Multidetector Computed Tomography (MDCT) Evaluation of Obstructive Jaundice: A Cross-sectional Study from a Tertiary Hospital of Nepal

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Abstract

Objectives: This study was done to evaluate the diagnostic accuracy of MDCT in assessment of obstructive jaundice in reference to surgical or histopathological diagnosis cum to study the MDCT features of various causes of obstructive jaundice.

Materials and Methods: We did a cross-sectional study using purposive sampling size of 30 participants with obstructive jaundice at ... We calculated the diagnostic statistics of non-neoplastic and neoplastic type of obstructive jaundice as well as individual etiology of obstructive jaundice detected on MDCT in reference to histopathological/cytopathological and/or surgical diagnosis. The ethical clearance was obtained from the institutional review committee of ... (Ref no: Acd/291/075/076-IRC).

Results: The sensitivity and the NPV of MDCT for non-neoplastic cause to detect obstructive jaundice were 100% (95% CI 79.41-100.00) and 100% (95% CI 75.29-100.00), while the specificity and the PPV for neoplastic cause to detect obstructive jaundice were 100% (95% CI: 79.41-100.00) and 100% (95% CI: 75.29-100.00). Similarly, the accuracy for either non-neoplastic or neoplastic cause was 96.67% (95% CI: 82.78-99.92). The most common cause for obstructive jaundice was choledocholithiasis (33.34%) followed by cholangiocarcinoma (20%), ampullary carcinoma (13.33%) and choledochal cyst (13.33%). The diagnostic accuracy of individual etiology of common causes of obstructive jaundice ranged from 82.78 to 100%. Biliary obstruction was most frequently observed in the periampullary region (83.33%), followed by the proximal CBD (6.67%), hilar region (6.67%) and intrahepatic region (3.33%).

Conclusion: The MDCT could serve as the initial, cost-effective, easily available, and time-efficient imaging modality for diagnosing various causes of obstructive jaundice, with an accuracy ranging from 82.78% to 99.92%. It can differentiate non-neoplastic from neoplastic causes of obstructive jaundice.

INTRODUCTION

The initial evaluation of obstructive jaundice involves distinguishing between intrahepatic and extra-hepatic biliary obstruction. Various non-invasive and invasive imaging modalities have been used to assess obstructive jaundice following a physical examination and biochemical parameters. Radiological investigations play an important role in determining treatment strategies (1, 2).

Although ultrasound is considered the first line imaging modality, its sensitivity is variable, ranging from 20–80% depending upon the etiology (3, 4). Artifacts due to bowel gas, gall bladder and bile duct calculi, breathing artifacts and obesity brings it down in the list of imaging modality of choice in obstructive jaundice (5).

We have used MDCT for diagnostic evaluation of biliary obstruction. Recent advances in MDCT with post-processing reconstruction techniques (e.g. multiplanar reformations (MPR), MinIP etc.) have improved better visualization of the hepato-biliary tree. The MPR technique allows multiplanar visualization of the biliary ductal anatomy, while MinIP (Minimal Intensity Projections) technique enables better depiction of a small biliary or pancreatic duct (6, 7). MDCT can differentiate between benign and malignant strictures, stage complex biliary malignancies, determine their involvement and invasion of adjacent organs as well as regional lymphadenopathy, metastasis and fluid in the peritoneal cavity (5, 8). Additionally, its rapid and can be performed in a single breath-hold (9).
We did this study to evaluate the diagnostic accuracy of MDCT in assessment of obstructive jaundice in reference to surgical or histopathological diagnosis as well as to study the MDCT features of various causes of obstructive jaundice.

**METHODS**

**Study design, sample size, and sampling technique:**

We conducted a hospital-based cross-sectional study in the Department of Radiodiagnosis and Imaging, BP Koirala Institute of Health Sciences, Dharan, Nepal over one year from 8th October 2019 to 7th October 2020. The sample size was calculated based on a study by Mathew et al. which found the sensitivity of MDCT in diagnosis and differentiation of cholangiocarcinoma to be 90% (10). Therefore, the estimated sample size for our study using 90% sensitivity was determined.

\[
no = \frac{Z^2 \times \text{sensitivity}(1 - \text{sensitivity})}{W^2}
\]

Taking 95% confidence interval, value of \( Z = 1.96 \), and \( W \) (allowable error) = 0.05

\[
no = \frac{(1.96)^2 \times 0.9(1 - 0.9)}{(0.05)^2}
\]

\[
= 139
\]

In the previous year, our hospital saw a total of 31 cases of obstructive jaundice with a final diagnosis. Since we are dealing with a finite population, we need to calculate the corrected sample size (\( n \)):

\[
n = \frac{no}{1 + \frac{no}{N}}
\]

\[
= \frac{139}{1 + \frac{139}{31}}
\]

\[
= 25.3 \approx 26 \text{ cases}
\]

The study utilized purposive sampling to collect samples. All patients exhibiting clinical and biochemical features of obstructive jaundice who were referred for MDCT scan and subsequently received a final diagnosis through histopathology, cytopathology or surgical findings were included as participants in the study. Patients with contraindications for contrast enhanced CT, those with non-obstructive cases of jaundice, and patients experiencing recurrent malignancy causing obstructive jaundice were excluded from the study. The research adhered to the STROCSS criteria during its execution (11).

**MDCT Imaging of participants with obstructive jaundice:**

The MDCT was performed using a multislice CT scanner (ECLOS 16; HITACHI, Japan) after excluding contraindications to CECT. Non-contrast CT followed by contrast CT was done in the supine position. Positive oral contrast and intravenous contrast images were acquired as per the institutional guidelines. Three-dimensional
reconstruction with thin planar slicing (0.625 mm) and MPR were performed in coronal and sagittal planes for better depiction of biliary tract's intraluminal and wall lesion (12, 13).

On non-contrast images, the presence of calculi, calcifications, masses, baseline HU of mass, and CBD wall were noted. On post contrast images, confirmation of the presence of a mass, size, shape & margins of mass, status of adjacent infiltration, and pattern of enhancement was noted. An HU difference of > 15 on post-contrast images from baseline HU was considered significant for labelling enhancement (14–16). An ill-defined mass with significant post-contrast enhancement, intraluminal polypoidal mass with adjacent mass thickened and/or enhancing biliary wall, abnormal invasion of surrounding structures or loss of fat plane, evidence of metastasis were considered malignant mass (14, 17–21).

In the presence of features of obstructive jaundice, dilatation of CBD was considered when the maximum transverse diameter was > 7 mm (22–24) and for post cholecystectomy > 10 mm (25) irrespective of age. A maximum diameter > 2.5 mm was considered dilated for MPD (26–28). A maximum diameter > 2 mm and/or of diameter > 40% compared to an adjacent portal vein branch were labeled as presence of IHBRD (29). In case of biliary obstruction at periampullary region, dilatation of both CBD and main pancreatic duct was considered as double duct sign (14, 28, 30, 31).

Regarding biliary stricture, the presence of a long segment (> 1.5 cm) (32), abrupt narrowing, thickness of wall > 1.5 mm, and presence of enhancement was considered as a neoplastic/malignant cause of stricture, whereas smooth gradual tapering with no abnormal enhancement was considered the non-neoplastic/benign cause of stricture (15, 33). Non-visualization of the confluence of right and left hepatic duct with abrupt tapering and the presence of IHBRD was considered finding favoring towards hilar cholangiocarcinoma (21, 34–36). The gall bladder was considered distended when the long axis dimension was > 10 cm and/or transverse diameter was > 4 cm (37–40).

The presence of calculi and non-neoplastic stricture in biliary tract was confirmed with surgical findings. Rest of the other findings was confirmed by both surgical and cyto/histopathology findings. Based on the above findings, the MDCT diagnosis was made and compared with the final diagnosis. The final diagnosis in 20 cases was made from cyto/histopathological reports, and in 10 cases, it was made from surgical findings. The accuracy of the MDCT was determined considering surgery and/or cyto/histopathology as the final diagnosis, as applicable. The findings were recorded on pro forma for analysis of the data.

Data entry and analysis:

The collected data were tabulated in the Microsoft Excel 2019 v16.0 (Microsoft, WA, USA) and analyzed using statistical package for social sciences (SPSS) version 11.5, IBM SPSS® v21 (IBM, Armonk, New York) and MedCalc for Window version 12.3.0 (MedCalc-Software, Mariakerke Belgium). We expressed the categorical data as frequency and percentages, and continuous data as mean ± standard deviation (SD). Similarly, the sensitivity, specificity, positive likelihood ratio (PLR), negative likelihood ratio (NLR), positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy of non-neoplastic and neoplastic type of obstructive jaundice as well as individual etiology of obstructive jaundice detected on MDCT were determined in reference to histopathological/cytopathological and/or surgical diagnosis.

Ethical approval:
The ethical clearance was obtained from the institutional review committee of ... (Ref no: Acd/291/075/076-IRC). The written informed consent was taken from each participant and the participation was entirely voluntary.

**Results**

Out of the 30 participants meeting the inclusion criteria, three-fifths of the participants (60%, 18) were female. The mean age of the participants were 54.90 ± 19.88 years with the minimum and maximum being 10 and 87 years. About two-fifths of the participants belonged to age group 31 to 60 years (40%, 12) and 61 to 90 years (43.30%, 13). *(Table 1)*

**Table 1: Background characteristics of the study (n=30)**

<table>
<thead>
<tr>
<th>SN</th>
<th>Characteristics</th>
<th>Frequency</th>
<th>Proportions (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>12</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>18</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>Age (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean ± SD (Min-Max)</td>
<td>54.90 ± 19.88 (10-87)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≤30</td>
<td>5</td>
<td>16.7</td>
</tr>
<tr>
<td></td>
<td>31-60</td>
<td>12</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>61-90</td>
<td>13</td>
<td>43.3</td>
</tr>
</tbody>
</table>

Out of 30 participants, the nine cases were diagnosed as choledocholithiasis on MDCT which were subsequently confirmed on surgery and one falsely diagnosed case of CBD sludge on MDCT was confirmed as choledocholithiasis on surgery. Similarly, 7 cases were diagnosed as cholangiocarcinoma on MDCT of which 6 cases were confirmed as cholangiocarcinoma on cyto/histopathological examination. One case was falsely diagnosed as stricturing type of cholangiocarcinoma on MDCT which was diagnosed as carcinoma head of pancreas on histopathology. Likewise, 3 cases were diagnosed as benign biliary stricture on MDCT, of which 2 cases were confirmed as benign biliary stricture postoperatively. One case of benign biliary stricture on MDCT came out to be periampullary metastatic deposit from gall bladder carcinoma on histopathology examination. *(Table 2)*

**Table 2: Comparisons of MDCT diagnosis with the final histopathological diagnosis of the cause of obstructive jaundice**
SN | Name of disease | MDCT diagnosis | Histopathological diagnosis¹# | TP | TN | FP | FN |
---|----------------|----------------|--------------------------------|----|----|----|----|
Non-neoplastic cause
1 | Choledocholithiasis | 9 | 10 | 9 | 20 | 0 | 1 |
2 | Choledochal cyst | 4 | 4 | 4 | 26 | 0 | 0 |
3 | Benign biliary stricture | 3 | 2 | 2 | 27 | 1 | 0 |
4 | CBD sludge | 1 | 0 | 0 | 29 | 1 | 0 |
Neoplastic cause
1 | Cholangiocarcinoma | 7 | 6 | 6 | 23 | 1 | 0 |
2 | Ampullary carcinoma | 4 | 4 | 4 | 26 | 0 | 0 |
3 | Carcinoma head of pancreas | 1 | 2 | 1 | 28 | 0 | 1 |
4 | Gastroduodenal carcinoma | 1 | 1 | 1 | 29 | 0 | 0 |
5 | Periampullary metastatic deposit | 0 | 1 | 0 | 29 | 0 | 1 |

¹#Final diagnosis

The sensitivity and the NPV of MDCT for non-neoplastic cause to detect obstructive jaundice were 100% (95% CI 79.41-100.00) and 100% (95% CI 75.29-100.00), while the specificity and the PPV for neoplastic cause to detect obstructive jaundice were 100% (95% CI: 79.41-100.00) and 100% (95% CI: 75.29-100.00). Similarly, the accuracy for either non-neoplastic or neoplastic cause was 96.67% (95% CI: 82.78-99.92). At the time of study, the reported prevalence from this study was 53.33 (95% CI: 34.33-71.66) and 46.67% (95% CI: 28.34-65.67). (Table 3)

Table 3: Diagnostic statistics of MDCT to detect obstructive jaundice
Table 4: Diagnostic statistics of individual diagnosed cases of obstructive jaundice detected in MDCT in reference to surgical or cyto-/histopathological diagnosis as final diagnosis

<table>
<thead>
<tr>
<th>SN</th>
<th>Statistic</th>
<th>Non-neoplastic cause</th>
<th>Neoplastic cause</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Value (%) 95% CI</td>
<td>Value (%) 95% CI</td>
</tr>
<tr>
<td>1</td>
<td>Sensitivity</td>
<td>100.00 79.41-100.00</td>
<td>92.86 66.13-99.82</td>
</tr>
<tr>
<td>2</td>
<td>Specificity</td>
<td>92.86 66.13-99.82</td>
<td>100.00 79.41-100.00</td>
</tr>
<tr>
<td>3</td>
<td>PLR&lt;sup&gt;a&lt;/sup&gt;</td>
<td>14.00 2.12-92.55</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>NLR&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-</td>
<td>0.07 0.01-0.47</td>
</tr>
<tr>
<td>5</td>
<td>Disease prevalence&lt;sup&gt;b&lt;/sup&gt;</td>
<td>53.33 34.33-71.66</td>
<td>46.67 28.34-65.67</td>
</tr>
<tr>
<td>6</td>
<td>PPV&lt;sup&gt;b&lt;/sup&gt;</td>
<td>94.12 71.31-99.85</td>
<td>100.00 75.29-100.00</td>
</tr>
<tr>
<td>7</td>
<td>NPV&lt;sup&gt;b&lt;/sup&gt;</td>
<td>100.00 75.29-100.00</td>
<td>94.12 71.31-99.85</td>
</tr>
<tr>
<td>8</td>
<td>Accuracy&lt;sup&gt;b&lt;/sup&gt;</td>
<td>96.67 82.78-99.92</td>
<td>96.67 82.78-99.92</td>
</tr>
</tbody>
</table>

<sup>a</sup> These values are in ratio (not %)

<sup>b</sup> These values are dependent on disease prevalence

PLR: Positive Likelihood Ratio and NLR: Negative Likelihood Ratio

The confidence intervals for sensitivity, specificity and accuracy are “exact” Clopper-Pearson confidence intervals.

The confidence interval for the likelihood ratios is calculated using “Log method”.

The confidence interval for the predictive values is the standard logit confidence intervals.

In our study, the MDCT had sensitivity of 90.00%, 100.00%, 100.00% and 0.00%; specificity of 100.00%, 100.00%, 96.43%, and 96.67%; PPV of 100.00%, 100.00%, 66.67%, 0.00%; and NPV of 95.24%, 100.00%, 100.00%, and 100.00% respectively for choledocholithiasis, choledochal cyst, benign biliary stricture and CBD sludge. Similarly, the MDCT had sensitivity of 90.00%, 100.00%, 100.00% and 0.00%; specificity of 100.00%, 100.00%, 96.43%, and 96.67%; PPV of 100.00%, 100.00%, 66.67%, 0.00%; and NPV of 95.24%, 100.00%, 100.00%, and 100.00% respectively for choledocholithiasis, choledochal cyst, benign biliary stricture and CBD sludge.

Likewise, the MDCT had sensitivity of 100.00%, 100.00%, 50.00%, 100.00% and 0.00%; specificity of 95.83%, 100.00%, 100.00%, 100.00%, and undefined; and NPV of 100.00%, 100.00%, 96.55%, 100% and 96.67% respectively for cholangiocarcinoma, ampullary carcinoma, carcinoma head of pancreas, gastroduodenal carcinoma, and periampullary metastatic deposit. (Table 4)
<table>
<thead>
<tr>
<th>SN</th>
<th>Disease</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PLR</th>
<th>NLR</th>
<th>PPV</th>
<th>NPV</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Benign</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Choledocholithiasis</td>
<td>90.00</td>
<td>100.00</td>
<td>-</td>
<td>0.10</td>
<td>100.00</td>
<td>95.24</td>
<td>96.67</td>
</tr>
<tr>
<td></td>
<td></td>
<td>55.50-99.75</td>
<td>83.16-100.00</td>
<td>0.02-0.64</td>
<td>66.37-100.00</td>
<td>76.18-99.88</td>
<td>82.78-99.92</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Choledochal cyst</td>
<td>100.00</td>
<td>100.00</td>
<td>-</td>
<td>0.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>39.76-100.00</td>
<td>86.77-100.00</td>
<td>-</td>
<td>39.76-100.00</td>
<td>86.77-100.00</td>
<td>88.43-100.00</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Benign biliary stricture</td>
<td>100.00</td>
<td>96.43</td>
<td>28.00</td>
<td>66.67</td>
<td>100.00</td>
<td>96.67</td>
<td>96.67</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15.81-100.00</td>
<td>81.65-99.91</td>
<td>4.09-191.88</td>
<td>9.43-99.16</td>
<td>87.23-100.00</td>
<td>82.78-99.92</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>CBD Sludge</td>
<td>-</td>
<td>96.67</td>
<td>-</td>
<td>-</td>
<td>0.00</td>
<td>100.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>82.78-99.92</td>
<td>0.00-97.50</td>
<td>88.06-100.00</td>
</tr>
<tr>
<td><strong>Malignant</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Cholangiocarcinoma</td>
<td>100.00</td>
<td>95.83</td>
<td>24.00</td>
<td>-</td>
<td>85.71</td>
<td>100.00</td>
<td>96.67</td>
</tr>
<tr>
<td></td>
<td></td>
<td>54.07-100.00</td>
<td>78.88-99.89</td>
<td>3.52-163.50</td>
<td>42.13-99.64</td>
<td>85.18-100.00</td>
<td>82.78-99.92</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Ampullary carcinoma</td>
<td>100.00</td>
<td>100.00</td>
<td>-</td>
<td>-</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
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<td></td>
<td></td>
<td>39.76-100.00</td>
<td>86.77-100.00</td>
<td>-</td>
<td>39.76-100.00</td>
<td>86.77-100.00</td>
<td>88.43-100.00</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Carcinoma head of pancreas</td>
<td>50.00</td>
<td>100.00</td>
<td>-</td>
<td>0.50</td>
<td>100.00</td>
<td>96.55</td>
<td>96.67</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.26-98.74</td>
<td>87.66-100.00</td>
<td>0.13-200</td>
<td>2.50-100.00</td>
<td>82.24-99.91</td>
<td>82.78-99.92</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Gastroduodenal carcinoma</td>
<td>100.00</td>
<td>100.00</td>
<td>-</td>
<td>-</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.50-100.00</td>
<td>88.06-100.00</td>
<td>-</td>
<td>2.50-100.00</td>
<td>88.06-100.00</td>
<td>88.43-100.00</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Periampullary metastatic deposit</td>
<td>0.00</td>
<td>100.00</td>
<td>-</td>
<td>1.00</td>
<td>-</td>
<td>96.67</td>
<td>96.67</td>
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<tr>
<td></td>
<td></td>
<td>0.00-97.50</td>
<td>88.06-100.00</td>
<td>1.00-1.00</td>
<td>82.78-99.92</td>
<td>82.78-99.92</td>
<td>82.78-99.92</td>
<td></td>
</tr>
</tbody>
</table>

Out of the 30 cases of obstructive jaundice, more than four-fifths (83.3%, 25) had periampullary obstruction, more than one-thirds (36.7%, 11) had mass, and more than four-fifths (80.0%, 24) had both CBD and IHBR type biliary dilatation. Similarly, out of the sixteen cases of obstructive jaundice due to malignant obstruction, more than two-thirds i.e. 78.6% and 68.8% had abrupt distal tapering of dilated biliary tract due to malignant and overall cases respectively. Excluding the hilar and intrahepatic level of obstruction, gallbladder was distended in 22.2% of the
participants. Likewise, out of periampullary obstruction in 25 cases, the MPD dilatation was absent in three-fourths (76%, 19). (Table 5A)

Table 5A: The characteristics of obstructive jaundice detected in MDCT scan

<table>
<thead>
<tr>
<th>SN</th>
<th>Characteristics</th>
<th>Non-malignant (%)</th>
<th>Malignant (%)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Level of obstruction (n=30)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Periampullary</td>
<td>14</td>
<td>11</td>
<td>25 (83.3)</td>
</tr>
<tr>
<td></td>
<td>Proximal</td>
<td>2</td>
<td>0</td>
<td>2 (6.7)</td>
</tr>
<tr>
<td></td>
<td>Hilar</td>
<td>0</td>
<td>2</td>
<td>2 (6.7)</td>
</tr>
<tr>
<td></td>
<td>Intrahepatic</td>
<td>0</td>
<td>1</td>
<td>1 (3.3)</td>
</tr>
<tr>
<td>2</td>
<td>Mass (n=30)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Present</td>
<td>0</td>
<td>11</td>
<td>11 (36.7)</td>
</tr>
<tr>
<td></td>
<td>Absent</td>
<td>16</td>
<td>3</td>
<td>19 (63.3)</td>
</tr>
<tr>
<td>3</td>
<td>Biliary dilatation (n=30)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CBD</td>
<td>1</td>
<td>0</td>
<td>1 (3.3)</td>
</tr>
<tr>
<td></td>
<td>IHBR</td>
<td>1</td>
<td>4</td>
<td>5 (16.7)</td>
</tr>
<tr>
<td></td>
<td>Both CBD and IHBR</td>
<td>14</td>
<td>10</td>
<td>24 (80.0)</td>
</tr>
<tr>
<td>4</td>
<td>Distal tapering of dilated biliary tract (n=16)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Smooth gradual</td>
<td>2</td>
<td>3</td>
<td>5 (31.3)</td>
</tr>
<tr>
<td></td>
<td>Abrupt</td>
<td>0</td>
<td>11</td>
<td>11 (68.8)</td>
</tr>
<tr>
<td>5</td>
<td>Status of gall bladder (n=27)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Distended</td>
<td>2</td>
<td>4</td>
<td>6 (22.2)</td>
</tr>
<tr>
<td></td>
<td>Non-distended</td>
<td>8</td>
<td>5</td>
<td>13 (48.1)</td>
</tr>
<tr>
<td></td>
<td>Post-cholecystectomy status</td>
<td>6</td>
<td>2</td>
<td>8 (29.6)</td>
</tr>
<tr>
<td>6</td>
<td>MPD Dilation (n=25)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Present</td>
<td>0</td>
<td>6</td>
<td>6 (24.0)</td>
</tr>
<tr>
<td></td>
<td>Absent</td>
<td>14</td>
<td>5</td>
<td>19 (76.0)</td>
</tr>
</tbody>
</table>

CBD: Common Bile Duct
IHBR; Intrahepatic Biliary Radicles
MPD: Main Pancreatic Duct
excluding choledocholithiasis and choledochal cyst

excluding hilar and intrahepatic obstruction

Out of periampullary obstruction only

About the characteristics of the mass causing the obstructive jaundice, the arterial phase enhancement, ill-defined margins, and surrounding invasions were present in 63.6%, 81.8% and 36.4% respectively. (Table 5B)

Table 5B: The characteristics of mass causing obstructive jaundice detected in MDCT

<table>
<thead>
<tr>
<th>Character of Mass (n = 11)</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SN</strong></td>
<td>Characteristics of mass</td>
</tr>
<tr>
<td>1</td>
<td>Enhancement</td>
</tr>
<tr>
<td>2</td>
<td>Margins</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Surrounding invasion</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Discussion

In our present study, we aimed to explore the diagnostic statistics as well as MDCT features of obstructive jaundice. The mean age of the participants in our study was 54.9 ± 19.8 years, with a maximum over 60 years (43.3%). This is in line with studies from Darwish et al. and Mathew et al., where the majority of the participants were from fifth to sixth decade (41). Our study showed female predominance, with male to female ratio of 1:1.5.

In a study by Anderson et al., they also found female predominance with male is to female ratio of 1:1.6 (42).

The sensitivity and negative predictive value (NPV) of MDCT for non-neoplastic causes to detect obstructive jaundice were both 100%, while the specificity positive predictive value (PPV) for neoplastic causes to detect obstructive jaundice were also both 100%. Similarly, the accuracy for either non-neoplastic or neoplastic causes of obstructive jaundice in our study was 96.67%. Anderson et al.’s study (42) showed sensitivity and accuracy of 69-87% and 84-88%, respectively, for diagnosing choledocholithiasis on MDCT, which was comparable to our study (42). Mathew et al. (10), Neitlich et al. (43) and Anderson et al. (42) showed sensitivity of 100%, 88% & 69–87%; specificity of 97.4%, 97% & 83–92% and accuracy of 98, 94% & 84–88%, respectively, for diagnosing choledocholithiasis.
Regarding the ability of MDCT to differentiate a benign lesion from a malignant one, in our study, CT correctly identified 13 out of 14 cases as malignant, with one false negative case, with almost perfect agreement (kappa value 0.933) with the final diagnosis. This is in agreement with multiple other studies. The study by Mathew et al. correctly identified 22 out of 23 cases as malignant, with sensitivity of 100%, specificity of 95.65%, and accuracy of 98% (44). The study by Reiman et al. correctly predicted malignancy in 25 (92%) of 27 patients and benign disease in 13 (77%) of 17 participants (45). Similarly, a study on MDCT for the assessment of patients with biliary obstruction conducted by Ahmetoglu et al. showed both sensitivity and specificity of 94% for diagnosis of malignant obstruction (46).

In our study, non-neoplastic causes of biliary obstruction were more common than neoplastic causes [16(53.3%) vs. 14(46.7%)]. As far as individual causes were concerned, the most common cause for obstructive jaundice was choledocholithiasis (33.34%) followed by cholangiocarcinoma (20%), ampullary carcinoma (13.33%) and choledochal cyst (13.33%). This is similar to the findings of Shimizu et al. and Mathew et al. who found choledocholithiasis (33.3% & 22% respectively) to be the most common cause of obstructive jaundice (44,47). Similar findings were also noted in studies by Roy et al.(48) and Darwish et al. (49).

In our study, mass lesion causing biliary obstruction was detected in 78.5% (11 out of 14) of malignant cases on MDCT. This finding is consistent with studies from Reiman et al. and Mathew et al. (44,45). Excluding choledocholithiasis and choledochal cyst, 68.8% (11/16) of participants had abrupt distal tapering. This is in accordance with the study conducted by Agrawal et al., which showed that abrupt tapering (50). In this study, among 25 cases with periampullary pathologies, 6 (24%) had dilatation of MPD and all of these were malignant. None of the benign periampullary pathology showed dilatation of MPD. This finding is supported by a study conducted by Tanaka et al. (27) which showed that presence of MPD dilatation of more than 2.5 mm showed significant association with periampullary malignant pathology. Similar findings were present on study conducted by Kim et al.(51), where the double duct sign was seen in 15 (52%) patients with ampullary carcinoma and 13 (62%) of cases with carcinoma head of pancreas. Likewise, Krishna et al. (30) concluded that dilation of both MPD and CBD on computed tomography/magnetic resonance imaging scans is suggestive of pancreatic malignancy.

Heterogeneous enhancement in delayed phase and peripheral rim enhancement in arterial phase were seen in 80% cases and 20% respectively (Figure 1 and 2). Study conducted by Darwish et al. (49) also showed 5 cases of cholangiocarcinoma, where all mass lesion had heterogeneous enhancement in delayed phase. Similar imaging characteristics were reported by Olthof et al. (52) and Chung et al. (36).

**Conclusion**

In our study on obstructive jaundice, the MDCT had demonstrated a sensitivity of 92.86%, specificity of 100%, positive predictive value (PPV) of 100%, negative predictive value (NPV) of 94.12%, and accuracy of 96.67% in detecting neoplastic causes. It also had a sensitivity of 100%, specificity of 92.86%, PPV of 94.12%, NPV of 100%, and accuracy of 96.67% in detecting non-neoplastic causes. The most common causes of obstructive jaundice were choledocholithiasis followed by cholangiocarcinoma. Biliary obstruction was most frequently observed in the periampullary region (83.33%), followed by the proximal CBD (6.67%), hilar region (6.67%) and intrahepatic region (3.33%). On MDCT, the majority of neoplastic causes of obstructive jaundice (78.5%) exhibited a mass lesion as well as abrupt distal tapering of biliary tract at the site of obstruction. Neoplastic causes were further characterized by the presence of enhancement and invasion of adjacent structures, irregular wall with abrupt distal tapering of biliary tract, distended gall bladder, non-visualization of confluence of right & left hepatic ducts, and double duct
sign. These features suggest that MDCT can serve as initial, cost-effective, easily available, and time-efficient imaging modality for diagnosing various causes of obstructive jaundice, with an accuracy ranging from 82.78% to 99.92%.

**Declarations**

**Acknowledgements**

None

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None

**Consent**

Written informed consent obtained.

**Declaration of conflicts of interest**

None

**Data availability statement**: All the data pertaining to this article are present here within.

**References**


Figures
Post-contrast axial (a) and reformatted coronal (b) sections show ill-defined heterogeneously enhancing lesion in hilar region with poor interface with adjacent liver parenchyma. Confluence of right and left hepatic ducts is not visualized and there is presence of IHBRD. It was diagnosed as hilar cholangiocarcinoma on histopathology. Photomicrograph (c) of hilar cholangiocarcinoma shows well defined tumor glands interspersed with poorly differentiated small tumor groups and single tumor cells (Hematoxylin and eosin stain 200x).
Figure 2

Post-contrast coronal reformatted image (a) showing heterogeneously enhancing mass lesion in head of pancreas with ill-defined margin, infiltration into surrounding structures, upstream dilatation of biliary tree and distended gall bladder. Post-operative Whipple's specimen (b) showing mass in head of pancreas infiltrating into the duodenum. On histopathological examination, it was confirmed as carcinoma head of pancreas. Photomicrograph (c) of ductal adenocarcinoma of head of pancreas shows nuclear atypia and desmoplasia along with atypical cells predominantly forming glands (Hematoxylin and eosin stain 400x).