


# Diagnostic Role of Triphasic Multidetector Computed Tomography (MDCT) in the Characterization of Cholangiocarcinoma with Histopathological Correlation

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## Abstract

**Background:** Cholangiocarcinoma is a malignant tumor of the biliary epithelium with poor prognosis due to late presentation. Histopathology is the gold standard for diagnosis but is invasive and limited in assessing tumor extent. Triphasic multidetector computed tomography (MDCT) offers a non-invasive alternative for evaluation. **Objective:** To assess the diagnostic role of triphasic MDCT in characterizing cholangiocarcinoma and to correlate imaging findings with histopathology. **Methods:** This cross-sectional study was conducted at Bangabandhu Sheikh Mujib Medical University, Dhaka, from September 2022 to August 2024. A total of 33 patients with suspected cholangiocarcinoma underwent triphasic MDCT. Imaging findings regarding lesion characteristics, location, growth pattern, vascular invasion, lymph node involvement, and enhancement patterns were analyzed. Histopathology was used as the reference standard. Diagnostic performance was calculated using sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy. **Results:** The mean age was  $65.6 \pm 7.51$  years, with 66.7% males. Most tumors were perihilar (63.64%) and periductal infiltrating (60.6%). Ill-defined margins (69.7%) and delayed enhancement (81.82%) were common findings. Vascular invasion and lymph node involvement were seen in 27.3% and 39.39% of cases, respectively. MDCT showed a sensitivity of 89.66%, specificity of 75%, accuracy of 87.88%, PPV of 96.3%, and NPV of 50%, with a significant correlation with histopathology ( $p = 0.01$ ). **Conclusion:** Triphasic MDCT is a reliable, non-invasive modality with high diagnostic accuracy for cholangiocarcinoma and is valuable for tumor characterization and staging.

**Keywords:** Cholangiocarcinoma; Multidetector Computed Tomography; Triphasic CT; Biliary Malignancy; Diagnostic Accuracy.

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## INTRODUCTION

Cholangiocarcinoma (CCA) is a malignant tumor arising from the biliary epithelium and can occur anywhere along the biliary tree, from the intrahepatic ducts to the ampulla of Vater [1]. It accounts for approximately 10–20% of all primary liver malignancies and is the most common malignancy of the biliary tract, ranking second after hepatocellular carcinoma [2]. The incidence of CCA shows marked geographic variation, with a particularly high prevalence in Southeast Asia due to endemic environmental and infectious risk factors [3].

The development of cholangiocarcinoma is strongly associated with chronic biliary inflammation. Several predisposing conditions have been identified, including primary sclerosing cholangitis, hepatobiliary parasitic infections such as *Opisthorchis viverrini* and *Clonorchis sinensis*, congenital anomalies like choledochal cyst and Caroli disease, hepatolithiasis, viral infections (hepatitis B, hepatitis C, Epstein–Barr virus), cirrhosis, and exposure to carcinogenic chemicals [4]. Histopathologically, more than 90% of CCAs are adenocarcinomas with abundant fibrous stroma, which significantly influences imaging characteristics [5].

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Based on anatomical location, CCA is classified into intrahepatic, perihilar, and distal types, with perihilar tumors being the most common (50–60%), followed by distal (20–30%) and intrahepatic (10–20%) forms [6]. Morphologically, these tumors are categorized into mass-forming, periductal infiltrating, and intraductal growth types, each demonstrating distinct radiological features and biological behavior [7]. Clinically, patients usually present in the sixth to seventh decade of life with symptoms such as jaundice, abdominal discomfort, weight loss, and weakness, often indicating advanced disease at diagnosis [8].

Histopathological examination remains the gold standard for definitive diagnosis of cholangiocarcinoma. However, it is an invasive procedure that requires tissue sampling through biopsy or fine-needle aspiration, which carries potential risks such as bleeding, infection, tumor seeding, and sampling errors, particularly in anatomically complex or inaccessible lesions. Furthermore, histopathology alone cannot adequately assess tumor extent, vascular involvement, lymph node status, or resectability, which are critical for treatment planning.

In contrast, imaging modalities play a crucial role in the non-invasive evaluation of cholangiocarcinoma. Among these, triphasic multidetector computed tomography (MDCT) has emerged as a widely used and effective diagnostic tool. It allows comprehensive assessment of tumor morphology, biliary dilatation, vascular invasion, lymph node involvement, and distant metastasis [9]. The multiphase approach—comprising arterial, portal venous, and delayed phases—enables better lesion characterization, particularly through the demonstration of delayed enhancement due to fibrous stromal components [10].

Several studies have demonstrated the diagnostic utility of MDCT in cholangiocarcinoma. Hamzawy *et al.*, reported a sensitivity of 96% in detecting CCA and highlighted its role in staging and prognostic evaluation [11]. Ni *et al.*, demonstrated that MDCT has good sensitivity (83.3%) and specificity (75.9%) in assessing tumor resectability [12]. Additionally, MDCT has shown high accuracy in evaluating vascular invasion and locoregional spread, which are essential for determining surgical feasibility [13].

Despite these advantages, there is limited evidence in the local context regarding the diagnostic accuracy of triphasic MDCT and its correlation with histopathological findings. Given the invasive nature of histopathology and the need for a reliable, non-invasive diagnostic modality, evaluating the role of MDCT is of significant clinical importance. Therefore, this study was undertaken to assess the diagnostic role of triphasic MDCT in the characterization of cholangiocarcinoma

and to correlate its findings with histopathological results.

## MATERIALS AND METHODS

This cross-sectional study was conducted over a period of two years, from September 2022 to August 2024, at the Departments of Radiology and Imaging, Hepato-biliary Surgery, and Pathology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka. The study population consisted of patients clinically suspected of cholangiocarcinoma, referred from the Hepato-biliary Surgery department to Radiology and Imaging for evaluation. Purposive sampling was employed to select patients who met the inclusion criteria, which included any age or sex with suspected cholangiocarcinoma presenting with obstructive jaundice. Patients with concomitant pathologies interfering with diagnosis, known hypersensitivity to contrast media, elevated serum creatinine, or those uncooperative for imaging were excluded. Written informed consent was obtained from each participant or their legal guardian after explaining the purpose, procedures, potential risks, and benefits of the study. Ethical approval was granted by the Institutional Review Board of BSMMU prior to commencement.

Eligible patients underwent triphasic multidetector computed tomography (MDCT) using a SIEMENS SOMATOM DEFINITION AS 128-slice helical CT scanner. Imaging was performed with a slice thickness of 5 mm and inter-slice gap of 1–2 mm. Contrast-enhanced scans were conducted after rapid intravenous bolus injection of 100–120 ml iodinated contrast at 3–5 ml/s, capturing arterial (25s), portal venous (60s), and delayed equilibrium phases (3–5 min). All MDCT images were independently interpreted by radiologists blinded to histopathology results, evaluating lesion site, size, growth pattern, Bismuth classification for perihilar lesions, margins, hepatic invasion, lymph node involvement, pre-contrast density, and contrast enhancement characteristics across phases.

Following imaging, patients underwent ultrasound-guided biopsy or fine-needle aspiration, and tissue samples were processed for histopathological examination in the Department of Pathology. Data, including demographic information, clinical presentation, MDCT findings, and histopathological results, were recorded in a structured data collection sheet. Correlation between MDCT findings and histopathology served as the reference standard for diagnosis. Sensitivity, specificity, positive and negative predictive values, and overall diagnostic accuracy of triphasic MDCT in characterizing cholangiocarcinoma were calculated using a 2×2 contingency table. Statistical analysis was performed using SPSS version 23, with descriptive statistics reported as means and frequencies, and a p-value <0.05 considered significant. Throughout the study, patient confidentiality was maintained, and participation was voluntary. All procedures adhered to

ethical standards to minimize risk while providing diagnostic benefit, and findings were intended to guide both clinical management and further research in biliary malignancies.

## RESULTS

A total of 33 patients with suspected cholangiocarcinoma were included in the study. The majority of patients were in the age group of 61–70 years (45.5%), followed by 71–80 years (30.3%) and 51–60 years (24.2%), with a mean age of  $65.6 \pm 7.51$  years. Male patients constituted 66.7% of the study population, while females accounted for 33.3%. All patients presented with jaundice (100%), and other clinical features included weight loss in 90.9% and anaemia in 87.9% of cases (Table I).

Triphasic MDCT findings demonstrated that most lesions measured 2–3 cm (48.5%), followed by >3 cm (27.3%) and <2 cm (24.2%), with a mean lesion size of  $2.46 \pm 0.57$  cm. Regarding tumor location, 6.06% were intrahepatic, 30.30% were extrahepatic, and the majority were perihilar, with distribution across Bismuth

types I to IV. Ill-defined borders were observed in 69.7% of cases, while 30.3% had well-defined margins. The predominant growth patterns included periductal infiltrating (60.6%) and mass-forming (39.4%). Most lesions were homogeneous (78.8%), with internal necrosis present in 9.1% of cases. Vascular invasion was identified in 27.3% of patients, and lymph node involvement was noted in 39.39%. On pre-contrast imaging, 75.76% of lesions appeared iso to slightly hypodense, whereas 24.24% were hypodense. Post-contrast evaluation showed portal venous enhancement in 18.18% and delayed enhancement in 81.82% of cases (Table II).

Comparison of triphasic MDCT findings with histopathological diagnosis revealed 26 true positive, 1 false positive, 3 false negative, and 3 true negative cases. The sensitivity, specificity, and overall diagnostic accuracy of MDCT were 89.66%, 75%, and 87.88%, respectively. The positive predictive value was 96.3%, and the negative predictive value was 50%. The association between MDCT findings and histopathological diagnosis was statistically significant ( $p = 0.01$ ) (Table III).

**Table I: Demographic characteristics & Clinical Features of the study population (n=33)**

Characteristics	Category	Frequency (%)
Age (Years)	51-60	8 (24.2%)
	61-70	15 (45.5%)
	71-80	10 (30.3%)
	Mean $\pm$ SD	$65.6 \pm 7.51$
Sex	Male	22 (66.7%)
	Female	11 (33.3%)
Clinical Features	Jaundice	33 (100%)
	Weight loss	30 (90.9)
	Anaemia	29 (87.9%)

**Table II: Triphasic MDCT Characteristics in Patients with Suspected Cholangiocarcinoma**

Characteristics	Category	Frequency (%)	
Size of lesion (cm)	<2	8 (24.2%)	
	2–3	16 (48.5%)	
	>3	9 (27.3%)	
	Mean $\pm$ SD	$2.46 \pm 0.57$	
	Range	1.50 - 3.50 cm	
Location of tumor	Intrahepatic	2 (6.06%)	
	Perihilar	Type I	1 (4.76%)
		Type II	10 (47.62%)
		Type IIIa	3 (23.81%)
		Type IIIb	5 (14.29%)
	Type IV	2 (9.52%)	
Extrahepatic	10 (30.30%)		
Border definition	Well defined	10 (30.3%)	
	Ill defined	23 (69.7%)	
Growth pattern	Periductal infiltrating	20 (60.6%)	
	Mass forming	13 (39.4%)	
Homogeneity	Homogeneous	26 (78.8%)	
	Heterogeneous	7 (21.2%)	
Internal necrosis	Present	3 (9.1%)	

Characteristics	Category	Frequency (%)
Vascular invasion	Absent	30 (90.9%)
	Present	9 (27.3%)
Lymph node involvement	Absent	24 (72.7%)
	Present (peri-hilar/abdominal)	13 (39.39%)
Pre-contrast findings	Not seen	20 (60.61%)
	Iso to slightly hypodense	25 (75.76%)
Post-contrast enhancement	Hypodense	8 (24.24%)
	Portal venous enhancement	6 (18.18%)
	Delayed enhancement	27 (81.82%)

**Table III: Diagnostic performance of MDCT in comparison to histopathology (n=33)**

MDCT findings	Histopathological findings		Total	P value
	Malignant	Non-malignant		
Malignant	26 (TP)	1 (FP)	27	0.01*
Non-malignant	3 (FN)	3 (TN)	6	
Total	29	4	33	
Diagnostic values		Values		
Sensitivity		89.66%		
Specificity		75%		
Accuracy		87.88%		
Positive Predictive Value (PPV)		96.3%		
Negative Predictive Value (NPV)		50%		

\*P value reached from Chi-Square Test

## DISCUSSION

This study evaluated the diagnostic performance of triphasic MDCT in the characterization of cholangiocarcinoma, using histopathology as the reference standard. The findings indicate that MDCT is a reliable imaging modality for assessing tumor characteristics, anatomical distribution, and staging parameters.

The mean age of patients in this study was  $65.6 \pm 7.51$  years, with a predominance of males (66.7%). These findings are consistent with the known epidemiological pattern of cholangiocarcinoma, which typically affects older individuals with slight male predominance [8]. Comparable results were reported by Hamzawy *et al.*, who observed a mean age of  $63.1 \pm 10.2$  years and male predominance in their cohort [11]. Clinically, all patients presented with jaundice, and a high proportion had weight loss and anemia, reflecting advanced disease at presentation. This aligns with previous observations that cholangiocarcinoma is often diagnosed late due to its insidious onset and nonspecific symptoms [8].

In terms of anatomical distribution, the majority of tumors in this study were perihilar (63.64%), followed by extrahepatic and intrahepatic types. This distribution is in agreement with established literature indicating that perihilar cholangiocarcinoma is the most common subtype [6]. However, the predominance of Bismuth type II lesions in this study differs from other studies where type III lesions were more frequent, suggesting possible regional or sample-related variation. The most common growth pattern observed was periductal

infiltrating (60.6%), followed by mass-forming type. This finding is consistent with previous studies that have identified periductal infiltration as the predominant morphological subtype [7]. The high frequency of ill-defined margins (69.7%) further supports the infiltrative nature of these tumors and highlights the diagnostic challenges associated with early detection.

Regarding imaging characteristics, the majority of lesions appeared iso- to hypodense on pre-contrast imaging, and most demonstrated delayed enhancement (81.82%) following contrast administration. This delayed enhancement pattern reflects the presence of abundant fibrous stroma, a well-documented feature of cholangiocarcinoma [10]. Such enhancement characteristics are valuable in differentiating CCA from other hepatic malignancies.

Vascular invasion and lymph node involvement were identified in 27.3% and 39.39% of cases, respectively, demonstrating the capability of MDCT in evaluating locoregional spread. Previous studies have also highlighted the high diagnostic accuracy of MDCT in assessing vascular involvement, which is critical for determining surgical resectability [13].

The diagnostic performance of triphasic MDCT in this study showed a sensitivity of 89.66%, specificity of 75%, and overall accuracy of 87.88%. These findings are comparable to those reported by Hamzawy *et al.*, who demonstrated a sensitivity of 96% [11], and Ni *et al.*, who reported sensitivity and specificity values of 83.3% and 75.9%, respectively [12]. The high positive predictive value (96.3%) observed in this study indicates that

MDCT is highly reliable in confirming malignancy. However, the relatively low negative predictive value (50%) suggests limitations in excluding disease, emphasizing the continued importance of histopathological confirmation.

### Study Limitations

This study has several limitations that should be considered while interpreting the findings. Firstly, it was conducted at a single tertiary care center, which may limit the generalizability of the results to a broader population. Secondly, the sample size was relatively small (n=33), which may reduce the statistical power and may not fully represent the spectrum of cholangiocarcinoma presentations. Thirdly, purposive sampling was used, which could introduce selection bias. Additionally, although histopathology was used as the gold standard, not all lesions may have been equally accessible for sampling, potentially leading to sampling errors.

### CONCLUSION

Triphasic multidetector computed tomography (MDCT) is an effective, non-invasive imaging modality for the evaluation and characterization of cholangiocarcinoma. It provides important information regarding tumor location, morphological pattern, extent of disease, vascular involvement, and lymph node status, which are essential for preoperative staging and treatment planning. Its use can facilitate early diagnosis, improve staging accuracy, and assist clinicians in making appropriate management decisions.

### REFERENCES

- Han JK, Choi BI, Kim AY, An SK, Lee JW, Kim TK, *et al.*, Cholangiocarcinoma: pictorial essay of CT and cholangiographic findings. *Radiographics*. 2002;22(1):173–187.
- Khan SA, Thomas HC, Davidson BR, Taylor-Robinson SD. Cholangiocarcinoma. *Lancet*. 2005;366(9493):1303–1314. Available from: [https://doi.org/10.1016/s0140-6736\(05\)67530-7](https://doi.org/10.1016/s0140-6736(05)67530-7).
- Slattery JM, Sahani DV. What is the current state-of-the-art imaging for detection and staging of cholangiocarcinoma? *Oncologist*. 2006;11(8):913–922.
- Plentz RR, Malek NP. Systemic Therapy of Cholangiocarcinoma. *Visc Med*. 2016 Dec;32(6):427-430. doi: 10.1159/000453084. Epub 2016 Nov 30. PMID: 28229078; PMCID: PMC5290432.
- Shaib, Y. and El-Serag, H.B., 2004, May. The epidemiology of cholangiocarcinoma. In *Seminars in liver disease* (Vol. 24, No. 02, pp. 115-125). Copyright© 2004 by Thieme Medical Publishers, Inc., 333 Seventh Avenue, New York, NY 10001, USA.
- Banales JM, Cardinale V, Carpino G, Marzioni M, Andersen JB, Invernizzi P, *et al.*, Expert consensus document: cholangiocarcinoma: current knowledge and future perspectives consensus statement from the European Network for the Study of Cholangiocarcinoma (ENS-CCA). *Nat Rev Gastroenterol Hepatol*. 2016;13(5):261–280.
- Yamasaki S. Intrahepatic cholangiocarcinoma: macroscopic type and stage classification. *J Hepatobiliary Pancreat Surg*. 2003;10(4):288–291. Available from: <https://doi.org/10.1007/s00534-002-0732-8>
- Pérez J, Barba I, Anaya-Prado R, *et al.*, Colangiocarcinoma, una revisión de retos en diagnóstico y manejo. *Cir Gen* 2014;36(01):48–57.
- Olthof SC, Othman A, Clasen S, Schraml C, Nikolaou K, Bongers M. Imaging of cholangiocarcinoma. *Visc Med*. 2016;32(6):402–410. Available from: <https://dx.doi.org/10.1159/000453009>.
- Chung, Y.E., Kim, M.J., Park, Y.N., Choi, J.Y., Pyo, J.Y., Kim, Y.C., Cho, H.J., Kim, K.A. and Choi, S.Y., 2009. Varying appearances of cholangiocarcinoma: radiologic-pathologic correlation. *Radiographics*, 29(3), pp.683-700.
- Hamzawy, A., Nada, M.Z.I.M. and Desouky, S.H., 2024. Diagnostic Performance and Prognostic Relevance of Computed Tomography for Patients with Cholangiocarcinoma. *Afr.J.Bio.Sc.* 6(4). pp. 1131-1145
- Ni, Q., Wang, H., Zhang, Y., Qian, L., Chi, J., Liang, X., Chen, T. and Wang, J., 2017. MDCT assessment of resectability in hilar cholangiocarcinoma. *Abdominal Radiology*, 42, pp.851-860.
- Ruys, A.T., Van Beem, B.E., Engelbrecht, M.R.W., Bipat, S., Stoker, J. and Van Gulik, T.M., 2012. Radiological staging in patients with hilar cholangiocarcinoma: a systematic review and meta-analysis. *The British journal of radiology*, 85(1017), pp.1255-1262.