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Comparative Diagnostic Performance of USG, CT scan, and MRCP in Periampullary Carcinoma

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Abstract **Original Research Article**

Background: Obstructive jaundice is a serious hepatobiliary condition often caused by malignant biliary obstruction, including periampullary tumors. No single imaging modality provides consistently complete diagnostic accuracy, making comparative evaluation necessary. This study compared the diagnostic performance of USG, CT scan, and MRCP in periampullary carcinoma using histopathology as the gold standard. ***Methods:*** This retrospective cross-sectional study was conducted in the Department of Surgery at Shaheed Suhrawardy Medical College and Hospital, Dhaka, Bangladesh. A total of 50 histopathologically confirmed periampullary carcinoma patients were included using purposive sampling. After ethical approval and informed consent, data from USG, CT scan, MRCP, and histopathology were collected and analyzed using SPSS version 24, with diagnostic performance parameters calculated ($p < 0.05$ significant). ***Results:*** A total of 50 patients (mean age 48.26 ± 14.88 years; 58% male) were included. Periampullary carcinoma was detected by USG in 72%, CT in 82%, and MRCP in 92%, while histopathology confirmed 96%. MRCP showed the highest accuracy (98%), followed by CT (96%) and USG (92%). MRCP and CT had 100% specificity, whereas USG had highest sensitivity (100%) but lower specificity (87.5%). Overall, MRCP was the most accurate modality, followed by CT and USG. ***Conclusion:*** MRCP is the most accurate imaging modality for detecting periampullary carcinoma, followed by CT scan, while USG is useful mainly as an initial screening tool.

Keywords: Periampullary Carcinoma, Ultrasonography, Magnetic Resonance Cholangiopancreatography.

INTRODUCTION

Obstructive jaundice is one of the most frequent and grave form of hepatobiliary disease [1]. Despite the technical advances, the operative modes of management of obstructive jaundice were associated with very high morbidity and mortality [2]. Malignant obstructive jaundice is result of mechanical obstruction of bile ducts from primary pancreato-billiary malignancies or metastatic deposits from the lung, breast or melanoma [3]. Pancreatic cancer is the seventh leading cause of cancer-related death worldwide due to poor prognosis and that less than 5% of patients survive 5 years after diagnosis [4]. This poor survival is the result of late diagnosis and low complete resection rate [5].

Correct choices among therapeutic options usually rest upon a precise assessment of etiology, location, level and extent of disease [6]. So, it is mandatory to determine pre-operatively the existence, the nature and site of obstruction because an ill chosen therapeutic approach can be dangerous [7]. Accurate identification of the site and cause of obstruction is essential for appropriate therapeutic planning and prognostication [8]. Ultrasonography remains the first-line investigation due to its wide availability, low cost, and absence of radiation exposure.

Ultrasonography (USG) has been always considered the first-choice technique in the study of biliary obstructive disease, due to its accessibility, speed,

ease of performance and low cost [9]. Traditional Computed Tomography (CT) scan is usually considered more accurate than US for helping determine the specific cause and level of obstruction [10]. MRCP has since evolved as a non-invasive, high-resolution imaging technique for evaluating the biliary and pancreatic ductal systems. It offers diagnostic accuracy comparable to endoscopic retrograde cholangiopancreatography (ERCP) for many pathologies but without its inherent risks such as pancreatitis, bleeding, or sepsis [11,12].

Each modality offers advantages and disadvantages that are unique to the specific technology. MRCP demonstrated the entire biliary tract and pancreatic duct without the use of intravenous or oral contrast and without any intervention. However, ultrasonography and CT do not accurately define the site and extent of biliary strictures [13]. The diagnostic accuracy, sensitivity and specificity of USG, CT scan and MRCP vary across studies, and no single modality is universally accepted as superior in all aspects of evaluation of periampullary and pancreaticobiliary lesions [14-16]. Therefore, comparative assessment of these imaging modalities is essential to determine their relative diagnostic performance in clinical practice.

Despite advances in imaging modalities, accurate preoperative characterization of periampullary and pancreaticobiliary lesions remains challenging in routine clinical practice. Ultrasonography, CT scan, and MRCP each offer important diagnostic advantages, yet their performance varies depending on lesion size, location, and operator or technique-related factors. No single modality consistently provides complete diagnostic accuracy in all clinical scenarios, and existing literature demonstrates variable sensitivity and specificity across studies. In addition, limited comparative data are available from our setting evaluating these modalities against histopathology as the definitive standard, particularly in patients presenting with obstructive jaundice due to periampullary carcinoma. Therefore, the objective of this study is to compare the diagnostic performance of ultrasonography (USG), computed tomography (CT) scan, and magnetic resonance cholangiopancreatography (MRCP) in the evaluation of periampullary carcinoma, using histopathology as the gold standard.

Objective

- To compare the diagnostic performance of USG, CT scan, and MRCP in detecting periampullary carcinoma.

METHODOLOGY & MATERIALS

This retrospective cross-sectional study was conducted in the Department of Surgery at Shaheed Suhrawardy Medical College and Hospital, Dhaka, Bangladesh, during the one-year period prior to approval of the study protocol. A total of 50 patients were included in the study, who were admitted with obstructive jaundice and clinical suspicion of malignancy and subsequently diagnosed with periampullary carcinoma on histopathological examination. Patients were selected using a purposive sampling technique based on predefined inclusion and exclusion criteria for the evaluation of the comparative diagnostic performance of USG, CT scan, and MRCP in periampullary carcinoma.

Inclusion Criteria

i. Patients aged more than 18 years
ii. Patients with obstructive jaundice
iii. Patients with histopathologically confirmed periampullary carcinoma
iv. Patients willing to participate in the study

Exclusion Criteria

i. Patients who did not provide informed consent
ii. Patients with contraindications to MRI
iii. Patients with pre-hepatic or hepatic causes of jaundice
iv. Patients with psychiatric illness

Data Collection Procedure

After obtaining ethical approval from the Ethical Review Committee of Shaheed Suhrawardy Medical College, eligible patients were identified and approached for participation. Written informed consent was obtained from each participant prior to inclusion. A total of 50 patients fulfilling the selection criteria were enrolled. Demographic data, clinical information, and relevant investigation findings were recorded using a structured case record form. All collected data were checked for completeness and consistency before analysis.

Ethical Considerations

Ethical clearance was obtained from the Ethical Review Committee of Shaheed Suhrawardy Medical College prior to commencement of the study. Confidentiality of patient information was strictly maintained, and data were accessible only to the investigators. Participation was voluntary, and all respondents were informed about the purpose, procedures, and their right to withdraw from the study at any time without any consequences. No financial incentives were provided to the participants.

Statistical Analysis

Data were analyzed using SPSS version 24 (SPSS Inc., Chicago, IL). Categorical variables were expressed as frequencies and percentages and analyzed using the Chi-square test. Continuous variables were presented as mean ± standard deviation and analyzed using Student's t-test where appropriate. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1: Baseline Characteristics of the Study Population (n = 50)

Variable		No. of patients	Percentage (%)
Age	≤30 years	7	14.0
	31–50 years	24	48.0
	51–70 years	15	30.0
	>70 years	4	8.0
	Mean ± SD	48.26 ± 14.88	
Gender	Male	29	58.0
	Female	21	42.0

The majority of the respondents were in the 31–50 years age group (48.0%), followed by 51–70 years (30.0%), ≤30 years (14.0%), and >70 years (8.0%). The mean age was 48.26 ± 14.88 years. Most of the respondents were male (58.0%), while females constituted 42.0% of the study population.

Table 2: Detection of Periampullary Carcinoma by Different Diagnostic Modalities (n = 50)

Diagnostic Modality	Result	No. of patients	Percentage (%)
USG	Yes	36	72.0
	No	14	28.0
MRCP	Yes	46	92.0
	No	4	8.0
CT scan	Yes	41	82.0
	No	9	18.0
Histopathology	Yes	48	96.0
	No	2	4.0

Periampullary carcinoma was detected in 72.0% of cases by USG, 82.0% by CT scan, and 92.0% by MRCP. Histopathological examination confirmed periampullary carcinoma in 96.0% of the study population.

Table 3: Comparison of USG, CT scan, and MRCP with Histopathology (Gold Standard) (n = 50)

Modality	Test Result	Histopathology		Total n (%)	p-value
		Positive (n = 48)	Negative (n = 2)		
USG	Positive	34 (70.8%)	2 (100%)	36 (72.0)	0.368
	Negative	14 (29.2%)	0 (0.0%)	14 (28.0)	
MRCP	Positive	46 (95.8%)	0 (0.0%)	46 (92.0)	0.001
	Negative	2 (4.2%)	2 (100%)	4 (8.0)	
CT scan	Positive	41 (85.4%)	0 (0.0%)	41 (82.0)	0.002
	Negative	7 (14.6%)	2 (100%)	9 (18.0)	

MRCP showed the highest detection of histopathologically confirmed periampullary carcinoma (95.8%), followed by CT scan (85.4%) and USG (70.8%). USG showed false-positive findings in histopathology-negative cases, whereas both CT scan and MRCP showed no false-positive results. The association between imaging findings and histopathology was statistically significant for MRCP (p = 0.001) and CT scan (p = 0.002), but not for USG (p = 0.368).

Table 4: Diagnostic Performance of USG, CT scan, and MRCP in Periampullary Carcinoma

Diagnostic Parameter	USG (%)	CT scan (%)	MRCP (%)
Sensitivity	100.0	95.3	97.8
Specificity	87.5	100.0	100.0
Positive Predictive Value (PPV)	94.4	100.0	100.0
Negative Predictive Value (NPV)	75.0	77.7	85.0
Accuracy	92.0	96.0	98.0

MRCP demonstrated the highest diagnostic accuracy (98%), followed by CT scan (96%) and USG (92%). Sensitivity was highest for USG (100%), while both CT scan and MRCP showed perfect specificity (100%). Positive predictive value was 100% for CT scan and MRCP, whereas USG showed 94.4%. Negative

predictive value was highest for MRCP (85%), followed by CT scan (77.7%) and USG (75%).

DISCUSSION

In this retrospective cross-sectional study conducted at Shaheed Suhrawardy Medical College and Hospital, Dhaka, Bangladesh, patients with obstructive jaundice who were subsequently confirmed to have periampullary carcinoma were evaluated to compare the diagnostic performance of USG, CT scan, and MRCP against histopathology. MRCP demonstrated the highest diagnostic accuracy and strongest correlation with histopathological findings, followed by CT scan, while USG showed comparatively lower diagnostic performance. Overall, the findings highlight the superior reliability of MRCP in the preoperative evaluation of periampullary carcinoma, supporting its role as the most effective imaging modality among the three techniques studied.

In the present study, the mean age of the patients was 48.26 ± 14.88 years, with the majority belonging to the 31–50 years age group (48.0%), followed by 51–70 years (30.0%), indicating that periampullary carcinoma predominantly affects middle-aged individuals. A male predominance was observed (58.0%), with females comprising 42.0% of the study population. These findings are comparable with those reported by Nalbant *et al.,*[17], who observed a higher mean age of 62.2 ± 8.38 years with 61% male patients, and Hashemzadeh *et al.,*[18], who reported a mean age of 54 ± 12.5 years with 56.3% male predominance. Similarly, Abass *et al.,*[19] reported a mean age of 51.6 years with nearly equal gender distribution. Although the mean age in the present study is slightly lower, the overall trend remains consistent with previous studies, demonstrating that periampullary carcinoma commonly occurs in middle to older age groups, with a slight male predominance.

In the present study, periampullary carcinoma was detected in 72.0% of cases by USG, 82.0% by CT scan, and 92.0% by MRCP, while histopathology confirmed the diagnosis in 96.0% of patients. These findings clearly demonstrate the superior diagnostic yield of MRCP compared to CT scan and USG. Similar observations were reported by Singh *et al.,*[7], who found that MRCP detected nearly all cases of periampullary carcinoma, whereas CT scan missed some cases and USG missed multiple cases due to its lower diagnostic capability. Likewise, Sharma *et al.,*[20] reported a higher sensitivity of MRCP (92.5%) compared to USG (77.5%), further reinforcing the superior diagnostic performance of MRCP. The findings of the present study are in close agreement with these observations, showing that MRCP has the highest detection rate, followed by CT scan, while USG demonstrates comparatively lower detection. This comparatively reduced performance of USG may be attributed to its operator dependency, limited acoustic window, and difficulty in visualizing distal biliary and periampullary regions.

In the present study, MRCP demonstrated the highest agreement with histopathology, correctly identifying 95.8% of histopathologically confirmed periampullary carcinoma cases, followed by CT scan (85.4%) and USG (70.8%). Both MRCP and CT scan showed no false-positive results, whereas USG produced false-positive findings in histopathology-negative cases. These findings are consistent with those reported by Schwarz *et al.,*[21], who observed that the sensitivity of advanced imaging modalities such as CT and MRI/MRCP ranged from 89% to 96% when compared with histopathology, indicating a high level of diagnostic concordance. Similarly, Chen *et al.,*[22] reported markedly lower sensitivity for USG (24%) and moderate sensitivity for CT (39%), while advanced imaging modalities demonstrated significantly better performance. Although the absolute sensitivity values in the present study are higher, the overall pattern remains comparable, demonstrating that MRCP has the strongest correlation with histopathological diagnosis, followed by CT scan, whereas USG shows comparatively lower diagnostic reliability.

In the present study, MRCP demonstrated the highest overall diagnostic performance with a sensitivity of 97.8%, specificity of 100%, and accuracy of 98%, followed by CT scan (sensitivity 95.3%, specificity 100%, accuracy 96%) and USG (sensitivity 100%, specificity 87.5%, accuracy 92%). These findings are consistent with those reported by Singh *et al.,*[7], who observed similar values for MRCP (sensitivity ≈95.8%, specificity ≈100%, accuracy ≈98%) and high diagnostic performance of CT, while USG showed comparatively lower specificity. Likewise, Schwarz *et al.,*[21] reported that the sensitivity of CT and MRI/MRCP ranged from 89% to 96% when compared with histopathology, which closely aligns with the sensitivity values observed in the present study for both CT and MRCP. Furthermore, Howard *et al.,*[23] demonstrated that CT scan has excellent specificity, often reaching 100%, despite variable sensitivity (~63%) and moderate accuracy (~86%), thereby supporting the present finding of perfect specificity for CT. Although USG in the current study demonstrated very high sensitivity, its comparatively lower specificity and negative predictive value indicate limitations in reliably excluding disease. Overall, these findings corroborate existing literature, confirming that MRCP provides the highest diagnostic accuracy and reliability, followed by CT scan, while USG, despite being sensitive, has comparatively lower overall diagnostic performance.

Limitations of the study

The study had a few limitations:

- The study was conducted at a single center, which may limit the generalizability of the findings.

- The sample size was relatively small.
- Randomization was not performed.
- The study duration was limited to six months, which may not have been sufficient for a more comprehensive evaluation.

CONCLUSION

Periampullary carcinoma is a challenging malignancy that requires accurate and timely imaging for effective diagnosis and management. This study demonstrated that MRCP is the most accurate imaging modality for detecting periampullary carcinoma, followed by CT scan and USG. MRCP showed the highest diagnostic accuracy and strongest correlation with histopathology, while CT scan also performed well with high diagnostic reliability. USG, although highly sensitive, demonstrated comparatively lower specificity and overall diagnostic performance. These findings suggest that MRCP should be considered the most reliable non-invasive imaging modality, with CT scan serving as a valuable complementary tool and USG as an initial screening investigation.

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