ORIGINAL ARTICLE

VALIDITY OF FOCUSED ABDOMINAL CT SCAN [FACT] FOR THE DIAGNOSIS OF ACUTE APPENDICITIS IN CLINICALLY/ SONOGRAPHICALLY EQUIVOCAL CASES.

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ABSTRACT

PURPOSE: To determine the validity of focused (unenhanced) abdominal CT scan [FACT] in clinically/sonographically equivocal cases of acute appendicitis taking histopathology as gold standard. **SUBJECTS AND METHODS:** A cross sectional prospective study of 90 patients with clinical/sonographical suspicion of acute appendicitis referred for FACT to radiology department of Dr. Ziauddin Hospital Karachi over a period of 1 year. Out of these 90, 48 were males and 42 were females. The results were compared with surgical and histopathological findings. **RESULTS:** Out of 90 patients, CT diagnosis of acute appendicitis was made in 83 patients (92.22%) and 82 patients (98.79%) were diagnosed as acute appendicitis on histopathology following surgery and one patient (1.2%) was diagnosed as having non-inflamed appendix on histopathology (negative appendectomy). CT showed no signs of acute appendicitis in 7 patients which were operated on the basis of clinical suspicion and 5 patients (true negative) showed non-inflamed appendix. (1 patient - omental infarction, 2 patients - ovarian pathology and 2 patients - ileal perforation) and 2 patients showed appendicitis on histopathology (false negative). Therefore, FACT showed 97.61% sensitivity, 83.33% specificity and 96.66% diagnostic accuracy for acute appendicitis. **CONCLUSION:** This study proves that focused (unenhanced) abdominal computed tomography scan (FACT) is highly accurate and quick method to exclude or diagnose appendicitis in patients who are clinically/sonographically equivocal for acute appendicitis. It is also helpful in reducing negative appendectomies.

Key words: Acute appendicitis; appendectomy; focused unenhanced computed tomography scan; accuracy

Introduction

Acute appendicitis is the most common cause of acute abdominal pain in adult that requires surgery.[1] Appendicitis is defined as an inflammation of the inner lining of the vermiform appendix. In fact, despite diagnostic and therapeutic advancement in medicine, appendicitis remains a clinical emergency and is one of the more common causes of acute abdominal pain. The incidence of appendicitis gradually rises from birth, peaks in the late teen years, and gradually declines in the geriatric years.[2] The incidence is highest in boys aged 10 to 14 years and in girls aged 15 to 19 years.[3] Obstruction of the appendiceal orifice by fecolith, lymphoid hyperplasia, or neoplasm remains the most likely causative factor. Progressive appendiceal luminal distention compromises lymphatic and vascular flow, resulting in appendiceal wall ischemia followed by consequent bacterial invasion, inflammation, and frank perforation if surgical treatment is delayed. Perforation at presentation ranges from 16% to 30%, and it is significantly increased by a delay in diagnosis usually seen at extremes of age or atypical presentation.[4]

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Traditionally, acute appendicitis has always been a clinical diagnosis based on patient history, physical examination, and laboratory testing. A high percentage of negative appendectomies (20%) were considered reasonable, based on the premise that delay would inevitably lead to perforated appendicitis and thus increased morbidity and even mortality. This classical practice is currently being abandoned by most surgeons, as negative appendectomies are no longer considered acceptable. They carry a substantial morbidity, increase hospital costs and may be avoided by using preoperative radiological imaging or diagnostic laparoscopy.[5]

Acute appendicitis can be accurately diagnosed by using both Ultrasonography (US) and helical computed tomography. However, helical CT is being used with increasing frequency because it is less operator dependent than US. In addition, the normal appendix is more commonly visualized at CT practically excluding the diagnosis of acute appendicitis. The visualization of the ileo-cecal valve and its relationship to the base of the appendix provide important information to help identify the appendix on CT scans.[6] CT provides rapid and complete evaluation of the right lower quadrant in cases of appendicitis and clearly depicts the typical findings, including a distended appendix, appendicolith, infiltration of periappendiceal fat, and focal thickening of the base of the cecum.[7]

Unenhanced CT is not a new technique since the invention of CT scan, it has been widely used for the detection of urinary tract calculi (CT pyelogram) but its role in the detection of acute appendicitis is still evolving. By emphasizing its role in the detection of acute appendicitis with the help of FACT, we can improve our diagnostic capabilities. FACT is very quick, effective and non-invasive tool for the detection of acute appendicitis especially in clinically/ sonographically equivocal cases of appendicitis. CT scan is now emerging modality in our part of world and very few studies were performed to highlight this aspect of CT. By performing this study we can make the decision of diagnosis quick and easy. It is also helpful in reducing morbidity and mortality by decreasing the delay in the surgical intervention and improves the quality of life.

Material and Methods

This study included 95 patients presented with right iliac fossa pain/tenderness, vomiting, central abdominal pain + raised leucocytes count + fever. In all these cases clinical and sonographic examinations were equivocal. These patients were referred to CT scan department of Ziauddin Hospital for CT FACT. The study was conducted for the period of 1 year after approval from ethical committee of our hospital. After explaining the purpose, procedure, risks and benefits of study; informed consent was taken from all the patients.

CT FACT was performed with Activion™ 16 Multislice CT System (Toshiba Japan). The imaging protocols were: the slice thickness of 3-5 mm and pitch of 1.5 from level of L1 vertebral body to pubic symphysis. CT images were reviewed by our senior radiologist at least having experience of 5 years. All patients were followed until their surgical notes and histopathological reports. Five patients were excluded from our study because they did not undergo surgery in our hospital and their operative findings and histopathological data was not available for analysis. Histopathological findings of all patients who undergo subsequent surgery were collected and compared with the computed tomography findings.

All collected information entered into Statistical Package for the Social Sciences software (IBM SPSS statistics v 22; SPSS, Inc, Chicago, IL) analyzed through it. Descriptive analysis were conducted i.e. frequencies and percentage for categorical variables like gender, mean and standard deviation for the continuous variables like age, duration of symptoms. Results were calculated in terms of presence/absence of appendicitis on CT FACT out of total cases correlated with histopathological analysis, sensitivity, specificity, positive predictive value, negative predictive value and accuracy of CT in detecting appendicitis calculated by using histopathology analysis as “Gold Standard”.

Results

During the period of 1 year 90 patients were included in our study, 48 (53.33%) were males and 42 (46.66%) were females. Male to female ratio was

1.14:1. (Tab. 1 and Fig. 1)/ Out of 90 patients, CT diagnosis of acute appendicitis was made in 83 patients (92.22%). From 83 patients, 82 patients (98.79%) were diagnosed as acute appendicitis on histopathology following surgery. One patient (1.2%) was diagnosed as having non-inflamed appendix on histopathology/surgery and labeled as negative appendectomy (false positive).

Statistics	Value(s)
Number of patients (n)	90
Number of males	48
Number of females	42
Average age at presentation	20.44
Minimum age at presentation	6 years
Maximum age at presentation	46 years
Median (age)	18.5
Mode (age)	16

Table 1: Table showing age statistics of patients included in this study.

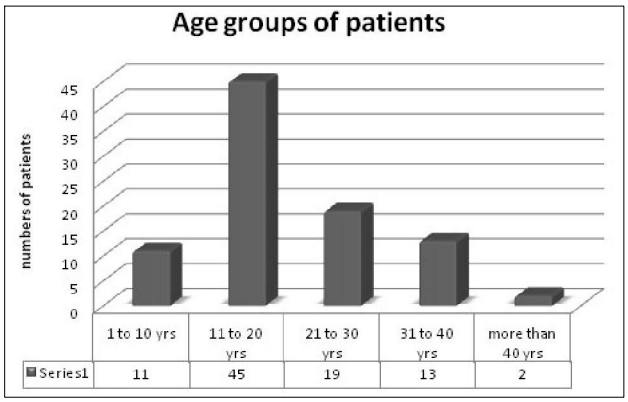

Figure 1: Bar chart showing distribution of patients according to their age groups in this study.

CT showed no signs of acute appendicitis in 7 patients which were operated on the basis of clinical suspicion and lab findings. Out of 7 patients, 5 patients showed non-inflamed appendix on surgery and labeled as true negative. Out of these 5 patients, 1 patient diagnosed as having omental infarction, 2 patients with ovarian pathology and 2 patients showed ileal perforation. Remaining 2 patients showed appendicitis on histopathology/surgery and labeled as false negative. Therefore, FACT showed 97.61% sensitivity and 83.33% specificity for acute appendicitis. Positive predictive value is 98.79% and negative predictive value is 71.42% (Fig. 2 and 3).

One of case interpreted as false negative because

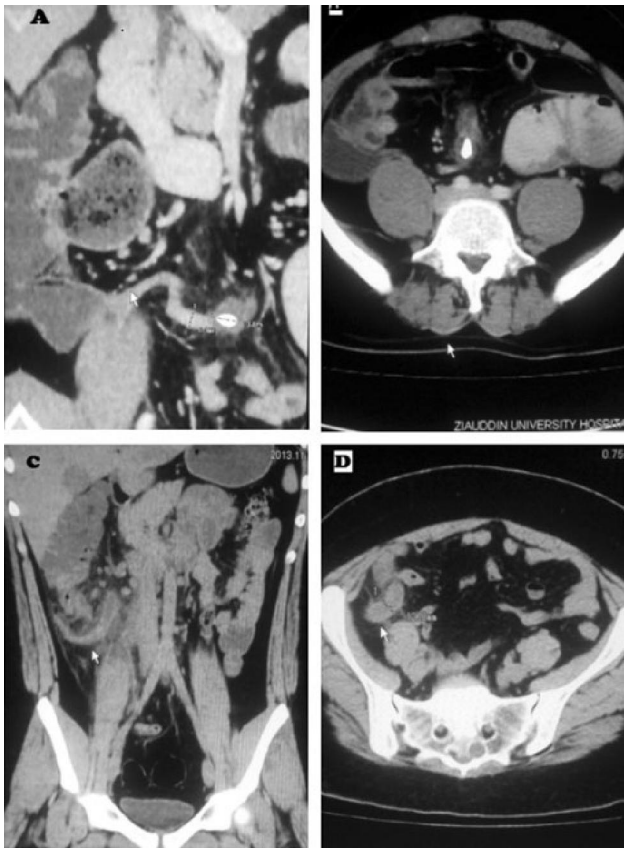

Figure 2: FACT axial and coronal reconstruction images of 3 different patients. Image A and B shows enlarged and fluid filled appendix showing gross peri appendiceal fat strandings. An appendicolith seen (cursor). Image C and D from two different patients showing enlarged and fluid filled appendix showing peri appendiceal inflammation.

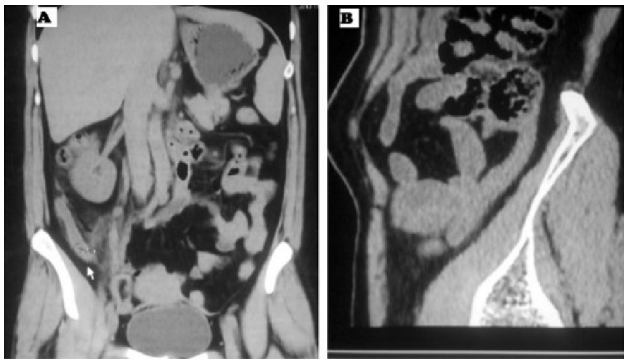

Figure 3: FACT coronal and curved MPR sagittal reconstruction images of 2 different patients showing elongated and enlarged fluid filled appendix associated gross peri appendiceal fat strandings.

of difficult visualization due to lack of body fat. In another false negative case the appendix was filled with fluid, air was present in proximal appendiceal lumen and showed normal range of the diameter. Acute appendicitis was correctly excluded pros-

pectively in 5 out of 7 patients (specificity 83.33%). The overall accuracy was 96.66% for diag-nosing acute appendicitis. The positive and negative predictive values were 98.7% and 71.42% respectively.

Discussion

Appendicitis is an acute inflammation of the appendix. Acute appendicitis is the common cause of abdominal pain. The diagnosis or exclusion of appendicitis is a common clinical problem. The clinical diagnosis of appendicitis is well known to be quite unreliable, with a classical presentation occurring in only 60% of patients. Many had a history of epigastric pain that led the clinicians to suspect pancreatitis or peptic ulcer disease. Others had diffuse abdominal pain without localization to the right lower quadrant. This fact reinforces the necessity to carefully evaluate the cecal and appendiceal region not only in patients with right lower quadrant pain but in all patients with unexplained epigastric or diffuse abdominal pain. Sometimes presentation is so atypical that even the most experienced surgeon may remove normal appendix. Incorporation of new diagnostic modalities in clinical decision making, low negative appendectomy rate can be achieved without increasing the rate of perforation. During the past years, Helical CT has dramatically improved our ability to detect appendicitis and its complications. It has led to improved patient outcomes and reduces the number of unnecessary surgeries. CT scan has proved to be superior to US in diagnosis of acute appendicitis and peri-appendiceal inflammation on the basis of being less operator independent, ease of interpretation and visualizing appendix in almost all anatomical locations especially in retro-cecal position. CT scan also gives benefit of alternative diagnosis in patients suspected of appendicitis. Therefore non-enhanced helical CT especially Focused CT to be an imaging modality of preference in cases of acute appendicitis.[8,9]

In this study we use same protocols for CT scan which Lane[11] et al used in their study which was published in 1999. Patients of all age group who presented to ER with clinical suspicion of acute appendicitis were referred to our department. CT scan studies were performed with a single breath-hold technique using 3-5mm collimation and 1.5 pitch. No oral, rectal or intravenous (iv) contrast was administered. The subsequent axial images with reconstructed, coronal and sagittal images were evaluated with special attention to determine the presence of normal or abnormal appendix. The CT findings were compared with surgery and histopathology findings. The CT scan interpretation used by CT scan was based on the primary and secondary diagnostic criteria described by lane[11] et al. Primary CT scan criteria for acute appendicitis are thickened appendix with a diameter of 6 mm or more, associated inflammatory changes in the peri-appendiceal fat, focal cecal thickening, lymphadenopathy and visualization of appendicolith were also noted prospectively. We found CT scan can detect an enlarged and inflamed appendix in 97.61 % (82/84). Ege[12] et al done a study on 296 adult patients between 1998-2000, and reported visualization of an inflamed appendix in 96% (104/108) on unenhanced CT scan. We also observed that periappendiceal mesenteric fat stranding was the most frequently visualized associated sign and was detected in 78 (95.12%) out of 82 true positive cases. Ege et al reported periappendiceal inflammation in 98% of patients with acute appendicitis. Rao[13] et al shows that an enlarged appendix with periappen-diceal fat stranding occurs in 93% of appendicitis. In this study one false negative interpretation that occurred due to thin, young patient with little intraperitoneal fat and lack of intraperitoneal fat in this patient resulted in obscuration of inflammatory process in the periappendiceal fat. Another false negative case was interesting in which only tip of appendix was inflamed and air was present in proximal appendix. Levine et al showed that most common reason for a false-negative CT scan in a patient with acute appendicitis is a paucity of intra-abdominal fat which serves as a natural contrast agent. This study shows there was 1 false positive that have appendicular diameter of 8mm but no periappendiceal inflammation. Aldaoud et al[14] also interpreted two out of three false positive cases due to increased diameter of appendix without periappen-diceal inflammation. Rao et al reported visualization of an appendicolith in 20-40% with appendicitis. We also observed that appendicolith is not frequently visualized as secondary sign and only observed in 29.26 % (24/82) in true positive cases.

Study also showed that 53.33% patients suffering from appen-dicitis were males. This is very much in accordance with international studies which favor slight male predilection for this disease. Aldaoud et al study yielded sensitivity of 90%, a specificity of 95%, and an accuracy of 95%. Edge et al study shows sensitivity of 96%, specificity of 98%, and an accuracy of 97%. Our study achieved a sensitivity of 97.61%, specificity of 83.33%, and an accuracy of 96.66%. Keyzer[15] et al were able to detect normal appendix in 98 (96.1%) of 102 patients. Our results were similar but better than Akhtar et al[16] that showed high sensitivity of 91%; intermediate specificity of 69% and accuracy of 76%. (Fig. 4)

In our study, we were able to detect normal appendix in 5 patients out of 7 cases. In this study, alternative diagnosis was established in 5 patients that showed non-inflamed appendix on surgery and labeled as true negative. Out of these 5 patients, 1 patient diagnosed as having omental infarction, 2 patients with ovarian pathology and 2 patients showed ileal perforation.

The alternative diagnosis based on CT scan findings were matched with the final diagnosis of the patients without acute appendicitis. Hence we were able to either prevent a negative laparotomy or influence the surgical management. Findings in the study by Aldaoud et al showed that an alternative diagnosis could be established in 95%.

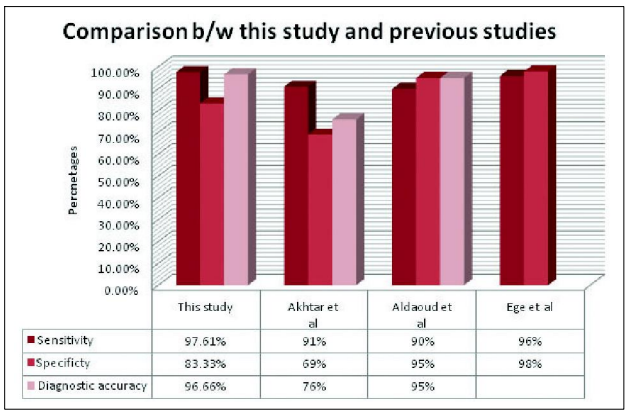

Figure 4: Bar chart showing comparison between this study and previous studies.

Conclusion

Focused (unenhanced) abdominal CT has high sensitivity for ruling out appendicitis and provides important ancillary information thus reducing negative appendectomy rate. Since, FACT is a relatively new and underused modality to diagnose appendicitis. Other reasons may include a lack of customized criteria for diagnosing appendicitis using FACT in our population.

It helps to make rapid decisions. Use of this rapid, non-invasive and highly accurate method improves patient care both by decreasing the delay in appropriate surgical management, reduces unnecessary hospital expenses and also guides in defining the disease extent and its associated complications.

With the help of experience and accurate interpretation of pathologies that mimics appendicitis clinically we can decrease unnecessary laparotomies and improve sensitivity and specificity. Taking into consideration the above advantages and high accuracy, FACT should be advised as routine screening method in patients clinical/sonologically equivocal for acute appendicitis.

FOOT NOTES

Disclosure

The authors declare no conflicts of interests in relation to this work.

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