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Original Article

Role of Computed Tomography in Evaluation of Biliary Lesions and Correlation with Histopathology

Dr Diksha Ahlawat[1], Dr Paresh Sukhani[2], Dr Jai Chowdhary[3], Dr Sunil Agrawal[4], Dr Aditya Shah[5], Dr Neha Gulia[6]

[1, 5, 6] PG Resident, Department of Radiodiagnosis, Mahatma Gandhi Medical College, Jaipur, Rajasthan
[2] Professor & HOD, Department of Radiodiagnosis, Mahatma Gandhi Medical College, Jaipur, Rajasthan
[3, 4] Professor, Department of Radiodiagnosis, Mahatma Gandhi Medical College, Jaipur, Rajasthan

Corresponding Author:

Dr Diksha Ahlawat

PG Resident, Department of Radiodiagnosis, Mahatma Gandhi Medical College, Jaipur, Rajasthan.

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ABSTRACT

Background: Biliary tract lesions encompass a diverse spectrum of pathologies from benign cholecystitis to aggressive malignancies. Accurate preoperative imaging is crucial for diagnosis, staging, and surgical planning. CT is the primary imaging modality but its diagnostic accuracy requires validation against histopathology.

Aim: To evaluate the diagnostic accuracy of computed tomography in the assessment of biliary lesions using histopathology as the gold standard.

Materials and Methods: This prospective observational study included 50 patients with suspected biliary pathology evaluated by contrast-enhanced MDCT at Mahatma Gandhi Medical College & Hospital, Jaipur, from April 2024 to September 2025. CT findings were correlated with histopathological diagnosis. Sensitivity, specificity, PPV, NPV, and diagnostic accuracy were calculated. Staging concordance between CT and histopathology was assessed.

Results: The mean age was 61.2 ± 7.8 years with female predominance (64%). Malignant lesions constituted 76% (38/50): gallbladder carcinoma 40%, cholangiocarcinoma 30%, and periampullary carcinoma 6%. Benign lesions comprised 24%. CT demonstrated sensitivity of 94.7%, specificity of 83.3%, PPV of 94.7%, and overall accuracy of 92.0% for malignancy detection. T-stage concordance was 73.7%, N-stage 68.4%, and resectability prediction accuracy 89.5%. Mass replacing the gallbladder was the commonest GB carcinoma pattern (60%). Periductal infiltrating type was the commonest cholangiocarcinoma morphology (53.3%). Of 38 malignant cases, 57.9% were resectable and 42.1% unresectable.

Conclusion: MDCT is a highly accurate modality for biliary lesion evaluation with 92% overall accuracy, enabling diagnosis, staging, and resectability assessment across the entire spectrum of biliary pathology.

Keywords: *Computed tomography; Biliary lesions; Gallbladder carcinoma; Cholangiocarcinoma; Diagnostic accuracy; Histopathology; Resectability.*

INTRODUCTION

Biliary tract lesions encompass a diverse spectrum of inflammatory, infectious, and neoplastic pathologies affecting the gallbladder, intrahepatic bile ducts, and extrahepatic biliary tree.[1] Biliary tract cancers represent the second most common primary hepatobiliary malignancy after hepatocellular carcinoma, accounting for approximately 3% of all gastrointestinal malignancies worldwide, with Asian populations exhibiting the highest burden.[2,3]

Gallbladder carcinoma is the most common biliary tract malignancy and the sixth most common gastrointestinal cancer

globally.[4] India contributes approximately 10% of the global gallbladder cancer burden, with particularly high incidence in the northern and eastern regions.[5] A marked female preponderance exists, with male to female ratios ranging from 1:3 to 1:4.[6] Gallstones are present in approximately 70–80% of Indian patients with gallbladder carcinoma.[7] Cholangiocarcinoma, classified anatomically into intrahepatic, perihilar, and distal subtypes, has shown increasing incidence of the intrahepatic variant over the past three decades.[8,9]

The clinical presentation of biliary malignancies is often insidious and non-specific, contributing to delayed diagnosis and poor prognosis.[10] Fewer than 20–30% of patients are candidates for radical surgery at the time of diagnosis.[11] The 5-year survival for gallbladder carcinoma remains below 5%, though early-stage incidental disease may achieve survival rates of up to 75%.[12]

Multidetector computed tomography (MDCT) has emerged as the workhorse imaging modality for comprehensive biliary evaluation, enabling tumor delineation, vascular assessment, and metastatic staging through multiphasic volumetric acquisition with sub-millimetre spatial resolution.[13,14] For gallbladder carcinoma, CT demonstrates 83–86% accuracy for local T-staging and 85% for resectability determination.[15] MDCT cholangiography has demonstrated sensitivity of 94% and specificity of 95% for differentiating benign from malignant biliary obstruction.[16]

Despite these advances, morphological overlap between malignant and benign conditions—such as xanthogranulomatous cholecystitis and adenomyomatosis—often leads to diagnostic uncertainty.[17] Histopathological correlation remains essential for definitive diagnosis. Given the high burden of biliary disease in India and the critical impact of imaging on treatment planning, this study was designed to evaluate the diagnostic performance of CT in this setting.

AIM AND OBJECTIVES

Aim: To evaluate the diagnostic accuracy of computed tomography in the assessment of biliary lesions using histopathology as the gold standard.

Objectives:

1. To determine sensitivity, specificity, PPV, NPV, and diagnostic accuracy of CT for biliary lesions.
2. To characterise CT imaging features of various biliary pathologies.
3. To assess CT ability in differentiating benign from malignant lesions and determining resectability.
4. To correlate CT staging with histopathological findings.

MATERIALS AND METHODS

Study Design and Setting: This prospective observational study was conducted at the Department of Radio-Diagnosis, Mahatma Gandhi Medical College & Hospital, Jaipur, from April 2024 to September 2025. The study was approved by the Institutional Ethics Committee (IEC) before commencement. Written informed consent was obtained from all participants. The study was conducted in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines.

Study Population: Fifty patients with suspected biliary pathology who underwent contrast-enhanced MDCT and subsequent histopathological confirmation were included. Sample size was calculated based on expected sensitivity of 90% with acceptable margin of error of 10%.

CT Protocol: All examinations were performed using a 128-slice GE Optima scanner with a standardised triphasic protocol (arterial phase at 25–30 seconds, portal venous phase at 60–70 seconds, and delayed phase at 180 seconds). Non-ionic iodinated contrast (1.5–2 ml/kg) was administered at 3–4 ml/sec. Thin-section images with multiplanar reformations (MPR) and minimum intensity projections (MinIP) were obtained.

Image Analysis: CT images were evaluated for: lesion morphology, enhancement pattern, wall characteristics, liver invasion (depth, segment involvement), vascular involvement (portal vein, hepatic artery), lymph node metastasis, adjacent organ invasion, distant metastases, and resectability. Staging was performed using AJCC 8th Edition. Bismuth-Corlette classification was applied for perihilar cholangiocarcinoma.

Histopathological Confirmation: Tissue diagnosis was obtained through surgical resection, EUS-guided FNAC, percutaneous biopsy, or liver/peritoneal biopsy as appropriate.

Statistical Analysis: Data were analysed using SPSS. A 2×2 contingency table was constructed. Sensitivity, specificity, PPV, NPV, and diagnostic accuracy were calculated with 95% CI. Chi-square test and Kappa statistics were applied. A p-value <0.05 was considered significant.

RESULTS

A total of 50 patients with suspected biliary pathology were evaluated. The demographic, clinical, and diagnostic profile is presented in Table 1.

Table 1: Demographic, Clinical, and Diagnostic Profile (n=50)

Characteristic	Number (n)	Percentage (%)
Age Group (Years)		
<50	8	16.0
50–60	18	36.0
61–70	17	34.0
>70	7	14.0
Sex (M:F = 1:1.78)		
Male	18	36.0
Female	32	64.0
Chief Complaints*		
Pain Abdomen	50	100.0
Nausea/Vomiting	38	76.0
Jaundice	34	68.0
Weight Loss	31	62.0
Anorexia	24	48.0
Final Diagnosis		
Malignant (n=38)	38	76.0
GB Carcinoma	20	40.0
Cholangiocarcinoma	15	30.0
Periampullary Carcinoma	3	6.0
Benign (n=12)	12	24.0
Chronic Cholecystitis	7	14.0
Acute Cholecystitis	2	4.0
Adenomyomatosis	2	4.0
Adenoma	1	2.0

Mean Age: 61.2 ± 7.8 years; *Multiple symptoms in most patients

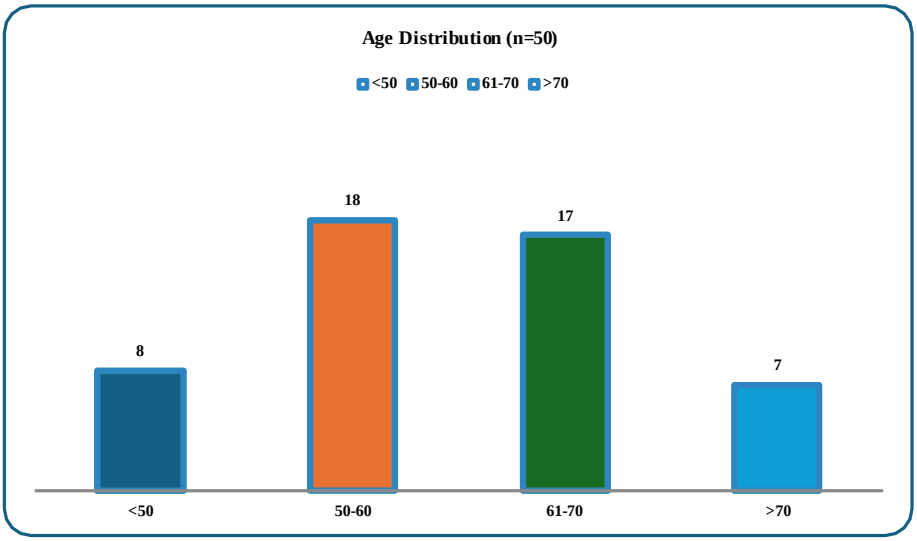

Figure 1: Age Distribution of Study Population (n=50)

Malignant lesions constituted 76% (38/50). GB carcinoma was the commonest malignancy (40%), followed by cholangiocarcinoma (30%). Among GB carcinoma cases, mass replacing the gallbladder was the commonest pattern (60%), gallstones were present in 70%, liver invasion in 75% (segments IVb+V in 40%), lymphadenopathy in 80%, and T3 was the commonest stage (50%). In cholangiocarcinoma, perihilar location was commonest (40%), periductal infiltrating pattern predominated (53.3%), and delayed enhancement was seen in 86.7%.

The diagnostic accuracy of CT is presented in Table 2.

Table 2: Diagnostic Accuracy of CT for Biliary Malignancy and Parameter-wise Accuracy

Parameter	Value (%)	95% CI
Overall Diagnostic Performance		
Sensitivity	94.7	82.3–99.4
Specificity	83.3	51.6–97.9
PPV	94.7	82.3–99.4
NPV	83.3	51.6–97.9
Overall Accuracy	92.0	80.8–97.8
2×2 Contingency Table		
True Positive	36	–
True Negative	10	–
False Positive	2	–
False Negative	2	–
Parameter-wise Accuracy	Sensitivity (%)	Accuracy (%)
Liver Invasion	93.3	90.0
Lymph Node Metastasis	87.5	85.0
Vascular Invasion	85.7	90.0
Adjacent Organ Invasion	80.0	87.5
Resectability Assessment	90.9	89.5
CT vs HPE Staging Concordance	Concordant	Accuracy (%)
T-Stage	28/38	73.7
N-Stage	26/38	68.4
Overall Stage	24/38	63.2

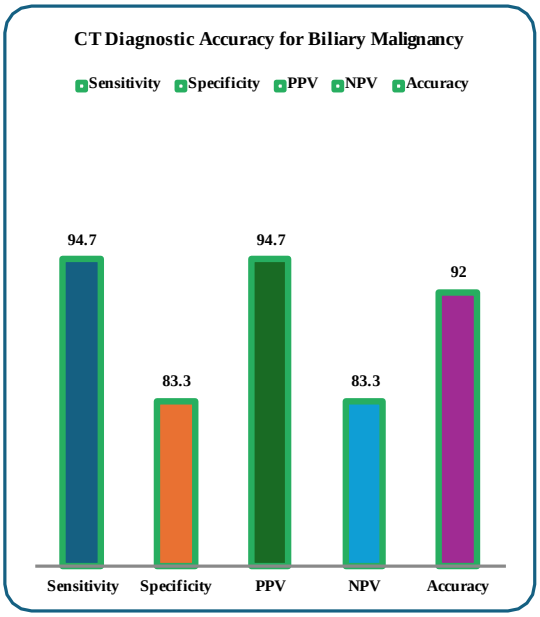

Figure 2: Diagnostic Accuracy Parameters of CT for Biliary Malignancy

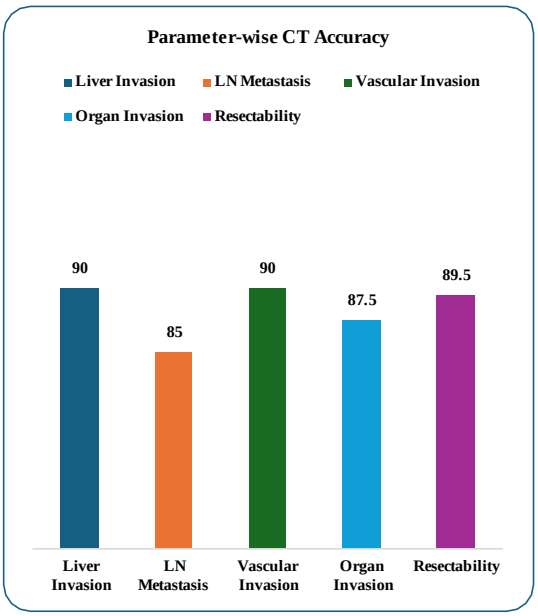

Figure 3: Parameter-wise Diagnostic Accuracy of CT

Among 38 malignant cases, the resectability and staging data are presented in Table 3.

Table 3: Staging, Resectability, and Histopathological Correlation (n=38 Malignant)

Category	n	Percentage (%)
GB Carcinoma T-Stage (n=20)		
T2a	3	15.0
T2b	4	20.0
T3	10	50.0
T4	3	15.0
Resectability (n=38)		
Resectable	22	57.9
Unresectable	16	42.1
Unresectability Reasons (n=16)		
Distant Metastasis	6	37.5
Extensive Liver Invasion	4	25.0
Vascular Encasement	3	18.75
Extensive Nodal Disease	3	18.75
Histological Type (n=38)		
Adenocarcinoma	35	92.1
Adenosquamous	2	5.3
Neuroendocrine	1	2.6
Tumor Grade (n=38)		
G1 (Well diff.)	10	26.3
G2 (Mod. diff.)	18	47.4
G3 (Poorly diff.)	10	26.3

The comparative analysis with published literature is presented in Table 4.

Table 4: Comparative Analysis of CT Diagnostic Accuracy with Published Literature

Study	Year	n	Sensitivity (%)	Specificity (%)	Accuracy (%)
Present Study	2024	50	94.7	83.3	92.0
Kumaran et al.	2002	–	–	–	93.3
Naz et al.	2016	–	90.5	85.7	88.9
Verma et al.	2016	–	91.7	94.4	–

Ragab et al.	2021	–	96.0	92.0	–
Sharma et al.	2018	–	–	–	85.0

DISCUSSION

Demographic Profile

The mean age of 61.2 years with female predominance (M:F = 1:1.78) is consistent with Levy et al.[18] who reported biliary malignancies predominantly affecting older women. Kalra et al.[19] from PGIMER reported mean age of 52.3 years, and Sharma et al.[20] from Shimla reported 58.6 years with 72% female patients. The slightly higher mean age in our study may reflect the inclusion of cholangiocarcinoma cases (30%), which typically present in the 6th–7th decade. Pain abdomen (100%), nausea/vomiting (76%), and jaundice (68%) were the commonest presentations, consistent with Sharma et al.[20] (pain 92%, jaundice 65%) and Kalra et al.[19] (pain 88%, jaundice 62%).

CT Diagnostic Accuracy

MDCT demonstrated sensitivity of 94.7%, specificity of 83.3%, and overall accuracy of 92.0%. These results are comparable to Kumaran et al.[21] (93.3% accuracy using dual-phase helical CT), Naz et al.[22] (sensitivity 90.5%, specificity 85.7%, accuracy 88.9%), Verma et al.[23] (sensitivity 91.7%, specificity 94.4%), and Ragab et al.[24] (sensitivity 96%, specificity 92%). The two false-positive cases in our study involved benign conditions (chronic cholecystitis with marked wall thickening) misdiagnosed as malignancy, underscoring the diagnostic challenge posed by inflammatory mimickers. Tongdee et al.[25] from Thailand identified features favouring malignancy including asymmetric thickening, mucosal irregularity, and adjacent organ invasion. Gupta et al.[26] proposed an algorithmic approach emphasising that discontinuous mucosal enhancement and heterogeneous wall thickening
>10mm are highly suggestive of malignancy.

Gallbladder Carcinoma

Mass replacing the gallbladder was the commonest pattern (60%), consistent with Levy et al.[18] (40–65%). Liver invasion was present in 75% with segments IVb and V most commonly involved (40%), detected with 90% CT accuracy. Kim et al.[15] emphasised that MPR reconstructions improve assessment of the tumor-liver interface. T-stage concordance of 73.7% is comparable to Kim et al.[15] (84%) and Kalra et al.[19] (72%). Soundararajan et al.[27] from PGIMER emphasised that wall-thickening-type lesions pose the greatest staging challenge.

Cholangiocarcinoma

Perihilar location was commonest (40%), followed by distal CBD (33.3%) and intrahepatic (26.7%). Periductal infiltrating pattern predominated (53.3%). All 15 cases showed IHBRD and CBD involvement (100%), with delayed enhancement in 86.7%—characteristic of the fibrous stroma. Lim[28] provided the morphologic classification of cholangiocarcinoma. Chung et al.[29] found CT and MRI had comparable accuracy for local staging. Li et al.[30] demonstrated complementary roles with MRI providing better ductal assessment and CT offering superior vascular mapping. For perihilar cases, Bismuth-Corlette classification showed Type II and IIIa as commonest (33.3% each).

Resectability Assessment

MDCT demonstrated 89.5% accuracy for resectability prediction. Of 38 malignant cases, 57.9% were resectable and 42.1% unresectable. Distant metastasis was the commonest cause of unresectability (37.5%), followed by extensive liver invasion (25%). Kumaran et al.[21] reported 93.3% resectability accuracy. Sharma et al.[20] reported 85% from a rural Indian setting. These findings support MDCT as the primary modality for surgical planning in biliary malignancies.

CONCLUSION

MDCT is a highly accurate, non-invasive imaging modality for comprehensive biliary lesion evaluation, demonstrating sensitivity of 94.7%, specificity of 83.3%, and overall diagnostic accuracy of 92.0%. It accurately characterises morphological patterns, assesses local extent including liver invasion (90% accuracy), vascular involvement (90%), and lymph node metastasis (85%), and predicts surgical resectability with 89.5% accuracy. T-staging concordance of 73.7% and N-staging concordance of 68.4% with histopathology are comparable to published literature. MDCT remains the imaging workhorse for biliary pathology, enabling accurate diagnosis, staging, and treatment planning across the entire spectrum of biliary lesions.

LIMITATIONS

1. Modest sample size of 50 patients.
2. Inter-observer variability was not formally assessed.
3. PET-CT was not available for comparison.
4. Wall-thickening-type lesions showed lower accuracy due to overlap with inflammatory conditions.
5. MRI/MRCP correlation was not performed in all cases.

DECLARATIONS

Ethics Approval: The study was approved by the Institutional Ethics Committee (IEC) of Mahatma Gandhi Medical College & Hospital, Jaipur (IEC Approval No. MGMC&H/IEC/JPR/2024/1957, dated 26/04/2024; IEC meeting held on 06 April 2024; IEC Registration No. EC/NEW/INST/2022/RJ/0097, valid till 9th June 2027). Written informed consent was obtained from all participants or their legal guardians after explaining the nature, purpose, and procedures of the study in their vernacular language. Confidentiality of patient data was maintained throughout the study. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and Good Clinical Practice guidelines.

Conflict of Interest: None declared.

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