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A prospective cross-sectional study of the spectrum of gallbladder masses on computed tomography, confirmed by histopathological examination at a tertiary care centre in eastern India.

Dr. Suruthi T. I.[1], Dr. Amit Kumar[2]*, Dr. Umakant Prasad[2], Dr. Bipin Kumar[3]
[1] Junior Resident, Department of Radio-diagnosis, IGIMS, Patna
[2] Additional Professor, Department of Radio-diagnosis, IGIMS, Patna
[3] Professor, Department of Pathology, IGIMS, Patna

Abstract

Introduction:
Gallbladder carcinoma is the most common malignancy of the biliary tract and is often diagnosed at an advanced stage due to non-specific clinical symptoms. Early and accurate imaging is crucial for timely diagnosis and appropriate surgical planning. This study aimed to evaluate the structural and enhancement characteristics of gallbladder masses using Multi-Detector Computed Tomography (MDCT) and to correlate the imaging findings with histopathological results.

Methodology:
A prospective cross-sectional diagnostic study was conducted in the Department of Radio-diagnosis at Indira Gandhi Institute of Medical Sciences (IGIMS), Patna. A total of 200 patients with clinically or sonographically suspected gallbladder cancer were enrolled between July 2021 and June 2022. All patients underwent contrast-enhanced MDCT using a Toshiba Aquilion 128-slice scanner. Imaging findings—including tumor morphology, local invasion, lymph node involvement, vascular encasement, and resectability—were recorded.

Results:
The mean age of the study population was 54.16 years, with a female predominance (70%). Common CT findings included focal irregular wall thickening (33.5%), sessile intraluminal polyps (27.5%), and masses replacing the gallbladder fossa (24.5%). Liver invasion was observed in 81% of cases, and lymph node metastases in 44.5%. Only 28% of patients had resectable disease at diagnosis. Histopathology revealed that moderately differentiated adenocarcinoma was the most frequent type (51.5%). MDCT demonstrated a sensitivity of 100%, specificity of 73.08%, and diagnostic accuracy of 96.5%.

Conclusion:
MDCT is a highly sensitive imaging modality for evaluating suspected gallbladder malignancies. It plays a critical role in tumor staging, assessing local extension, and determining operability. However, due to late-stage presentation, the majority of cases remain unresectable at the time of diagnosis.

Recommendation:
In endemic regions for gallbladder cancer, early screening through ultrasound followed by contrast-enhanced CT imaging is recommended to facilitate earlier detection and improve surgical outcomes.

Keywords: *Gallbladder carcinoma, Multi-Detector Computed Tomography (MDCT), Histopathology, Gallbladder mass, Diagnostic accuracy, Adenocarcinoma, Liver infiltration, Resectability, Contrast-enhanced CT.*
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Corresponding Author: *Dr. Amit Kumar*
Email: *amitmd2008@gmail.com*
Additional Professor, Department of Radio-diagnosis, IGIMS, Patna.

Introduction:
Gallbladder cancer is the most frequently occurring malignancy of the biliary system. Its prevalence shows significant geographic and ethnic differences, both globally and within India. Higher rates are reported in regions such as South America, East Asia, and parts of Central Europe. In India, the disease tends to be more common in the northern and northeastern states

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compared to the southern regions. Studies consistently show that women are at a greater risk of developing gallbladder cancer than men across all populations.

In addition to geographic location, female sex, and advancing age, several other risk factors contribute to the development of this cancer. These include genetic predisposition, obesity, gallstones (cholelithiasis), and persistent inflammation of the gallbladder, often triggered by chronic bacterial or parasitic infections.

Gallbladder cancer often presents with non-specific symptoms or remains asymptomatic until it has advanced, making early detection difficult. In many cases, it is discovered unexpectedly—either during surgery for other gallbladder conditions or through histopathological examination following a routine cholecystectomy. Sometimes, the diagnosis is only made when the tumor has already invaded nearby organs. At this point, the disease is typically at an advanced stage.

The cancer can spread through the lymphatic system, the bloodstream, the peritoneal cavity, or along surgical or biopsy tracts.[2]

Gallbladder cancers tend to infiltrate surrounding tissues and metastasize at an early stage, a pattern that may be explained by the organ's unique anatomical features. Unlike other hollow organs, the gallbladder has a relatively thin wall and lacks a submucosal layer. Its structure includes a mucosal lining, a single layer of muscle, perimuscular connective tissue, and serosa—though serosal covering is absent on the portion embedded in the liver.

Due to the absence of a thicker muscle wall, tumors can more easily breach into the liver, whereas in other organs, a second muscular layer would typically offer more resistance. This anatomical vulnerability may contribute to the early spread of cancer through the bloodstream and lymphatic system. Once a tumor penetrates the muscular layer, it can quickly access key vascular and lymphatic channels, facilitating rapid dissemination throughout the body. Though surgery is the only cure compared to chemotherapy or radiotherapy, as gallbladder cancer is frequently diagnosed at an unresectable stage due to its silent spread, it has a poor prognosis 4. The overall 5-year survival rate of patients with gallbladder cancer is 20% with a median survival of 16 months for resectable cases.5 For advanced untreated cases, the median survival is 2 to 5 months, and long-term survival is exceedingly rare.6 Serum tumor markers like CA19-9 and CEA are of minimal clinical value when compared to clinical suspicion and good quality imaging in appropriate cases.

Serum tumor markers are helpful in following a patient for recurrence if they are elevated before treatment and normalized after treatment. Before the era of ultrasonography (USG) and computed tomography (CT), gallbladder cancer was rarely diagnosed preoperatively. Usually, ultrasonography is used as the initial modality of investigation for suspected gallbladder pathology, but accurate diagnosis and staging may be difficult in the case of gallbladder carcinoma. Therefore, high-resolution, cross-sectional imaging like CT with contrast or magnetic resonance imaging (MRI) should be done for proper staging in patients who are suspected to have gallbladder cancer or incidentally detected gallbladder cancer after cholecystectomy. These modalities provide crucial information about the local extent of results obtained from a CT scan. As most of the patients present in the advanced stage, it is important to establish the diagnosis and to know the extent of the disease with cross-sectional imaging to minimize nontherapeutic surgical exploration. Tissue diagnosis is not done for resectable cases due to the propensity of seeding of malignant cells in the tract, and it is reserved only for unresectable tumours to guide the oncologist. (7-10)

AIMS AND OBJECTIVES

AIM:

To study the spectrum of gallbladder fossa masses on CT with their histopathological correlation.

OBJECTIVES:

1. To evaluate the diagnostic value of Multi Detector CT (sensitivity, specificity, positive predictive value, and negative predictive value) in detecting malignant gallbladder fossa masses.
2. To know the staging and resectability of malignant gallbladder masses at the time of Multi-Detector CT diagnosis.
3. To know the structural pattern and enhancement pattern of gallbladder fossa masses (benign and malignant) on Multi Detector CT.
4. To know the associated findings noted on CT imaging in gallbladder malignancy.

Implications of the study:

This study on the various gall bladder masses whose histopathology has been proven is highly valued, as imaging using multi-detector computed tomography gives lots of valuable details. Some of them are whether the mass has replaced the gall bladder, eccentric/diffuse gall bladder wall thickening, polyp/polypoidal growth. Hepatic infiltration or invasion, extension to the porta hepatis, Biliary obstruction, antroduodenal and hepatic flexure involvement, and involvement of the pancreas.

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Vascular encasement/ thrombosis of the portal vein was noted. Lymph node involvement, especially the cystic duct, peri-choledochal or porta hepatis, peripancreatic, periduodenal, celiac, or superior mesentric nodes, can be detected. MDCT has a good role in staging the disease before surgery. There is high scope for this study, as well as to do further study on a larger scale in the future.

MATERIALS AND METHODOLOGY

STUDY DESIGN:

This was a **prospective cross-sectional diagnostic study** conducted to evaluate gallbladder masses using contrast-enhanced Multi-Detector Computed Tomography (MDCT) and confirm findings through histopathology.

STUDY PLACE:

The study was carried out in the Department of Radio Diagnosis, Indira Gandhi Institute of Medical Sciences (IGIMS), Patna, a tertiary care teaching hospital equipped with advanced imaging facilities, including a 128-slice Toshiba Aquilion MDCT scanner. Patients were recruited from July 1, 2021, to June 30, 2022. All clinical assessments, imaging, biopsies, and follow-up were done within this time frame.

STUDY POPULATION:

Patients with sonographically and or clinically suspected gallbladder carcinoma who were referred to the Department of Radiology, Indira Gandhi Institute of Medical Sciences (tertiary care centre), Shiekhpura, Patna, Bihar, India, for evaluation by multi-detector computed tomography.

Inclusion criteria:

1. Patient with clinically/sonographically suspected gallbladder malignancy.
2. Any age groups.
3. Both genders.
4. Patients with obstructive jaundice.

Exclusion criteria:

1. Patients with raised serum creatinine (>1.5 mg/dl)
2. Pregnant females
3. Patients with a previous allergic history to iodinated i.v. Contrast medium.
4. Patients taking Metformin.
5. Patients having multiple myeloma/ thyrotoxicosis.
6. Patients who have been previously diagnosed with GB malignancy and received treatment (surgery/chemoradiotherapy)

STUDY DURATION:

The study was conducted over one year: from July 1, 2021, to June 30, 2022.

SAMPLE SIZE:

A total of 200 patients were enrolled. The sample included both men (30%) and women (70%), across a wide age range (25–81 years), with all undergoing MDCT and subsequent histopathological confirmation.

SAMPLE SIZE CALCULATION:

By taking true positive predictive value (%) as 95.92%, precision (%) as 5%, 95% desired confidence level as references, and applying them in the following formula, the minimum sample size needed is 60 to know the diagnostic value of Multi Detector CT in detecting gallbladder malignancy. Software used is *a master 2.0*
Calculating sample size using positive predictive value
Assumption: The variable must be categorical.
Formula

$$n = \frac{(Z\ 1-\alpha/2)^2\ p\ (1-p)}{r^2}$$

Where,

p : Positive predictive value (performance characteristic of the test)
r : Precision
Z 1-α/2: Desired Confidence level

Using the formula:

$$n = \frac{(Z\ 1-\alpha/2)^2\ p\ (1-p)}{r^2}$$

Where:

- $Z1-\alpha/2=1.96 Z_{1-\alpha/2} = 1.96 Z1-\alpha/2 =1.96$ for 95% confidence
- $p=0.9592 p = 0.9592 p=0.9592$ (positive predictive value)
- $r=0.05 r = 0.05 r=0.05$ (precision)

$n=(0.05)^2(1.96)^2 \cdot 0.9592(1-0.9592)$ $n=0.00253.8416 \cdot 0.038998$ $n \approx 0.00250.14992 \approx 59.97$
Thus, a minimum of 60 subjects was required. However, 200 patients were recruited to increase statistical power and account for dropouts and variability.

Bias and Control Measures:

To minimize selection bias, all eligible patients presenting during the recruitment period were included consecutively. Observer bias was reduced by having

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radiological findings independently reviewed by two radiologists. Histopathological confirmation was performed in a blinded manner without prior knowledge of imaging findings. Standard protocols for imaging and reporting were followed consistently throughout the study.

DATA COLLECTION METHODOLOGY:

CT Technique: Toshiba Aquilion 128 slice Multi Detector Computed Tomography (MDCT) machine, operating under 120 kVp, 250 mAs(varies according to the thickness of the patient), 0.5mm reconstruction interval, and 0.5 sec gantry rotation time were used in the study. The procedure was explained to the patient in detail, including the chances for contrast reaction, and written consent was obtained from each patient before the procedure. 600-1000 ml of oral neutral contrast medium (water) given at regular intervals in divided doses was used for proper distension of the stomach and bowel loops. Non-ionic iodinated water-soluble contrast medium (Omnipaque TM) containing 350mg iodine/ml will be used as contrast medium. The patient was placed on the gantry table in a supine position with both arms above the head, and a CT scan will be done. Pre contrast study of the whole abdomen will be performed initially, then a post contrast scan will be done by injecting 1 ml/kg body weight of non-ionic iodinated water-soluble contrast manually via an 18G angiocath placed in the antecubital vein or via power injector.

CT criteria for T staging of gall bladder masses are as follows: T1, polypoid lesions without focal thickening of the gallbladder wall; T2, nodular or sessile lesions associated with focal thickening of the gallbladder wall at what was considered to be attachment sites and with the presence of an apparently smooth fat plane separating the adjacent organs; T3, tumor perforates the serosa (visceral peritoneum) and directly invades the liver or one other adjacent organ or structure (such as the stomach; duodenum; colon; or pancreas, omentum, or extrahepatic bile ducts) with loss of intervening fat palne; and T4, tumor invades main portal vein or hepatic artery or invades multiple extrahepatic organs or structures.

The regional lymph nodes of gallbladder carcinoma are the nodes in the hepatoduodenal ligament, the nodes along the common hepatic artery, and the nodes cranial to the duodenal papilla on the posterior surface of the head of the pancreas. Disease spread to the nodes other than the regional lymph nodes is considered distant metastases. A size criterion for lymph nodal metastasis is 1 cm or more in short axis diameter/ heterogeneous enhancement / perinodal extension.

Resectability criteria for gall bladder masses according to our institute are as follows:

1. Involvement of non-regional lymph nodes
2. Distant organ metastasis, except for drop metastasis in the hepatic biliary radicles.
3. Bilateral hepatic hilar involvement, either vascular or biliary, or both
4. Involvement of the main portal vein / common hepatic artery either by the mass lesion or due to extra nodal spread from involved lymph nodes

For calculating pre- and post-contrast HU of the lesion, a region of interest is placed over the lesion in the non-contrast and contrast-enhanced study in the portal venous phase, respectively.

For histopathological examination, ultrasound-guided core cut biopsy of suspected gallbladder lesions was obtained with Bard Biopsy Gun (diameter 18G and cutting length 20 mm) after explaining the procedure and getting consent from the patient. Cholecystectomy specimens obtained postoperatively following a CT scan will also be used for histopathological examination.

STATISTICAL METHOD:

Sensitivity, Specificity, Positive predictive value, and Negative predictive value were used to evaluate the diagnostic value of MDCT in detecting malignant gallbladder fossa masses, taking histopathological diagnosis as the gold standard test.

Percentages were applied to know how many cases of GB malignancy are operable at the time of CT imaging, to know the structural pattern, enhancement pattern of GB masses on Multi Detector CT imaging, and associated findings noted in GB malignancy on CT. And, all statistical calculations were done on "*n master 2.0"*.

Ethical Considerations:

This study was approved by the Institutional Ethics Committee of Indira Gandhi Institute of Medical Sciences (IGIMS), Patna. Ethical clearance was granted under Letter No. 1126/IEC/IGIMS/2019, dated 16/10/2019. Written informed consent was obtained from all participants before inclusion in the study.

RESULTS:

The mean age of our study participants was 54.16 years with a standard deviation of 11.69 years. Minimum age was 25 years and maximum of 81 years. There was a female preponderance in our study, with 140 females (70%) and 60 (30%) males.

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Demographic Characteristics:

Among the 200 participants:

- **Mean age**: 54.16 years (SD ±11.69), age range: 25–81 years
- **Gender distribution**:
  - **Female**: 140 patients (70%)
  - **Male**: 60 patients (30%)

Participant Flow

A total of **235 patients** were referred to the Department of Radio Diagnosis during the study period with suspected gallbladder carcinoma.

- **220** were screened for eligibility.
- **15** were excluded due to:
  - High serum creatinine (6)
  - Contrast allergy (4)
  - Previous gallbladder surgery or treatment (5)
- **205** were eligible and gave informed consent.
- **5** dropped out or did not complete the full evaluation.
- A final sample of **200 patients** was analyzed.

Total referred patients with suspected GB malignancy

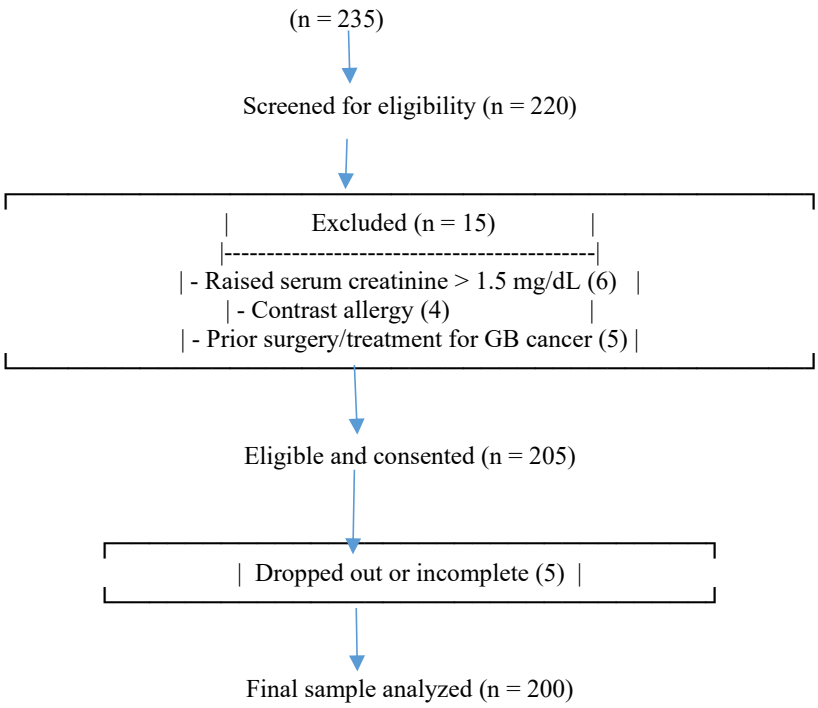

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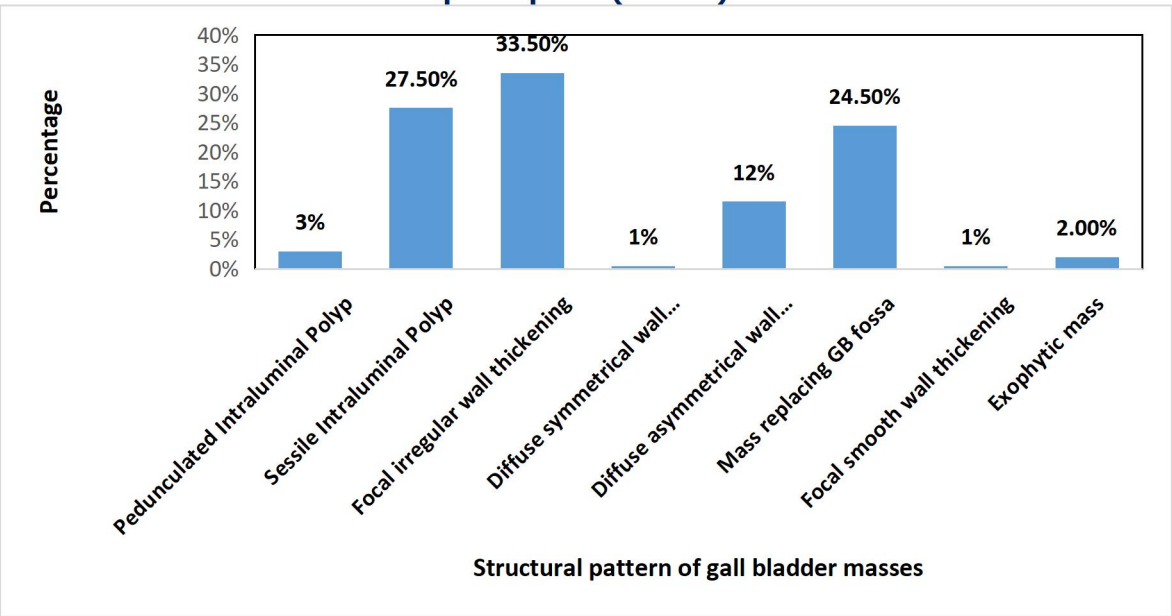
Figure 1: Distribution of structural patterns of gall bladder masses among the study participants (N=200)



In our study, focal irregular wall thickening was found to be around 33.5% followed by sessile intraluminal polyp 27.5%, mass replacing GB fossa 24.5%, diffuse asymmetrical wall thickening 12%, pedunculated intraluminal polyp 3%, exophytic mass 2%, diffuse symmetrical wall thickening 1% and focal smooth wall thickening 1%. The diffuse symmetrical wall thickening with mild heterogeneous enhancement turned out to be empyema gall bladder. Two cases with focal asymmetrical wall thickening turned out to be chronic cholecystitis, and two cases with diffuse asymmetrical wall thickening turned out to be chronic cholecystitis; among these, one has a perforated gall bladder with minimal pericholecystic collection. Two cases of sessile intraluminal polyps turned out to be benign hyperplasia and hyaline degeneration.

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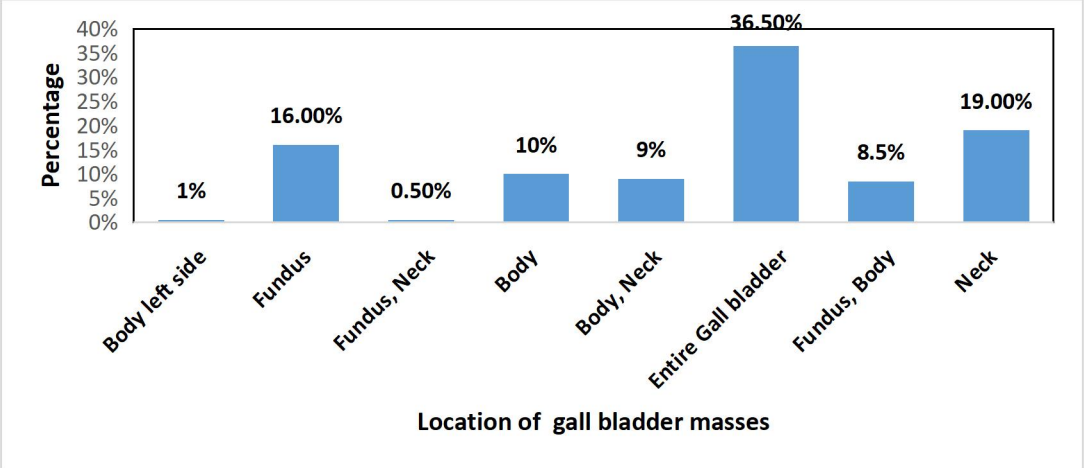
Figure 2: Distribution of the location of gall bladder masses among the study participants (N=200)



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36.5% of the gall bladder masses were situated on the entire gall bladder followed by 19% situated on the neck, 16% on the fundus, 10% on the body, 9% body, neck, 8.5% fundus, body; 1% on the left side of the body and, 0.5% on the fundus and neck.

Table 1: Distribution of liver infiltration among the study participants (N=200)

Slno	Liver infiltration	Frequency	Percentage
1	Present	162	81
2	Absent	38	19

Table 2: Distribution of extrahepatic involvement of organs among the study participants (N=200)

Slno	Number of extrahepatic organs involved	Frequency	Percentage
1	One extra hepatic organ	48	24
2	Two or more extrahepatic organs	41	20.5

Around 81% of the gall bladder masses had infiltrated into the liver, while 24% of the study participants had one extrahepatic organ involvement, and 20.5% had two or more extrahepatic organ involvement.

Table 3: Distribution of infiltration of secondary confluence among the study participants (N=200)

Slno	Infiltration of secondary confluence	Frequency	Percentage
1	Present	4	2
2	Absent	196	98

Table 4: Distribution of infiltration of primary confluence among the study participants (N=200)

Slno	Infiltration of the primary confluence	Frequency	Percentage
1	Present	51	25.5
2	Absent	149	74.5

About 2% of the study participants had infiltration of secondary confluence, while 55% had involvement of the primary confluence. Infiltration of extra extrahepatic bile duct was present among 11.5% of the study participants. Intrahepatic bile radicle dilatation was present among 46% of the study participants.

Table 5: Distribution of vascular involvement in gall bladder carcinoma among the study participants (N=200)

Slno	Blood supply	Frequency	Percentage
1	Portal vein involvement	30	15
2	Arterial involvement	20	10

Around 15% of gall bladder masses had portal vein involvement. Around 10% had hepatic artery involvement.

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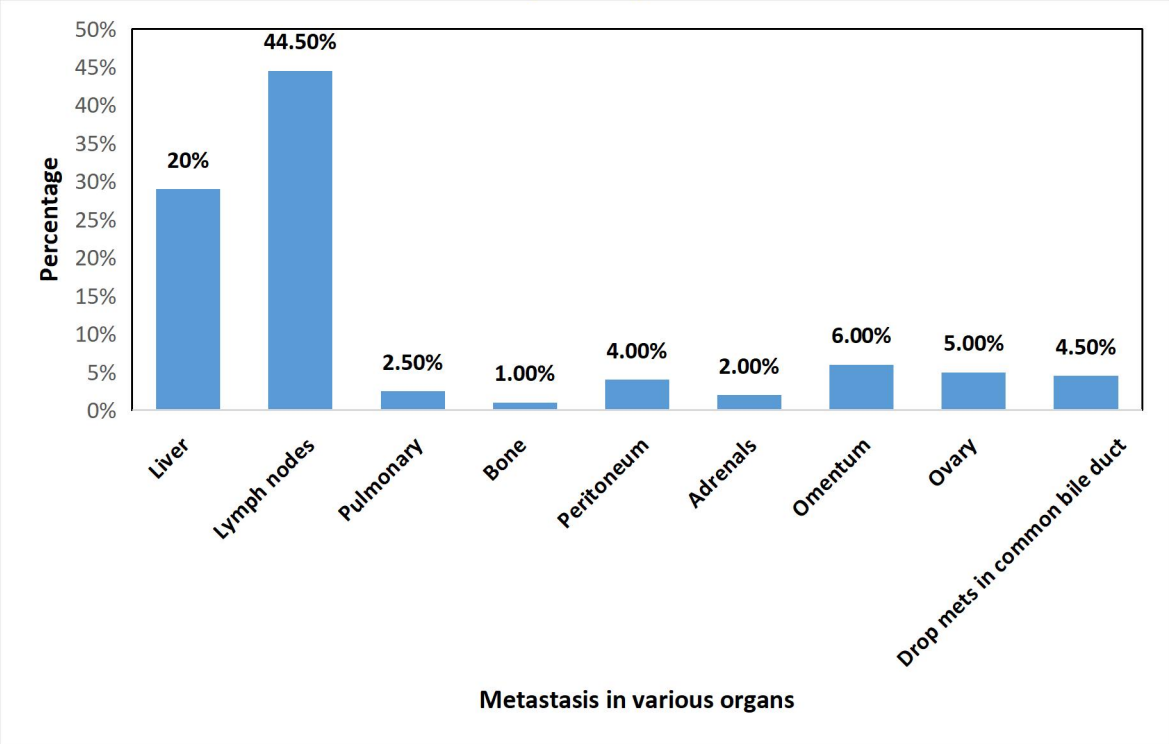
Table 6: Distribution of Arterial involvement in gall bladder carcinoma among the study participants (n=20)

Slno	Arterial involvement	Frequency	Percentage
1	Right hepatic artery	13	65
2	Common hepatic artery	5	25
3	Left hepatic artery	1	5
4	Hepatic artery proper	1	5

Around 65% of them had right hepatic artery involvement, followed by 25% common hepatic artery involvement, 5% left hepatic artery, and 5% hepatic artery proper.

Figure 3: Distribution of metastasis in various organs among the study participants (N=200)



Metastasis of lymph node was seen in 44.5% of the study participants, followed by 20% in the liver, 6% in the omentum, 5% in the ovary, 4% in the peritoneum, 4.5% in drop mets in the common bile duct, 2.5% in the pulmonary, 2% adrenals and 1% in bone.

Around 28% of the study participants had resectable gall bladder masses, and around 73% of the study participants had unresectable gall bladder masses.

Table 7: Distribution of Pre contrast HU and Post contrast HU among the study participants (N=200)

Slno	Contrast HU	Mean±SD	t, (df), p
1	Pre	42.30±10.49	-12.765 (147) <0.001
2	Post	57.55±14.83	

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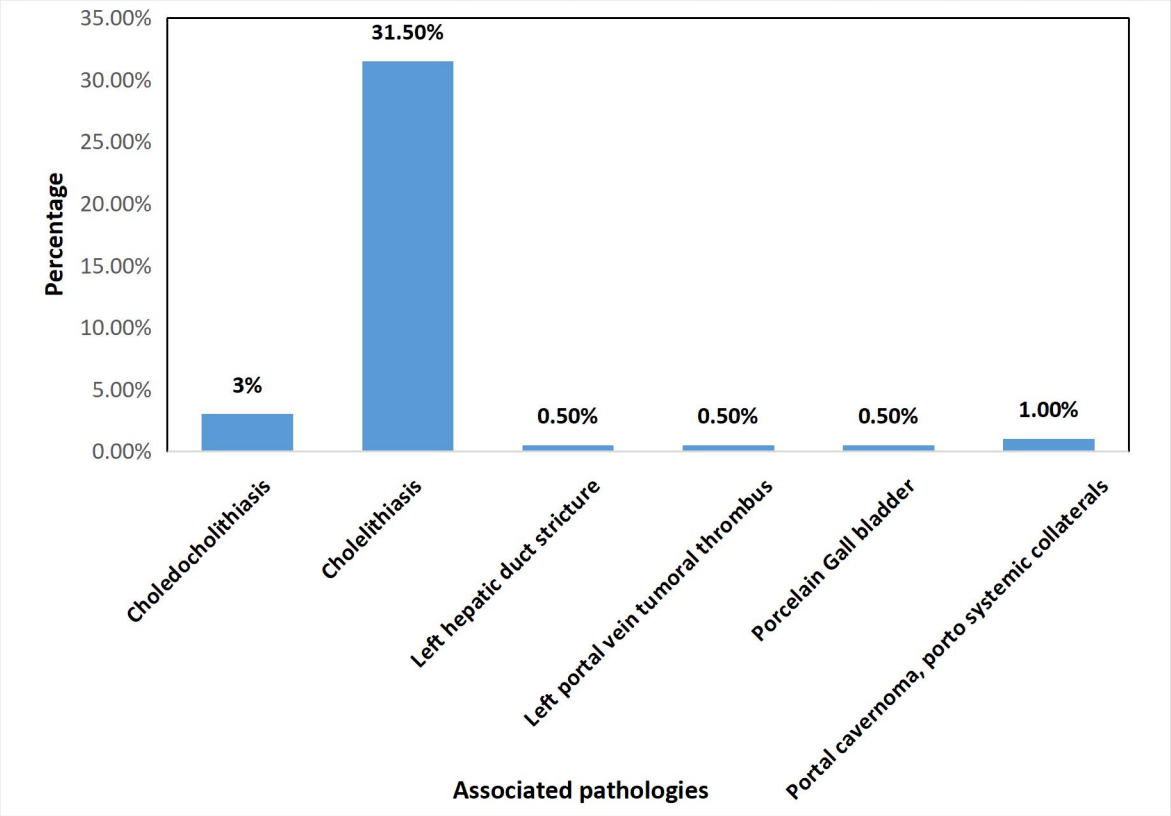
There was mild enhancement of the lesion in post post-contrast study acquired in the portal venous phase.

Figure 4: Distribution of associated pathologies among the study participants (N=200)



Around 31.5% of the study participants had cholelithiasis, followed by 3% choledocholithiasis, 0.5% had left hepatic duct stricture, 0.5% had left portal vein tumoral thrombus, 0.5% porcelain gall bladder, and 1% portal cavernoma.

Table 8: Distribution of Histopathological type among the study participants (N=200)

Slno	Histopathological type	Frequency	Percentage
1	Mucin-producing adenocarcinoma	1	0.5
2	Papillary type adenocarcinoma	1	0.5
3	Well-differentiated adenocarcinoma	13	6.5
4	Moderately differentiated adenocarcinoma	103	51.5
5	Poorly differentiated adenocarcinoma	52	26
6	Adenocarcinoma with squamous differentiation	1	0.5
7	Undifferentiated carcinoma of the gall bladder	3	1.5
8	Benign hyperplasia	1	0.5
9	Hyaline degeneration	1	0.5
10	Empyema of the gall bladder	1	0.5
11	Chronic cholecystitis	4	2
12	Drop outs	19	9.5

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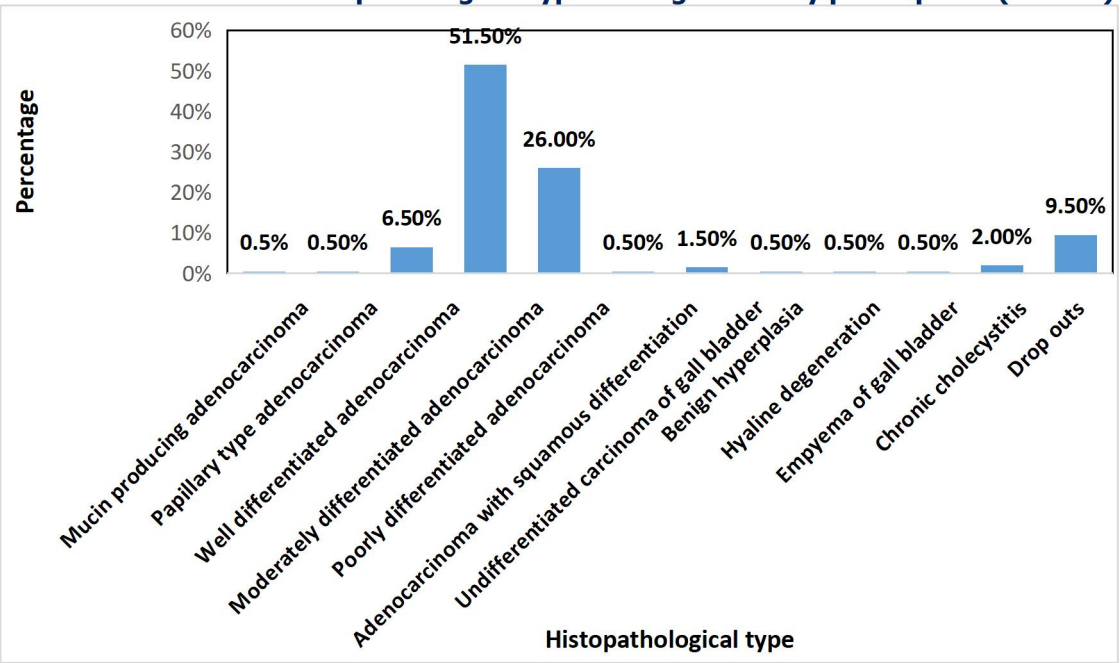
Figure 5: Distribution of Histopathological type among the study participants (N=200)



Around 51.5% had moderately differentiated adenocarcinoma, followed by 26% poorly differentiated adenocarcinoma and 6.5% well differentiated adenocarcinoma. Around0.5% mucin-producing adenocarcinoma, 0.5% papillary-type adenocarcinoma,0.5% adenocarcinoma with squamous differentiation, and 1.5% undifferentiated carcinoma of the gall bladder. Around 0.5% benign hyperplasia, 0.5% hyaline degeneration, 0.5% empyema of the gall bladder, 2% chronic cholecystitis, and around 9.5% were dropouts.

Table 9: Diagnostic test accuracy of CT for carcinoma gall bladder (N=200)

Slno	CT	HPE		TOTAL
		Malignant	Others	
1	Malignant	174	7	181
2	Others	0	19	19
	TOTAL	174	26	200

Table 10: Diagnostic Performance of MDCT in Detecting Gallbladder Carcinoma Compared to Histopathology (N = 200)

Parameter	Value (95% Confidence Interval)
Sensitivity	100% (97.90% to 100.00%)
Specificity	73.08% (52.21% to 88.43%)
Positive Predictive Value	96.13% (92.96% to 97.91%)
Negative Predictive Value	100% (97.90% to 100.00%)
Accuracy	96.50% (92.92% to 98.58%)

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The sensitivity of CT in the diagnosis of gall bladder carcinoma (GB fossa mass) was found to be 100% with a specificity of 73.08%, positive Predictive Value of 96.13% and negative predictive value of 100%.

DISCUSSION:

CT has never been important for gallbladder disease assessment. Doctors test gallbladder illness with sonography or nuclear medicine. Because it can see the gallbladder regardless of disease, CT is the main imaging modality for acute abdominal evaluation. Advanced CT scanners can see bile, gallstones, cholecystitis, and cancer (10,11).

Gallbladder cancer symptoms are nonspecific, and 60–85% of cholecystitis cases are unrelated.12 CT, the recommended imaging method for acute abdomen assessment, may be better than sonography's excellent sensitivity and specificity.

Our study participants averaged 54.16 years old with 11.69 SD. From 25 to 81. Our survey had 140 women (70%) and 60 men (30%). Singh et al (13) examined 60 cases. The gender ratio was 2.16:1, 41 women to 19 men. They were 32–84. Most patients were 51–60 (36.67%). Participants averaged 55.73 years old. Most patients (85%) felt stomach pain, and abdominal mass (45%). Twelve (20%) suffered stomach distension, and seventeen (26.7%) lost weight.

We found focal irregular wall thickening at 33.5%, sessile intraluminal polyp 27.5%, mass replacing GB fossa 24.5%, diffuse asymmetrical 12%, pedunculated 3%, exophytic mass 2%, and focal smooth 1% Gore et al. (2002), Hagga et al. (2003), and Afifi et al. (2012) reported that gallbladder replacement or obscuration with hepatic invasion is the most common presentation, with wall thickening of varying degrees being the least prevalent (14-16). George et al. (2007) found focal or diffuse wall thickening in 12 (24%) and 16.3% of individuals(17).

Our study found 36.5% of gall bladder masses on the entire gall bladder, 19% on the neck, 16% on the fundus, 10% on the body, 9% body and neck, 8.5 on % fundus, body, 1% on the left side of the body, and 0.5% on the fundus and neck. Singh(13) discovered 63.3% gall bladder fossa masses. More than 50% of gall bladder tumours were fundus-based, according to Gore et al (14). George et al. (2007) reported 10% intraluminal polypoidal mass in the GB, while Gore et al. (2002) identified 25%. Uniform contrast enhancement was seen in polypoidal intraluminal mass images. Polypoid gallbladder cancer rarely necroses or calcifies(14,17). Lesion enhancement was varied in our study.

Singh et al.(13) detected liver infiltration in 37 of 49 (81.7%) gallbladder cancers on CT. Duodenum, pancreas, and omentum infiltration in 21, lymph node metastases in 26, and intrahepatic biliary enlargement in 12 (24.5%). Ascites and pleural effusion were observed in 15 (30.6%) of 28 (57.1%), and peritoneal involvement in 10 (20.4%). In another study, George et al. (2007) revealed liver involvement in 36 (72%) cases and duodenum, pancreas, and omentum infiltration in 23 (46%) cases at diagnosis, and 21 (42%) cases had lymph nodes involved. Our investigation found metastases in 98.5% of gall bladder tumours. In 44.5% of cases, lymph nodes metastasized, followed by liver (20%), omentum (6%), ovary (5%), peritoneum (4%), common bile duct (4.5%), pulmonary (2.5%), adrenals (2%), and bone (1%).

In 46% of individuals, intrahepatic bile radicle dilation occurred. 11.5% of study participants had extrahepatic bile duct involvement. Gall bladder masses invaded the liver 81% of the time. 20.5% of research patients had pylorus, duodenum, omentum, or hepatic flexure.

Localised mass lesion from GB (43.7%) followed extensive, uneven, increasing wall thickening in 49.4% (n = 43) with an intraluminal component, according to Pandey et al(18). Further disease progression signs include biliary blockage and liver involvement, which are commonly misinterpreted as pancreatic or liver cancer. Liver enlargement spreads gall bladder cancer, but lymph nodes are commonly involved. Our study demonstrated parenchymal liver invasion in 65 patients (74.7%). Portal and peripancreatic adenopathy reached 58.1% in our study. Vascular metastases are rare but conceivable. Pandey et al (18) found portal vein invasion in 11 (12.6%). Lymphadenopathy or bile radicals can clog gallbladders. Direct biliary radical invasion was prevalent (13.8-18.4%). Intestinal, omentum, and pancreatic disease progress. Many (41.4-48.3%) had duodenal invasion. The incidence of hepatic flexure invasion was 33.3%. Their examination indicated 19.5% peritoneal deposits and 31% ascites.

Our institute's gall bladder mass resectability criteria are non-regional lymph nodes, distant organ metastasis except for drop metastasis in extra hepatic biliary radicles, bilateral hepatic hilar involvement, and mass lesion or extra nodal spread from involved lymphnodes involving the main portal vein or common hepatic artery Our investigation found 28% resectable gall bladder masses and 73% unresectable ones.

Results must be examined for abdominal CT cholecystitis diagnosis. Singh et al(13) found gallstones in 95% of acute cholecystitis patients, although CT sensitivity was 75%. Unlike biliary attenuation, cholesterol stones can be insulating or hypoattenuating,

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making them difficult to detect. Patients had 31.5% cholelithiasis, 3% choledocholithiasis, 0.5% adenocarcinoma, left hepatic duct stricture, left portal vein tumoral thrombus, 0.5% porcelain gall bladder, and 1% portal cavernoma.

For gall bladder cancer (GB fossa mass), CT had 100% sensitivity, 73.08% specificity, 96.13% positive predictive value, and 100% negative predictive value. CT's gallbladder cancer diagnostic sensitivity was 100%, specificity 84.62%, positive predictive value 95.92%, and negative predictive value 100%, according to Singh et al. And, this all improves gall bladder mass CT assessment.

Generalizability:

The findings of this study, conducted at a tertiary care center in eastern India, are particularly relevant to populations in regions with a high prevalence of gallbladder carcinoma, such as northern and northeastern India. Given the prospective cross-sectional design and the inclusion of a broad age range and both sexes, the results may apply to similar clinical settings where patients present with suspected gallbladder malignancies. However, as this was a single-center study with hospital-based recruitment, the results may not fully represent the general population, especially asymptomatic individuals or those with early-stage disease who may not seek medical attention. The high proportion of advanced, unresectable cases may also reflect referral bias common in tertiary centers. Therefore, while the diagnostic accuracy of MDCT observed here is likely reproducible in well-equipped settings, further multicenter or community-based studies are needed to confirm the findings in broader populations.

CONCLUSION:

Gallbladder cancer is sometimes misdiagnosed as symptomatic cholelithiasis or chronic cholecystitis with non-specific symptoms. Females predominate. Malignant and mildly enhancing gallbladder carcinoma (almost 90% have metastases at diagnosis). About 73% of research participants had unresectable gall bladder masses. To reduce non-therapeutic surgical exploration, cross-sectional imaging like Multi-detector CT is needed to diagnose and assess illness. According to this study, most sonographically/clinically suspected gallbladder carcinoma patients present in an advanced stage at CT evaluation, making curative resection impossible. We recommend screening for gall bladder carcinoma at least in endemic regions (north and north eastern India) with ultrasonography followed by contrast-enhanced CT to give early curative surgical resection and better prognosis.

Limitations:

- Being a **single-center, hospital-based** study, the results may not fully reflect the broader population, including asymptomatic cases or patients from different geographic areas.
- The referral bias likely contributed to a **high proportion of advanced and unresectable tumors**, limiting applicability to earlier-stage disease.
- We did not assess **inter-observer variability** in CT interpretation, which other studies have shown can affect staging accuracy.
- Our sample, while sizable, is still relatively limited; similar MDCT studies in Gujarat and Karnataka had fewer cases (50–100), affecting statistical power.
- Some patients lacked complete data (e.g., follow-up imaging), which may have led to underreporting of certain disease patterns.

Recommendations

1. Use MDCT as the Primary Diagnostic Tool
2. In line with findings from North India and other regions, multidetector CT is highly effective for diagnosing gallbladder carcinoma and assessing resectability. We recommend routine use of contrast-enhanced MDCT in all clinically or sonographically suspicious cases.
3. Adopt Dual-Phase CT with 3D Reconstruction.
4. Studies in AJR have shown that dual-phase CT with 3D reconstructions improves staging and helps map vascular anatomy, aiding surgical. Where available, this should be part of the imaging protocol.
5. Standardize MDCT Protocols (Include MPR Where Possible)
6. The diagnostic accuracy of MDCT increases significantly when multiplanar reconstructions (MPR) are added to axial images. We recommend that axial CT be routinely supplemented with MPR views when available.
7. Differentiate Query:
8. Radiological Features to Differentiate Cancer vs. Benign Pathology
9. Research indicates that features such as focal wall thickening, mucosal disruption, pericholecystic fat stranding, and lymph node size may help distinguish carcinoma from

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inflammatory mimics like xanthogranulomatous cholecystitis. Radiologists should be trained and protocols refined to assess these features rigorously.

10. Encourage Early Imaging in High-Risk Areas
11. Given the frequent late presentation of gallbladder cancer in regions with high prevalence (e.g., parts of northern India), public health strategies should include early ultrasound screening followed by CT imaging in suspected cases to detect disease at a potentially operable stage.
12. Routine Histopathological Examination
13. Although our study used imaging-histopathology correlation, other research highlights the importance of routinely sending all gallbladder specimens—even those removed for presumed benign disease—for histopathology to catch incidental carcinoma and improve outcomes.
14. Multi-Center Studies for External Validation
15. Our findings are consistent with other single-center reports but may not reflect broader populations. We recommend multicenter or community-based diagnostic accuracy studies to validate results across diverse settings.

Conflict of Interest:

The authors declare no conflict of interest related to this study.

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Data Availability

The datasets generated and analyzed during this study are not publicly available due to institutional data protection policies and patient confidentiality, but are available from the corresponding author on reasonable request and with appropriate ethical approval.

Author Contribution

Dr. Suruthi T. I., Dr. Amit Kumar, Dr. Umakant Prasad, and Dr. Bipin Kumar all contributed equally to the planning, execution, and completion of this study. Each author was actively involved in formulating the study design, analyzing imaging and pathological data, coordinating cross-departmental processes, and reviewing literature. Together, they participated in interpreting findings, discussing results, and writing and revising the manuscript. All authors have read and approved the final version and take full responsibility for the integrity of the work.

Author Biography

- Dr. Suruthi T. I. is a Junior Resident in the Department of Radio-diagnosis at IGIMS, Patna. She is currently pursuing her post-graduate training with a keen interest in abdominal and oncologic imaging. Her enthusiasm for learning and strong analytical skills played a key role in data collection and CT interpretation during the study.
- Dr. Amit Kumar serves as an Additional Professor in the Department of Radio-diagnosis at IGIMS, Patna. With a solid background in diagnostic radiology, he brings significant experience in cross-sectional imaging. His leadership in academic research and hands-on clinical insight were valuable throughout the development of this study.
- Dr. Umakant Prasad is also an Additional Professor in the Department of Radio-diagnosis at IGIMS, Patna. He has extensive experience in advanced imaging techniques and is actively involved in postgraduate training. His contributions to image analysis and manuscript refinement reflect his commitment to research-based diagnostics.
- Dr. Bipin Kumar is a Professor in the Department of Pathology at IGIMS, Patna. He has a strong academic and diagnostic background in histopathology. His role in correlating imaging findings with histopathological outcomes was vital in confirming diagnoses and adding depth to the study's conclusions.

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List of Abbreviations

CT Computed Tomography
MDCT Multi-Detector Computed Tomography
HPE Histopathological Examination
IGIMS Indira Gandhi Institute of Medical Sciences
HU Hounsfield Unit
GB Gallbladder
CBD Common Bile Duct

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