e-ISSN: 0975-5160, p-ISSN: 2820-2651

Available online on www.ijtpr.com

International Journal of Toxicological and Pharmacological Research 2022; 12(9); 415-421

Original Research Article

The Effects of Contrast Medium Dose on Appendicolith Detection in Abdominal CT Scans: Hospital-based Research

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Received: 18-06-2022 / Revised 24-07-2022 / Accepted 21-09-2022
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Conflict of interest: Nil

Abstract:

Aim: The aim of the present study was to investigate the impact of the amount of contrast material used in abdominal CT examinations regarding the diagnosis of appendicolith.

Methods: This was a cross-sectional study that was performed to evaluate the diagnostic value of the CT examination in patients with acute appendicitis referred to Department of Radio-Diagnosis for 12 months. Two hundred patients that met the inclusion criteria entered the study using census method. Demographic data of patients including age, gender were obtained.

Results: In 70 patients, the CT scan findings were favorable for acute appendicitis, and the diagnosis was confirmed by the post-appendectomy pathological testing. Among the individuals undergoing CT scans, 5 false positive and 8 false negative results were recorded. The CT scan revealed that the patients had reduced peritoneal fat as well as a retrocecal appendix. The sensitivity, specificity, positive and negative predictive value of CT scans based on pathology results were 88.6%, 82.8%, 95.5%, and 78.2%, respectively, in patients with low clinical suspicion. We evaluated the CT scan and ultrasonography based on the gender of patients.

Conclusion: In the clinical cases that there is suspicion of acute appendicitis, nephrolithiasis and ureterolithiasis, the present study recommends the acquisition of an abdominal CT applying however the following workflow. The CT protocol should apply first a low-dose pelvis CT scan in the region of cecum without contrast material. Subsequently, a second CT scan should be acquired with the use of oral and IV contrast.

Keywords: Acute appendicitis; Appendicoliths; Nephrolithiasis; Computed Tomography (CT); Contrast material

Introduction

Acute appendicitis is one of the most common causes of abdominal pain in emergency departments. Acute uncomplicated and complicated appendicitis are epidemiologically and clinically different disease entities[1] also supporting the idea of a different pathophysiology and disease course. The majority (70–80%) of cases are uncomplicated. The incidence of uncomplicated acute appendicitis has been declining, whereas the incidence of complicated acute appendicitis has been quite steady over time.[2] Acute appendicitis is the most common source for this symptom and the lifetime probability

for acute appendicitis is approximately 7% (8.6% for males and 6.7% for females). [3,4,5,6] Although a surgical procedure can efficiently treat appendicitis, the rate/risk of appendectomy is much lower for males than for females (12% vs. 23%). [5,6] The presence of an appendicolith has been identified as an independent prognostic risk factor for treatment failure in nonoperative treatment of uncomplicated acute appendicitis,[7,8] and it has also been shown to be associated with appendiceal perforation.[9]

The data from the medical record of the patient is commonly used for the clinical diagnosis (e.g. positive signs of appendicitis, psoas sign in the physical examination, fever and elevated inflammation values in lab tests). If a definitive diagnosis of appendicitis has not been reached after the results of the physical examination, anamnesis, lab tests and transabdominal ultrasound (U/S) (and having excluded the possibility of pregnancy), a Computed Tomography (CT) examination of the abdomen should be performed. This should be especially the case for patients with atypical signs of appendicitis or suspected perforation.[10] Based on the above description, it appears that radiological imaging can be critical for diagnosis of appendicitis. In the case of suspected appendicitis, the level of the effective CT dose used in both the unenhanced and contrast-enhanced CT scans is significant. Hence, they do not fully characterize contrast material–enhanced CT examinations, which are commonly used in CT imaging.

Contrast medium administration is used in CT to provide better image quality. The formation of DSB double-strand breaks is generally followed by DNA repair, depending on the individual's DSB double-strand break repair capacity.[11] However that process presumably applies to both unenhanced and iodine-enhanced CT examinations. Therefore, the impact of iodine administration on radiation dose is relevant in spite of the biologic and physiologic complexities of cellular effects. Thus, it is important to characterize the impact of the dose associated with contrast medium in the context of individual patients.

Hence, investigating the impact of the amount of contrast material used in abdominal CT examinations regarding the diagnosis of appendicolith.

Materials and Methods

This was a cross-sectional study that was performed to evaluate the diagnostic value of the CT examination in patients with acute appendicitis referred to Department of Radio-Diagnosis, Narayan Medical College and Hospital, Jamuhar, Sasaram, Bihar, India for 12 months. Two hundred patients that met the inclusion criteria entered the study using census method. Demographic data of patients including age, gender were obtained. All patients received a medical history, a thorough physical examination, and standard laboratory tests. Based on these observations, an initial diagnosis was formed and recorded.

Inclusion and exclusion criteria

Inclusion criteria include patients with the acute abdominal pain between the ages of 15 to 65 years that referred to the emergency department (ED). Also, written informed consent was obtained from the patients. Exclusion criteria were determined, including patients with age below 15 years and more than 65 years, symptoms less than 72 hours, immunocompromised patients, and patients with other diseases.

Clinical findings

The Alvarado score was initially used to diagnose acute appendicitis (Table 1). In the majority of investigations, a score of 1-4 rules out acute appendicitis, while a score of 7 or higher confirms the diagnosis. With a score of 5-6, the patient can be watched and may require further testing. In the

current study we entered the patients with Alvarado score ≥ 7.[12]

Imaging protocol

A radiologist performed abdominal ultrasonography on all patients. Following ultrasonography, if a tentative diagnosis was made, treatment was initiated. The diagnostic criteria for appendicitis on ultrasonography were a dilated distal appendix measuring more than 6 mm in diameter with additional positive findings, including abscess, echogenic peri-appendicular fat, appendicolith, hyperemic appendiceal walls, or pericecal fluid, which was diagnostic of appendicitis. The ultrasonography report was read as negative, positive, or not visualized for acute appendicitis.

If the results of the ultrasonography were negative or unclear, a CT scan was performed using oral contrast. The radiologist reported the results of the CT scan. The diagnostic criteria for appendicitis on a CT scan were an appendix with a diameter greater than 6 mm and additional positive findings on a CT scan, such as cecal wall thickening, abscess, peri-appendicular fat stranding, appendicolith, or phlegmon, were considered diagnostic for appendicitis. The radiologist studied the CT data and deter- mined whether it was positive or negative for appendicitis. Finally, all CT scan data were reevaluated by an experienced radiologist and compared to the patient's final diagnosis in the case of surgery and pathology results.

Statistical analysis

After collecting the study da- ta, they were entered into SPSS software (version 25, IBM Corporation, Armonk, NY) and analyzed. The results are expressed as mean ± standard deviation. Comparison between the two groups weas performed using Student's t-test, Chi-square test or Fisher's exact test, when appropriate. P-value < 0.05 was considered as the significance threshold.

Table 1: The Alvarado score for acute appendicitis[12]

	Score
Symptoms	
Migratory of pain	1
Anorexia	1
Nausea and vomiting	1
Signs	
Tenderness in RLQ*	2
Rebound tenderness	1
Elevation of temperature > 37.3°C	1
Laboratory	
Leukocytosis	2
Shift to the left	1
Total	10

Results

Table 2: The relationship of CT scan results and negative and positive appendectomy

Variables		**Appendectomy**		P Value
		Positive	Negative	
CT Scan				
	Positive	70 (93.34)	5 (6.66)	< 0.001
	Negative	8 (32)	17 (68)	

In 70 patients, the CT scan findings were favorable for acute appendicitis, and the diagnosis was confirmed by the post-appendectomy pathological testing. Among the individuals undergoing CT scans, 5 false positive and 8 false negative results were recorded. The CT scan revealed that the patients had reduced peritoneal fat as well as a retrocecal appendix. It appears that the anatomical position of the cecum and appendix and the lack of adequate fat around the cecum and appendix contributed to the absence of acute appendicitis symptoms and the occurrence of false-negative results. These patients may benefit from a more thorough assessment with the use of a CT scan with contrast material injection.

Table 3: Sensitivity, specificity, positive and negative predictive values of CT scan and ultra- sonography for diagnosis of appendicitis based on the pathological findings

Variables	CT scan
Specificity	82.8%
Sensitivity	88.6%
Positive predictive value	95.5%
Negative predictive value	78.2%

The sensitivity, specificity, positive and negative predictive value of CT scans based on pathology results were 88.6%, 82.8%, 95.5%, and 78.2%, respectively, in patients with low clinical suspicion. We evaluated the CT scan and ultrasonography based on the gender of patients.

Discussion

Acute appendicitis has a lifetime incidence frequency of approximately 7%. The annual incidence ranges from 96.5 to 100 incidences per 100,000 adult population worldwide, with adolescents and children facing the highest risk.[13] The most prevalent cause of emergency abdominal surgery is acute appendicitis, which must be differentiated from other sources of abdominal pain.[14] Perforation and inflammatory mass may complicate the diagnosis in 2-10% of cases when it is delayed.[15] Acute appendicitis is diagnosed using a history and physical examination, laboratory testing, and imaging.[16] With these diagnostic techniques, it is anticipated that more than 90% of patients can be diagnosed with acute appendicitis quickly and accurately, including premenopausal women for whom gynecologic diseases can mimic appendicitis and elderly patients for whom appendicitis can present with unusual clinical symptoms such as lack of leukocytosis, generalized instead of localized abdominal pain.[17]

In 70 patients, the CT scan findings were favorable for acute appendicitis, and the diagnosis was confirmed by the post-appendectomy pathological testing. Among the individuals undergoing CT scans, 5 false positive and 8 false negative results were recorded. The CT scan revealed that the patients had reduced peritoneal fat as well as a retrocecal appendix. The sensitivity, specificity, positive and negative predictive value of CT scans based on pathology results were 88.6%, 82.8%, 95.5%, and 78.2%, respectively, in patients with low clinical suspicion. We evaluated the CT scan and ultrasonography based on the gender of patients. The most frequent cause of emergency abdominal surgery globally is appendicitis, which is characterized as inflammation of the vermiform appendix. It is still difficult for emergency physicians and surgeons to make a clinical diagnosis of acute appendicitis.[15] As a result, imaging modalities have taken on a far more significant role in the diagnostic work-up of patients who may have acute appendicitis.[18] Both CT and

ultrasonography have been shown to be useful in diagnosing cases of suspected acute appendicitis.[19] The decision between ultrasonography and CT is determined by avail- able competence and institutional preference. [15]

Ultrasonography is also frequently used for appendicitis diagnosis due to its widespread availability, portability, cost-effectiveness, and lack of ionizing radiation.[20]

In 2022, Naidu and others[21] conducted a study on 200 patients to compare ultrasonography abdomen and CT scan for the diagnosis of acute appendicitis. In comparison to abdominal ultrasonography, they discovered that CT scan diagnosis of acute appendicitis had great- er sensitivity, positive predictive value, and a negative appendectomy. Despite this, they highly recommend that CT scans be used to review all negative ultrasonography results to rule out acute appendicitis, even though they are far faster to conduct and spare most patients from ionizing radiation and contrast. A "first-pass" strategy using ultrasonography first and subsequently CT, if the ultrasonography is not diagnostic, may be preferable to balance test performance with adverse effects and ED patient throughput times. . In another study[22], 69 and 18 patients were evaluated by ultrasonography and CT scan, respectively. In this study, it was discovered that CT scanning can alter the treatment plan in uncertain situations, minimize hospital stay duration and expenses, decrease the complication rate and negative laparotomy rate, and decrease conversion to open surgery. Also, the researchers thought that a CT scan (rather than ultrasonography) was a better way to detect and manage acute appendicitis and its consequences.

Conclusion

In the clinical cases that there is suspicion of acute appendicitis, nephrolithiasis and ureterolithiasis, the present study recommends the acquisition of an abdominal CT applying however the following workflow. The CT protocol should apply first a low-dose pelvis CT scan in the region of cecum without contrast material. Subsequently, a second CT scan should be acquired with the use of oral and IV contrast. Furthermore, we propose the performance of an additional examination to identify the presence of appendicoliths as this may be of prognostic importance for appendiceal perforation.

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