75% in EUS and 100% in IOC and LIOUS.

These findings in accordance with **Li et al**., [34] who stated that LIOUS is equal to IOC in choledocholithiasis detection, 95 percent sensitivity and 98 percent specificity.

In their first meta-analysis, **Aziz et al.** announced that LIOUS had the diagnostic accuracy equal to IOC to detect CBD stones [35].

In comparison to this finding, **Aziz et al**. proposed in another meta-analysis that LUS is very effective in detecting CBDS (pooled sensitivity of 0.87 and specificity of 1.00) vs. IOC (pooled sensitivity of 0.87 and specificity of 0.99) [35].

This is in accordance with **Costi et al.,** [36] who indicated that IOUS had a sensitivity of 92%-95% and 99%-100% specificity for CBDS detection.

This is in accordance with Tranter and **Thompson** [37] who registered LIOS specificity and sensitivity levels of 96% and 100%, respectively, compared with IOC sensitivity and specificity rates of 86% and 99%.

Ahrmeijer et al. [33] higher sensitivity levels were also observed for LUS vs. IOC (82.1% vs. 75%) and an equivalent specificity of 98.7%.

Ameta-analysis showed that the aggregated sensitivities of EUS and MRC were 93% and 85%, while their specificity was 96% and 93% respectively for the identification of CBD stones [33].

The sucess frequency in our sample was 100% in IOUS, EUS and 100% in IOS.

This leads to agreement with **Ishido et al.,** [38] who claimed that the success rate in both IOUS and IOC was 88-100 percent.

The timing for our analysis was 13.6min. 20min in LIOUS. In the European Union and 14.6min. At IOS. Compared to the **Ishido et al.** study [38], the time for LIOUS analysis was approximately 7min. Although the IOC's time was 14min. twice as long.

When compared to the analysis carried out by **Li et al.** [34], it was recorded that the time for evaluating LIOUS was 5-10min, whereas IOC was 10-17min. It meant that LUS ' testing time was about half the IOC's.

Contrary to our performance, **Machi et al.** [39] were 95% in IOUS and 92% in IOS, 9 min in LIOUS and 16 min in IOS, respectively.

Conclusion

In this study, comparison between diagnostic value of EUS and IOUS revealed that the correct diagnostic identification, reached by IOUS, has allowed to:

1. Select patients with cancer really resectable.
2. Detect accurately CBD stones.

It requires less time & can easily be performed by an adequately trained surgeon.

In this study, it shows that in the detection of CBD stones, **IOUS** has comparable sensitivity and specificity to **IOC**. **IOUS** can always be performed and repeated, and provides accurate images. It requires less time than **IOC** and can easily be performed by an adequately trained surgeon. **IOUS** is an accurate alternative to **IOC** during laparoscopic cholecystectomy.

A requirement for maximizing the benefits of IOUS is to have a trained and experienced specialist to perform and interpret the IOUS during surgery, which has the added advantage of allowing close collaboration between the radiologist and the surgical team, providing real-time information regarding the tumor's characteristics, which can immediately be compared with the preoperative imaging findings.

Recommendations

EUS and IOUS can be a valid imaging modality in diagnosis of malignant lesions in a noninvasive and accurate way. Multiple institutions and further studies are required to evaluate on wide scales of patients the role of EUS and IOUS in the diagnosis of common bile duct stricture as this is a single center study.

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