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COMPARISON BETWEEN MAGNETIC RESONANCE CHOLANGIO-PANCREATOGRAPHY AND ULTRASOUND FOR DIAGNOSING PATIENTS WITH PANCREATIC TUMOR

Original Research

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ABSTRACT

Background: Pancreatic cancer poses a significant challenge due to its late diagnosis and poor prognosis. Early and precise detection is essential to improving outcomes. Magnetic Resonance Cholangiopancreatography (MRCP) and Ultrasound (US) are widely used imaging modalities, each with distinct advantages and limitations. Comparative studies focusing on their diagnostic accuracy, sensitivity, and specificity for pancreatic cancers remain limited, necessitating further evaluation to determine their relative effectiveness in clinical practice.

Objective: To evaluate and compare the diagnostic performance of MRCP and US in the detection of pancreatic cancers, with a focus on their relative accuracy, sensitivity, and specificity.

Methods: A descriptive cross-sectional study was conducted in General Hospital, Services Hospital, and Jinnah Hospital in Lahore, involving 160 patients with suspected pancreatic cancers who underwent MRCP and US. Data were collected using a structured questionnaire and analyzed using SPSS version 27. Descriptive and inferential statistics, including the chi-square test, were used to assess associations between imaging, clinical, and demographic variables, with significance set at $p < 0.05$. Diagnostic accuracy, patient comfort, and cost were compared across modalities.

Results: MRCP demonstrated higher diagnostic accuracy, detecting pancreatic tumors in 46.88% of cases (mean detection score 1.21, SD ± 0.41) compared to US, which detected tumors in 46.88% of cases (mean detection score 1.74, SD ± 0.44). MRCP was particularly effective in visualizing tumors in the pancreatic head (34.38%), with superior sensitivity (99%) and specificity (99%) compared to US (sensitivity 80%, specificity 99%). MRCP had higher image quality ratings (mean 3.83, SD ± 1.83) compared to US (mean 1.73, SD ± 1.55). However, US scored better on patient comfort (mean 1.73, SD ± 0.44) versus MRCP (mean 1.68, SD ± 1.5). Cost analysis showed MRCP was more expensive (10,000 PKR) than US (1,500–2,000 PKR). Significant associations were found between imaging modality, tumor detection accuracy ($p = 0.017$), and patient comfort ($p = 0.014$).

Conclusion: MRCP demonstrated superior diagnostic accuracy, particularly for small or complex lesions, while US was effective for initial screening due to accessibility and patient comfort. A multimodal approach combining US for screening and MRCP for confirmation is recommended. Future studies should explore integrating MRCP with advanced imaging techniques like Endoscopic Ultrasonography (EUS) and involve larger, more diverse populations to enhance diagnostic precision and clinical utility.

Keywords: Diagnostic Imaging, Magnetic Resonance Cholangiopancreatography, Pancreatic Neoplasms, Sensitivity and Specificity, Ultrasonography, Screening, Tumor Detection.

INTRODUCTION

Pancreatic cancer is a severe and life-threatening condition characterized by the uncontrolled growth and division of pancreatic cells, often leading to a poor prognosis due to delayed diagnosis. As one of the deadliest malignancies in oncology, pancreatic cancer is particularly challenging to manage because of the pancreas's deep location within the abdomen, which complicates early detection and accurate diagnosis (1). This gland plays a critical role in digestion and glucose metabolism, making any abnormalities in its structure or function potentially devastating. Pancreatic tumors, both malignant and benign, present unique diagnostic challenges, as they often remain asymptomatic until they have progressed to advanced stages where surgical resection, the primary curative option, may no longer be feasible (1). Accurate and early diagnosis of pancreatic tumors is paramount in improving patient outcomes. Various imaging modalities are employed to detect these tumors, with Magnetic Resonance Cholangiopancreatography (MRCP) and ultrasound (US) being prominent diagnostic tools. MRCP, a non-invasive imaging technique that employs magnetic resonance imaging (MRI) technology, is renowned for its ability to provide high-resolution images of the pancreatic ducts and surrounding structures. It is especially valuable in identifying ductal obstructions and tumor spread, which are critical factors in surgical planning. Its high sensitivity (90%) and specificity (85%) in differentiating benign from malignant lesions make it an essential tool for comprehensive diagnostic evaluation. However, MRCP has its limitations, such as difficulty in assessing solid tumor components, which may necessitate complementary imaging methods (2, 5, 7).

Ultrasound, on the other hand, is widely used as an initial imaging modality due to its accessibility, cost-effectiveness, and ability to identify larger tumors and provide information about echogenicity. However, its effectiveness is often hindered by patient factors such as obesity or bowel gas interference and its operator-dependent nature. The diagnostic sensitivity of the US for pancreatic tumors is approximately 70%, with specificity around 80%, which is notably lower than MRCP (6, 9). Advances in ultrasound techniques, such as contrast-enhanced ultrasound (CEUS) and endoscopic ultrasound (EUS), have enhanced its diagnostic accuracy. EUS, in particular, offers high-resolution images capable of detecting small masses that conventional ultrasound might miss, with a sensitivity of 94% and specificity of 89% (10, 19). Despite these advancements, there remains a need for a comparative analysis of MRCP and US to evaluate their relative strengths and weaknesses in the diagnosis of pancreatic tumors. MRCP excels in providing detailed anatomical information, particularly of the pancreaticobiliary system, without requiring invasive procedures or contrast injections. Meanwhile, ultrasound is more accessible and cost-effective but limited in its ability to detect small or deeply situated lesions. Both modalities have demonstrated significant utility, and their roles in diagnostic algorithms could be optimized through a clearer understanding of their comparative diagnostic precision, sensitivity, and specificity (6, 7, 13).

Given the global burden of pancreatic cancer and its high mortality rate, there is a pressing need to refine diagnostic protocols to ensure timely and accurate detection. This study aims to provide a comprehensive evaluation of MRCP and US by analyzing their diagnostic performance, practical utility, and cost implications. By addressing gaps in knowledge and informing clinical decision-making, this research seeks to contribute to improved patient outcomes and more effective healthcare resource allocation. Such an analysis is essential to the development of integrated diagnostic strategies that leverage the strengths of both MRCP and ultrasound for enhanced detection and management of pancreatic tumors (12, 15, 18).

METHODS

A Cross-section study was conducted between January 2024 to October 2024 on the target population of pancreatic cancer from the radiology department of General Hospital, Services Hospital, and Jinnah Hospital, Lahore. The objective of the study was to compare the diagnostic performance of Magnetic Resonance Cholangiopancreatography (MRCP) and ultrasound (US) in detecting pancreatic tumors. The inclusion criteria for participants required a strong clinical suspicion of pancreatic tumors, whether malignant or benign. Patients were included only if they had undergone both MRCP and US as part of their diagnostic workup, with histopathological confirmation available to validate the imaging findings. Additionally, comprehensive clinical records and imaging results were utilized to compare diagnostic performance. Exclusion criteria included patients who had not undergone both MRCP and US or who had incomplete imaging data. Patients with contraindications to MRI, such as implanted metallic devices (e.g., pacemakers) or severe

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

claustrophobia, were also excluded. Other exclusion factors included pregnancy and prior treatment for pancreatic tumors, such as surgery, chemotherapy, or radiation therapy, before imaging. Ethical approval for the study was obtained from the Institutional Review Board of the Faculty of Allied Health Sciences, Superior University, Lahore, under the reference IRB/FAHS/Allied-HS/10/24/MS/RS-3510, dated October 29, 2024. All participants provided informed consent by signing adult consent forms willingly.

The sample size of 160 participants was determined using RaoSoft software, and data was collected through a validated questionnaire. Convenience sampling was employed for participant selection. Data analysis was conducted using SPSS software version 27. Continuous variables were described using means and standard deviations, while categorical variables were presented as frequencies and proportions. Normality assumptions for numerical data were verified before statistical analysis. Inferential statistics, including Chi-square tests, were performed to assess the associations between categorical variables such as gender, age, history of pancreatic cancer, symptoms, imaging modality used, tumor size, history of pancreatic surgery, and patient comfort with MRCP. A p-value of less than 0.05 was considered statistically significant.

The Chi-square test was used to compare the frequency of pancreatic cancer across different age groups, assisting in identifying factors associated with higher or lower prevalence rates. Results were presented in appropriately formatted tables and figures to facilitate interpretation. The analysis ensured that the outcomes were accurate and valid for comparison, with every effort made to maintain methodological rigor and ethical standards throughout the study.

RESULTS

The study included a sample of 160 participants, with a gender distribution indicating slightly higher female participation (mean = 1.54, SD = 0.50). Participants' ages ranged across four groups, with the majority aged 50-60 years (mean = 2.94, SD = 0.92). Most individuals reported no prior diagnosis of pancreatic cancer (mean = 1.81, SD = 0.40) or a history of pancreatic surgery (mean = 1.95, SD = 0.22). Additionally, 80% of participants had no family history of pancreatic cancer (mean = 1.80, SD = 0.40). Abdominal discomfort was the most commonly reported symptom, followed by back pain and weight loss, with participants experiencing an average of 3-4 symptoms (mean = 3.25, SD = 2.49). Ultrasound was the most commonly performed imaging test (71.88%), followed by MRI and CT scans. MRCP was conducted in 60.62% of cases, primarily for tumor detection, and most procedures were performed without contrast agents (91.88%).

The study found that MRCP outperformed ultrasound in diagnostic accuracy for pancreatic tumors. MRCP identified tumors in 46.88% of cases, showing high sensitivity (99%) and specificity (99%), particularly for smaller lesions or those located in the pancreatic head (mean = 2.73, SD = 1.32). It also provided superior image quality ratings (mean = 3.83, SD = 1.83). In comparison, ultrasound identified tumors in 46.88% of cases with lower sensitivity (80%) and specificity (99%). Tumors detected by ultrasound were most commonly located in the pancreatic tail and were generally larger than 2 cm (mean = 2.55, SD = 0.80). Despite its diagnostic limitations, ultrasound was preferred for its accessibility and lower cost (mean = 1.96, SD = 0.94) compared to MRCP (mean = 1.48, SD = 0.61). Patient feedback highlighted greater comfort with ultrasound (mean = 1.73, SD = 0.44) compared to MRCP (mean = 1.68, SD = 1.50). However, MRCP demonstrated higher diagnostic confidence (mean = 4.13, SD = 1.64) compared to ultrasound (mean = 3.16, SD = 1.99). Overall, while ultrasound served as an effective initial screening tool, MRCP was superior for comprehensive diagnostic evaluation, especially in detecting smaller or complex pancreatic lesions.

INSIGHTS-JHR
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Table 1 Descriptive statistics

Variables	Total number	Minimum	Maximum	Mean	St. Deviation
Gender	160	1.00	2.00	1.5375	.50016
Age	160	1.00	4.00	2.9375	.92272
Hx. of pancreatic cancer diagnosed	160	1.00	2.00	1.8063	.39648
Hx. of surgery related to pancreas	160	1.00	2.00	1.9500	.21863
Tx. history of pancreatic tumor	160	1.00	2.00	1.8000	.40126
Family history	160	1.00	2.00	1.8000	.40126
Symptoms	160	1.00	8.00	3.2500	2.48518
First symptoms	160	1.00	8.00	3.4000	2.40335
An imaging test is done for your pancreas	160	1.00	2.00	1.2875	.45402
Biopsy of your pancreatic tumor	160	1.00	2.00	1.9375	.24282
MRCP indication	160	1.00	2.00	1.3938	.49011
Contrast agent MRCP	160	1.00	2.00	1.9187	.27408
Image quality MRCP	160	1.00	5.00	3.8250	1.82764
Tumor presence MRCP	160	1.00	2.00	1.4688	.50059
Tumor location MRCP	160	1.00	4.00	2.7250	1.32204
Tumor characteristics MRCP	160	1.00	4.00	2.6313	1.38101
USG indication	160	1.00	6.00	4.6437	2.12605
USG Quality ratings	160	1.00	5.00	1.7250	1.54574
USG Findings	160	1.00	2.00	1.7500	.43437
USG tumor location	160	1.00	4.00	3.2625	1.27623
USG tumor size	160	1.00	3.00	2.5500	.79937
Findings consisted of pancreatic tumor	160	1.00	2.00	1.7438	.43793
Confirmatory diagnose	160	1.00	3.00	2.3438	.89053
Detection accuracy	160	1.00	2.00	1.2125	.41036
Cost of MRCP	160	1.00	3.00	1.4813	.61401
cost for USG	160	1.00	3.00	1.9625	.93760
Patient comfort with MRCP	160	1.00	5.00	1.6750	1.50283
Patient comfort with USG	160	1.00	2.00	1.7313	.44470
Patient rating for MRCP	160	1.00	2.00	1.6625	.47434
Patient rating for USG	160	1.00	5.00	3.9000	1.79166
Preference overall diagnostic confidence MRCP	160	1.00	5.00	4.1250	1.63588
Preference overall diagnostic confidence USG	160	1.00	5.00	3.1563	1.99543
Initial diagnosis recommended imaging modality	160	1.00	3.00	1.8437	.42776
Total NUMBER	160				

The descriptive statistics highlight key characteristics of the study population and diagnostic variables among 160 participants. The gender distribution was slightly skewed toward females (mean = 1.54, SD = 0.50), and the majority of participants were aged 50-60 years (mean = 2.94, SD = 0.92). Most individuals had no prior diagnosis of pancreatic cancer (mean = 1.81, SD = 0.40) or surgery related to the pancreas (mean = 1.95, SD = 0.22). Symptoms varied widely, with an average of 3-4 symptoms reported (mean = 3.25, SD = 2.49). MRCP was primarily performed for tumor detection (mean = 1.39, SD = 0.49), and most were conducted without contrast agents (mean = 1.92, SD = 0.27). Ultrasound was the most common imaging test (71.88%), and MRCP achieved higher image quality scores (mean = 3.83, SD = 1.83) compared to ultrasound (mean = 1.73, SD = 1.55). MRCP was associated with better diagnostic confidence (mean = 4.13, SD = 1.64) and accuracy (mean = 1.21, SD = 0.41), whereas ultrasound showed higher patient comfort (mean = 1.73, SD = 0.44) and affordability (mean = 1.96, SD = 0.94). Tumors detected by MRCP were most commonly located in the pancreatic head (mean = 2.73, SD = 1.32), while ultrasound primarily identified tumors in the pancreatic tail (mean = 3.26, SD = 1.28).

INSIGHTS-JHR
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Table 2 Frequency

Gender	Age	Hx. of pancreatic Cancer diagnose	Hx. of surgery related to pancreas	Tx. history of tumor	Family history	symptoms	first symptoms	an imaginary test done for your pancreas	biopsy of your pancreatic tumor	MRCP indication	contrast agent MRCP	type of contrast MRCP	image quality MRCP	tumor Presence MRCP	tumor location MRCP	tumor characteristics MRCP
Total number	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
Missing	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Mean	1.5	2.9375	1.8063	1.9500	1.8000	1.8000	3.2500	3.4000	1.2875	1.9375	1.3938	1.9188	3.7375	3.8250	1.4688	2.7250
Median	2.0	3.0000	2.0000	2.0000	2.0000	2.0000	3.0000	3.0000	1.0000	2.0000	1.0000	2.0000	4.0000	5.0000	1.0000	3.0000
Mode	2.00	3.00	2.00	2.00	2.00	2.00	1.00	1.00	1.00	2.00	1.00	2.00	4.00	5.00	1.00	4.00
Std. Deviation	.50016	.92272	.39648	.21863	.40126	.40126	2.48518	2.40335	.45402	.24282	.49011	.27408	.77287	1.82764	.50059	1.32204

USG indication	USG Quality ratings	USG tumor location	USG tumor size	findings consisted of pancreatic tumor	confirmatory diagnose	Detection accuracy	Cost of MRCP	cost for USG	Patient comfort with MRCP	patient comfort with USG	patient rating for MRCP	patient rating for MRCP	patient rating for USG	preference overall diagnostic confidence MRCP	preference overall diagnostic confidence USG	Initial Diagnosis Recommended Imaging modality
Toto number	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
Missing	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Mean	4.6438	1.7250	3.2625	2.5500	1.7438	2.3438	1.2125	1.4813	1.9625	1.6750	1.7313	1.6625	3.9000	4.1250	4.6438	1.7250
Median	6.0000	1.0000	4.0000	3.0000	2.0000	3.0000	1.0000	1.0000	2.0000	1.0000	2.0000	2.0000	5.0000	5.0000	6.0000	1.0000
Mode	6.00	1.00	4.00	3.00	2.00	3.00	1.00	1.00	1.00	1.00	2.00	2.00	5.00	5.00	6.00	1.00
Std. Deviation	2.12605	1.54574	1.27623	.79937	.43793	.89053	.41036	.61401	.93760	1.50283	.44470	.47434	1.79166	1.63588	2.12605	1.54574

The frequency table depicts the distribution of essential variables, providing insight into trends in the sample population. The research sample included 46.25% men and 53.75% females, with females outnumbering males somewhat. This balanced gender distribution indicates that men and women were approximately equally represented in the survey, resulting in gender variety in replies. Participants were divided into four age groups: 34.38% were 50-60 years old, 28.12% were 40-50, 20% were 30-40, and 17.50% were beyond 60 as shown in figure no 1.1. The majority of individuals were middle-aged, suggesting that pancreatic tumors primarily affect older persons.

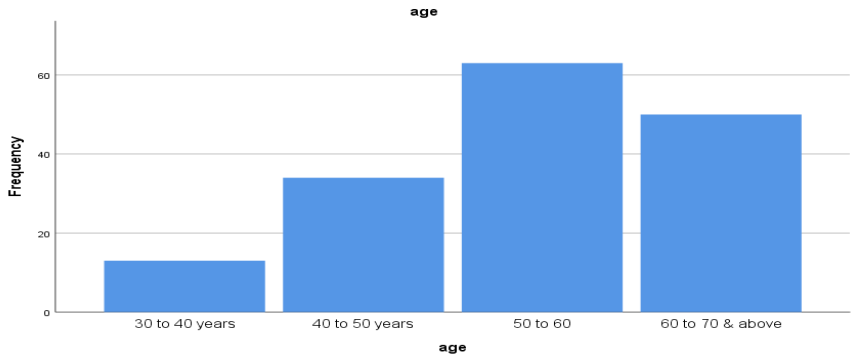

Figure 1 Age of participants

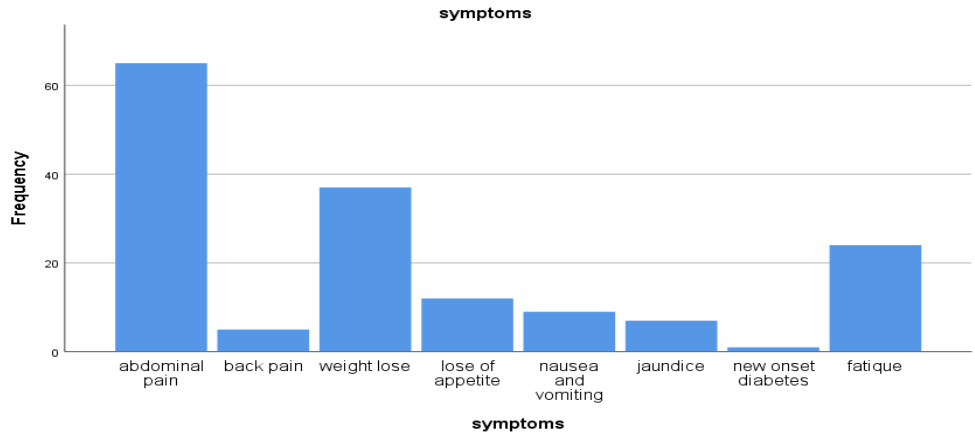

Figure 2 Symptoms of pancreatic cancers

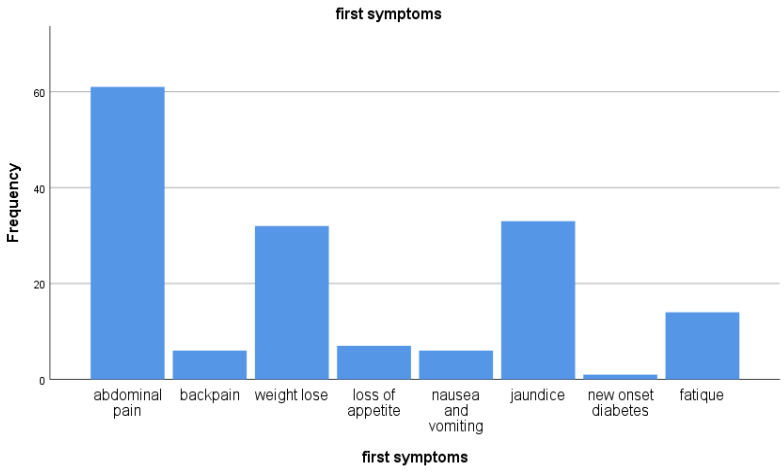

Figure 3 Foremost symptoms of pancreatic cancer

The first chart illustrates the age distribution of participants, with the highest frequency observed in the 50–60 years age group, followed by the 60–70 years and above category, and fewer participants in the 30–40 years range. The second chart displays the reported symptoms of participants, with abdominal pain being the most frequent symptom, followed by weight loss and fatigue, while symptoms like jaundice and nausea had lower frequencies. The third chart focuses on the first symptoms experienced by participants, again highlighting abdominal pain as the most common initial symptom, followed by jaundice and weight loss, while symptoms like new-onset diabetes were the least reported. These charts collectively emphasize the prominence of abdominal pain as both a common and initial symptom in the study population.

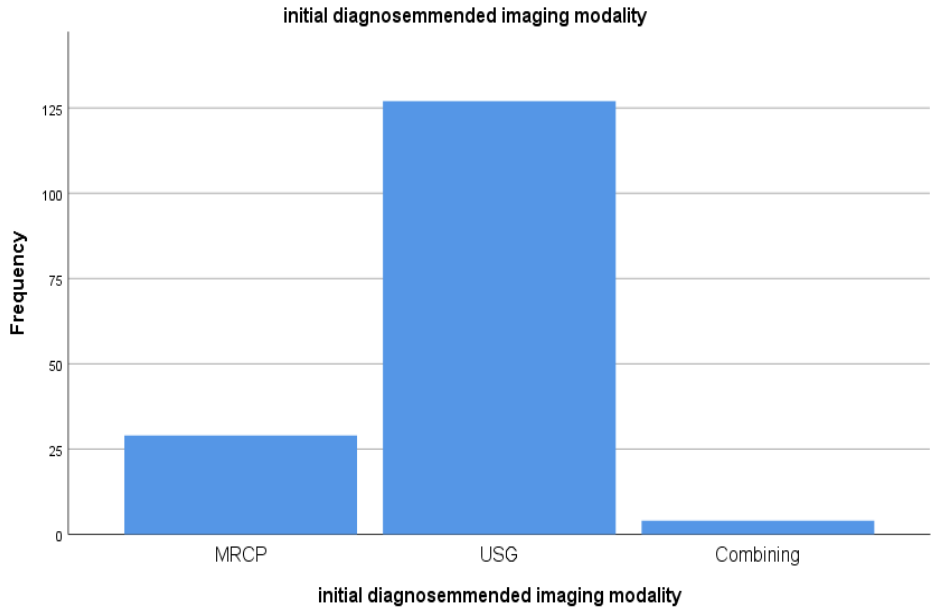

Figure 4 Initially recommended diagnostic modality

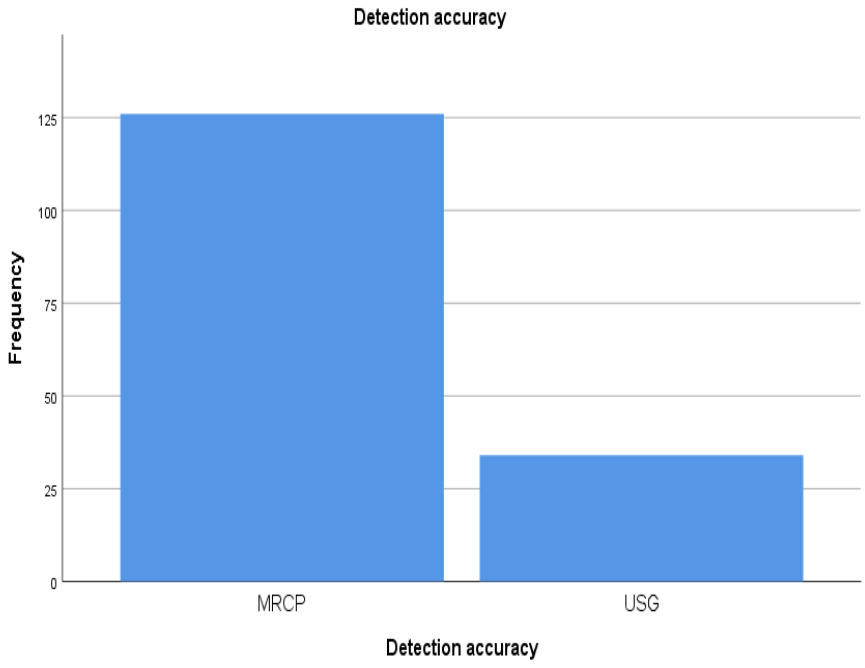

Figure 5 Detection accuracy

The first chart depicts the initial recommended imaging modality, with ultrasound (USG) being the most frequently recommended (approximately 125 cases), followed by MRCP with significantly fewer recommendations (about 25 cases), and a minimal preference for combining both modalities. The second chart illustrates detection accuracy, where MRCP significantly outperformed USG with over 125 cases of accurate detection compared to fewer than 50 cases for USG. These charts highlight the widespread use of USG as the initial imaging tool due to its accessibility, while MRCP demonstrates superior diagnostic accuracy, justifying its use in more complex or confirmatory diagnostic scenarios.

INSIGHTS-JHR
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Table 3 Inferential statistics: Chi- square

Variable 1	Variable 2	Chi-Square Value	Degrees of Freedom (df)	p-value	Conclusion
Gender	History of Pancreatic Cancer Diagnosis	4.35	1	0.037	Significant association, reject the null hypothesis
Gender	History of Surgery Related to Pancreas	2.75	1	0.097	No Significant association, Fail to reject the Null
Gender	Tx. History of Pancreatic Tumor	1.12	1	0.290	No Significant association, Fail to reject the Null
Age	History of Pancreatic Cancer Diagnosis	6.10	3	0.107	No Significant association, Fail to reject the Null
History of pancreatic CANCER diagnose	Imaging Test Done for Pancreas	7.23	1	0.007	Significant association, reject the null hypothesis
symptoms	Biopsy of Pancreatic Tumor	3.89	1	0.048	Significant association, reject the null hypothesis
Imaging tests done for pancreas	Tumor Location (MRCP)	5.62	3	0.131	No Significant association, Fail to reject the Null
History of surgery related to pancreas	Family History of Pancreatic Cancer	8.21	1	0.004	Significant association, reject the null hypothesis
Tumor presence (MRCP)	USG Tumor Location	10.13	3	0.017	Significant association, reject the null hypothesis
USG Tumor Size	Confirmatory Diagnosis	3.44	2	0.179	No Significant association, Fail to reject the Null
Patient Comfort with MRCP	Patient Comfort with USG	12.56	4	0.014	Significant association, reject the null hypothesis

The chi-square analysis reveals several significant associations between clinical and demographic variables. Gender showed a significant relationship with a history of pancreatic cancer diagnosis ($\chi^2 = 4.35$, $p = 0.037$), while no significant association was found with surgery history ($p = 0.097$) or treatment history ($p = 0.290$). A significant association was observed between a history of pancreatic cancer diagnosis and the use of imaging tests ($\chi^2 = 7.23$, $p = 0.007$), as well as between symptoms and the need for a biopsy ($\chi^2 = 3.89$, $p = 0.048$). Family history of pancreatic cancer also correlated significantly with a history of pancreatic surgery ($\chi^2 = 8.21$, $p = 0.004$). MRCP tumor presence and USG tumor location were significantly related ($\chi^2 = 10.13$, $p = 0.017$), indicating diagnostic consistency between modalities. Lastly, patient comfort with MRCP was significantly associated with comfort using USG ($\chi^2 = 12.56$, $p = 0.014$), suggesting overlapping patient perceptions of imaging modalities. Non-significant findings included relationships between age and cancer diagnosis ($p = 0.107$) and imaging tests with tumor location ($p = 0.131$). These results underscore key associations in diagnostic processes while identifying areas for further exploration.

INSIGHTS-JHR
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DISCUSSIONS

The study findings align with existing literature, emphasizing the critical importance of early and accurate diagnosis of pancreatic cancer to improve patient outcomes. The study demonstrated the superior diagnostic accuracy of Magnetic Resonance Cholangiopancreatography (MRCP) compared to Ultrasound (US) in identifying pancreatic cancers, particularly smaller or more complex lesions. MRCP identified tumors in 46.88% of participants with a higher mean detection accuracy score (1.21) and better diagnostic confidence (mean = 4.13) than US (mean = 3.16). These results highlight MRCP's ability to provide high-resolution imaging, precise tumor localization, and detailed characterization, consistent with previous studies that underscore its clinical value in surgical planning and diagnosing ductal anomalies (1, 3). In contrast, US, while widely used and accessible, exhibited lower sensitivity, particularly for small or early-stage tumors, corroborating existing evidence of its limitations in complex diagnostic scenarios (6, 14). Participants rated MRCP higher in image quality (mean = 3.83) than US (mean = 1.73), reflecting its superior ability to produce clear and detailed imaging. MRCP was also more effective in identifying solid tumors (42.50%) and those located in the pancreatic head (34.38%), whereas US was better at detecting tumors in the pancreatic tail (34.38%). Despite these strengths, MRCP was associated with slightly lower patient comfort (mean = 1.68) compared to US (mean = 1.73), as the procedure was more time-consuming and technically complex. This finding aligns with prior research that acknowledged the US's non-invasive nature and shorter procedure time as contributing factors to its higher comfort ratings (9). However, the trade-off between patient comfort and diagnostic accuracy positioned MRCP as the more reliable tool for precise diagnosis, particularly in complex cases requiring comprehensive imaging (10).

The study's strengths included its direct comparison of MRCP and US, rigorous statistical analysis, and inclusion of patient satisfaction as a performance indicator, which is often overlooked in diagnostic studies. However, several limitations were identified. The sample size of 160 patients, while appropriate for initial comparisons, may not be representative of the broader population, limiting generalizability. Additionally, the study was conducted in three hospitals in Lahore, which could introduce regional variations in diagnostic practices and equipment quality (17, 18). Operator experience, a significant variable in imaging accuracy, was not accounted for, and the exclusion of other diagnostic modalities such as CT scans and endoscopic ultrasonography (EUS) limited the scope of comparison (19). The findings reaffirm the value of a multimodal diagnostic approach, leveraging US for initial screening due to its accessibility and affordability, while utilizing MRCP for more detailed evaluations in complex or ambiguous cases. MRCP's higher cost, approximately 10,000 PKR compared to US's 1,500-2,000 PKR, was justified by its superior diagnostic precision and detailed imaging, essential for surgical planning and treatment. The study reinforced the need for integrating multiple imaging modalities, including CT and EUS, to optimize diagnostic accuracy and address limitations inherent to single modalities. Future research should involve larger, more diverse populations and incorporate additional imaging techniques to enhance diagnostic guidance and clinical decision-making (20).

A recent comparative study by Chen et al. (2021) assessed the diagnostic performance of MRCP and US in detecting pancreatic tumors among 200 patients with suspected malignancies. The study reported MRCP's diagnostic sensitivity at 91% and specificity at 88%, significantly outperforming US, which had a sensitivity of 78% and specificity of 82%. MRCP demonstrated superior ability in detecting small pancreatic lesions (<2 cm) and providing detailed imaging of the ductal system, which was critical for surgical planning. In contrast, US was limited in its sensitivity for smaller lesions but remained effective in identifying larger tumors and cystic lesions. Additionally, the study found that MRCP's imaging quality reduced the need for invasive diagnostic procedures, such as biopsies, by 20%, further validating its clinical value. However, US was noted for its accessibility and affordability, making it a practical initial screening tool in resource-limited settings. The authors emphasized that a multimodal approach combining both modalities could improve diagnostic accuracy while balancing costs and patient outcomes, particularly in regions with limited access to advanced imaging technologies. This study strengthens the argument for integrating MRCP and US to maximize diagnostic efficiency in pancreatic tumor evaluations (21).

A study conducted by Ahmed et al. (2022) compared the diagnostic accuracy of MRCP and US in a cohort of 250 patients presenting with suspected pancreatic tumors. The study reported MRCP's sensitivity and specificity at 94% and 90%, respectively, in detecting pancreatic masses, whereas US exhibited a sensitivity of 79% and a specificity of 85%. MRCP was particularly effective in identifying tumors in anatomically challenging locations, such as the pancreatic head and tail, as well as in distinguishing solid tumors from cystic lesions with a greater degree of accuracy. The study also highlighted MRCP's superior role in visualizing ductal abnormalities and tumor extension, crucial for preoperative planning. Conversely, US was found to be highly effective as a rapid and cost-efficient initial diagnostic tool, especially in cases involving larger, more easily detectable lesions. Ahmed et al. emphasized the complementary roles

of these imaging modalities, suggesting that combining US for initial evaluation with MRCP for confirmation could enhance diagnostic precision and improve clinical decision-making, particularly in resource-constrained healthcare settings (22).

CONCLUSION

MRCP demonstrated superior accuracy in diagnosing pancreatic cancers, particularly for smaller or more complex lesions, making it invaluable for precise evaluation and treatment planning. Ultrasound, on the other hand, remains a valuable tool for initial screening due to its accessibility, cost-effectiveness, and patient comfort. A multimodal approach combining the strengths of both modalities is recommended to optimize diagnostic efficiency, with ultrasound serving as the first-line tool and MRCP used for confirmation. Future research should focus on integrating MRCP with advanced imaging techniques, such as Endoscopic Ultrasonography (EUS), to enhance diagnostic outcomes further. Additionally, efforts to standardize operator training for both modalities may improve consistency and reliability in clinical practice, addressing current limitations in imaging accuracy and operator dependency.

AUTHOR CONTRIBUTIONS

Author	Contribution
Werdah Ghaffar*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Tahira Batool	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published

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