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Accuracy of Ultrasound and Magnetic Resonance Cholangiopancreatography Findings in the Diagnosis of Biliary System Stones

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ABSTRACT

This study aimed to evaluate the diagnostic accuracy of magnetic resonance cholangiopancreatography (MRCP) and Ultrasound (US) images for the diagnosis of biliary system stones, as well as to assess the consistency between MRCP and US findings. The study sample included 200 cases (90 males and 110 females) with symptomatic biliary system stones between 14 and 82 years. All cases underwent both the US and MRCP imaging for biliary system diagnosis. The study revealed that the most prominent age group with symptoms of biliary system stones was the 33-60-year-old group. It also found that the accuracy of US and MRCP in detecting gallbladder (GB) stones compared with the final diagnosis was 94% and 91%, respectively, with moderate conformity between their results. The accuracy of US and MRCP images in detecting common bile duct (CBD) stones was 61% and 98%, respectively, with fair conformity between their results. In addition, there is a significant agreement between the MRCP and US results in detecting the GB and CBD stones with an agreed percentage of 74% and 71%, respectively. The study concluded that US is the preferred imaging technique for patients with symptomatic gallbladder stones, whereas MRCP is a trustworthy investigation for common bile duct stones.

Keywords: Accuracy, biliary system stones, diagnosis, MRCP, ultrasound

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INTRODUCTION

The biliary system stones (gallbladder and common bile duct stones) need a specific diagnosis and accurate technique because of the overlapping signs and symptoms. Thus, medical imaging modalities play a key role in establishing biliary lithiasis diagnoses and formulating an ideal treatment (Peixoto et al., 2019).

Some common clinical problems caused by biliary stones, especially in patients older than 60 years, can cause serious clinical complications, such as pancreatitis and acute cholangitis (Alkarboly et al., 2016; Chan et al., 2013). For example, CBD stones were estimated for 10 to 20% of cases with symptomatic gallstones and can cause some health problems, such as infection, jaundice, pain, and acute pancreatitis (Williams et al., 2017). Moreover, gallstones are associated with a higher risk of gastrointestinal cancer (Pang et al., 2021).

Biliary stones are prevalent in women compared to men (Kratzer et al., 2021). Besides, gallbladder (GB) stone is more prevalent in obese patients and associated with upper abdominal pain, nausea, and vomiting in some cases (Kichloo et al., 2021). Costi et al. (2014) mentioned that the biliary stones are collected from the bile salts, cholesterol component, or black pigment. The primary common bile duct stones are formed inside the common bile duct, whereas the secondary common bile duct stones are formed in the gallbladder and migrated to the common bile duct (Williams et al., 2008). While 5% -30% of biliary stones are combined with choledocholithiasis (Wu et al., 2021).

Many researchers have reported that computed tomography can help in detecting GB stones, especially with difficult and inconclusive cases or GB perforation, and is still recommended for abdominal pain evaluation, only if the diagnosis is uncertain (Harraz & Abouissa, 2020; Danse et al., 2018; Wertz et al., 2018). On the contrary, a CT scan is less accurate than ultrasound (US) imaging in detecting biliary stones and debatably the most effective for diagnosing gallbladder condition, especially for gallstone ileus and pancreaticobiliary tract evaluation (Veronica et al., 2019; Alshargi et al., 2018).

Ultrasound imaging is the investigation of choice in confirming or excluding dilated bile ducts, cysts, and calcifications (Liu et al., 2012). In addition, ultrasound should be a valuable first-line imaging modality of choice for biliary system stones diagnosis due to its inherent superiority compared to other imaging modalities. For patients with suspected CBD stones, trans-abdominal US imaging is recommended (Williams et al., 2017). Despite that, US imaging is a highly operator-dependent modality, and difficult to standardize its' findings. Some studies (De Silva et al., 2019; Gurusamy et al., 2015; Şurlin et al., 2014) have revealed varied accuracy of US regarding the detection of common bile duct stones ranging between 44% and 90%.

On the other hand, MRCP imaging (Magnetic resonance imaging for bile duct, gallbladder, and pancreatic duct) is a non-invasive technique to evaluate the pancreatic

ductal system and hepatic biliary tree without ionizing radiation or iodinated contrast material and can provide the diagnostic range equivalent to the endoscopic retrograde cholangiopancreatography (Getsov et al., 2020). MRCP diagnostic performance has proved to be a convenient imaging technique for biliary diseases diagnosis and a valuable alternative to endoscopic retrograde cholangiopancreatography (ERCP) without the risks associated with these procedures. MRCP imaging exploits the biliary and pancreatic ducts fluid as a contrast agent by acquiring MR images using T2 weighted sequences (Griffin et al., 2012).

Many studies have investigated the accuracy of MRCP imaging in the diagnosis of the biliary system; for instance, some studies (Goud et al., 2020; Veronica et al., 2019; Virzì et al., 2018) have stated that MRCP is a highly accurate diagnostic modality in establishing the diagnosis of obstructive biliary pathologies, allowing a detailed evaluation of the biliary and pancreatic ducts, and providing excellent anatomical imaging in both normal and pathologic conditions with the advantage of the improved biliary system for stone detection without ionizing radiation.

Akkuzu et al. (2020) stated that the sensitivity of MRCP for choledocholithiasis detection was 81.5%, other studies have documented vary accuracy rate for MRCP in the diagnosis of biliary system stones and pathologies which ranged between 86.4% and 100% (Yahya et al., 2021; Agha et al., 2018; Giljaca et al. 2015; Limanond et al., 2004; Figueras et al., 2000).

In contrast, some other studies have reported several limitations which may mask various pathologic conditions of the pancreatic or extrahepatic bile duct (Williams et al., 2017; Maccioni et al., 2010).

This research aimed to evaluate the accuracy of US and MRCP modalities in detecting the biliary system stones and estimate the agreement between US and MRCP results. Results of this research can provide updated guidance to specialized professionals with valuable information about the role of US and MRCP modalities in diagnosing biliary system stones to choose the best modality.

MATERIALS AND METHODS

This study was conducted on patients with symptomatic biliary system stones referred to the radiology department at the University of Science and Technology Hospital in Sana'a city, Yemen. A prospective review of 200 cases (90 males and 110 females) suspected of having biliary system stones (gallbladder (GB) stones and common bile duct (CBD) stones). The study's participants are aged between 14–82 years. They all underwent US and MRCP exams for biliary lithiasis diagnosis during the same period (less than one week) for each.

US imaging technique uses high-frequency sound waves to characterize tissue. In the initial examination of the gallbladder and bile ducts, abdominal US imaging was used for

all selected patients. The high-frequency US probe (2-7 MHz) was used to gain adequate penetration.

On the other hand, MRCP with a 1.5 Tesla system was performed for all selected patients fasting for five hours before the examination. As a result, the MRCP imaging technique has high contrast resolution, different plans, and an artifact-free display of anatomy and pathology.

Two radiologists independently reviewed the MRCP and US images to determine the absence or presence of GB and CBD stones. The results of US and MRCP images in the detection of biliary system stones were correlated with the final diagnosis and operative findings as a standard reference. In addition, the diagnostic accuracy of both imaging modalities was compared to assess the agreement between their results.

Ethical Consideration

The ethical approval for conducting this study was obtained from the Medical Research Ethics Committee of the University of Science and Technology, Yemen (MECA No.: EAC/UST202).

RESULTS AND DISCUSSION

The findings of this study showed that the biliary system stones were more frequently occurred among females (55%) than males (45%). Figure 1 shows the classification of the study sample according to gender.

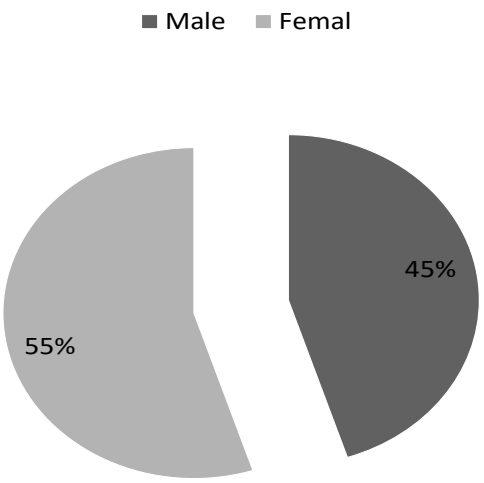

Figure1. Distribution of suspected biliary stones cases according to gender

According to Wu et al. (2021), women are more likely to develop biliary system stones, associated with higher estrogen levels and less exercise.

Regarding age, the mean age of the study sample was 50.2 years, and the predominant age of patients with biliary system stones symptoms was the 33–60 years group. Table 1 shows the classification of the study sample according to age group.

Table 1

Distribution of ages for suspected biliary stones cases

Age (yrs.)	N	%
<33	32	16%
33–60	110	55%
>60	58	29%
Total	200	**100%**

The findings of this study are relatively in line with Kolomiytsev et al. (2019), who reported that the mean age of patients suspected of having choledocholithiasis was 56.4±15.11 years and ranged from 19 to 87.

GB Stones Diagnosis using MRCP and US Imaging

From 200 cases with cholelithiasis symptoms, gallstones were more detected by US (76%) than MRCP (74%), as shown in Figure 2.

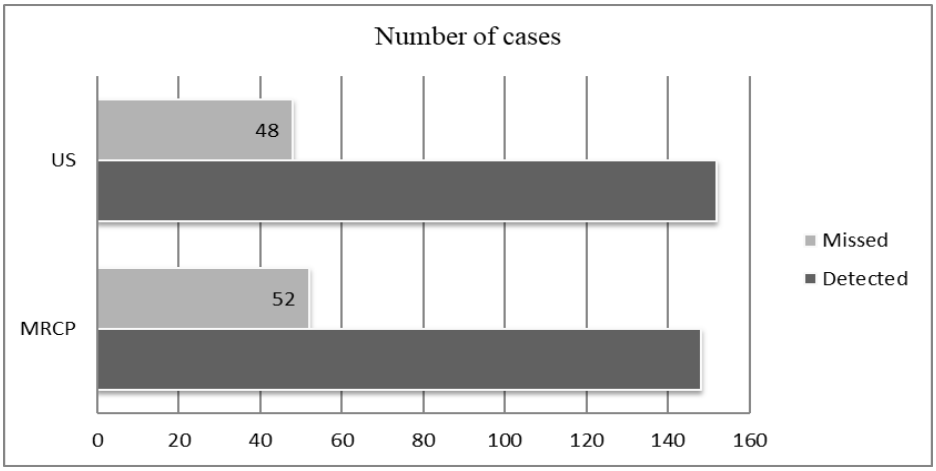

Figure 2. MRCP and US findings for suspected gallbladder stones cases

US imaging showed more sensitivity to detect gallbladder (GB) stones with an accuracy of 94% as well as a positive predictive value over 98% when correlated with the final diagnosis and operative findings. This finding appeared to be better than that reported by Pinto et al. (2013), who revealed high sensitivity of US (88%) in detecting GB stones in patients with suspected acute calculous cholecystitis. Because gallbladder stones are likely to be surrounded by the bile and can be detected by the US accurately, the US is an initial imaging technique for the GB stones diagnosis. This finding is in line with that of Ahmed and Diggory (2011), who documented the superiority of the US in cholelithiasis diagnosis.

In contrast, negative results may be referred to as gallstones with small size (less than 2 mm) because they may not be readily detectable on US imaging or because gallstones that impact the gallbladder's neck may be silhouetted with the surrounding intraperitoneal fat or echogenic bowel gas. This finding is consistent with Rubens (2007), who stated that ultrasound is a primary imaging modality for the initial diagnosis of suspected biliary disease. On the other hand, MRCP imaging showed an accurate diagnosis of GB stones by 91% and a positive predictive value of 95%. This result is better than that reported by Polistina et al. (2015), who found an MRCP accuracy rate of 80.5% in detecting biliary stones. The MRCP negative results may occur in patients with < 2 mm stones or those with massive ascites. Moreover, MRCP accuracy can be affected by patient cooperation, positioning, and imaging procedures. Consequently, US imaging is considered a reference technique and an initial diagnostic imaging modality for GB stones.

The Agreement between MRCP and US Results in the GB Stones Diagnosis

Kappa test was used. Table 2 shows the symmetric values between MRCP and US imaging results to evaluate the inter-rate symmetry (agreement) between MRCP and US results in detecting GB stones.

Table 2

Results of inter-rate agreement between US and MRCP in detecting GB stones

		GB stones result by MRCP imaging		Measure of Agreement (kappa)	
		Missed	Detected	value	Sig.
GB stones result by US imaging	Missed	24	24	0.31	< 0.001
	Detected	28	124		

Although the overall conformity percentage between US and MRCP results was 74%, the results of the Kappa test showed fair agreement (K = 0.31) between US and MRCP in the detection of GB stones by MRCP in comparison with the US.

Diagnosis of CBD Stones using MRCP and US Imaging

From 200 patients with choledocholithiasis symptoms, common bile duct (CBD) stones were mostly diagnosed by MRCP (67%; n=108) compared with US (46%; n=66), as shown in Figure 3.

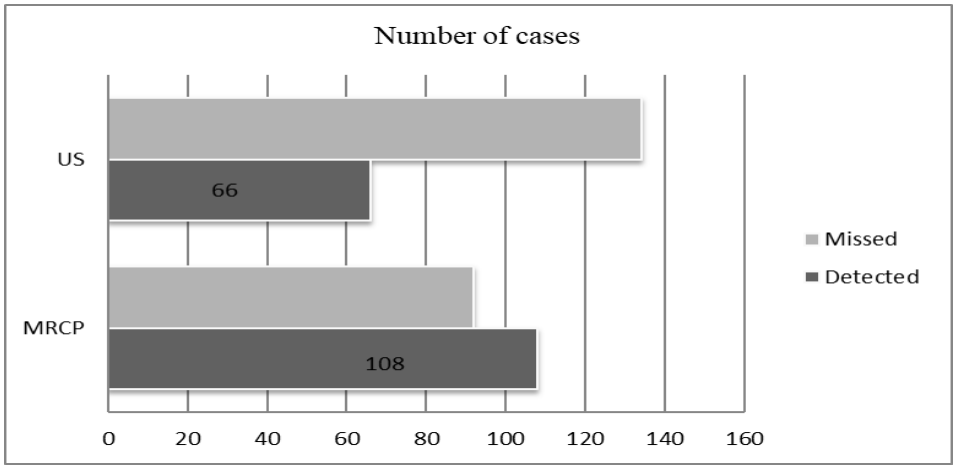

Figure 3. MRCP and US findings for suspected CBD stones cases

The results showed that CBD stones were detected in 108 cases by MRCP with an accuracy rate of over 98% based on the final diagnosis, including histological and surgical findings. This result is similar to those reported by Karwa and Patil (2017), who showed a 95% accuracy rate for the MRCP in the detection of CBD stones, as well as consents with Lee et al. (2018), who documented a 93.3% accuracy rate for MRCP in the diagnosis of CBD. In contrast, this finding is relatively better than those reported by Orman et al. (2018), who found an 86.4% MRCP sensitivity for choledocholithiasis detection, as well as Akkuzu et al. (2020), who reported an 81.5% MRCP sensitivity for hepatobiliary system stones.

In addition, this present study demonstrated that CBD stones larger than 6 mm could be detected with high accuracy without contrast. The results showed that CBD stones were detected in 66 cases by the US with an accuracy rate of 61%; approximately the same results were documented by Kolomiytsev et al. (2019), who reported a 66% accuracy rate for US imaging in the detection of CBD stones. On the contrary, this finding is better than those of Orman et al. (2018), who found a 40.8% US sensitivity in detecting choledocholithiasis.

The number of cases with CBD stones detected by both modalities was less than the number detected for GB stones. Moreover, there were more negative results for the US (i.e., defined as negative findings in the US with positive findings at MRCP and were confirmed in the final diagnosis). However, this result revealed higher diagnostic accuracy for MRCP in detecting CBD stones, which is in line with the findings of Virzì et al. (2019), who reported higher positive predictive values for MRCP in detecting CBD stones compared with the US imaging. This advantage, therefore, can reduce the misdiagnosis of normal US examinations.

The limited accuracy of US in detecting CBD stones may be attributed to many reasons such as the operator skill or lack of fluid around compressed CBD stones against the duct wall, which reduces stone border visibility. In contrast, gallbladder stone is easily seen because it is surrounded by bile. Also, the location of CBD stones at the ampulla of Vater (hepatopancreatic ampulla) may be hidden by bowel gas and difficult to see in US image. In addition, poor acoustic shadows for small stones. This finding is in line with that of Qiu et al. (2015), who revealed low US imaging accuracy in diagnosing CBD stones.

The Agreement between MRCP and US Results in the Diagnosis of CBD Stones

The Kappa test evaluated the agreement between MRCP and US results detecting GB stones. Table 3 shows the symmetric values between MRCP and US imaging results.

Table 3

Results of agreement between US and MRCP in the detection of CBD stones

		CBDS result by MRCP imaging		Measure of Agreement (kappa)	
		Missed	Detected	K – value	Sig.
CBDS result by US imaging	Missed	84	50	0.44	< 0.001
	Detected	8	58		

The MRCP negative results were only shown in 2 cases with a < 2 mm stone which is less than US imaging negative results. MRCP imaging appears to be sensitive and specific for the CBD stone diagnosis. Table 3 revealed that the overall conformity percentage between MRCP and US was 71%, while the Kappa test results showed moderate agreement (0.44) in detecting CBD stones by MRCP compared to the US.

CONCLUSION

In conclusion, the US is an accurate imaging modality for patients with symptomatic GB stones and is considered as the benchmark investigation because of its better availability, lower costs, and accuracy for GB stones detection. At the same time, MRCP is a more valuable imaging technique for detecting CBD stones. Although there is a statistically significant agreement between MRCP and US findings in biliary diagnosis stones, MRCP and US have a fair agreement in detecting GB stones. In contrast, the findings of this study showed moderate conformity between MRCP results for suspected cases and their US results in the detection of CBD stones.

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