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Investigating the Sensitivity and Specificity of CT Scan in Differentiation between Complicated and non-complicated Appendicitis

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Abstract

Introduction: Acute appendicitis is the most common explanation for acute abdomen presentation. CT scan is modality of choice in diagnosis of acute appendicitis and differentiates it from the other case of acute abdomen. This study evaluates accuracy of CT scan in differentiation complicated and non complicated appendicitis. Methods: our study is a retrospective study performed on 94 patients who underwent appendectomy in Firuzgar Hospital within a period of 2 years in 2016-2018. These patients examined by CT scan within 48 hr before surgery. CT scan evaluated by an expert radiologist and CT scan data compared with pathological results. Diagnosis of complicated appendicitis was performed base on one of five CT scan findings: abscess, phlegmon, extra luminal air, extra luminal appendicolith, focal defect in the appendiceal wall. In pathological results perforated and nonperforated gangrenous appendicitis classified as complicated appendicitis.Results: 33% and 67% of patients were female and male respectively .mean age of population was 36.5 years .sensitivity and specificity of CT scan in diagnosis of acute appendicitis were 100% and 78% respectively. This study showed the sensitivity and specificity and accuracy of CT scan in diagnosis of complicated appendicitis were 71%, 94%, 89% respectively.Conclusion: same of previous study, this study showed high sensitivity and specificity in diagnosis of acute appendicitis and also showed high specificity in diagnosis of complicated appendicitis. In present study, the sensitivity of CT scan in diagnosis of complicated appendicitis is lower than previous studies probably because gangrenous non perforated appendicitis cases didn't have prominent finding in CT scan for differentiation from non gangrenous non perforated appendicitis (non complicated appendicitis).

Key words: Acute appendicitis, complicated appendicitis, CT scan, Appendectomy

Introduction

Acute appendicitis is the most common explanation for the acute abdomen presentation to an emergency department shows life time risk of 7%. (D'Souza and Nugent, 2016) The most commonly accepted pathogenesis of appendicitis is the obstruction of the appendiceal lumen by fecalith, lymphoid hyperplasia, foreign bodies, parasites or primary or metastatic tumors.(Leung*et al.*, 2010; Petroianu*et al.*, 2007) The early stage of appendicitis develops when obstruction leads to fluid accumulation; elevation of intra luminal pressure and luminal distention and ultimately ischemia. Subsequently the appendix enlarges and incites inflammatory changes in the surrounding tissues such as in the pericecal fat and peritoneum. (Petroianu and Barroso, 2016) Delayed diagnose and surgically treatment at an early stage, may cause progression to gangrene and perforation of appendix. Gangrenous appendicitis results when increasing intramural inflammatory changes leads to appendiceal ischemia and transmural necrosis with serosal exudates. Gangrenous change leading to perforation.(Dogra, 2014) In many patients with appendiceal perforation a liquefied abscess forms either in the peritoneal cavity (RLQ or pelvis) or in the retroperitoneum often in the right anterior pararenal space with retrocecal appendicitis.in other patients an indurate inflammatory mass (phlegmon) develops involving the surrounding soft tissue involving the meso appendix, omentum, small bowel and its adjacent mesentery. (Carr, 2000) The typical clinical presentations of acute appendicitis are right lower quadrant (RLQ) pain, tenderness and fever, mass may also be palpable. The clinical diagnosis is aided by laboratory finding as increased WBCcount. (Nshuti*et al.*, 2014) up to one third the patient with a classic presentation may have an appendectomy without preoperative imaging this approach often become complicated when a normal appendix is removed in a patients with symptoms causal by other factors. On the other hand up to one third of patients with acute appendicitis have atypical presentation. Surgery may be delayed in this patients and lead to gangrenous appendicitis and perforation before the surgery, making it a complicated and difficult procedure, often followed by abscess formation. Perforation occurred in up to 35% of patients. (Rumark, 2018) Negative laparotomy and other hand delayed surgery can be avoided in many patients if modern diagnostic methods are used to confirm or exclude acute appendicitis. multidetector computer tomography (CT) decrease negative appendectomy from 20% to 2.5%. (Raja*et al.*, 2010) Both CT scan and ultrasound provide sensitive and accurate diagnosis of appendicitis, the choice of imagining modality is determined somewhat by local expertise. CT is modality of choice to diagnose of acute appendicitis and differentiate it from the other cause of acute abdomen. Ultrasound seems to be less sensitive and less

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accurate in diagnose of acute appendicitis as compared to CT scan (Hernanz-Schulman, 2010) But U/S is modality of choice in woman and children. The sensitivity of sonography for diagnosis of appendicitis decreases with perforation. (Rumark, 2018)

This study attempts to evaluate efficiency of CT examination for diagnosis of appendicitis and differentiation between complicated (perforated and gangrenous) appendicitis and non complicated appendicitis using by 16 slice CT scanner.

Patient and Method

The present study is a retrospective study which is performed on 94 patients within a period of 2 years between 2015-2017.the patients underwent appendectomy in the Firouzgar hospital and examined by CT scan within a period of 48 hours before appendectomy. The examinations were performed using Siemens 16-slice scanner in supine position. The scan parameters included: slice thickness ranged 5 mm, kvp 110. 72 patients were injected intravenous contrast medium during CT scan, while examination performed in 23 patients without intravenous contrast medium. The final diagnosis of acute appendicitis and differentiation between noncomplicated and complicated appendicitis (gangrenous and perforate appendicitis) were based on post operative pathological reports. The CT findings were reported by an expert radiologist .previous report of CT scan and the pathologic findings were hidden from the radiologist. Acute appendicitis in CT scan was diagnosed by observing of two findings: swollen appendix (>6 mm in diameter) and stranding of periappendiceal fat planes. The diagnosis of complicated appendicitis was reported by at least one of five CT findings including abscess formation, phlegmon, extraluminal air, extraluminalappendicolith and focal defect in the appendicular wall. An abscess was determined by well circumscribed collection or air fluid level with nearly intact enhancing wall. The phlegmon was defined as condensation of fat stranding and soft tissue thickening with or without ill-defined free fluid collection. Extra luminal air pockets were seen at the right iliac region mainly and sometimes seen at the right hypochondrial region rarely at the epigastric region.
The statistical data was analyzed using different five CT findings for differentiation between non- complicated and complicated acute appendicitis. The sensitivity, specificity, accuracy, positive predictive value (PPV) and negative predictive value (NPV) were calculated for each CT finding after correlation with the pathological outcome.

Results

In this study, 67% were male and 33% were female (63 males and 31 females) ranging between 11-73 years old and mean age was 36.5 years .the sensitivity and specificity of CT scan in diagnosis of acute appendicitis were 100% and 78% respectively. The accuracy of diagnosis was 94%. Also PPV and NPV were 92% and 100%. (Table 1)

Table 1: The sensitivity, specificity, accuracy, positive predictive value (PPV), negative predictive value (NPV) were evaluated for each CT finding individually in diagnosis of acute appendicitis

	sensitivity	Specificity	Accuracy	PPV	NPV
Male	100%	75%	94%	92%	100%
Female	100%	82%	94%	91%	100%
Male & female	100%	78%	94%	92%	100%

In pathology report, 17 patients (18%) had complicated appendicitis (perforated and gangrenous non perforated appendicitis) and 50 patients (53%) had non-perforated appendicitis. 27 patients (30%) had normal appendix or other conditions, not acute appendicitis in pathology evaluation for example: xanthogranuloathos appendicitis, congested appendix, fibrosis of appendix and follicular hyperplasia of appendix. (table2)

Table 2.Study of population including number of patients, average age, SD, range of age and also number of perforated, acute & normal appendicitis after diagnosis in pathology separated by gender

	Number	Average age	SD	Range	complicated	Acute	Normal &etc
Male	63	34.4	14	11-73	12 (19%)	35 (56%)	16 (25%)
Female	31	41.5	17.5	12-71	5 (16%)	15 (48%)	11 (35%)
Male & female	94	36.53	15.4	11-73	17 (18%)	50 (53%)	27 (30%)

We diagnosed complicated appendicitis based of one of these findings in CT scan: abscess, phlegmon, extaluminalair,extraluminalappendicolith, focal defect in appendicular wall. The sensitivity, specificity, accuracy, positive predictive value (PPV) and negative predictive value (NPV) were calculated for each CT finding after correlation with the pathological outcome as table 3.
CT evaluations of these patients showed 17 (18%) patients with complicated appendicitis and 57 (61%) patients with acute appendicitis without complication. 20 patients (21%) had normal appendix in CT scan.

Table 3: number of perforated, acute appendicitis and normal appendix base on gender by CT report after appendectomy

	CT scan evaluation		
	N of Perforated	N of Acute	N of Normal &etc
Male	13	38	12
Female	4	19	8
Male & female	17	57	20

The sensitivity of CT scan in diagnosis of complicated appendicitis was 75%, 50% and the specificity was 92%, 96% in males and females respectively. Also accuracy was 89% and 90% in male and female respectively. The PPV and NPV between two group bases on gender calculated 69% and 94% for males and 67% and 93% for female according to Table 4.

Table 4: Evaluation of complicated appendicitis base on gender by CT report

	Male & Female	Male	Female
Sensitivity	71%	75%	50%
Specificity	94%	92%	96%
Accuracy	89%	89%	90%
PPV	71%	69%	67%
NPV	94%	94%	93%

Table 5: The sensitivity, specificity, accuracy, positive predictive value (PPV), negative predictive value (NPV) were evaluated for each CT finding individually in diagnosis of complicated appendicitis

CT findings	Abscess	Phlegmon	Extraluminal air	Extraluminalappendicolith	Focal defect in the appendicular wall
Sensitivity	29%	24%	35%	12%	6%
Specificity	99%	96%	97%	99%	95%
Accuracy	86%	83%	86%	83%	79%
PPV	83%	57%	75%	67%	20%
NPV	86%	85%	87%	84%	82%

Discussions

Acute appendicitis is the most common acute abdominal surgery. Usually diagnosis of acute appendicitis is based on patient history, clinical finding and laboratory data.

The accuracy of clinical diagnosis of acute appendicitis varies between 76%-92%. (Moghimi*et al.*, 2015) The diagnostic value of CT scan is well established, as many studies revealed high sensitivity and specificity in detection of acute appendicitis ranging between 94-98%. (Rao*et al.*, 1998) But diagnosis of acute appendicitis is not enough for clinician, also determination of severity and associated complication and differentiation between the complicated (gangrenous and perforated) appendicitis and non complicated acute appendicitis is important. The management of complicated and non complicated appendicitis is not same and in case of perforated appendicitis many surgeons avoid surgical approach for fear of preoperative complications as intra abdominal sepsis, intestinal fistula and reoperation. (Oliak*et al.*, 2000) Some studies proved that conservative management and percutaneous drainage is preferred for perforated appendicitis with or without interval appendectomy. In the other hand the rate of postoperative intra abdominal abscess formation was significantly greater in patient with non perforated gangrenous appendicitis in comparison to those with simple non perforated appendicitis and patients with non perforated gangrenous appendicitis should receive extended course of post-operative antibiotics. (van den Boom*et al.*, 2018) This is why it is important that we differentiate complicated and non complicated appendicitis by imagining. Ultrasound frequently does not allow the detection of perforated appendicitis. (Tulin-Silver*et al.*, 2015)

In the other word US is highly specific but non sensitive for detection of perforated appendicitis .several US findings are associated with perforation ,especially the presence of complex periappendiceal fluid. (Carpenter*et al.*, 2016)

Our study shows each CT findings (abscess, phlegmon, extraluminal air, extraluminalappendicolith, focal defect in the appendiceal wall) had sensitivity ranging between 6 and 35% While each finding is used alone and sensitivity is 75% while any of these findings is used for

diagnosis of perforated appendicitis. Sensitivity of CT findings for diagnosis of perforated Appendicitis is lower in females, (50% and 75% in females and males respectively). Lower sensitivity in females probably is due to gynecologic problem in these patients.

In our study the sensitivity of extraluminal air is highest (35%) and the sensitivity of focal wall defect is lowest (6%) in diagnosis of complicated appendicitis.

Talaat et al evaluate CT scan of 85 patients in a prospective study over a period of 2 years, the patients performed 256 slice CT scan and followed by appendectomy within 4-48 hr after ending the CT examination. The sensitivity of abscess formation, phlegmon, extra luminal air , extra luminal appendicolith, focal defect in the appendiceal wall were 46%, 51%, 37%, 20%, 40%respectively.when the diagnosis of perforated appendicitis was based on detection of at least one CT finding, sensitivity rise 97%. (Ali and Nabil, 2017)

Mindy et al reviewed the CT scan of 94 patients with acute appendicitis, the reported sensitivity for abscess, phlegmon, extra luminal air, extra luminal appendicolith and focal defect in the appendiceal wall in diagnosis of perforated appendicitis were 36%, 46%, 36%, 21% and 64% respectively. (Horrow*et al.*, 2003)

In our study the sensitivity of focal defect in the appendiceal wall in diagnosis of perforated appendicitis was very low (6%) in compare to Talaat study (40%).

Similarly, Maniatis et al performed a retrospective study and found that the sensitivity of CT scan in diagnosis of perforated appendicitis reached 97%. (Maniatis*et al.*, 2000)

Our analyze shows the specificity of CT scan in diagnosis of perforated appendicitis were 94%. (92% and 96% in male and females respectively). Specificity for abscess, phlegmon, extraluminal air, extreluminalappendicolith, focal defect in the appendicular wall were respectively 99%, 96%, 92%, 99% and 95%.in the other words the highest specificity in diagnosis of perforated appendicitis were for abscess and extraluminalappendicolith and the lowest specificity was for extraluminal air. In Talaat study, the specificity of CT scan in diagnosis of perforated appendicitis was between 86% and 100%. In this study, the specificity of abscess, extraluminal air and extraluminalappendicolith were 100% and phlegmon had the lowest specificity in diagnosis of perforated appendicitis (86%). (Ali and Nabil, 2017)

Kim et al in a systematic review, evaluate twenty-three studies, and 184 overlapping descriptors for various CT findings were subsumed under 14 features. of these,10 features were informative for complicated appendicitis. there was a general tendency for these features to show relatively high specificity (74%-100%),but low sensitivity (14%-59%). (Kim*et al.*, 2017)

Our study shows high specificity in diagnosis of perforated appendicitis, same previous studies but lower sensitivity in diagnosis of perforated appendicitis in compare to previous studies. It is probably due to pathologic findings; we categorized patients to two groups, patients with non complicated appendicitis (acute none perforated non gangrenous appendicitis) and patients with complicated appendicitis (perforated appendicitis and gangrenous non perforated appendicitis). CT findings in gangrenous non perforated appendicitis is not prominent and it can cause CT diagnosis of gangrenous non perforated appendicitis be less than the actual .in the other word we did not find significant findings to differentiate simple acute appendicitis from gangrenous non perforated appendicitis.

Another limitation of our study included type of study (retrospective study). In the other word while the radiologist knows patients underwent appendectomy, he performs targeting evaluation of appendix in CT scan and in this condition sensitivity and specificity of evaluation may be different from the truth.

Conclusion

Along with clinical and laboratory findings CT scan is a helpful modality in diagnosis of acute appendicitis .also CT scan is modality of choice in differentiation of complicated and non complicated appendicitis. CT findings show high specificity and acceptable sensitivity in differentiation of complicated and non complicated appendicitis. But more studies should be done to evaluate CT scan ability in diagnosis of gangrenous appendicitis before perforation of appendix.

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