Research Article

Comparison of computed Tomography and ultrasonography in evaluating causes of obstructive jaundice

Kaushal L[1], Patil A[2], Ahirwar C.P[3] , Sharma K

[1]Dr. (Mrs.) Lovely Kaushal, Professor & Head of the Department, [2]Dr. Abhijit Patil, Associate Professor, [3]Dr. Chandra Prakash Ahirwar, Assistant Professor, [4]Dr. Kshitij Sharma, Post graduate student, all authors are attached with Department of Radio diagnosis and Imaging, Gandhi Medical College, Bhopal, Madhya Pradesh, India.

Address for Correspondence: Dr. Kshitij Sharma, Email: stormoffire76@gmail.com

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Abstract

Objective: To observe and compare the role of ultrasonography and computed tomography in evaluation of causes of obstructive jaundice. **Materials and Methods:** A total of 100 patients were enrolled in this cross-sectional study done in Department of Radiodiagnosis and Imaging, Gandhi Medical College, Bhopal. **Results:** Computed tomography and ultrasonography were able to detect the presence of biliary obstruction in 100% of cases. Liver function tests were altered in all the patients with alkaline phosphatase raise out of proportion to the AST/ALT. The highest incidence of biliary obstruction was found in 61-70 years' age group with mean (±SD) age of the patient was 62.7 ± 12.64 years. Sensitivity, specificity and accuracy of computed tomography and ultrasonograhy in detecting the various causes of obstructive jaundice were 90.85%, 99.21%, 98.15% and 84.15%, 98.86% and 97% respectively. **Conclusions:** Computed tomography has a high sensitivity, specificity and accuracy in detecting the causes of biliary obstruction. Considering these attributes, computed tomography can be used as an effective diagnostic modality in cases of obstructive jaundice. Accuracy and specificity for ultrasonography is high in detecting the causes of biliary obstruction with a slightly low sensitivity. Hence, ultrasonography can be used as an effective screening modality in cases of obstructive jaundice.

Keywords: Computed Tomography, Ultrasonography, Obstructive jaundice, Biliary obstruction.

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Introduction

The main goals of any imaging procedure in clinically suspected cases of obstructive jaundice are to confirm the presence of obstruction, its location, extent, probable cause, and to provide a sufficiently accurate overview of the biliary tree that will help the surgeon to determine the approach to each individual case [1,2].

Obstructive jaundice can be caused by a plethora of conditions. These include benign as well as benign and malignant conditions. Obstructive jaundice can be caused by the obstruction of the bile duct as with gall and CBD stones, strictures, malignancy, such as cholangiocarcinoma (in which the jaundice is persistent and progressive), periampullary carcinoma, carcinoma gall bladder and carcinoma head of pancreas, Castlemann disease, Caroli's syndrome and metastatic liver tumor [3].

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USG is fairly accurate to detect dilated and non-dilated bile ducts. USG allows dynamic and real time evaluation of the biliary tree. Diagnostic procedures using ultrasound are painless, harmless, relatively inexpensive, easily available and free of ionizing radiation [4].

Gross intrahepatic dilatation is easy to detect sonographically and result in the "too many tubes" sign, created by the increased number of radiolucent channels in the liver, or the "parallel channel sign", formed by dilated intrahepatic ducts running anterior and parallel to the portal vein tributaries [5].

The normal diameter of CHD measures 4-5 mm or less on sonograms. The CBD measures 4-6 mm normally, with a 6-7 mm diameter considered equivocal.

A diameter of more than 8 mm is indicative of ductal dilatation [6].

Computed tomography is highly accurate to detect dilated and non-dilated bile ducts. CT offers a comprehensive analysis of liver as well as extrahepatic abdomen and pelvis. The ability to provide multiplanar and 3D reconstructions greatly add to diagnostic accuracy of computed tomographic scans. However, computed tomography is potentially hazardous due to its use of ionizing radiation. The average size of the normal intrahepatic ducts is 2 mm in the central liver and 1.8 mm in the periphery. Bile ducts appear as water density tubular branching structures converging at the portahepatis. The left and right hepatic ducts course through portahepatis and join to form the CHD lying anterior to the portal vein [7].

The CHD and CBD are usually visible within the hepato-duodenal ligament. The proximal hepatic duct forms a fairly straight, thin walled, low density tube antero-lateral to the portal vein, angling towards the midline. The distal CBD appears on cross section as a circular, low density structure in the pancreatic head or in a groove posterior to the pancreatic head. The duct wall may be discerned separately with a mean thickness of 1 mm and maximal thickness of 1.5 mm. contrast enhancement of the duct may occur [7]. The normal CHD on CT is 3-6 mm in diameter and 8-9 mm is considered dilated [8].

Our institution has a fair influx of patients suffering from obstructive jaundice with the patients constituting a fair number of hospital admissions. Computed tomography and ultrasonography are the primary modalities used in the evaluation of obstructive jaundice. As these modalities are fairly easily available, and constitute the prima facie radiological investigation for the condition, this study is designed to evaluate the diagnostic role and accuracy of computed tomography and ultrasonography in clinically suspected cases of obstructive jaundice.

Materials and Methods

This study was carried out in the Department of Radiodiagnosis and Imaging, Gandhi Medical College, Bhopal from January 2014 to December 2015. 100 clinically suspected cases of obstructive jaundice were included in the study by simple random sampling. The presumptive diagnosis was based on combination of clinical and laboratory parameters including itching, weight loss, icterus, upper abdominal mass, raised serum values of liver enzymes with alkaline phosphatase raised out of proportion to AST/ALT.

Prior to the commencement of the study the research protocol was approved by ethical review committee and scientific research committee of Gandhi Medical College, Bhopal.

The aim of this study along with details of procedure, involved risk and benefits were explained to the patients and informed consent was taken. Data collection was done according to the afore-structured preformat.

Scanning protocol- The scan was done after 6 hours fast so that gall bladder is not contracted. An initial survey of gall bladder, biliary tree, liver, pancreas and duodenum was done with the patient mainly in supine and left lateral decubitus positions**.** Organs were visualized in longitudinal and transverse planes in midline, parasagittal, midclavicular, mid-axillary and intercostal views.

An initial plain CT was obtained and then another post contrast scan was obtained after administration of contrast agent Diatrizoate meglumine and Diatrizoate sodium 76% both orally and iv in appropriate concentration and dosage. Low density oral contrast material was given prior to the procedure. 1000 to 1500 cc of contrast was given 30 min prior to the procedure.

The post contrast scanning protocols were according to the organ predominantly involved as practiced in our institute.

The size of intrahepatic and extra hepatic biliary tree, maximum transverse diameter of main pancreatic duct, maximum transverse diameter of common duct, lumen and size of gall bladder, presence of choledocholithiasis or cholelithiasis/ size if present, presence of any mass lesion/ maximum antero-posterior and transverse diameter if present, presence of lymphadenopathy, (periportal, peripancreatic, pre and para aortic, retroperitoneal), presence of narrowing / strictures of biliary tree, presence of focal dilatation of intra and/or extra-hepatic bile ducts, presence of ascites. The findings were correlated with histopathological reports.

Statistical analysis- Statistical analysis was done by computer software devised as the statistical package for social sciences (SPSS). The results were summarized as tables and charts. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of computed tomography and ultrasonography as diagnostic modalities were calculated. A p value of <0.05 was considered significant.

Results

Female cases were 55 (55%) and male were 45 (45%). The highest incidence of biliary obstruction was found in 61-70 years' age with mean (±SD) age of the patient was 62.7 ± 12.64 years. The levels of serum alkaline phosphatase, aspartate aminotransferase and alanine aminotransferase were raised with alkaline phosphatase raised out of proportion to the other two.

Figure 1, shows the ultrasonographic features of dilated biliary tree. Figure 2, shows the computed tomography features of dilated biliary tree.

Fig-1: Grossly dilated common duct and intrahepatic biliary radicles due to presence of large obstructing common duct stone.

Fig-2: Dilated gall bladder, common duct and intrahepatic biliary ductules due to presence of large mass lesion diagnosed on CT as cholangiocarcinoma. It was further confirmed on histopathology as cholangiocarcinoma.

As shown in table 1, malignancy was the cause of obstructive jaundice in 80% of cases as compared to benign etiology in 20% of cases. Carcinoma of gall bladder was the leading cause of obstructive jaundice.

Table-1: Distribution of cases according to the cause of obstructive jaundice.

Causes of obstructive jaundice	No. of Patients	% of Patients
1. Carcinoma GB	41	41
2. Cholangio-Carcinoma	17	17
3. Pancreatic Head Ca	11	11
4. Choledocho-lithiasis	7	7
5. Stricture	5	5
6. Pancreatitis	4	4
7. Hepatocellular Carcinoma	3	3
8. Metastases	3	3
9. Choledochal Cyst	3	3
10. Lymphadenopathy Portal	3	3
11. Pancreatic Metastases	1	1
12. Carcinoma Duodenum	1	1
13. Mirizzi syndrome	1	1

Overall, computed tomography and ultrasonography were 100% sensitive in detecting biliary obstruction. However, the sensitivity decreased for delineating the cause and level of obstruction.

Table-2: Diagnostic value of Ultrasonography in evaluating findings in cases of obstructive jaundice.

USG	Cholelithiasis	Carcinoma GB	Choledocho-lithiasis	Cholangio-Carcinoma	Choledochal Cyst	Stricture	Pancreatitis	Pancreatic Head Ca
Sensitivity	94.23	82.9	68.42	82.4	100.0	100.0	100.0	81.8
Specificity	97.92	98.3	98.77	91.6	100.0	100.0	100.0	98.9
PPV	98.0	97.1	92.86	66.7	100.0	100.0	100.0	90.0
NPV	94.0	89.2	93.02	96.2	100.0	100.0	100.0	97.8
Accuracy	96.0	92.0	93.0	90.0	100.0	100.0	100.0	97.0

As shown in table 2, sensitivity of ultrasonography was in range of 80-90% in for most of the causes of obstructive jaundice except for choledocholithiasis in which case it was 68.42%. Positive predictive value of ultrasonography was above 90% for most diagnosis except for cholangiocarcinoma in which it was low. Diagnostic accuracy of ultasonography was above 90% for all the findings. Sensitivity of ultrasonography was 94.23% for cholelithiasis which was a common associated finding seen in the cases of obstructive jaundice.

Table-3: Diagnostic value of computed tomography in evaluating findings in cases of obstructive jaundice.

CT Scan	**Cholelithiasis**	**Carcinoma GB**	**Choledocho-lithiasis**	**Cholangio-Carcinoma**	**Choledochal Cyst**	**Stricture**	**Pancreatitis**	**Pancreatic Head Ca**
Sensitivity	78.85	90.2	84.21	88.2	100	100	100	90.9
Specificity	97.92	98.3	98.77	95.2	100	100	100	98.9
PPV	97.62	97.4	94.12	78.9	100	100	100	90.9
NPV	81.03	93.5	96.39	97.5	100	100	100	98.9
Accuracy	88	95	96	94	100	100	100	98

As shown in table 3, sensitivity of computed tomography was above of 85% in for all the causes of obstructive jaundice. Positive predictive value of computed tomography was above 90% for most diagnosis except for cholangiocarcinoma in which it was low. This was due to number of infiltrative large hilar cholangiocarcinomas. Diagnostic accuracy of computed tomography was above 94% for all the causes. Sensitivity of computed tomography was 78.85% for cholelithiasis which was a common associated finding seen in the cases of obstructive jaundice.

The present study findings indicate that computed tomography is a more effective diagnostic modality as compared to ultrasonography for most of causes of obstructive jaundice.

Discussion

In previous studies, the mean age of presentation of biliary obstruction were 48.42 ± 1.6 years [4] and 48.14 ± 12.55 [7] as compared to 62.7 ± 12.64 in our study, which was considerably lower. An increased pre-ponderance of involvement of elderly population is seen. The maximum number of patients 45 (45%) were seen in 61-70 years of age group.

No significant difference was seen in prevalence of obstructive jaundice in males and females. However, female preponderance was seen in the cases of carcinoma of gall bladder. This observation may be attributed to the fact that incidence of cholelithiasis was higher in females.

Malignancy was cause of obstructive jaundice in 80% of cases. Most common as well as most common malignant cause of obstructive jaundice was carcinoma of gall bladder 41/100 (41%), followed by cholangiocarcinoma 17/100 (17%) cases. The most common benign cause was choledocholithiasis causing obstruction in 7/100 (7%) of cases, followed by benign biliary strictures (5%). K. Siddique et al (2007) [10], in their study found that Commonest malignancy was Carcinoma (Ca) of the head of pancreas (30%) followed by Ca gall bladder (13.33%) and cholangiocarcinoma (11.66%). Naffisa Adedin [4] et al. reported carcinoma gall bladder as the most common etiology of obstructive jaundice.

Serum alkaline phosphatase, aspartate aminotransferase and alanine aminotransferase were raised in 100% of study subjects with serum alkaline phosphatase raised out of proportion to the other two. In obstructive jaundice, serum alkaline phosphatase is usually more than three times the upper limit of normal (40-125 U/l). [11]

In the present study, sensitivity, specificity, PPV, NPV and accuracy of ultrasonography for detection of choledocholithiasis were 68.42%, 98.77%, 92.86%, 93.02% and 93% respectively. Amandeep Singh et al. (2014) [12] in their study found the diagnostic accuracy, sensitivity and specificity of USG for choledocholithiasis were 96%, 93.3% and 97.14% respectively. Naffisaadedin et al (2012)[4] in their study found that the sensitivity, specificity, accuracy, PPV and NPV of USG for evaluation of choledocholithiasis were 62.5%, 100%, 94.7%, 100%, 94.2% respectively. In another study, ultrasonography correctly identified ductal stones as cause of obstruction in 71% of cases. [13] Ultrasonography could not detect choledocholithiasis in some cases due to poor visualisation of distal common bile duct owing to bowel gas and obesity.

Sensitivity, specificity, PPV, NPV and accuracy of CT for detection of choledocholithiasis were 84.21%, 98.77%, 94.12%, 96.39%, 96% respectively. Amandeep Singh et al. (2014) [12] in their study found the diagnostic accuracy, sensitivity and specificity of CT for choledocholithiasis were 94.29%, 75% and 96.77% respectively. Naffisaadedin et al (2012)[4] in their study found that the the sensitivity, specificity, accuracy, PPV and NPV of CT for evaluation of choledocholithiasis were 75%, 100%, 96.5%, 100%, 96.1% respectively. Stephan W. Anderson et al (2006) [14] found in their study that the overall sensitivity of CT for diagnosis of choledocholithiasis between the two observers ranged from 69% to 87%, specificity from 83% to 92%, and accuracy from 84% to 88%.

41% of the cases were diagnosed with carcinoma of gall bladder. Sensitivity, specificity, PPV, NPV and accuracy of USG for detection of carcinoma gall bladder were 82.9%, 98.3%, 97.1%, 89.2%, 92% respectively with a p value< 0.001. Naffisaadedin et al (2012) [4] in their study found that the sensitivity, specificity, accuracy, PPV and NPV of USG for evaluation of CA GB were 95%, 94.6%, 93%, 90.5%, 97.2% respectively. Khalili and Wilson (2005) [15] in their study estimated the sensitivity of USG in diagnosis of Gall Bladder malignancy to be 94%. Yeh [16] observed the accuracy of ultrasonography in the diagnosis of gall bladder carcinoma to be 84.6%. The present study showed a similar accuracy with a lower sensitivity.

Sensitivity, specificity, PPV, NPV and accuracy of CT for detection of carcinoma gall bladder were 90.2%, 98.3%, 97.4%, 93.5%, 95% respectively with a p value< 0.001. Naffisaadedin et al (2012)[4] in their study found that the sensitivity, specificity, accuracy, PPV and NPV of CT for evaluation of CA GB were 100%, 100%, 100%, 100%, 100% respectively. Ghafoor N. et al (2006) [17] in their study observed 93.3% sensitivity of computed tomography for evaluation of gall bladder malignancy. Kumran et al (2002) [18] found the accuracy of CT in the diagnosis of GB mass to be 93.3%. Yoshimitsu et al (2002) [19] in their study found that the sensitivity and accuracy of CT for detection of Gall bladder mass was 80% and 86% respectively. Sensitivity of computed tomography in different studies is comparable.

Loss of fat planes with infiltration into the liver parenchyma was present in 31/41 (75.6%) cases. S. Pradhan et al (2002) [20] in their study found presence of liver infiltration in 74% of cases of carcinoma of gall bladder.

Sensitivity, specificity, PPV, NPV and accuracy of USG for detection of cholangiocarcinoma were 82.4%, 91.6%, 66.7%, 96.2%, 90% respectively with a p value< 0.001. Amandeep Singh et al. [12] (2014) in their study found the diagnostic accuracy, sensitivity, specificity and NPV of USG for cholangiocarcinoma was 96%, 66.67%, 100%, 95.65% respectively. L E Hann et al (1997) [21] found in their study that ductal masses were revealed by sonography in 87%.

Sensitivity, specificity, PPV, NPV and accuracy of CT for detection of cholangiocarcinoma were 88.2%, 95.2%, 78.9%, 97.5%, 94% respectively with a p value< 0.001. Amandeep Singh et al. [12] (2014) in their study found the diagnostic accuracy, sensitivity and specificity of CT for cholangiocarcinoma was 97.14%, 83.33% and 100% respectively.

11/17 (64.7%) cases of cholangiocarcinoma were extrahepatic, 5/17 (29.4%) cases were hilar, 1/17 (5.9%) cases were intrahepatic variety.

Sensitivity, specificity, PPV, NPV and accuracy of USG for detection of carcinoma head of pancreas were 81.80%, 98.9%, 90%, 97.8%, 97% respectively with a p value< 0.001. Naffisa adedin et al (2012) [4] in their study found that the sensitivity, specificity, accuracy, PPV and NPV of USG for evaluation of CA Pancreas were 80.0 %, 97.6%, 93%, 92.3%, 93.2% respectively. Thomas MJ et al (1982) [22] in their study found that USG was 97% sensitive with 100% PPV, accuracy of USG was 80.0%. Hessel et al (1982) [23] found that USG has a sensitivity of 69% and specificity of 82%.

Sensitivity, specificity, PPV, NPV and accuracy of CT for detection of carcinoma of pancreas were 90.90%, 98.9%, 90.9%, 98.9%, 98% respectively with a p value< 0.001. Naffisaadedin et al (2012)[4] in their study found that the sensitivity, specificity, accuracy, PPV and NPV of CT for evaluation of CA Pancreas were 93.3%, 97.6%, 96.5%, 93.3%, 97.6% respectively.

Thomas MJ et al (1982) [22] in their study found that accuracy of CT was 93%. Hessel et al (1982) [23] found that that CT has a sensitivity of 87% and specificity of 90%.

Sensitivity, specificity, PPV, NPV and accuracy of USG for detection of cholelithiasis were 94.23%, 97.92%, 98%, 94%, 96% respectively. Weltman DI et al (1994)[24] reported the accuracy of USG for detection of cholelithiasis to be 94%. Sensitivity, specificity, PPV, NPV and accuracy of CT for detection of cholelithiasis were 78.85%, 97.92%, 97.62%, 81.03%, 88% respectively. Paulson EK et al (2000) [25] reported the sensitivity of CT for detection of gall stones to be 75%.

Sensitivity, specific, PPV, NPV and accuracy of USG for detection of metastases were 88.90%, 97.8%, 80.0%, 98.9%, 97% respectively with a p value< 0.001. Sensitivity, specific, PPV, NPV and accuracy of CT for detection of metastases were 88.90%, 98.9%, 88.9%, 98.9%, 98% respectively with a p value< 0.001.

Sensitivity, specific, PPV, NPV and accuracy of computed tomography and ultrasonography both for detection of choledochal cyst, biliary stricture, hepatocellular carcinoma and pancreatitis as a cause of obstructive jaundice were 100%, 100%, 100%, 100%, 100% respectively. All the cases were Modified Todani Type I choledochal cyst. However, not much about the statistical significance can be said due to the limited number of cases.

The overall sensitivity, specificity, PPV, NPV, accuracy of USG for detecting various causes of obstruction was

84.15%, 98.86%, 91.39%,97.74% and 97% respectively with a p value of <0.0001. Satish K. Bhargava et al (2013) [26], in their study found that USG could pick up the presence of biliary obstruction in almost all cases (100%). Accurate detection of the level was possible in 98% of cases and to a much lesser extent the cause of obstruction in 75% of cases. Naffisaadedin et al (2012) [4] in their study found that sensitivity, accuracy and PPV for USG to detect the cause of biliary obstruction were 68.4%, 68.4% and 100% respectively.

The overall sensitivity, specificity, PPV, NPV, accuracy of CT for detecting various causes of obstruction was 90.85%, 99.21%, 94.3%, 98.69% and 98.15% respectively with a p value of <0.0001. Satish K. Bhargava et al (2013) [26], in their study found that CECT could detect the presence and level of obstruction in all cases (100%).

Naffisaadedin et al (2012) [4] in their study found that sensitivity, accuracy and PPV for CT to detect the cause of biliary obstruction were 96.5%, 96.5% and 100% respectively.

Conclusions

Malignancy was the cause of obstructive jaundice in 80% of cases as compared to benign causes in 20% of cases. The most common cause of obstructive jaundice was carcinoma of gall bladder. The most common benign cause of obstructive jaundice was choledocholithiasis. The most common associated finding seen in cases of obstructive jaundice was cholelithiasis followed by lymphadenopathy.

Overall, CT was effective diagnostic modality for all the causes, however, it had a decreased sensitivity for detection of cholelithiasis. With the above statistical evaluation and in accordance with the findings of previous studies it can be safely said that computed tomography is a better diagnostic modality as compared to ultrasonography in clinically suspected cases of obstructive jaundice and provides good quality diagnostic information.

Malignancy with gall bladder carcinoma was found as leading the cause of obstructive jaundice. Further studies investigating into the various predisposing factors for the increased prevalence of GB carcinoma are required.Further studies are required to validate the significance of CT and USG as staging modality in malignant causes of obstructive jaundice.

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