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Diagnostic Accuracy of Ultrasonography in Detecting Biliary Ascariasis Taking Surgery as Gold Standard

Original Article

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ARTICLE INFORMATION

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ABSTRACT

Background: Biliary ascariasis, caused by the intestinal parasite *Ascaris lumbricoides*, is a diagnostic challenge due to its varied clinical manifestations. This study evaluates the effectiveness of ultrasonography as a non-invasive diagnostic tool for detecting biliary ascariasis, using surgical findings as the gold standard.

Objective: To assess the diagnostic accuracy of ultrasonography in identifying biliary ascariasis.

Methodology: This cross-sectional analytical study was conducted over 4 months at Pak City Diagnostic Centre D.G Kahn, analytical study employed non-probability purposive sampling. The study included 127 patients of all ages and genders presenting with symptoms indicative of biliary ascariasis and who had undergone surgery in the past year. Exclusion criteria were cholecystectomy history, pregnancy, lactation, or suspected biliary malignancy. Ultrasound imaging was performed using GE Logiq P7 convex probe.3.5-5MHz

Results: Of the 127 participants, 57.5% were male and 42.5% female. Common symptoms included abdominal pain (88.2%), jaundice (68.5%), vomiting (66.1%), and diarrhea (66.9%). Observations of worms occurred in 70.9% of patients. Ultrasound findings correlated with surgical results in 98.3% of cases. Diagnostic metrics demonstrated a sensitivity of 98.33%, specificity of 71.43%, and an area under the curve (**AUC**) of 0.849, confirming high diagnostic accuracy.

Conclusion: The study highlights ultrasonography as a highly sensitive and specific diagnostic tool for biliary ascariasis. Its reliability and accuracy, comparable to surgical findings, support its role as a valuable, non-invasive method for diagnosing this condition.

Introduction:

Ascariasis is a parasitic infection caused by the nematode *Ascaris lumbricoides*, which is among the most prevalent human helminth infections globally. Affecting nearly one billion individuals annually, this disease results in over 60,000 deaths each year. The adult worms primarily inhabit the jejunum, and their lifecycle involves a unique process of larval migration through the host's lungs before reaching full maturity in the intestines. Transmission occurs through the ingestion of embryonated eggs present in contaminated food or water. This neglected tropical disease thrives in regions with poor sanitation and hygiene, such as Sub-Saharan Africa, East Asia, Latin America, and other tropical and subtropical areas, highlighting its direct correlation with socioeconomic disparities [2, 11, 14].

The worm's exhibit sexual dimorphism, with adult females reaching lengths of 20–30 cm and males 15–20 cm. Female worms are prolific, laying up to 200,000 eggs per day, which exit the host in feces and can remain viable in moist soil for extended periods. The eggs develop into infectious larvae within two to eight weeks under favourable conditions. Upon ingestion, the larvae hatch in the duodenum, infiltrate the intestinal mucosa, and traverse the circulatory system to the lungs. Upon maturation, they return to the digestive tract, therefore finishing their lifetime. This cyclical process highlights the significance of environmental pollution in sustaining infection cycles, especially in endemic regions with insufficient waste management and the application of untreated human excrement as fertilizer.[1, 14, 24].

Ascariasis is both a historical health concern and one with ancient origins, evidenced by findings in Egyptian mummies and accounts in early medical writings by Hippocrates and Aristotle. Notwithstanding its historical connection to human populations, contemporary instances reveal that the illness continues to be a significant concern. Urbanization and globalization have facilitated its proliferation, as travel and migration enable infections to occur even in non-endemic regions. This has underscored the necessity for extensive public health initiatives to tackle both local and global threats. [11, 23].

Clinically, ascariasis manifests a range of symptoms from minor gastrointestinal distress, including nausea, abdominal pain, and diarrhea, to serious consequences. This encompasses intestinal blockages, volvulus, and appendicitis resulting from the physical presence of mature worms. In instances of significant larval migration, patients may exhibit Loffler syndrome, a type I hypersensitivity reaction marked by eosinophilic pneumonitis, fever, and respiratory manifestations. Chronic infections, especially in children, may result in malnutrition, impaired growth, and developmental setbacks. Additionally, superinfections can lead to biliary and pancreatic problems, such as cholangitis, pancreatitis, and hepatic abscesses. [10, 13, 24].

Diagnostic techniques have evolved, with stool examinations for eggs remaining the gold standard. Imaging modalities such as ultrasound and computed tomography (CT) scans play a pivotal role in detecting biliary and intestinal involvement. The "four-line sign" observed on ultrasound is a characteristic finding for biliary ascariasis. Advanced tools like endoscopic

retrograde cholangiopancreatography (ERCP) provide both diagnostic and therapeutic benefits, especially for cases with severe complications. However, ultrasonography remains the first-line diagnostic tool due to its non-invasive nature and accessibility [16, 25].

Ascariasis treatment involves anthelmintic agents such as mebendazole, albendazole, and pyrantel pamoate, which effectively eliminate parasites. Surgical or endoscopic procedures may be necessary in instances of problems, especially when worms impede bile or pancreatic conduits. Preventive measures, such as enhanced sanitation, education on hygiene habits, and access to potable water, are essential for alleviating the illness load. The widespread global occurrence of ascariasis, estimated to harm up to 25% of the global population, highlights its designation as a critical public health issue and necessitates focused measures to alleviate its effects.[9, 16, 25].

This overlooked tropical disease illustrates the convergence of biology, public health, and socioeconomic factors. The worldwide distribution, historical importance, and many clinical manifestations underscore the necessity for a multidisciplinary strategy for its management. Improved diagnostic capabilities, along with strong public health activities, provide optimism for alleviating the burden of ascariasis and enhancing health outcomes for impacted people globally.[23, 25].

Material & Methodology:

This cross-sectional analytical study was conducted at Pak City Diagnostic Centre, D.G. Khan, over a 04-month period. A total of 127 patients with symptoms of biliary disease who had undergone surgery for biliary ascariasis within the past year were included. Inclusion criteria encompassed patients of any age and gender presenting with symptoms suggestive of biliary disease. Patients with conditions that could affect the accuracy of ultrasound imaging, such as severe obesity, cholecystectomy, pregnancy, or known or suspected biliary tract malignancies, were excluded. Ultrasonography was performed using a GE Logiq P7 convex probe (3.5–5 MHz), and findings were compared with surgical outcomes. Ethical approval for the study was obtained from the institutional review board, and informed consent was secured from all participants. Statistical analyses, including sensitivity, specificity, and predictive values, were conducted using SPSS (Version 25). Chi-square tests were performed to assess the correlation between ultrasonographic and surgical findings, with p-values less than 0.05 considered statistically significant.

Results:

The study included 127 participants, with 73 males (57.5%) and 54 females (42.5%). The most commonly reported symptoms included abdominal pain (88.2%), severe jaundice (68.5%), and vomiting (66.1%). Ultrasound findings indicated the presence of worms in the duodenum in 70.9% of cases. A strong correlation was observed between ultrasonographic findings and surgical results, with 98.3% concordance ($p < 0.001$).

Table 1: Gender and Age distribution

Gender		
	Frequency	**Percent**
Male	73	57.5
Female	54	42.5
Total	127	100.0
Age < 30	45	35.5
Age ≥ 30	82	64.5
Total	127	100.0

Table.01 Gender distribution in the study population of 127 individuals is presented in the table. Out of the total participants, 73 (57.5%) were male, and 54 (42.5%) were female.

The diagnostic performance metrics were as follows: sensitivity, 98.33%; specificity, 71.43%; positive predictive value, 98.33%; negative predictive value, 71.43%; and an overall accuracy of 96.85%.

Table 2 : Distribution of jaundice severity based on bilirubin levels

Jaundice		
	Frequency	Percent
0.3-1.2mg/dl (normal)	18	14.2
1.2-2.9mg/dl (mild jaundice)	2	1.6
3.0-5.9mg/dl (moderate jaundice)	20	15.7
6.0 or >6,0 mg dl (severe)	87	68.5
Total	127	100.0

The distribution of jaundice severity among the 127 individuals in the study based on bilirubin levels. The categories include normal (0.3-1.2mg/dl), mild jaundice (1.2-2.9mg/dl), moderate jaundice (3.0-5.9mg/dl), and severe jaundice (6.0 mg/dl or higher).

In the "Frequency" column, it shows the number of participants in each jaundice severity category. The majority, 87 individuals (68.5%), exhibited severe jaundice, while the other categories had fewer participants.

The "Percent" column provides the percentage of participants in each category relative to the total sample size. Severe jaundice represents the highest percentage at 68.5%.

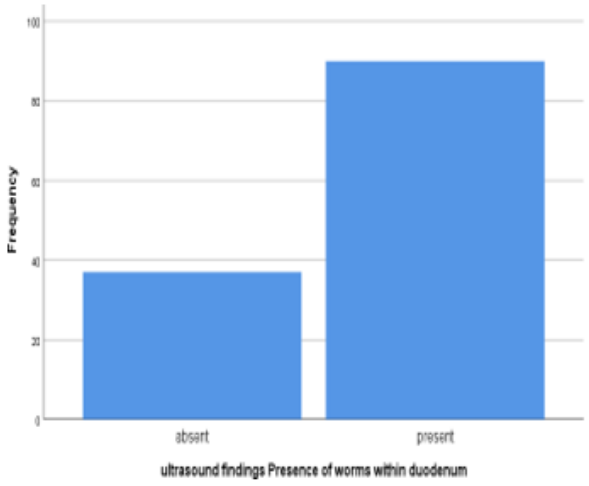

Figure 1: Ultrasound Detection of Worms Within the Duodenum

Ultrasound findings regarding the presence or absence of worms within the duodenum for the 127 individuals in the

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study. Among the participants, 29.1% did not exhibit ultrasound evidence of worms, while the majority, constituting 70.9%, showed positive ultrasound findings indicating the presence of worms within the duodenum.

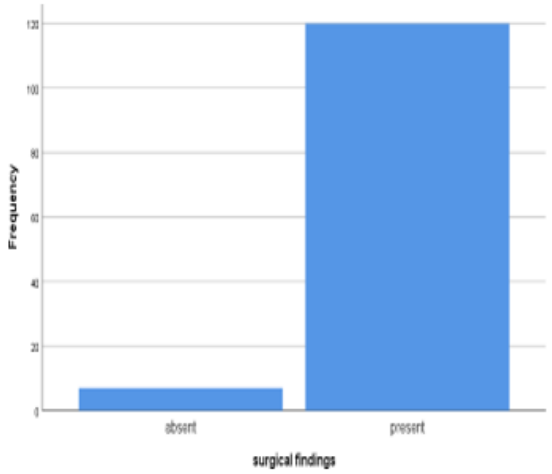

Figure 2: Distribution of surgical findings among 127 study participants.

The surgical findings among the 127 individuals in the study. Of the total participants, 5.5% had no reported surgical findings, while a significant majority, accounting for 94.5%, presented with positive surgical findings.

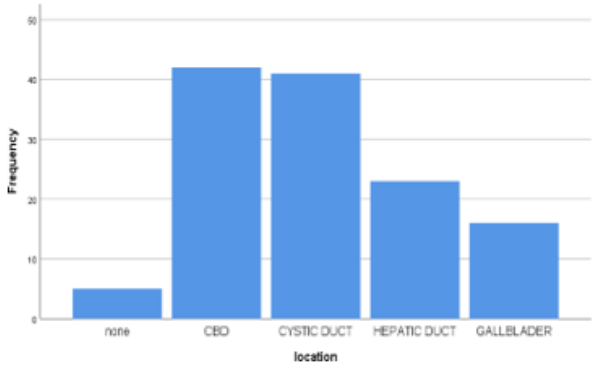

Figure 3: The anatomical locations of dilated bile ducts detected via ultrasound

The presence or absence of dilated bile ducts among the 127 individuals in the study. Thirty- eight-point six percent (38.6%) of participants exhibited the absence of dilated bile ducts, while the majority, constituting 61.4%, showed positive ultrasound findings indicating the presence of dilated bile ducts.

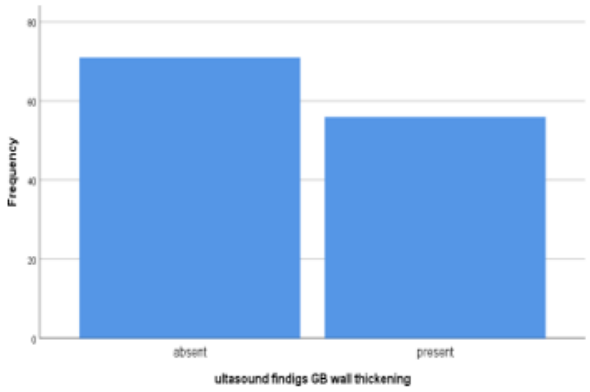

Figure 4: Ultrasound findings related to gallbladder (GB) wall thickening

Ultrasound findings related to gallbladder (GB) wall thickening among the 127 individuals in the study. Fifty-five point nine percent (55.9%) of participants displayed the absence of GB wall thickening, while 44.1% exhibited positive ultrasound findings indicating the presence of GB wall thickening.

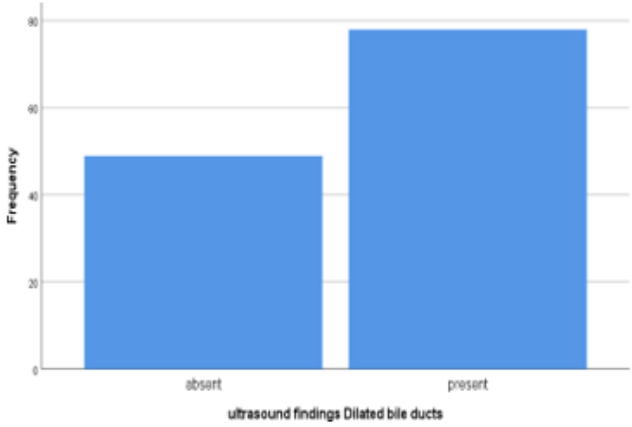

Figure 5: Ultrasound detection of dilated bile ducts

The existence or nonexistence of dilated bile ducts in the 127 participants of the research. Thirty-eight point six percent (38.6%) of subjects demonstrated the lack of dilated bile ducts, whereas the majority, comprising 61.4%, revealed positive ultrasonography results indicative of dilated bile ducts.

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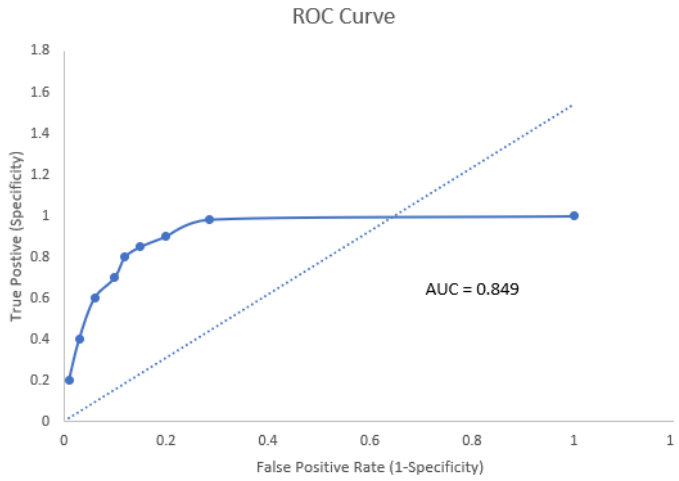

Figure 6: ROC curve illustrating the diagnostic accuracy of ultrasonography

The ROC curve demonstrates strong diagnostic performance of ultrasonography in detecting biliary ascariasis, with an AUC of 0.849 indicating good accuracy. The curve shows a steep rise toward the top-left corner, reflecting high sensitivity and low false positive rates. This supports ultrasonography as a reliable, non-invasive tool for clinical diagnosis compared to surgical findings

Discussion:

This study's findings indicate that ultrasonography is an exceptionally excellent diagnostic instrument for identifying biliary ascariasis, with a sensitivity of 98.33%, specificity of 71.43%, and an overall accuracy of 96.85%. Of the 127 individuals, ultrasonography detected worms in 70.9% of instances and demonstrated a robust concordance with surgical results in 98.3% of cases, exhibiting a statistically significant connection ($p < 0.001$). The elevated positive predictive value of 98.33% highlights the dependability of ultrasonography in verifying biliary ascariasis when clinical suspicion is significant. Despite its superior diagnostic accuracy, limitations such as operator reliance and decreased specificity provide obstacles in ruling out negative instances, particularly in patients with confounding variables such as obesity or intestinal gas interference. Additionally, the moderate specificity (71.43%) despite high sensitivity may be due to false-positive findings from artifacts, biliary sludge, or misinterpreted echogenic structures resembling worms. These factors highlight the potential for diagnostic overlap, necessitating cautious interpretation by trained radiologists, particularly in resource-limited or high-prevalence settings.

These findings align with the literature highlighting the diagnostic efficacy of ultrasonography for biliary ascariasis. Khuroo et al. thoroughly detailed the distinctive sonographic characteristics of biliary ascariasis, notably the "spaghetti sign," which denotes the emergence of elongated, echogenic structures indicative of worms inside the biliary system. Their research highlighted ultrasonography's capacity to identify worm movement in real-time, a conclusion that aligns with this study, which showed a strong correlation between ultrasonography and surgical outcomes. Furthermore, the sensitivity obtained in Khuroo's study closely corresponds with the 98.33% sensitivity identified in our research, therefore reinforcing the validity of ultrasonography as a dependable diagnostic instrument.

Anand et al. emphasized that ultrasonography is the most effective diagnostic technique for hepato-pancreato-biliary ascariasis, surpassing stool analysis and endoscopy. Their research highlighted ultrasonography's capacity to detect biliary blockages and monitor worm movements, a significant diagnostic benefit in resource-constrained environments. The constraints identified in their work, including the challenge of visualizing tiny or deeply situated worms, were also evident in our investigation and led to decreased specificity (71.43%).

Anand et al. emphasized the significance of ultrasound in tracking patient improvement, a viewpoint that corresponds with our findings, since ultrasonography's non-invasive and reproducible characteristics render it appropriate for follow-up assessments.

Unlike the invasive and resource-demanding characteristics of endoscopic retrograde cholangiopancreatography (ERCP), ultrasonography is a cost-efficient and readily available alternative, especially in endemic areas. Although ERCP offers diagnostic and therapeutic advantages, as noted by Parida et al., its accessibility is constrained in low-resource environments, hence emphasizing the need of ultrasonography as a primary diagnostic instrument. Ultrasonography's capacity to detect real-time worm movement, identify problems such biliary sludge, and offer excellent sensitivity renders it essential for diagnosing biliary ascariasis.

This study's findings corroborate and enhance previous studies, notably those of Khuroo et al. and Anand et al., highlighting the essential function of ultrasonography in identifying biliary ascariasis. Despite drawbacks including diminished specificity and operator reliance, the non-invasive characteristics and high diagnostic precision of ultrasonography render it an invaluable asset in resource-constrained environments. These findings endorse its application as a main diagnostic tool while promoting a multimodal strategy in intricate situations to improve overall diagnostic accuracy.

Conclusion:

The study's findings indicate that ultrasonography is a dependable diagnostic instrument for biliary ascariasis. Ultrasonography exhibits high sensitivity and moderate specificity, showing strong concordance with surgical findings. While surgery remains the gold standard, ultrasound offers a dependable, non-invasive diagnostic alternative, particularly valuable in resource-constrained environments.

The study is clinically relevant, methodologically sound in core design, and well-situated within the literature.

Limitations & Recommendations:

The study exhibited numerous shortcomings, notably a demographic imbalance with a 73% male preponderance, which diverges from previous studies, potentially attributable to geographic and sampling discrepancies, hence constraining generalizability. The emphasis on a specific demographic and dependence on surgical outcomes omitted less severe patients and generated selection bias. The variability in clinical manifestations relative to previous research indicates the necessity for a more comprehensive examination of the illness spectrum. The focus on surgical results neglected the

effectiveness of non-surgical therapies such as mebendazole. Operator reliance in ultrasonography adversely impacted repeatability, underscoring the necessity for standardization.

Future study ought to encompass varied groups to enhance generalizability and rectify gender disparities. Comparative analyses of conservative therapies such as mebendazole against surgical results are essential to enhance management methods and reduce superfluous procedures. Examining milder or asymptomatic instances would enhance comprehension of the illness spectrum and affirm the efficacy of ultrasonography in early identification. Standardized ultrasound methods and comparison analyses with other modalities, such as CT or MRCP, can improve diagnosis accuracy. Longitudinal research and the integration of epidemiological data are advised for thorough understanding, while operator training programs are crucial to maintain constant accuracy in healthcare environments. Implementing these techniques will enhance the diagnosis and management of biliary ascariasis.

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CONFLICT OF INTEREST

Authors declared no conflict of interest, whether financial or otherwise, that could influence the integrity, objectivity, or validity of their research work.

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DATA SHARING STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request

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