Use of Magnetic Resonance Imaging in the Evaluation of Acute Cholecystitis in Emergency Setting

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ABSTRACT

Background

Acute cholecystitis is one of the commonest surgical disease. The rapid diagnosis at its early stage is one of the crucial factor in patient care and management.

Objective

To evaluate the role of magnetic resonance imaging (MRI) and magnetic resonance cholangiopancreatography (MRCP) in the diagnosis or exclusion of acute cholecystitis, coexisting choledocholithiasis, and acute pancreatitis in emergency setting.

Method

This study was conducted in the department of radiodiagnosis B&C teaching hospital, Birtamod, Nepal from July 2016 to November 2019. Patients, clinically diagnosed as acute cholecystitis or biliary condition with positive Murphy's sign with or without jaundice and deranged Liver Function Test, raised Leucocyte counts were evaluated by Magnetic Resonance imaging. The sensitivity, specificity, Positive Productive Value (PPV), Negative Productive Value (NPV) were calculated for the diagnosis of acute cholecystitis. Data was entered and analysed by using SPSS version 20.

Result

There were 40 patients included in our study. Among them 27 (67.5%) were females and 13 (32.5%) male. The age of the patients ranged from 16 years to 79 years, mean age 49.4 years. Majority of the patients were in the age group of 40-60 years (57.5%). The overall sensitivity, specificity, Positive Productive Value and Negative Productive Value of Magnetic Resonance imaging diagnosis of acute cholecystitis were 100%, 66.6%, 94.4% and 100% respectively. Acute cholecystitis associated with gall stone disease were common and found in 72.5% cases, with sensitivity 96.5%, specificity 27.7%, Positive Productive Value 77.7% and Negative Productive Value 75.0%.

Conclusion

Magnetic resonance imaging (MRI)/Magnetic resonance cholangiopancreatography (MRCP) is an excellent tool for the evaluation of biliary pathology and can be used for the preoperative evaluation of acute cholecystitis at the emergency setting.

KEY WORDS

Acute Cholecystitis, Cholelithiasis, Magnetic resonance cholangiopancreatography

INTRODUCTION

Acute cholecystitis is an inflammation of the gallbladder that is one of the most prevalent surgical reasons for emergency hospitalizations. In terms of patient treatment and management, it's critical to diagnose patients with suspected biliary and pancreatic pathology, as well as other acute abdominal illnesses, as soon as possible. Ultrasound is still the primary initial screening tool for evaluating patients with biliary disorders, and it is primarily supplemented by computed tomography (CT).

Ultrasonography is operator dependent and has limitations especially in the evaluation of the distal common bile duct (CBD) due to bowel gas shadowing. Gall bladder (GB) stones are detected with high sensitivity using US.[1,2] However US is less accurate in detecting common bile duct stones and has limited value in the evaluation of underlying complications of acute cholecystitis.[3-5] CT scan also has its limitations in demonstrating biliary stones and biliary strictures with a sensitivity of only 90%.[6,7]

Technically upgraded MR imaging equipment is becoming available in the emergency scenario in the tertiary care hospital, and faster acquisition protocols give superior tissue contrast, making Magnetic resonance imaging (MRI) an appealing modality for imaging acute abdominal diseases. In the emergency room, the use of MRI and magnetic resonance cholangiopancreatography (MRCP) allows for the quick, non-invasive, and accurate diagnosis or exclusion of acute cholecystitis, coexisting choledocholithiasis, and acute pancreatitis.

METHODS

The study was conducted in the department of radiodiagnosis B and C teaching hospital, Birtamod, Nepal from July 2016 to November 2019. The study protocol was approved by institution ethical committee and the informed consent for the study was waived. A total number of forty patients with clinical diagnosis of acute cholecystitis of all age groups and either sex were included in the study. Patients, clinically diagnosed as acute cholecystitis or biliary condition with positive Murphy's sign with or without jaundice and deranged LFT, raised leucocyte counts were evaluated by MR imaging. Unstable patients and having cardiac pacemakers, prosthetic heart valves, cochlear implants or any metallic orthopedic implants were excluded from the study. Magnetic resonance imaging (MRI) and magnetic resonance cholangiopancreatography (MRCP) examinations were performed based on a standardized protocol. All patients were imaged with a 1.5 T system (A-series, Philips) using a phased array body coil. Patients were nil orally for 6-8 hours prior to the examination. No contrast medium was administered. All pulse sequences were acquired in the axial planes, supplemented with a coronal T2W and fat suppressed images. All pulse sequences were acquired in breath hold T1-weighted gradient echo (GE) and T2-weighted (T2W) half-Fourier single shot turbo spin echo (HASTE) sequences were used for examining the liver and pancreas. Source images, including multiplanar reformation and maximum intensity projection (MIP) images were used for evaluation. The following MR observations were noted: (a) gallbladder wall thickness, (b) gallbladder wall edema (c) gallbladder distension > 40 mm (d) presence of gall stones (e) gall stones impacted in the GB neck or cystic duct (f) pericholecystic edema/fluid (g) fluid around the liver. The final diagnosis of acute cholecystitis was confirmed by findings of an inflamed gallbladder at surgery or followed by a positive histopathologic examination or follow-up clinical evaluation.

Data was entered and analysed by using SPSS version 20. The sensitivity, specificity, Positive Productive Value (PPV), Negative Productive Value (NPV) were calculated for the diagnosis of acute cholecystitis.

RESULTS

In our study, out of forty patients, 27 (67.5%) were females and 13 (32.5%) male (Table 1). The age of the patients ranged from 16 years to 79 years, mean age 49.4 years. Majority of the patients were in the age group of 40-60 years (57.5%).

Table 1. Sex distribution in the acute cholecystitis

Sex	No of cases	%
Female	27	67.5
Male	13	32.5
Total	40	100

The overall sensitivity, specificity, PPV and NPV of MR imaging diagnosis of acute cholecystitis were 100%, 66.6%, 94.4% and 100% respectively (Table 2). Two of the 40 patients diagnosed by MRCP as acute cholecystitis, actually had acute viral hepatitis causing gallbladder wall edema.

Table 2. Correlation between Final Diagnosis and MRCP Diagnosis

		Final Diagnosis		Total	McNemar Test
		Present	Absent		
MRCP Diagnosis	Present	34	2	36	p=0.5000
	Absent	0	4	4	
Total		34	6	40	
Spearman Correlation coefficient (R)= 0.793; p<0.0001 Measure of Agreement (Kappa)= 0.773; p<0.0001					

The sensitivity, specificity, PPV, NPV of MRCP Diagnosis *for acute cholecystitis are: 100%, 66.6%, 94.4%, 100%.*

Table 3. Sensitivity, Specificity PPV & NPV of MRCP findings for Acute Cholecystitis

MRCP findings	Acute Cholecystitis (Total)	Sensitivity % (95% CI)	Specificity % (95% CI)	PPV % (95% CI)	NPV % (95% CI)
GB stones	29 (40)	100	83.3	96.5	100
GB stones impacted in the neck	13 (29)	100.0 (75.29-100.0)	6.25 (0.16-30.23)	46.43 (27.51-66.13)	100.0 (2.50-100.0)
Stones in CBD	10 (40)	100.0(69.15-100.0)	13.33(3.76-30.72)	27.78(14.20-45.19)	100.0(39.76-100.0)
Wall thickness > 3 mm	32 (40)	96.7	50	93.7	66.6
GB wall edema	35(40)	94.29(80.84-99.30)	40.0(5.27-85.34)	91.67(77.53-98.25)	50.0(6.76-93.24)
Pericholecystic edema/fluid	33(40)	93.94 (79.77- 99.26)	28.57 (3.67- 70.96)	86.11 (70.50- 95.33)	50.00 (6.76 - 93.24)
GB diameter > 4 cm	22(40)	90.91 (70.84- 98.88)	11.11 (1.38-34.71)	55.56(38.10-72.06)	50.00 (6.76-93.24)
GB sludge	12(40)	91.67(61.52- 99.79)	10.71(2.27-28.23)	30.56(16.35- 48.11)	75.00 (19.41- 99.37)
GB length > 7 cm	30(40)	90.00 (73.47- 97.89)	10.00 (0.25-44.50)	75.00 (57.80-87.88)	25.00 (0.63-80.59)
CBD diameter > 6 mm	27 (40)	96.30 (81.03-99.91)	23.08 (5.04- 53.81)	72.22 (54.81- 85.80)	75.00 (19.41- 99.37)
Fluid around the liver	5 (40)	100.0 (47.82-100.0)	11.43 (3.20- 26.74)	13.89 (4.67-29.50)	100.0 (39.76-100.0)

These patients had acute pain in right hypochondrium with local tenderness and clinical suspicion of acute cholecystitis. Four patients, who were clinically suspected for having acute cholecystitis were negative in MRCP and it was ruled out in the follow-up evaluation. MRI/MRCP observation of different single criteria for the diagnosis of acute cholecystitis are given in table 3. Acute cholecystitis associated with gall stone disease were common and found in 72.5% cases, with sensitivity 96.5%, specificity 27.7%, PPV 77.7% and NPV 75.0%. GB stone impacted in the neck of GB was found in 13 cases (44.8%) with high sensitivity at diagnosing acute calculus cholecystitis. (Fig. 1) In 25% patients (n:10) there were associated choledocholithiasis confirmed at surgery.

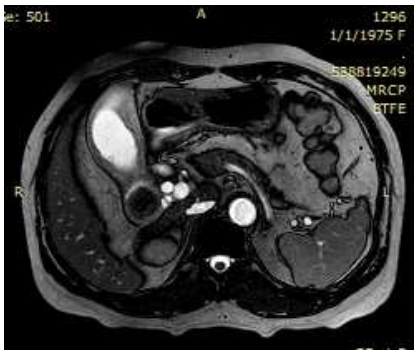

Figure 1. 42 years old female with acute right hypochondrial pain. Axial MRI shows calculus impacted in the GB neck with edematous GB wall thickening.

DISCUSSION

Acute cholecystitis is a clinical diagnosis made on the basis of right upper quadrant abdominal pain, a positive Murphy's sign, and fever.[8] However, other disease entities with comparable clinical presentations, such as duodenal ulcer, pancreatitis, acute appendicitis, renal colic, pneumonia, and acute myocardial infarction, might mimic acute cholecystitis.[1,8,9] As a result, diagnostic methods are required to confirm or rule out the suspected diagnosis.

Due to its accessible availability, lower cost, shorter examination time, and lack of radiation, ultrasonography (US) remains the most popular initial imaging modality for the evaluation of suspected acute cholecystitis and biliary disease. Gallbladder stones are detected with high sensitivity using US.[1,9] However, US is less accurate in detecting common bile duct stones.[3,4,9] Modern MR systems with fast pulse sequences have made highly diagnostic abdominal examination possible.[9-12] MRCP is non-invasive, does not use radiation, does not require anesthesia, is less operator dependent, and allows for improved imaging of the duct proximal to an obstruction when paired with conventional T1- and T2- weighted spin echo sequences. In addition to verifying the diagnosis of acute cholecystitis, the ability to see the biliary tree with MR imaging may aid the surgeon in planning the operation.

The primary imaging procedure of choice in a patient with suspected acute cholecystitis is usually an ultrasound or a CT scan. However, demonstrating a stone impacted in the cystic duct or GB neck can be difficult. For the diagnosis of acute cholecystitis, MR imaging offers a better sensitivity than US.[9,12] MRI findings of acute uncomplicated cholecystitis include: (a) gall bladder stones, often impacted in the GB neck or cystic duct (b) GB wall thickening (> 3 mm), (c) GB wall edema, (d) GB distension (diameter > 40 mm), (e) pericholecystic fluid, and (f) fluid around the liver.[5,9,13] The presence of one or more of the six criteria indicates acute cholecystitis, with an 88 percent sensitivity and an 89 percent specificity.[9] Cholecystitis-related consequences such as gangrene, perforation, and pericholecystic abscess can all be detected and characterized using MRI.

Gallbladder wall thickening can occur as a result of a variety of illnesses, including acute cholecystitis, chronic cholecystitis, adenomyomatosis, malignant tumor, and acute hepatitis. An acute inflammatory process is indicated by a thicker GB wall with a diffuse or patchy distribution of increased signal intensity on fat-suppressed T2-weighted imaging.[9,13] Our investigation found GB wall thickening in

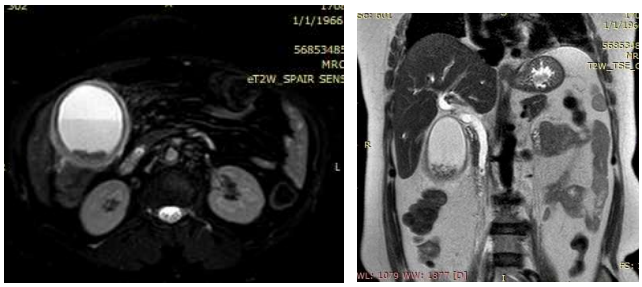

Figure 2a, 2b. 52 yrs old female. T2W SPAIR axial and T2W coronal images show hyperintense edematous GB wall thickening. Calculi are seen in the lumen with layered sludge. A tiny calculus present in the distal CBD.

80 percent of patients with acute right upper abdomen discomfort and clinically suspected acute cholecystitis (Fig. 1, 4), which is comparable to Håkansson et al.[9] Furthermore, our study identified GB wall edema in 87.5 percent of patients, with 94.2 percent sensitivity and 40.0 percent specificity (Fig. 2a,b). The study by Regan et al. had 91 percent sensitivity and 78 percent specificity, while Håkansson et al. had 77 percent sensitivity and 78 percent specificity.[9,12] In our investigation, however, two of the 40 patients identified with acute cholecystitis by MRCP actually had acute viral hepatitis causing gallbladder wall edema.

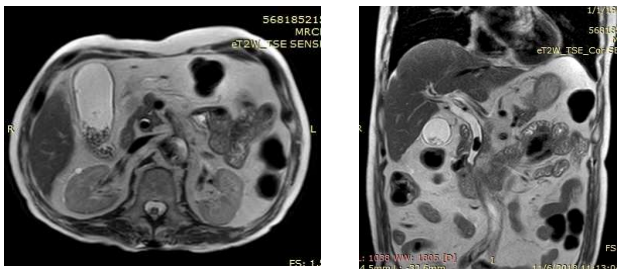

Figure 3a, 3b. 79 years male. T2W axial and coronal images demonstrate choledochocholelithasis. Distended gallbladder is seen with multiple calculi.

One of the symptoms that causes a positive Murphy's sign with variation is gallbladder distension. Because of the variations in the structure of the gallbladder, assessing it might be challenging. In our investigation, gallbladder distension of more than 4 cm was identified in 55% of cases (Fig. 3a,b), in contrast to Håkansson et al. study, which reported GB distension in all cases of acute cholecystitis.[9] The sensitivity and specificity for GB stones were 96.6% and 27.7% respectively, with PPV 77.7% and NPV 75%, whereas

Figure 4. Acute acalculus cholecystitis. 67 years male with right hypochondrial pain. T2 W SPAIR axial image shows distended gallbladder with edematous thickening of the GB wall.

GB stones impacted in the neck had 100% sensitivity and low specificity of 6.25%. The sensitivity for stones in the gallbladder was high, which is in accordance with other studies.[9,14]

The incidence of CBD stones in patients with acute cholecystitis is reported to be 7-25%, and in the present study it was 25%.[15] Multiple studies report a sensitivity between 75% and 100% of MRCP in the diagnosis of choledocholithiasis and are in accordance with the present study.[5,14,16]

CBD diameter was more than 6 mm in 67.5% of cases in our study, that could be due to associated inflammatory stricture.

Fluid around the liver was detected in 12.5% cases only, contrary to the study by Håkansson et al. which showed perihepatic fluid in 53.3% cases.[9]

The MRCP has limits in terms of availability and expense, and it cannot be used in sick or unstable individuals and who have metallic implants, pacemakers, or aneurysmal clips.

CONCLUSION

Patients with acute cholecystitis or biliary disorders, as well as accompanying complications, present with a variety of clinical symptoms in the emergency room. MRI/MRCP is a good tool for evaluating biliary disease and can be utilized in the emergency room to assess acute cholecystitis prior to surgery. It offers the benefit of detecting choledocholithiasis and pancreatic pathology in the same patient.

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