

Comparative Diagnostic Accuracy of Ultrasonography and Multi-Detector Computed Tomography in Diagnosing Common Causes of Acute Abdominal Pain: A Hospital-Based Cross-Sectional Study

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Abstract

Background and Aim

The recurrent condition that necessitates prompt and quick diagnosis is acute abdominal pain (AAP). AAP may vary from little belly aches to life-threatening conditions that require surgical treatment. AAP is the most common complaint, representing 4% to 10% of visits in the emergency department. The study's primary objective was to compare the accuracy of ultrasonography (USG) and computed tomography (CT) in diagnosing acute abdominal pain.

Methods

The descriptive cross-sectional study was conducted in the radiology department of a private diagnostic center using computed tomography and ultrasonography on 93 patients utilizing a convenient sampling approach. All patients had a history of abdominal pain for more than 3 hours but less than 5 to 6 days throughout our research length, of all age groups.

Results

The gender of patients presenting with acute abdominal pain demonstrates that females (59, 63.4%) are more familiar with developing acute abdominal pain than males (34, 36.6%). The age groups of patients illustrate that the age group between more than 21 and less than 45 years has the highest frequency of acute abdominal pain, while the age group below 20 years shows the lowest frequency. The results show that appendicitis is the most frequent cause of acute abdominal pain, accounting for 40 (43%), followed by diverticulitis 20 (21.5%), while pancreatitis only accounts for 4 (4.3%) of cases. The sensitivity of CT is higher than USG in diagnosing appendicitis, diverticulitis, and cholecystitis.

Conclusion

Computed tomography has a substantially higher rate of accuracy than ultrasonography in identifying acute abdominal pain, and it has a higher sensitivity than ultrasonography in diagnosing appendicitis, diverticulitis, inflammatory bowel disease, and cholecystitis. However, in the case of pancreatitis, both ultrasound and computed tomography have the same sensitivity and specificity.

Keywords: Acute Abdominal Pain, Appendicitis, Diverticulitis, Computed Tomography, Cholecystitis

1. Introduction

Abdominal pain can relate to abrupt and lingering discomfort that may be acute or chronic. The recurrent condition that necessitates prompt and quick diagnosis is acute abdominal pain (AAP). AAP may vary from little bellyaches to life-threatening conditions requiring surgical treatment [1]. AAP is the most common complaint, representing 4% to 10% of visits

to the emergency department [2,3]. There are several different types of acute abdominal pain, each with its own distinct characteristics. Visceral pain, for example, originates from internal organs like the appendix, stomach, or intestines and is commonly described as dull, crampy, or achy. Somatoparietal pain, on the other hand, is defined by severe, strong pain that is usually caused by inflammation of the peritoneum, the

abdominal cavity's lining. In addition, movement can make this type of pain worse. Furthermore, referred pain is another type where pain is perceived in a location other than the actual site of pain origin, for example, pain from the gallbladder being felt in the right shoulder. Understanding these classifications is critical for healthcare providers when diagnosing and treating acute abdominal pain effectively [4]. The difficult situation for a physician is to identify patients who have unusual or life-threatening pain that requires early diagnosis and treatment, such as bowel obstruction, appendicitis, incarcerated inguinal hernia, and diverticulitis. AAP is typically a mild condition such as a urinary tract infection or constipation [5]. Infection, inflammation, ulcers, organ perforation or rupture, poorly coordinated muscle contractions, obstructions blocking blood flow to the organs, and other conditions can all result in acute abdominal pain [6].

Abdominal pain can be caused by a wide range of illnesses; thus, in order to get an appropriate diagnosis, we had to correlate with other clinical signs and symptoms [7]. Patients with an acute abdomen should be kept in the emergency room while undergoing periodic physical exams and history-taking to ensure diagnostic accuracy. The etiology for acute abdominal pain includes Gastroenteritis (bacterial and viral illness) typically causes stomach and intestinal swelling. Each year, children under the age of five experience 3-5 billion cases and close to 2 million fatalities [8]. Appendicitis has a lifetime incidence of 6% to 7%. Appendicitis, which typically affects teenagers and young adults, is most common in the second decade of life. This condition rarely affects children under the age of five. The most prevalent causes of abdominal pain requiring surgery affect 250,000 people in the United States each year [9]. Common causes of abdominal pain with incarcerated hernia include constipation, pancreatitis, urinary tract infection, ectopic pregnancy, renal colic (urolithiasis), hydronephrosis, ovarian torsion, testicular torsion, inflammatory bowel diseases, diverticulitis, small bowel obstruction, and pelvic inflammatory diseases [10,11].

Imaging modalities are essential for identifying the cause of acute abdominal pain [12,13]. In cases of acute abdominal pain, both USG and CT are often employed imaging modalities. Abdomen-pelvis The American College of Radiology advises computed tomography with contrast for those who are experiencing acute abdominal pain [14]. USG is readily available or takes less time, ultrasonography is very useful for identifying the causes of acute abdominal pain in patients [15]. Additionally, abdominal sonography is inexpensive as it shows how an organ's blood flows and offers real-time information on abnormalities like bowel movements [16]. For detecting the presence of abdominal abnormalities like constipation, appendix inflammation, ovarian torsion, testicular rotation, enlargement of mesenteric lymph nodes, intestinal infection, distended bowel loops, and inflammation of the urinary tract, computed tomography is the painless, non-invasive method of choice [17]. The sole disadvantage of CT compared to ultrasonography is that it uses ionising radiation and cannot move. When using USG, the diagnosis is sonographer-dependent, and its efficacy in detecting AAP in obese individuals is reduced [18]. Making an accurate or timely diagnosis might help a doctor get praise

for saving lives, as in the example of an inflamed appendix, but doing so can also have fatal consequences by either failing to act when it is important to do so or by doing unneeded procedures.

The study's aims were to find the best ways for early detection of acute abdominal pain in patients by using ultrasound or computed tomography. Diagnosing the condition causing acute abdominal pain is crucial for timely and effective treatment, understanding the comparative accuracy of ultrasound and CT findings in diagnosing these conditions can help healthcare providers choose the best imaging modality for emergency patients.

2. Material and Methods

2.1 Study Design, Setting, Inclusion & Exclusion Criteria and Ethical Considerations

This descriptive cross-sectional study was conducted on 93 patients utilizing a convenient sampling approach from August 2024 to December 2024. It was conducted in the radiology department of a private diagnostic center using computed tomography and ultrasonography in Lahore, Pakistan. All patients had a history of abdominal pain for more than 3 hours but less than 5 to 6 days throughout our research length, aged 10 to 60 years. This research excluded the pregnant women, patients with flank discomfort, acute abdominal aneurysms, suspected renal colic, traumatized patients, RTA, patients with normal clinical findings, and recalcitrant patients.

The study was conducted in accordance with the Declaration and Ethical Guidelines of Helsinki for studies involving humans and approved by the Institutional Review Board of the Faculty of Allied Health Sciences, the University of Lahore, Lahore, Pakistan (Reference No: UOL-IRB/AL/1634, 2024) on August 29th, 2024. Informed consent was obtained from all patients involved in the study. Participation in the study was voluntary, and students were notified that their responses would be kept confidential and anonymous.

2.2 Imaging Protocols

In the ultrasound procedure, a convex array probe with a frequency range of 3.5 to 7.5 MHz was employed using a transabdominal approach. Acoustic gel was applied to the abdomen to minimize acoustic impedance mismatch. The scan commenced by positioning the ultrasound transducer in the midline of the patient's abdomen, just below the xiphoid process. For imaging deeper structures, the sonographer selected a lower frequency setting and adjusted the depth according to the region of interest. The liver was examined in the transverse plane by gradually moving the transducer from the midline to the right upper quadrant. Boundaries of the liver, gallbladder, and hepatic arteries were identified. To obtain sagittal images of the liver and gallbladder, the transducer was rotated 90 degrees. The pancreas was assessed by continuing the scan in the transverse plane, shifting the transducer from the right upper quadrant to the left upper quadrant, allowing evaluation of the pancreas's head, body, and tail. The spleen was visualized by moving the transducer laterally and inferiorly from the left upper quadrant to the left lower quadrant. Each kidney was examined individually by positioning the transducer longitudinally just below the ribcage. Lastly, the urinary bladder was evaluated by lowering

the transducer to the suprapubic region, assessing bladder distention, wall thickness, and any potential masses or stones.

For the computed tomography (CT) procedure, a 64-slice multi-detector CT scanner was used. Scanning parameters included a tube voltage of 120 kV, a current of 200 mA, and a slice spacing of 5 mm.

2.3 Data Collection

After taking written informed consent form each participant, data was collected by the researchers with the help of the data collection tools. Data was collected using medical records of patients who visited the radiology department during the study period. A record of all previous reports of ultrasound and CT were taken from reporting room. The findings were noted along with demographic data such as patient name, age and gender.

2.4 Statistical Analysis

Data were evaluated and results compiled using SPSS version 23. The findings were presented in tables and graphs. Qualitative variables were described using frequency and percentage. Cross-tabulation was employed to determine the sensitivity and

specificity of both ultrasound and CT.

3. Results

Table 1 shows the gender of patients presenting with acute abdominal pain, which demonstrates that females 59 (63.4%) were more familiar with developing acute abdominal pain than males 34 (36.6%). The age groups of patients were categorized as less than 20 years 9 (9.7%), 21-45 years 39 (41.9%), 46-60 years 32 (34.4%), and more than 60 years 13 (14.0%). It illustrates that the age group between more than 21 and less than 45 years has the highest frequency of acute abdominal pain, while the age group below 20 years shows the lowest frequency. Acute abdominal pain can be caused by a variety of conditions, and this table provides some insight into the most common causes. The data shows that appendicitis is the most frequent cause of acute abdominal pain, accounting for 40 (43%), followed by diverticulitis 20 (21.5%). Acute abdominal discomfort is also frequently caused by cholecystitis, accounting for 22 (23.7%), while pancreatitis only accounts for 4 (4.3%) of cases. Inflammatory bowel disorder is the final cause of acute abdominal discomfort, accounting for 7 (7.5%) of all cases.

Category	Variable	Frequency (n)	Percentage (%)
Gender	Male	34	36.6%
	Female	59	63.4%
	Total	93	100%
Age Groups	Less than 20 years	9	9.7%
	21-45 years	39	41.9%
	46-60 years	32	34.4%
	More than 60 years	13	14.0%
	Total	93	100.0%
Causes of Acute Abdominal Pain	Appendicitis	40	43.0%
	Diverticulitis	20	21.5%
	Cholecystitis	22	23.7%
	Pancreatitis	4	4.3%
	Inflammatory Bowel Disease	7	7.5%
	Total	93	100%

Table 1: Demographic Characteristics and Common Causes of Acute Abdominal Pain Among Study Participants

Variable	Statistical Technique	Results	Conclusion				
Appendicitis on ultrasound	Crosstabulation	Appendicitis on computed tomography			Sensitivity $24 / (24+12) = 0.66$ Specificity $53 / (53+4) = 0.92$		
			Present	Absent		Total	
		Appendicitis on ultrasound	Present	24		4	28
		Absent	12	53		65	
Total		36	57	93			
Appendicitis on computed tomography	Crosstabulation	Appendicitis on ultrasound			Sensitivity $24 / (24+4) = 0.85$ Specificity $53 / (53+12) = 0.81$		
			Present	Absent		Total	
		Appendicitis on computed tomography	Present	24		12	36
		Absent	4	53		57	
Total		28	65	93			

Diverticulitis on ultrasound	Crosstabulation	Diverticulitis on computed tomography			Sensitivity $11/11+8 = 0.58$		
				Present	Absent	Total	Specificity $71 / 71+3 = 0.95$
		Diverticulitis on ultrasound	Present	11	3	14	
			Absent	8	71	79	
Total		19	74	93			
Diverticulitis on computed tomography	Crosstabulation	Diverticulitis on ultrasound			Sensitivity $11/11+4 = 0.78$		
				Present	Absent	Total	Specificity $71/71+8 = 0.89$
		Diverticulitis on computed tomography	Present	11	8	19	
			Absent	3	71	74	
Total		14	79	93			
Cholecystitis on ultrasound	Crosstabulation	Cholecystitis on computed tomography			Sensitivity $9/9+10 = 0.47$		
				Present	Absent	Total	Specificity $71 / 71+3 = 0.95$
		Cholecystitis on ultrasound	Present	9	2	11	
			Absent	10	72	82	
Total		19	74	93			
Cholecystitis on computed tomography	Crosstabulation	Cholecystitis on ultrasound			Sensitivity $9/ 9+2 = 0.81$		
				Present	Absent	Total	Specificity $72/72+10 = 0.87$
		Cholecystitis on computed tomography	Present	9	10	19	
			Absent	2	72	74	
Total		11	82	93			
Pancreatitis on ultrasound	Crosstabulation	Pancreatitis on computed tomography			Sensitivity $1/1+1 = 0.5$		
				Present	Absent	Total	Specificity $90/90+1 = 0.98$
		Pancreatitis on ultrasound	Present	1	1	2	
			Absent	1	90	91	
Total		2	91	93			
Pancreatitis on computed tomography	Crosstabulation	Pancreatitis on ultrasound			Sensitivity $1/1+1 = 0.5$		
				Present	Absent	Total	Specificity $90/90+1 = 0.98$
		Pancreatitis on computed tomography	Present	1	1	2	
			Absent	1	90	91	
Total		2	91	93			
Inflammatory bowel disease on ultrasound	Crosstabulation	Inflammatory bowel disease on computed tomography			Sensitivity $2/2+3 = 0.4$		
				Present	Absent	Total	Specificity $87/87+01 = 0.98$
		Inflammatory bowel disease on ultrasound	Present	2	1	3	
			Absent	3	87	90	
Total		5	88	93			
Inflammatory bowel disease on computed tomography	Crosstabulation	Inflammatory bowel disease on ultrasound			Sensitivity $2/2+1 = 0.6$		
				Present	Absent	Total	Specificity $87/87+3 = 0.96$
		Inflammatory bowel disease on computed tomography	Present	1	1	2	
			Absent	1	87	88	
Total		3	90	93			

Table 2: Cross tabulation for causes of acute abdominal pain on USG and Computed Tomography.

Diagnosis	Sensitivity USG	Sensitivity CT	Specificity USG	Specificity CT
Appendicitis	24/ 24+12 =0.66	24/ 24+4 =0.85	53/53+4 = 0.92	53/53+12 = 0.81
Diverticulitis	11/11+8 =0.58	11/11+4= 0.78	71 /71+3 = 0.95	71/71+8= 0.89
Cholecystitis	9/9+10 =0.47	9/9+2 =0.81	72/72+2 = 0.97	72/72+10 = 0.87
Pancreatitis	1/1+1= 0.5	1/1+1= 0.5	90/90+1=0.98	90/90+1=0.98
Inflammatory bowel disease	2/2+3 = 0.4	87/87+01=0.98	2/2+1= 0.6	87/87+3= 0.96

Table 3. The sensitivity and specificity for causes of acute abdominal pain on USG and Computed Tomography.

The table 3 shows the sensitivity and specificity of ultrasound (USG) and computed tomography (CT) scans in the diagnosis of different medical conditions. Sensitivity refers to the ability of a test to correctly identify those with a particular condition, while specificity refers to the ability of a test to correctly identify those without the condition. For appendicitis, USG has a sensitivity of 0.66 and CT has a sensitivity of 0.85, meaning that they can correctly identify 66% and 85% of patients with appendicitis, respectively. The USG has a specificity of 0.92, while the CT has a specificity of 0.81, meaning that they can correctly identify 92% and 81% of patients without appendicitis, respectively. For diverticulitis, USG has a sensitivity of 0.58 and CT has a sensitivity of 0.78, meaning that they can correctly identify 58% and 78% of patients with diverticulitis, respectively. USG has a specificity of 0.95, while CT has a specificity of 0.89, meaning that they can correctly identify 95% and 89% of patients without diverticulitis, respectively. The sensitivity of CT is higher than USG in diagnosing appendicitis and diverticulitis. For cholecystitis, USG has a sensitivity of 0.47 and CT has a sensitivity of 0.81, meaning that they can correctly identify 47% and 81% of patients with cholecystitis, respectively. USG has a specificity of 0.97, while CT has a specificity of 0.87, meaning that they can correctly identify 97% and 87% of patients without cholecystitis, respectively. For pancreatitis, both USG and CT have a sensitivity of 0.5, meaning that they can correctly identify 50% of patients with pancreatitis. USG and CT both have a specificity of 0.98, meaning that they can correctly identify 98% of patients without pancreatitis. For inflammatory bowel disease, USG has a sensitivity of 0.4 and CT has a sensitivity of 0.6, meaning that they can correctly identify 40% and 60% of patients with inflammatory bowel disease, respectively. USG has a specificity of 0.98, while CT has a specificity of 0.96, meaning that they can correctly identify 98% and 96% of patients without inflammatory bowel disease, respectively.

4. Discussion

The current study demonstrates that females (59, 63.4%) are more likely than males (34, 36.6%) to experience acute abdominal pain. A study conducted by MacKersie AB et al. published in 2015 also demonstrated similar results: females (55%) were more familiar with developing acute abdominal pain than males [19]. Another study conducted by Adrienne van Randen et al. published in 2011 also demonstrated similar results: the females (47, 51.6%) were more familiar with developing acute abdominal pain than males [20]. A study conducted by Thomas et al. in which four hundred three patients were discharged from the ED with undifferentiated abdominal pain. The female-to-male ratio was almost 3:1, which is also similar to the results of the present study [20].

The present study shows that the age group between 21–45 years has the highest frequency of acute abdominal pain 39 (41.9%), while the age group below 20 years and more than 60 years shows the lowest frequency 9(9.7%) and 13 (14%) respectively. A study conducted by Gianfranco Cervellin et al. published in 2016 also demonstrated similar results: the age group between 36 and 45 years has the highest frequency of acute abdominal pain (957, 17.92%). The mean age of the patients was 49 years for both genders [2]. Another study conducted by Adrienne van Randen et al. also demonstrated similar results, with a mean age of 47 years (range 19–94 years) [21].

Acute abdominal pain can be caused by a variety of conditions, and this study provides some insight into the most common causes. The present study shows that appendicitis is the most frequent cause of acute abdominal pain, accounting for 40 (43%), followed by diverticulitis 20 (21.5%). Acute abdominal discomfort is also frequently caused by cholecystitis, accounting for 22 (23.7%), while pancreatitis only accounts for 4 (4.3%) of cases. A study conducted by MacKersie AB et al. published in 2015 demonstrated similar results. The most common final diagnoses were acute appendicitis (n = 10), renal colic (n = 6), and acute diverticulitis (n = 6) [19]. Another study conducted by Gianfranco Cervellin et al. published in 2016 also demonstrated similar results: pancreatitis (1.89%) is least frequent [2]. Another study conducted by Adrienne van Randen et al. published in 2011 also demonstrated similar results: appendicitis (284; 28%) is most frequent, and pancreatitis (28; 2.7%) is least frequent [21].

The current study shows, for appendicitis, USG has a sensitivity of 0.66 and CT has a sensitivity of 0.85, meaning that they can correctly identify 66% and 85% of patients with appendicitis, respectively. The USG has a specificity of 0.92, while the CT has a specificity of 0.81, meaning that they can correctly identify 92% and 81% of patients without appendicitis, respectively. Our study shows that CT more accurately identifies patients with appendicitis than ultrasound. This is in agreement with a study published by Adrienne van Randen et al. that demonstrated similar results; ultrasound sensitivity in detecting acute appendicitis was 76% versus 94% for CT [21]. For diverticulitis, USG has a sensitivity of 0.58 and CT has a sensitivity of 0.78, meaning that they can correctly identify 58% and 78% of patients with diverticulitis, respectively. USG has a specificity of 0.95, while CT has a specificity of 0.89, meaning that they can correctly identify 95% and 89% of patients without diverticulitis, respectively. The sensitivity of CT is higher than USG in diagnosing diverticulitis. Adrienne van Randen et al., published in 2011, demonstrated similar results; ultrasound sensitivity for acute diverticulitis was 61% versus 81% on CT [21].

For inflammatory bowel disease, USG has a sensitivity of 0.4 and CT has a sensitivity of 0.6, meaning that they can correctly identify 40% and 60% of patients with inflammatory bowel disease, respectively. USG has a specificity of 0.98, while CT has a specificity of 0.96, meaning that they can correctly identify 98% and 96% of patients without inflammatory bowel disease, respectively. Adrienne van Randen et al. published research in 2011 demonstrating similar results. The sensitivity in detecting inflammatory bowel disorders was higher for CT (67%) than for ultrasound (37%) [21].

For cholecystitis, USG has a sensitivity of 0.47 and CT has a sensitivity of 0.81, meaning that they can correctly identify 47% and 81% of patients with cholecystitis, respectively. USG has a specificity of 0.97, while CT has a specificity of 0.87, meaning that they can correctly identify 97% and 87% of patients without cholecystitis, respectively. Joss R. Wertz et al. published research in 2018 demonstrating similar results: the sensitivity of CT for detecting AC was significantly greater than that of US: 85% versus 68% ($p = 0.043$), respectively [22]. Peter J.'s published article in 2015 also demonstrated similar results. Computed tomography was more sensitive than US for the diagnosis of AC (92% versus 79%, $p=0.015$) [23].

This study effectively compares the diagnostic accuracy of ultrasonography (USG) and computed tomography (CT) in identifying common causes of acute abdominal pain, using real patient data and standardized imaging protocols. Strengths include the use of both modalities on the same patient group, allowing direct comparison, and coverage of multiple conditions such as appendicitis, diverticulitis, and cholecystitis. However, the study is limited by a relatively small sample size ($n=93$), the operator dependency of ultrasound, and limited generalizability due to its single-center, non-randomized design. Future studies should include a larger, multi-center sample and assess inter-observer variability to enhance the generalizability and reliability of findings.

5. Conclusion

In diagnosing acute abdominal discomfort, CT has a higher rate of accuracy than USG. CT has a better sensitivity than USG in identifying appendicitis, diverticulitis, inflammatory bowel illness, and cholecystitis. In the event of pancreatitis, however, both USG and CT have the same sensitivity and specificity. Because ultrasonography is dependent on the observer and has certain limitations in obese patients, the proportion of missed cases on ultrasonography was considerably lower, and computed tomography enables a complete examination of the abdominal viscera.

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