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Role of Computed Tomography in Differentiating between Benign and Malignant Gallbladder Masses with Histopathological Correlation

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Abstract

A cross-sectional study was done to evaluate computed tomography (CT) scans as a diagnostic tool for distinguishing between benign and malignant gallbladder masses corroborated by histopathological findings. The study was conducted in the Department of Radiology & Imaging of Sir Salimullah Medical College and Mitford Hospital, Dhaka, Bangladesh, between January and December of 2013. The study included a total of 45 patients who were ultrasonographically diagnosed with gallbladder masses. Later, those patients underwent CT scans using a 16-slice helical CT scan machine. All CT scan findings were interpreted by the specialist radiologists, focusing on lesion involvement, contrast enhancement characteristics, and invasion into adjacent structures. Postoperative tissues were examined histopathologically, and these findings were correlated with the CT scan results. The study revealed a higher prevalence of GBC in females (73.33%) and in the age group of 40-60 years. CT scans indicated malignancy in 84.44% of cases, which was confirmed as adenocarcinoma in 88.89% of cases through histopathology. The sensitivity, specificity, and accuracy of CT scans for detecting malignant gallbladder masses were 90.24%, 75.00%, and 88.89%, respectively. For benign masses, the corresponding values were 75.00%, 90.24%, and 88.89%. The positive predictive value was notably high at 97.37% for malignant masses but lower at 42.86% for benign masses. CT scans demonstrated high sensitivity and specificity in the diagnosis of malignant gallbladder masses, corroborated by histopathological findings. The study underscores the utility of CT scans as an effective, non-invasive diagnostic tool for early detection and management of gallbladder masses, although caution is advised in interpreting benign results due to a lower positive predictive value.

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Introduction

Gallbladder carcinoma (GBC) is a rare yet highly aggressive malignancy, ranking as the fifth most common gastrointestinal cancer and the leading cancer of the biliary tree.[1] Despite its severity, early diagnosis remains elusive due to often vague and non-specific symptoms that typically manifest at advanced stages, usually when adjacent organs like the liver are invaded.[2,3] This late presentation is a significant contributor to the dismal prognosis of GBC, with most large studies reporting a five-year survival rate of less than 5%.[2] Recent advancements in medical imaging have revolutionized the diagnostic landscape for GBC. Ultrasonography (USG) is commonly the first-line imaging modality, particularly useful for initial evaluations of symptoms such as jaundice or right-upper quadrant pain.[4] However, USG has limitations, including interference from bowel gas and limited depth resolution.[5]

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Computed Tomography (CT) scans offer a more comprehensive assessment, providing vital information on tumor invasion, distant metastasis, and portal vein involvement.[6,7] Evidence showed the effectiveness of multislice spiral CT in differentiating between chronic cholecystitis and thick-wall gallbladder carcinoma.[8] While Magnetic Resonance Imaging (MRI) is gaining popularity for its sensitivity and non-invasiveness, it is often reserved for inoperable or palliative cases.[9,10] Hence, CT scans, being more accessible, quicker, and cost-effective, remain the preferred initial diagnostic tool for GBC.[10] MRI, however, excels in soft-tissue characterization and is increasingly utilized for diagnosis, staging, and treatment evaluation.[11] The complexity of diagnosing gallbladder masses involves a multifaceted approach that includes clinical history, imaging findings, and the expertise of the radiologists.[4] While histopathology remains the definitive method for diagnosis, it is invasive and usually feasible only post-surgery. In contrast, CT scans, particularly those with 3D reconstruction capabilities, offer a non-invasive, efficient, and cost-effective alternative for initial diagnosis and treatment planning. Given the critical role of early and accurate diagnosis in the management of GBC, this study aims to evaluate the efficacy of CT scans in differentiating between benign and malignant gallbladder masses.

Methods

This cross-sectional study was conducted in the Department of Radiology & Imaging in collaboration with the Department of Medicine, Surgery & Pathology of Sir Salimullah Medical College Mitford Hospital, Dhaka, Bangladesh, between January and December of 2013. Ethical approval was obtained from the ethical committee of the institution, and informed written consent was collected from each patient. Initially, 53 patients with clinically suspected gallbladder masses were considered; however, 7 were unfit for surgery due to metastasis, and one refused surgery, leaving 45 patients for final evaluation. These patients were selected irrespective of age and sex and underwent CT scans using a 16-slice helical CT scan machine (Emotion 16, Siemens) with specific parameters. The CT scans were interpreted by specialist radiologists, focusing on lesion involvement, contrast enhancement characteristics, and invasion into adjacent structures. Postoperative tissues were examined histopathologically, and these findings were correlated with CT scan results.

Data were collected using a semi-structured questionnaire and analyzed using SPSS (Statistical Package for Social Sciences). Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of CT scans were calculated based on histopathological findings using standard formulae. All statistical analysis was carried out using SPSS software version 20.0. All tests were two tailed and $p<0.05$ was considered to be statistically significant. The study was approved by the Ethical Review Committee of Sir Salimullah Medical College, Dhaka, Bangladesh.

Results

45 patients, the age distribution was skewed towards the older population, with the majority falling within the 40-60 age range. Specifically, 17 patients (37.78%) were between 40-50 years old, and 20 patients (44.44%) were in the 50-60 age group. Fewer patients were observed in the

younger and older age groups; only 1 patient (2.22%) was between 20-30 years, 3 patients (6.67%) were between 30-40 years, and 4 patients (8.89%) were between 60-70 years. The mean age of the participants was 50.66 years with a standard deviation of 2.35 years. Regarding gender distribution, the study had a higher representation of females, with 33 patients (73.33%), compared to 12 male patients (26.67%) (Table-I). Based on their CT scan findings, 38 patients (84.44%) were detected with malignancy of the gall bladder, while the rest 7 patients (15.56%) were diagnosed with benign masses of the gall bladder (Fig. 1).

Table-I: Distribution of participants by sociodemographic characteristics (N=45)

Variable	Number of patients	Percentage
Age group (in years)		
20-30	1	2.22%
30-40	3	6.67%
40-50	17	37.78%
50-60	20	44.44%
60-70	4	8.89%
Mean + SD	50.66 + 2.35 years	
Gender		
Male	12	26.67%
Female	33	73.33%

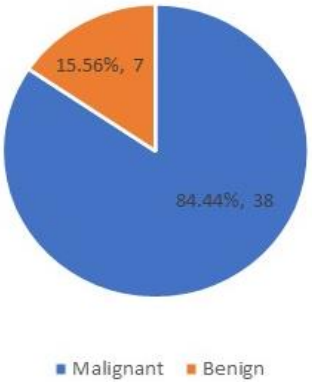

Fig. 1: Distribution of patients by diagnosis of gallbladder mass using CT scans (N=45)

Histopathological examinations revealed that the majority, 40 (88.89%), had adenocarcinoma, followed by 4(8.89%) patients with adenomatous polyps, and 1(2.22%) had squamous cell carcinoma (Fig. 2). Out of 45 patients, CT scans correctly identified 37 malignant gallbladder masses, resulting in 37 true positives (TP). There was 1 false positive (FP), where the CT scan incorrectly indicated a malignant mass. Conversely, CT scans missed 4 malignant cases, resulting in 4 false negatives (FN), but correctly identified 3 cases as not malignant, resulting in 3 true negatives (TN) (Table-II).

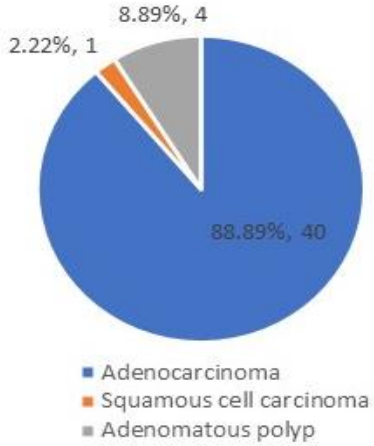

Fig.2: Distribution of patients by histopathological diagnosis of gallbladder mass (N=45)

Table-II: Comparison between CT scan and histopathological diagnosis for prediction of malignant gallbladder mass (N=45)

CT diagnosis	Histopathological diagnosis		Total
	Positive for GB Malignant Mass	Negative for GB Malignant Mass	
Positive for GB Malignant Mass	37 (TP)	1 (FP)	38
Negative for GB Malignant Mass	4 (FN)	3 (TN)	7
Total	**42**	**4**	**45**

Thus, CT scans showed a sensitivity of 90.24% i.e., highly effective at detecting malignant gallbladder masses. The specificity was 75%, indicating a moderate ability to correctly identify benign cases. The overall accuracy of the CT scans in this study was 88.89%. The positive predictive value was notably high at 97.37%, but the negative predictive value was lower at 42.86% (Table-III). CT scans correctly identified 3 benign gallbladder masses, resulting in 3 true positives (TP). However, there were 4 false positives (FP), where CT scans incorrectly indicated benign masses. On the other side, CT scans correctly identified 37 cases as not benign, resulting in 37 true negatives (TN), but missed 1 benign case, resulting in 1 false negative (FN) (Table-IV). To predict benign gallbladder masses, CT scans had a sensitivity of 75%, indicating a moderate ability to correctly identify benign cases. The specificity was high at 90.24%, showing strong accuracy in ruling out benign conditions. The overall accuracy of the CT scans was 88.89%. However, the positive predictive value was low at 42.86%, suggesting caution when interpreting a benign result from a CT scan.

Table-III: Sensitivity, specificity, accuracy, positive and negative predictive values of CT evaluation for prediction of malignant gallbladder mass (N=45)

Validity Test	Percentage
Sensitivity	90.24%
Specificity	75.00%
Accuracy	88.89%
Positive Predictive value	97.37%
Negative Predictive value	42.86%

Table-IV: Comparison between CT and histopathological diagnosis for prediction of benign gallbladder mass (N=45)

CT diagnosis	**Histopathological diagnosis**		**Total**
	Positive for GB Benign Mass	Negative for GB Benign Mass	
Positive for GB Benign Mass	3 (TP)	4 (FP)	7
Negative for GB Benign Mass	1 (FN)	37 (TN)	38
Total	4	41	45

In contrast, the negative predictive value was extremely high at 97.37%, indicating reliability in ruling out benign conditions when the CT scan is negative (Table-V).

Table-V: Sensitivity, specificity, accuracy, positive and negative predictive values of CT evaluation for prediction of benign gallbladder mass (N=45)

Validity Test	Percentage
Sensitivity	75.00%
Specificity	90.24%
Accuracy	88.89%
Positive Predictive value	42.86%
Negative Predictive value	97.37%

Discussion

The demographic profile of the study population revealed a mean age of 50 years, with a male-to-female ratio of 2:5. This is notably different from what is generally reported in Western literature, where the mean age of presentation is usually a decade higher. This discrepancy could be

attributed to regional variations in disease prevalence or perhaps to advancements in imaging modalities that enable earlier detection. Kumar *et al*.[12] also reported a similar trend in a North Indian population, suggesting that this might be a broader regional phenomenon. The clinical symptoms reported by the patients, such as flatulent dyspepsia, upper abdominal pain, and jaundice, are aligned with the previous reports by multiple authors.[13-15] These symptoms often indicate more advanced stages of the disease, which is consistent with the low five-year survival rates reported by another study.[2] The CT findings in this study are particularly noteworthy.

A majority of the cases (62.2%) presented with a mass in the gallbladder fossa, 17.8% had polypoidal growth, and 20% had gallbladder wall thickening. These observations are in line with those reported by George *et al.*[4] The study also underscores the diagnostic challenges posed by gallbladder wall thickening, which can be indicative of a range of conditions from chronic cholecystitis to carcinoma, as also noted by Levy *et al*.[16] and Yoshimitsu *et al.*[17] The study found cholelithiasis in 80% of the patients, which is consistent with its established role as a significant risk factor for gallbladder carcinoma. This supports the findings of Zissin *et al.*[14] and adds weight to the hypothesis that irritation from gallstones may lead to chronic inflammation and eventually to carcinoma, as described by Lamps.[18] One of the most compelling aspects of this study is its diagnostic accuracy metrics. The sensitivity, specificity, and positive predictive value for detecting malignant gallbladder masses were 90.24%, 75%, and 97.37%, respectively. These figures are in line with those reported by Ohtani *et al.,*[19] who also found high positive predictive values, thereby emphasizing the utility of CT scans in determining surgical resectability and treatment plans.

However, our study had some limitations, particularly in detecting benign gallbladder masses. The sensitivity and positive predictive value were 75% and 42.86%, respectively. This suggests that while CT is highly effective in detecting malignant masses, its efficacy is somewhat limited when it comes to benign conditions. Moreover, the study was conducted in a single hospital with a small sample size. Hence, the results may not be able to represent the whole community.

Conclusion

In summary, the present study provides a comprehensive evaluation of the role of CT scans in diagnosing and staging gallbladder masses. While the study confirms the utility of CT scans in malignant cases, it also highlights the need for caution in interpreting benign results. The findings contribute significantly to the existing body of literature and offer valuable clinical insights. Future research could focus on improving the diagnostic accuracy for benign conditions and further investigating the observed regional variations in disease presentation.

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