



Comparison of Diagnostic Accuracy of CT scan and USG in Right Upper Quadrant Pain: A Review Analysis

Laiba Maryam¹, Farwa Sikandar², Muhammad Shaheryar³

¹Mayo Hospital, Lahore

²Akhtar Saeed trust hospital Lahore

³THQ Hospital, Bhera

ABSTRACT

Purpose: Acute right upper quadrant (RUQ) pain is a common presenting symptom in emergency departments and outpatient medical practices, and is most commonly attributable to biliary and hepatic pathology. The main objective of the study is to systematically analyse the comparison of diagnostic accuracy of ultrasound and computed tomography in right upper quadrant pain.

Material and methods: This study was conducted using a systematic search on Google scholar, Pubmed and Web of science published until 20th June 2020. The cited references of retrieved articles and previous reviews were also manually checked to identify any additional eligible studies with indexed search terms for cholecystitis, US, cholescintigraphy, CT, and MR imaging.

Results: After excluding duplicates and articles that did not meet the inclusion criteria, we obtained 30 articles with full-texts which were read for further evaluation, where another 60 were excluded as irrelevant. Overall, we included 30 articles that directly match on the inclusion criteria.

Conclusion: It is concluded that RUQ pain were not as good as sensitivities reported in prior studies. CT was statistically significantly better for the diagnosis of RUQ pain than US, most likely because of an unclear clinical picture, the patient population, and a high proportion of poor-quality US examinations. However, US is still our first test of choice if RUQ pain is suspected clinically, whereas CT is performed when the clinical picture is unclear.

KEYWORDS: Accuracy, CT scan, Diagnostic, Pain

INTRODUCTION

Acute right upper quadrant (RUQ) pain is a common presenting symptom in emergency departments and outpatient medical practices, and is most commonly attributable to biliary and hepatic pathology. Ultrasound should be used as a first-line imaging modality for the diagnosis of gallstones and cholecystitis, as it allows the differentiation of medical and surgical causes of upper abdominal pathology, and in many circumstances is sufficient to guide patient management. Knowledge of strengths and limitations of ultrasound in the evaluation of RUQ is paramount in correct diagnosis¹.

Approximately 10%–15% of adults in the Western population have gallstones. Each year, between 1% and 4% of these individuals become symptomatic. With a prevalence of 5%, acute cholecystitis is a common entity in patients presenting at the emergency department with acute abdominal pain². The condition can be life threatening and may require direct medical intervention. The preferred treatment is a laparoscopic cholecystectomy. Timing of the operation has long been debated, but through a Cochrane Library review, the conclusion was reached that early laparoscopic cholecystectomy is safe. Accurate and timely diagnosis is essential to initiate adequate treatment³. Clinical history, physical examination, and routine laboratory tests alone result in too many unnecessary cholecystectomies and missed diagnoses. Therefore, imaging plays a major role in the management strategy and is performed in a large number of patients to improve diagnostic accuracy⁴.

Ultrasonography (US) is the primary imaging modality of choice for initial assessment of acute right upper quadrant abdominal (RUQ) pain, particularly in the emergency department (ED) setting. The American College of Radiology (ACR) Appropriateness Criteria for US have a rating of 9 (out of 9) in patients with appropriate clinical indications⁵. There are a variety of differential considerations for RUQ pain, and US is a fast cost-effective real-time dynamic modality, which does not use ionizing radiation or nephrotoxic intravenous contrast medium and provides a definitive diagnosis or at least a considerably narrowed list of differential possibilities. Multiple organ systems are included at standard RUQ US, and a variety of disease processes that are diagnosable at



US can be identified, including hepatic, pancreatic, adrenal, renal, gastrointestinal, vascular, and thoracic conditions, all of which may manifest with RUQ pain⁶. Therefore, familiarity with the spectrum of disease processes outside of the gallbladder and biliary tree that may manifest with RUQ pain and US recognition of these alternative causes is pivotal for early accurate diagnosis and efficient appropriate management. Early accurate diagnosis is particularly critical for those conditions that require timely intervention such as pyonephrosis and appendicitis, among others. In some cases, subsequent computed tomography (CT), magnetic resonance (MR) imaging including MR cholangiopancreatography (MRCP), or cholescintigraphy may be considered as the next appropriate management, depending on the clinical situation and US findings⁷.

For this purpose we performed a systematic review of comparison studies of diagnostic accuracy of ultrasound and computed tomography in right upper quadrant pain.

METHODOLOGY OF THE STUDY

Search strategy

This retrospective study was conducted using a systematic search on Google scholar, Pubmed and Web of science published until 20th June 2020.

Inclusion criteria

- All those study papers which include the diagnostic accuracy of ultrasound and computed tomography in right upper quadrant pain.

Exclusion criteria

- Studies were excluded if they were case reports or if the study population consisted of patients in an intensive care unit.

Study selection

The cited references of retrieved articles and previous reviews were also manually checked to identify any additional eligible studies with indexed search terms for cholecystitis, US, cholescintigraphy, CT, and MR imaging. Imaging study reports were reviewed for gallbladder and non-gallbladder explanations of right upper quadrant pain and were considered positive for cholecystitis when two or more supportive features were present. Encounter outcomes were evaluated on the basis of pathology data and clinical management.

An article was considered potentially eligible if US, cholescintigraphy, CT, or MR imaging was evaluated in adult patients who were suspected of having acute cholecystitis. Full-text versions of potentially eligible articles were obtained for further evaluation. The reference lists of the included studies were manually searched to identify other potentially eligible articles. Disagreements in study selection between the two reviewers were resolved through discussion.

Data extraction and analysis

The data was collected and analysed systematically. All citations were imported into a bibliographic database and duplicates were removed. Title, abstract and then full-text of all articles were screened for eligibility.

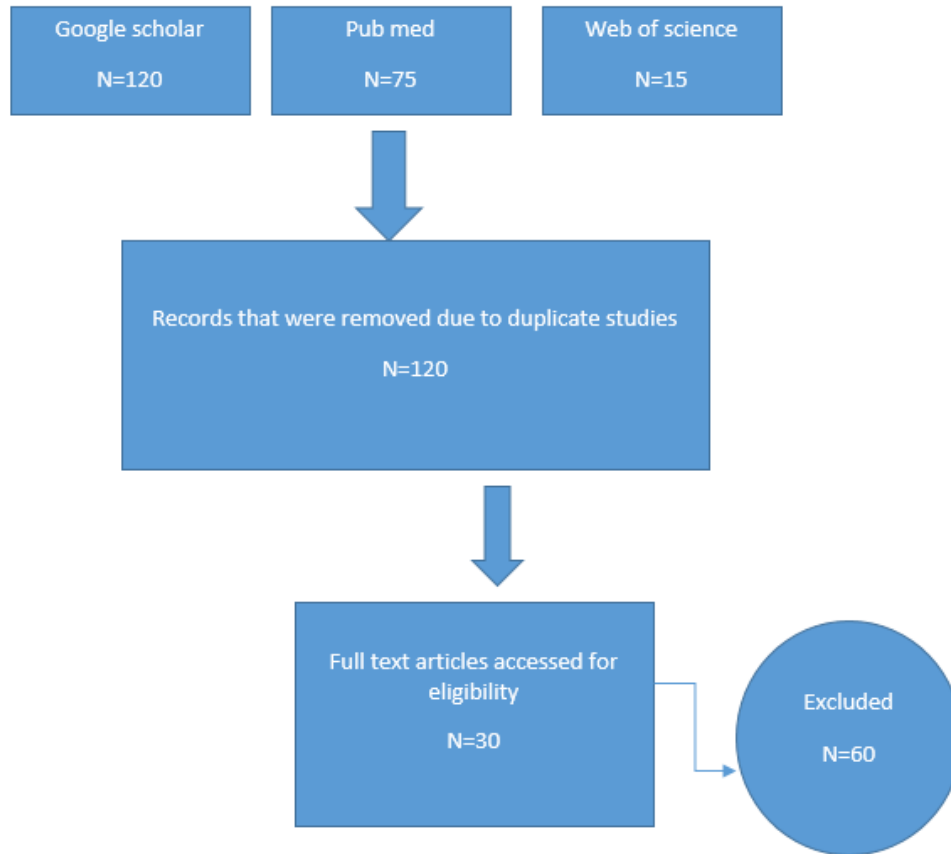


Figure 1: Flow of information through the different phases of a systematic review.

RESULTS

All those studies who met the inclusion criteria were and published during 2010 to 2020 were added in this review analysis. There were total 310 studies that identified initially from PubMed, Google scholar and Web of Science databases. After excluding duplicates and articles that did not meet the inclusion criteria, we obtained 30 articles with full-texts which were read for further evaluation, where another 60 were excluded as irrelevant. Overall, we included 30 articles that directly match on the inclusion criteria.

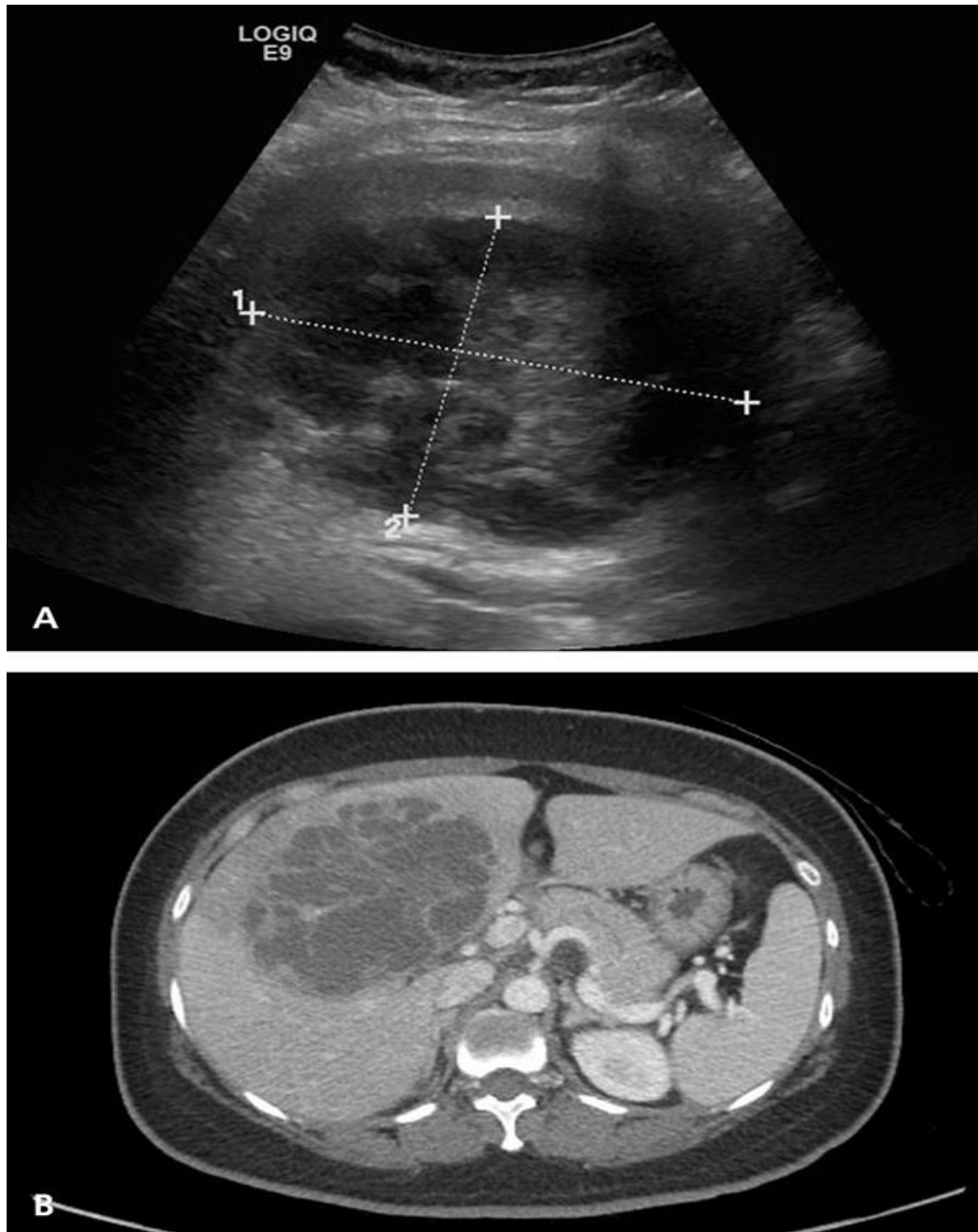
Table 01: Review analysis of selected studies

Serial No	Author Name	Year	Results
1	Adrienne et al	2011	CT misses fewer cases than ultrasound, but both ultrasound and CT can reliably detect common diagnoses causing acute abdominal pain. Ultrasound sensitivity was largely not influenced by patient characteristics and reader experience.
2	Resmi et al	2011	Finally, diagnosis of complicated cholecystitis by sonography and CT can guide alternative treatments including



			minimally invasive percutaneous and endoscopic options.
3	Jordy et al	2012	Cholescintigraphy has the highest diagnostic accuracy of all imaging modalities in detection of acute cholecystitis. The diagnostic accuracy of US has a substantial margin of error, comparable to that of MR imaging, while CT is still underevaluated.
4	Emma et al	2013	US might be used as an imaging tool as part of a focused diagnostic examination of patients.
5	Troels et al	2016	There were significant differences regarding the use and organizational aspects of point-of-care ultrasound in general practice in Europe.
6	Joss et al	2018	CT was significantly more sensitive for diagnosing RUQ pain than US.
7	Ee at al	2018	It is noted that both US and CT had a significant false negative rate for acute cholecystitis, and if there remains a clinical suspicion despite initial normal imaging, repeat delayed imaging and/or surgical opinion may be war-ranted.
8	Díaz et al	2019	Ultrasonography performed by radiologists is a useful tool in the assessment of acute abdominal pain. The general surgeon can accurately diagnose gallstones, but the diagnosis of cholecystitis and appendicitis is more challenging.
9	Vincent et al	2020	CT imaging in the pediatric population has provided a higher sensitivity and diagnostic accuracy. However, the diagnostic benefit of US cannot be excluded in this patient population.
10	Khan et al	2020	Integrating US in primary health care empowers primary health-care physicians to provide high-quality, safe, and cost-effective care to the patients.

Computed tomography (CT) has not been widely studied for the evaluation of right upper quadrant pain. It may be considered in patients with inconclusive ultrasonography or cholescintigraphy results or to help guide surgical planning. Several small studies of magnetic resonance imaging (MRI) suggest that it may be useful for evaluating acute cholecystitis, with a sensitivity (85%) and specificity (81%) similar to that of ultrasonography.¹⁴ MRI can be used in patients with equivocal ultrasonography findings or to visualize hepatic and biliary abnormalities that cannot be characterized on ultrasonography.



Liver abscess on ultrasonography (A) in a patient with right upper quadrant pain. Computed tomography (B) was obtained prior to surgical intervention (Reference: Cartwright SL, Knudson MP. Diagnostic imaging of acute abdominal pain in adults. Am Fam Physician. 2015 Apr 1;91(7):452-9. PMID: 25884745.)

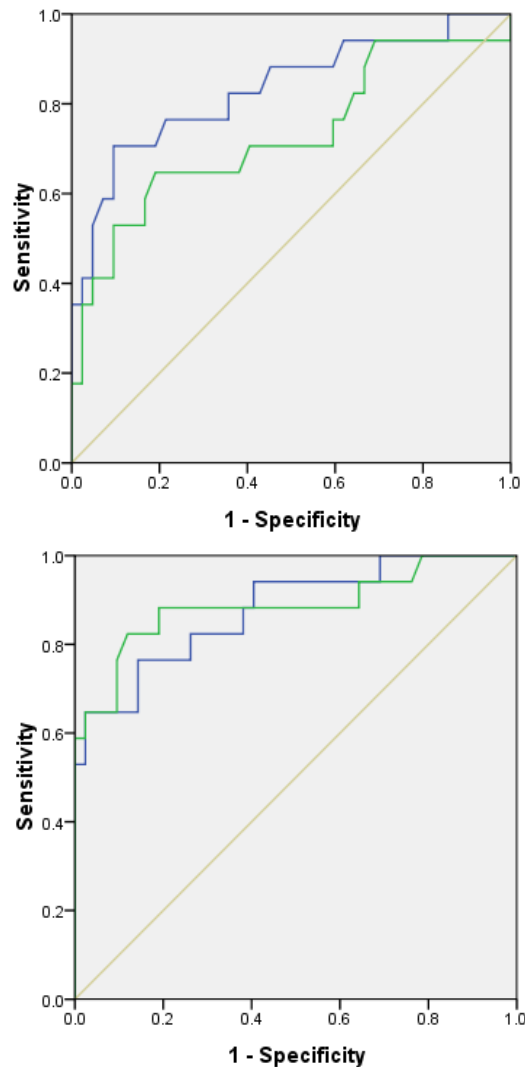


Figure 2. ROC curve of all diagnostic accuracy of US and CT in RUQ pain.

Radiography

Conventional radiography is widely available in the ambulatory setting and is often the initial imaging test for evaluation of outpatients with abdominal pain. However, studies have shown that it has limited diagnostic value for assessing abdominal pain and that the results rarely change patient treatment. Conventional radiography may be appropriate for a select group of patients. It has been shown to have good accuracy for diagnosing suspected bowel obstruction, perforated viscus, urinary tract calculi, or foreign bodies⁷.

Sonography of Right Upper Quadrant Pain

Ultrasound of the right upper quadrant is one of the most commonly performed sonographic studies. Sonography is the first-line imaging modality for evaluation of the patient who has right upper quadrant abdominal pain. It is accurate, quick, easy to perform, does not use ionizing radiation, and can be done in at the patient's bedside⁸.

The standard RUQ US examination includes dedicated evaluation of the liver, gallbladder, intra- and extrahepatic biliary ducts, pancreas, right kidney, and vasculature, with standard images that should be obtained from each of these organs as part of every RUQ US examination. Obtaining additional images beyond the standard protocol may be required for full assessment of RUQ pain,



tailored to the individual patient and based on the patient’s clinical presentation, the clinical findings, and findings on standard RUQ US images.

Table 01: US protocols for RUQ pain

Liver
Gray-scale transverse and longitudinal US images through the right hepatic lobe, left hepatic lobe, and caudate lobe
Gray-scale US images through the hepatic dome to include the right diaphragm and pleural space
Gallbladder
Gray-scale transverse and longitudinal US images through the gallbladder, evaluated in at least two different patient positions
Gray-scale transverse US image of the gallbladder, with measurement of gallbladder wall thickness
Assessment for a sonographic Murphy sign
Biliary tract
Gray-scale and color Doppler [†] longitudinal US images of the common bile duct, without and with measurement of diameter in the proximal, mid-, and distal aspects
Color Doppler US [†] images of the right and left hepatic lobes to assess for intrahepatic biliary ductal dilatation
Pancreas
Gray-scale transverse and longitudinal US images through the pancreatic head, uncinate process, body, and tail, as visible
Right kidney
Gray-scale longitudinal US image without and with measurement of renal length
Gray-scale transverse US images through the upper, mid-, and lower poles
Color Doppler US image at the renal hilum [‡]
Vasculature
Gray-scale transverse and longitudinal US images of the aorta and inferior vena cava (IVC)
Gray-scale transverse and longitudinal images of the hepatic veins and main portal vein
Color Doppler US image to assess the patency of the portosplenic confluence

Reference: Gayatri Joshi et al., 2018

Several additional structures are within the field of view of the standard RUQ US protocol that may be the source of RUQ pain. For example, real-time assessment can be performed of the right lung base and right pleural space (when evaluating the hepatic dome); the right adrenal gland (when assessing the hepatorenal interface); the hepatic flexure, right colon, and appendix (when assessing the inferior margin of the liver and right kidney); the stomach and duodenum (when assessing the hepatic hilum and pancreas); and the branches of the aorta (when assessing the upper abdominal aorta). Additional images can be obtained as appropriate if abnormalities are identified within the field of view when performing the standard protocol for RUQ US⁹.

DISCUSSION

Several factors make the veteran population in our quality improvement project different from the random populations with RUQ pain in most studies. Although gallstones and cholecystitis are more prevalent in women, the veteran population is unique in that most of the VA’s patients are male, leading to an overwhelmingly high ratio of male-to-female patients. During the study period at the Raymond G. Murphy VA Medical Center, there were 60 patients with a diagnosis of RUQ pain¹⁰. The age range for this group was 31 to 94 years old with a mean age of 66 years. The distribution of patients by sex was 56 men and four women. The fact that the population was skewed toward older and male patients presented a number of challenges. Only a minority of patients presented with a typical picture of right upper quadrant pain, fever, nausea, vomiting and anorexia. Most presented with a variety of complaints including but not limited to chest pain, vague abdominal pain, anorexia, isolated fevers, and back pain. Although the studies in the



literature suggest that US is the most appropriate initial test for RUQ, the atypical presentations at our VA facility led to a higher incidence of CT as the initial radiologic test ordered¹¹.

US is the initial imaging modality of choice when AC is suspected clinically. Advantages include its widespread availability, lack of ionizing radiation, rapid time to image acquisition, and relatively low cost. Another advantage of US is its ability to diagnose AC on the basis of the presence of the Murphy sign. The Murphy sign is a useful tool, in conjunction with cholelithiasis, having a PPV for AC of 92%. Cholescintigraphy has been shown to have a higher sensitivity and specificity for AC than US and CT¹². Cholescintigraphy is generally reserved for ambiguous cases because of logistic issues and the relatively long examination time. A lengthy examination is prohibitive because many patients undergoing evaluation for AC are seen in the ED where rapid diagnosis is necessitated. CT is also easily accessible and can be completed rapidly, although its drawbacks include ionizing radiation and high cost. CT is often used to evaluate patients with an unclear clinical presentation, wide differential diagnosis, and pain not solely localized to the right upper quadrant¹³.

CONCLUSION

It is concluded that RUQ pain were not as good as sensitivities reported in prior studies. CT was statistically significantly better for the diagnosis of RUQ pain than US, most likely because of an unclear clinical picture, the patient population, and a high proportion of poor-quality US examinations. However, US is still our first test of choice if RUQ pain is suspected clinically, whereas CT is performed when the clinical picture is unclear.

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