

A SYSTEMATIC REVIEW ON COMPARISON OF DIAGNOSTIC ACCURACY OF ULTRASOUND AND COMPUTED TOMOGRAPHY IN RIGHT UPPER QUADRANT PAIN

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ABSTRACT

In this systematic review we aimed to explore relevant data on efficacy of the ultrasound and computed tomography (CT) scan regarding right upper quadrant (RUQ) pain, studied in recent decades. For this study we collected data of different regions to evaluate the diagnostic accuracy of CT and ultrasound for RUQ pain.

METHODOLOGY: Research was conducted with the help of keywords. Two hundred and sixty-two articles were found at initial stage. We included demographic information like the sample size, author information, and area of the study in table form. We also observed the CT and Ultrasound findings regarding sensitivity, specificity, true positive (TP), false positive (FP), false negative (FN), and true negative (TN) of selected studies related to acute cholecystitis, acute pancreatitis, small bowel obstruction, pancreatic cysts, gallbladder adenomyomatosis, and renal colic. **RESULTS:** Pooling results of this systematic review depicts that in the recent decades, researchers were more concerned with conducting retrospective studies (60%) as compared to prospective studies (40%). Results revealed that 53% of studies were conducted in the United States and other regions which discovered the high incidence of disease in these areas. Only 33% of studies observed the TN, FN, FP, and TP values, whereas the overall sensitivity and specificity of CT was greater than ultrasonography in RUQ pain. **CONCLUSION:** CT was statistically and significantly better for the diagnosis of RUQ pain than US but was considered for secondary imaging modality and it was mostly used with those negative or inconclusive ultrasonographic results. While US was used as a primary imaging modality because of its ease of availability, low cost, safe (no ionizing radiations) and convenient handling.

Keywords: CT Imaging, sonographic evaluation of RUQ, renal colic, pancreatitis, cholecystitis, gallbladder adenomyomatosis.

Introduction

In emergency department, acute right upper quadrant (RUQ) pain is most prevalent disorder associated with biliary and hepatic pathology. Early evaluation can assist in the management of RUQ pain.¹ Imaging modalities play an important role in evaluating the

area of RUQ pain. At the initial stage of diagnosis, accuracy of the diagnostic tools helped to find out the real source of the disease as well as disease risk in a large population. It also helped to evaluate the advances in the diagnostic tool, disease management

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as well as treatment of the disease. Accuracy of such diagnostic tool made a clinical picture of any abnormality before it becomes apparent. Ultrasound is recommended because it is easy to use and easily available than other imaging techniques which are also cost-effective. While in the case of CT scans, there is the use of ionizing radiation and it may be the cause of high-risk regarding cancer progression in the body. It is the disadvantage of the usage of CT scan when used for diagnostic purposes for patients in case of upper quadrant pain. Right upper quadrant pain includes abnormalities in the liver, gallbladder, intra- and extrahepatic biliary ducts, pancreas, right kidney and intestine which need proper radiological evaluation for management of pain.³ Due to the high consumption of alcohol and medical drugs, the morbidity rate of RUQ is frequently high in first-world countries. Approximately 10-15% of adults suffer from gallbladder issues which end in cholecystectomy. Statistical reports declared that 1 to 4% population is affected with RUQ pain every year. Acute cases of RUQ pain such as acute cholecystitis needs medical assistance in the emergency department.⁴ Total 5% morbidity ratio of acute cholecystitis turns into a high risk of mortality. With the help of early laparoscopic cholecystectomy mortality ratio can be controlled. The perfect timing for laparoscopic surgery is debatable yet, but imaging techniques can easily provide management strategies for acute cases.⁵ Prolonged diagnosis in terms of clinical outcomes and evaluation of patient's history was another reason for the mortality ratio and to avoid all these, ultrasound is considered as the best first-line imaging technique.⁶ Although ultrasonography provides great visual modality still some drawbacks of this method raised questions on it. Ultrasonography failed to capture the information regarding organ structures which can be visualized through computed tomography.⁷

Objectives

The main objective of this study is to systematically analyze the comparison of diagnostic accuracy of ultrasound and computed tomography in right upper quadrant pain. We will also focus on the usage of US as an initial modality of choice and to the CT as

a second line imaging modality, used only in those with negative or inconclusive ultrasonographic results.

Search Strategy:

For this study, we follow the Preferred Reporting Items guideline for conducting this systematic review analysis (PRISMA). Electronic articles were searched out from 2011 to 2019 on PUB Med, an online Willey library and Science Direct and Research Gate site for this systematic review. Keywords were included to find out the desired data. Mostly data was collected through keywords like "Diagnostic imaging, Diagnostic Doppler ultrasound, Diagnostic ultrasonographic Radiology, Medical imaging, Doppler ultrasound, sonography, efficacy of ultrasonography in acute cholecystitis, efficacy of ultrasonography in pancreatitis, efficacy of ultrasonography in small bowel obstruction, sensitivity and specificity values of ultrasonography, Doppler ultrasound for right quadrant abdominal pain" to search relevant articles. With help of the keywords, we analyzed title, abstract aims, and objectives to extract the relevant data. We used Boolean operators for this research.

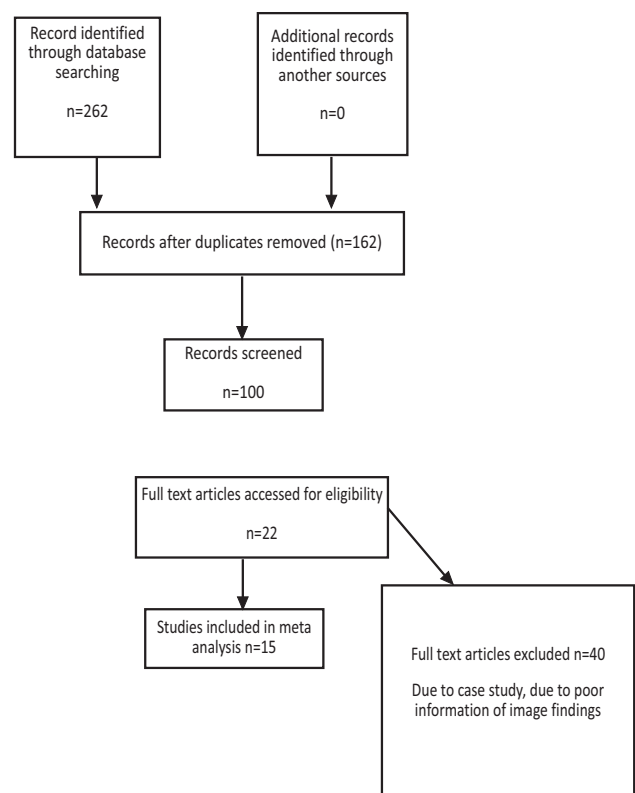


Figure 1: Study selection flowchart.

At the initial stage of data collection, we found two hundred and sixty-two articles with selected keywords. In the first screening, we excluded 162 duplicate articles and further screen out the rest of 100 articles. Later-on, we omitted 40 articles with poor information on sonography and emphasis on CT imaging and 22 articles were further observed keenly to get desired information. At the last stage, we found 15 articles that fulfilled the inclusion criteria and had an adequate data on our topic.

We kept demographic information of patients like mean age and range, the sample size, author information and area of the study in tabular form. We also observed the ultrasound findings regarding sensitivity, specificity, TP, FP, FN, and TN of the selected studies related to small bowel obstruction, Pancreatic cysts, gallbladder adenomyomatosis and renal colic. T- test was applied at 0.05% significant value.

Inclusion criteria:

Only those articles which comprise on complete information of study type, total population of disease, ultrasound specificity, sensitivity, prevalence of disease among patients were included for this

research. We gathered relevant articles from year 2011-2019.

Exclusion Criteria:

Information in the form of posters, case studies with CT and US imaging, letters to editors, and articles with copied information was excluded from this study. Articles which were written in other than English language were not included for this research. On the behalf of keywords, we found two hundred and sixty-two articles. Majority of researches utilized magnetic resonance imaging for diagnosis of right quadrant. So, all the studies which used MRI were excluded after screening. The evaluation of our selected data was further done into two phases, first we selected the data based on abstract and title. Secondly, we examined the inner text of the articles and included if they were suitable to fill the inclusion criteria of our study.

Results

Pooling results of this systematic review depicts that in the recent decade, researchers are more interested

| Author | Year | Study design | Region / Country | Total population | Segment evaluated | Diagnosis technique |
|-----------------------------|------|---------------|------------------|------------------|-----------------------------|---------------------|
| Alan A Bloom | 2019 | prospective | USA | 27 | Acute Cholecystitis | US |
| Ali Nawaz Khan | 2018 | prospective | UK | 83 | Acute Cholecystitis | US+CT |
| SnehaLalith | 2019 | prospective | India | 90 | Acute Pancreatitis | US+CT |
| Télllez-Ávila ⁸ | 2016 | Retrospective | Mexico | 34 | Pancreatic Cysts | US |
| Zhang ⁹ | 2016 | Retrospective | Canada | 43 | Pancreatic Cysts | Us |
| Alston ¹⁰ | 2016 | Retrospective | USA | 37 | Pancreatic Cysts | US |
| Ünlüer et al ¹¹ | 2010 | Prospective | Turkey | 174 | SBO | US |
| Jang et al ¹² | 2011 | Prospective | USA | 76 | SBO | US |
| Chang ¹³ | 2017 | Retrospective | Taiwan | 31 | SBO | CT |
| Millet ¹⁴ | 2017 | Retrospective | France | 256 | SBO | CT |
| Matsushima ¹⁵ | 2016 | Retrospective | USA | 111 | SBO | CT |
| He et al ¹⁶ | 2016 | Retrospective | China | 57 | SBO | CT |
| Joo ¹⁷ | 2013 | Retrospective | South Korea | 45 | Gallbladder adenomyomatosis | US |
| Bang et al ¹⁸ | 2014 | Prospective | Korea | 40 | Gallbladder adenomyomatosis | US+ CT |
| Daniels ¹⁹ | 2016 | Prospective | USA | 835 | Renal Colic | US |
| Fields ²⁰ | 2015 | Prospective | USA | 77 | Renal Colic | US |
| Herbst ²¹ | 2014 | Prospective | USA | 670 | Renal Colic | US |
| Smith-Bindman ²² | 2014 | Retrospective | USA | 777 | Renal Colic | US |

Table 1: Review analysis of selected studies

| Author | Year | Sensitivity % | Specificity % | No. of TP Findings | No. of FP Findings | No. of TN Findings | No. of FN Findings |
|----------------|------|-------------------|---------------------|--------------------|--------------------|--------------------|--------------------|
| Alan A Bloom | 2019 | 95 | 80 | - | - | - | - |
| Ali Nawaz Khan | 2018 | US: 91 CT: 90 | US: 79 CT: 95 | - | - | - | - |
| SnehaLalith | 2019 | US: 88 CT: 100 | - | - | - | - | - |
| Télez-Ávila | 2016 | 62 | 59 | - | - | - | - |
| Zhang | 2016 | 62 | 55 | - | - | - | - |
| Alston | 2016 | 92 | - | - | - | - | - |
| Ünlüer et al. | 2010 | 97.7 | 92.7 | - | - | - | - |
| Jang et a | 2011 | 93.9 | 81.4 | - | - | - | - |
| Chang | 2017 | 50 | 95 | - | - | - | - |
| Millet | 2017 | 94 | 76 | - | - | - | - |
| Matsushima | 2016 | 84 | 65 | - | - | - | - |
| He at el | 2016 | 94 | 93 | - | - | - | - |
| Joo | 2013 | US: 73.1 CT:50 | US: 96.3 CT:98.2 | - | - | - | - |
| Bang et al | 2014 | 80 | 85.7 | - | - | - | - |
| Daniels | 2016 | 65 | 75 | 288 | 98 | 295 | 154 |
| Fields | 2015 | 87 | 82 | 46 | 9 | 42 | 7 |
| Herbst | 2014 | 73 | 73 | 231 | 94 | 258 | 87 |
| Smith-Bindman | 2014 | 54 | 71 | 145 | 123 | 361 | 148 |

Table 2: Study characteristics of included studies.

| Variables | Range | Mean | Standard deviation | p-value |
|-------------|----------|-------|--------------------|--------------------------|
| Sensitivity | 50-97.7 | 75.73 | 16.8 | < .00001 |
| Specificity | 55- 98.2 | 79.88 | 13.7 | < .0001 |
| Pool Total | | | 15.38 | 0.465 (0.7677-0.2323) |

Table 3: Pool data of sensitivity and specificity of selected studies

with conducting retrospective studies (60%) as compared to prospective studies (40%).

Results depict that 53% of studies were conducted in the United States and other regions which revealed the high progression of disease in those areas. Only 33% of studies observed the TN, FN, FP, and TP values whereas the overall sensitivity and specificity

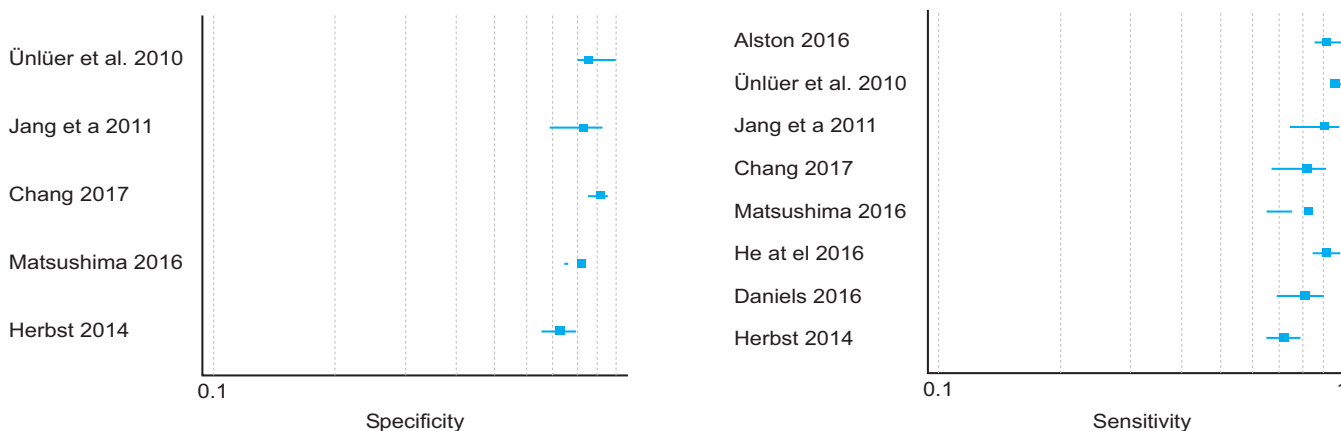


Figure 1, 2: Sensitivity and specificity plot of CT findings

of CT was greater than Ultrasonography in RUQ pain. 11 studies with Ultrasonographic findings, 4 studies related to computed tomography and 3 study with both US and CT was selected for this research.

Discussion

Right upper quadrant pain includes abnormalities in the liver, gallbladder, intra- and extrahepatic biliary ducts, pancreas, right kidney and intestine. In this systematic review, we were more concerned with gallbladder, pancreas, and renal colic abnormalities and their evaluation through ultrasonography and computed tomography. In the recent decades, abdominal pain was one of the prevalent disorders which need spontaneous administration in emergency department. In 2012, 10 million cases of abdominal pain were reported in different states of the United States.²³

In recent years gallstone disorder was reported as a major cause of abdominal pain with an estimated high (700,000) cholecystectomies annually in the United States.²³ Ultrasound was favoured in case of diagnosis regarding acute cholecystitis and it was known as the primary technique for the diagnosis and examination in case of biliary pathology (Trowbridge et al., 2003). The key outcomes of acute cholecystitis in ultrasound imaging also covered the presence of stones as well as distension of the gallbladder lumen, gallbladder wall thickening, a positive US Murphy sign, pericholecystic fluid (Nino-Murcia and Jeffrey Jr, 2001), and a hyperemic wall upon evaluation with color Doppler (Schiller et al., 1996). Ultrasound has the quality of best sensitivity and specification for the diagnosis of suspected gallstones in patients (Shea et al., 1994).

As it is mentioned in the previous studies (Lorusso et al., 2012), few ultrasonographic findings of evidence were much powerfully related to acute cholecystitis than others: a positive Murphy's sign (pain is provoked by either the transducer or the sonographer's palpation under guidance in the exact area of the gallbladder) was reported to have sensitivity as high as 88%

(Reginelli et al., 2008). Ralls et al. have suggested that the most essential advantages of ultrasound over other imaging techniques in the examination of acute cholecystitis was the capability to assess for a sonographic Murphy sign which was a reliable indicator of acute cholecystitis with a sensitivity of 92% (Ralls et al., 1985). An increased gallbladder wall thickness of > 3.5 mm is a reliable and independent predictor of acute cholecystitis (Imhof et al., 1992). Visualization of gallbladder wall thickening in the presence of gallstones using ultrasound had a positive predictive value of 95% for the diagnosis of acute cholecystitis (Laing et al., 1981).

As mentioned in the previous reports, that the cholecystitis diagnosis was done with the gallbladder sonography. It was the first popular tool which was applied to study the imaging character of cholecystitis. The first choice for diagnosis was due to its sensitivity and specificity. But in some cases, due to complications of presentation in some patients, it was not feasible to use gallbladder sonography. So, for such type of complications and diagnostic problem CT was the most feasible choice of diagnosis (Vagvala and O'Connor, 2018). These complications included abscess in specific part, bowel syndrome or it could be any other complication in abdomen such as abdominal inflammation. So, in such case, the preferably diagnosis was done with CT instead of cholecystitis sonography (Van Epps and Regan, 1999). Not only in abdominal cases, CT was also used as a powerful tool in case of gangrenous cholecystitis, hemorrhagic cholecystitis. It was also used in case of gall stone as well as to evaluate the emphysematous cholecystitis (Reginelli et al., 2012). Rather that, CT had a strong diagnostic tool instead of ultrasound due to its sensitivity and specificity in case of obesity (Buonamico et al., 2008). While, in the case of appendicitis and in case of diverticulitis, CT had more significant result than ultrasound diagnosis. In few patients, acute diverticulitis and appendicitis were not diagnosed by CT imaging technique but its results were comparable with ultrasound diagnosis.

The previous studies suggested that the use of diagnostic approaches for random patients which had no previous diagnosis regarding acute abdominal pain should prefer the CT approach of crucial circumstances in case of an abdominal problem and right upper quadrant pain with ultrasound first and CT after

a negative or indecisive ultrasound (Laméris et al., 2009). The studies revealed that there should be an experienced observer for the dealing of ultrasound. Due to this reason, results could not be varied, and imaging was also not affected. The ultrasound accuracy was also dependent to the different groups of patients like age, sex, or reproductive status of women in case of pregnancy and much more. While in case of CT techniques, such factors were minimized, and it all depends on inter observer handling.

Conclusion

In past, very limited number of researches were conducted which depicted the sensitivity of RUQ pain. After considering both imaging modalities we conclude that CT is way, more effective than ultrasonography to visualize the complete structure of upper quadrant organs. But due to its high cost and handling procedure, many regions used ultrasonography for diagnosis as a primary imaging modality while CT as a secondary imaging modality mostly in those with negative or inconclusive ultrasonographic results. This study also concluded that every technique has its own prone and cons. So, neglecting one technique over the other is not satisfactory. To get more accuracy of CT and ultrasound techniques in upper quadrant pain, more detailed studies are required to subside the harmful effects and accuracy of such techniques.

Conflict of interest: There was no conflict of research.

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