Value of Contrast Enhanced MDCT in Distinguishing Complicated from Non-Complicated Acute Appendicitis

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Abstract

Objectives: To estimate the value of Contrast enhanced MDCT in preoperative distinguishing complicated from non-complicated acute appendicitis.

Patients and Methods: All surgical reports of appendectomies done from January 2015 to January 2016 were retrospectively checked. Cases were included only if abdominopelvic CE-MDCT scans were done prior to surgery and who underwent appendectomy within the subsequent 24 hours after MDCT imaging and pathology reports confirmed the diagnosis of appendicitis. One hundred and two cases (Males/Females = 87/15) with their age ranged from 14-33 years ≥±4 were included in this study.

Results: One hundred and two patients (Males/Females = 87/15) age range (14-33) years ≥±4 complied with the selection criteria. According to radiological, surgical and pathological findings; 76 cases were diagnosed as acute non complicated appendicitis while 26 cases were complicated appendicitis. Complications were as follow: 18 cases perforated acute appendicitis, 2 cases complicated with appendicular mass due to phlegmon and 6 cases were complicated with abscess. The scans also could detect the presence of intraluminal appendicoliths in 48 cases, combined intraluminal + extra luminal appendicoliths in 4 cases, presence of extra luminal air in 14 cases, caecal wall thickening in 59 cases and small bowel reactive dilatation in 6 cases.

Conclusion: MDCT using the axial and coronal reformed images improves the self-confidence in the preoperative diagnosis of acute appendicitis and its complications with high benefits on both the clinical outcome and cost–effectiveness for the patients presented to the hospitals with suspected appendicitis.

Key Words: MDCT – Appendicitis – Phlegmon – Appendicoliths.

Introduction

ACUTE appendicitis is the most common cause of abdominal surgical emergency. Appendectomy is therefore, one of the most frequently performed surgical procedures worldwide with a subsequent major impact upon the current health systems [1,2].

Accurate and timely diagnosis of pre-operative acute appendicitis significantly diminishes morbidity and mortality of the disease [1-3]. Delay in the diagnosis increases the danger of complicated appendicitis, postoperative complications and the medical cost [4]. On the other hand, misdiagnosis of assumed appendicitis lead to unneeded surgeries, major affectation of patient’s daily life and significant waste of hospital finances in addition to the esteemed postoperative complications [5]. The reported rates of unneeded appendectomies are variable where they reach up to 20% in surgical literature. The presence of other abdominal pathological conditions with similar clinical presentation increases the difficulty in diagnosis of appendicitis and increases the rate of unneeded surgical appendectomies or laparotomies [1,6-8].

The main goal in diagnosis of acute appendicitis is to differentiate a non-complicated simple acute appendicitis from complicated acute appendicitis. The clinical management is significantly different in both cases.

Although clinical assessment is the mainstay of diagnosis of acute appendicitis, imaging is a valuable tool to help reaching a definite diagnosis. Using advanced imaging modalities including MDCT in assessment of patients with symptoms suggestive of acute appendicitis can avoid the negative operations or reduce their rate of occurrence [9,10].

In spite of the advances in imaging modalities, surgeons are still convinced that the clinical diag-
nosis of acute appendicitis is sufficient. They therefore, withstand the usage of CT in the routine diagnosis [11]. Most surgeons, however support the use of MDCT in patients at high risk for error in diagnosis such as fertile women, obese patients, and patients in extremes of age. The indiscriminant use of MDCT scanning in virtually all patients is still being criticized [12].

In the United States; the decision of diagnosis of acute appendicitis is now dependent upon the imaging diagnosis rather than clinical findings alone even if the diagnosis was certainly made based on the clinical findings alone. This change may be attributed to many factors; the need for immediate diagnosis by imaging rather than follow up the patients in the busy emergency departments, the wide-ranging accessibility of MDCT, the need for reduction of the percentage of appendectomies and the worry of medico-legality when there is missing diagnosis [13].

The use of CT axial images alone in the detection of the appendix is limited because the appendix has a tortuous course. Adding Coronal Reformat images obtained from MDCT increases the detection rate of normal appendix and the accurate exclusion of acute appendicitis especially in clinical situations mimicking appendicitis [14]. This is especially useful for clinicians with low expertise in evaluating CT scans by supplying a concise anatomic overview of the relationship between the inflammation of the appendix and the surroundings [11,15]. The coronal reformat images, which is correspondent to antro-posterior view of X-ray abdomen was found to be more familial for both surgeons and radiologists [16,17].

MDCT was found recently to have a noticeable value in diagnosis of acute appendicitis and its complications with accuracy of 99% for the diagnosis. Therefore, some governments now suggest the use of imaging by MDCT as a routine for all cases with suspected acute appendicitis [3].

Aim of the work:

Aim of the current study was to estimate the value of preoperative contrast enhanced MDCT in distinguishing complicated from non-complicated acute appendicitis.

Patients and Methods

All surgical reports done at King Fahad Hospital, Al-Madinah Al-Munwarah from January 2015 to January 2016 were retrospectively checked to define cases of appendectomies done during this period. Cases were included only if they fulfill all of the following criteria: (1) Age of patients above 12 years, (2) They have a contrast enhanced abdominopelvic MDCT (CE-MDCT) scans done prior to surgery, (3) Who underwent appendectomy within the subsequent 24 hours after the MDCT imaging and (4) Have pathology reports confirmed the diagnosis of appendicitis.

One hundred and two patients fulfilled this criteria, (Males/Females = 87/15) with their age ranged from 14-33 years ±5.4. Patients were excluded from the study if they underwent appendectomies without performing MDCT prior to surgeries or whom surgeries were done in a period more than 24 hours from MDCT imaging and also in cases without pathological reports and if the patient age <12 years and patients who were allergic to iodinated contrast material. Correlation of the MDCT imaging findings with those of surgery were done.

Examinations:

Clinical data of patients was checked. Patients were diagnosed clinically as acute appendicitis according to the modified Alvarado scoring system [18], and patients with an equivocal history and physical and laboratory findings were subjected to abdominopelvic MDCT scanning with IV and oral contrast.

Patient's preparation:

Patients were asked to ingest about 1.5 liter of diluted Gastrografin with water 2 hours prior the examination. 100ml of IV contrast material were injected using a rate of 2-3ml/sec and starting to scan after the end of contrast injection.

Scanning parameters for abdominal or abdominopelvic MDCT:

Because of the retrospective nature of the study, the imaging parameters used were those of the routine protocol done in the hospital. All MDCT studies were performed using 64 channel MDCT scanners beginning 50-60 seconds after the initiation of contrast material injection. Images are acquired with 0.75-2.5mm collimation, a pitch of 1-1.5, 120kVp, 100-140mAs and a section thickness of 3-5mm and a reconstruction interval of 3-5mm.

Image analysis:

For each case, the axial and coronal reformatted images were reviewed to identify signs supporting the diagnosis of acute appendicitis: Dilated appendix (>0.6mm), thickened wall (>0.2mm), enhanced wall (by comparing the suspected segment with
unaffected small bowel loops), peri-appendiceal fat stranding. Perforated acute appendicitis was diagnosed when the diameter of the appendix was (>0.6mm) with at least one of the five specific CT signs; a defect within the enhanced wall, peri-appendiceal phlegmon (fluid collections surrounding the appendix, without a clear wall) or abscess; (when the phlegmon shows a well-defined thickened wall that show peripheral enhancement after injection of contrast medium), extraluminal air and extraluminal appendicolith. Diagnosis of appendiceal mass was made by the presence of an inflammatory mass consisting of an inflamed appendix and adjacent viscera, ranging from phlegmon to well-defined abscess. The presence or absence of any mass effect upon the surroundings structures were also recorded.

Presence or absence of associated mesenteric Lymph nodal enlargement was defined. The liver and the rest of the abdominal and pelvic organs were assessed for any associated abnormality.

Statistical methods:

Descriptive statistical analysis was done with IBM SPSS Statistics software release 21; SPSS Inc. for windows (Microsoft). Data were collected, checked, coded and entered. Statistical methods included descriptive analysis like; mean ± standard deviation, number and percentage, frequencies, sensitivity and significant tests ... etc.

Results

One hundred and two patients (males/females = 87/15) ranging in age from 14 to 33 year (SD ±5.4) with a mean of 23 year complied with the selection criteria of having management including appendectomies within 24 hours of contrast enhanced abdominopelvic MDCT scans and pathology reports confirmed the diagnosis of appendicitis.

According to the radiological, surgical and pathological findings; 76 cases (74.5%) were diagnosed as acute non complicated appendicitis, Twenty six cases (25.5%) were diagnosed as complicated appendicitis; out of these complicated cases 18 cases (17.6%) were diagnosed as acute appendicitis complicated with perforation. Acute appendicitis complicated with appendicular mass was seen in 8 cases (7.8 %); out of these 8 cases, 2 cases (2.0%) were diagnosed as appendicular mass due to phlegmon and 6 cases (5.9%) could be diagnosed as appendicular mass due to abscess formation (Table 1).

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>No. of cases</th>
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<tbody>
<tr>
<td>Acute non complicated appendicitis</td>
<td>76 (74.5%)</td>
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<tr>
<td>Acute appendicitis with complications:</td>
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<tr>
<td>• Acute appendicitis complicated with perforation</td>
<td>26 (25.5%)</td>
</tr>
<tr>
<td>• Acute appendicitis complicated with appendicular mass due to phlegmon</td>
<td>18 (17.6%)</td>
</tr>
<tr>
<td>• Acute appendicitis complicated with appendicular mass due to abscess formation</td>
<td>2 (2.0%)</td>
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Patients were classified into two groups; Group 1 (patients with acute non complicated appendicitis). Group 2 (patients with acute appendicitis complicated with simple perforation or complicated with appendicular mass due to either phlegmon or abscess.

Group (1): Patients diagnosed as acute non complicated appendicitis. This group involved 76 cases; The MDCT signs of acute appendicitis that were seen in those patients were as follow; appendiceal dilatation in 68/76 cases (89.5%); thickened enhanced wall in 76/76 cases (100%), peri-appendiceal fat stranding in 76/76 cases (100%), isolated intra luminal appendicoliths in 35/76 cases (46.1%), thickening of the wall of the caecum in 40/76 cases (52.6%), enlarged mesenteric lymph nodes in 55/76 cases (72.4%), no small bowel reactive dilatation was seen in this group of patients (Table 2) and (Fig. 1).

Table (1): Surgical, MDCT and pathologic diagnosis of the studied cases.

<table>
<thead>
<tr>
<th>MDCT Findings</th>
<th>No. of Cases/76</th>
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<tbody>
<tr>
<td>Appendiceal dilatation</td>
<td>68 (89.5%)</td>
</tr>
<tr>
<td>Thickened enhanced wall</td>
<td>76 (100%)</td>
</tr>
<tr>
<td>Peri-appendiceal fat stranding</td>
<td>76 (100%)</td>
</tr>
<tr>
<td>Isolated intra luminal appendicoliths</td>
<td>35 (46.1%)</td>
</tr>
<tr>
<td>Thickening of the wall of caecum</td>
<td>40 (52.6%)</td>
</tr>
<tr>
<td>Enlarged mesenteric lymph nodes</td>
<td>55 (72.4%)</td>
</tr>
<tr>
<td>Small bowel reactive dilatation</td>
<td></td>
</tr>
</tbody>
</table>

Group (2): Patients diagnosed as acute appendicitis with complications. This group involved 26 cases; 18 cases with perforation; 2 cases with appendicular mass due to phlegmon and 6 cases with appendicular mass due to abscess formation. The following MDCT signs were seen in those patients; appendiceal dilatation in 22/26 cases (84.6%); thickened enhanced wall in 22/26 cases (84.6%), peri-appendiceal fat stranding in 22/26 cases (84.6%), focal defect within the enhanced wall in 21/26 cases (80.6%), isolated intra luminal
appendicoliths in 13/26 cases (50%), combined intra and extra luminal appendicoliths in 4/26 cases (15.3%), periappendiceal fluid collection in 24/26 (92.3%), extra luminal air was seen in 14/26 (53.8%), thickening of the wall of caecum in 19/26 cases (73.1%), enlarged mesenteric lymph nodes in 26/26 cases (100%), appendicular mass due to phlegmon in 2/26 cases (7.6%), appendicular mass due to abscess formation in 6/26 (23.1%) cases and small bowel reactive dilatation in 6/26 patients (23.1%) (Table 3) (Figs. 2,3).

Table (3): Frequency of identification of individual MDCT findings in acute appendicitis with complications, Group 2 (26 patients).

<table>
<thead>
<tr>
<th>MDCT Findings</th>
<th>No. of Cases/76</th>
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<tbody>
<tr>
<td>Appendiceal dilatation</td>
<td>22 (84.6%)</td>
</tr>
<tr>
<td>Thickened enhanced wall</td>
<td>22 (84.6%)</td>
</tr>
<tr>
<td>Peri-appendiceal fat stranding</td>
<td>22 (84.6%)</td>
</tr>
<tr>
<td>Focal defect within the enhancing wall</td>
<td>21 (80.6%)</td>
</tr>
<tr>
<td>Isolated Intra luminal appendicoliths</td>
<td>13 (50%)</td>
</tr>
<tr>
<td>Combined Intra and extra luminal appendicoliths</td>
<td>4 (15.3%)</td>
</tr>
<tr>
<td>Periappendiceal fluid collection</td>
<td>24 (92.3%)</td>
</tr>
<tr>
<td>Extra luminal air</td>
<td>14 (53.8%)</td>
</tr>
<tr>
<td>Thickening of the wall of caecum</td>
<td>19 (73.1%)</td>
</tr>
<tr>
<td>Enlarged mesenteric Lymph nodes</td>
<td>26 (100%)</td>
</tr>
<tr>
<td>Appendicular mass due to phlegmon</td>
<td>2 (7.6%)</td>
</tr>
<tr>
<td>Appendicular mass due to abscess formation</td>
<td>6 (23.1%)</td>
</tr>
<tr>
<td>Small bowel reactive dilatation</td>
<td>6 (23.1%)</td>
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</table>

MDCT revealed appendiceal dilatation in 90 cases (88.2%); 68 of them were seen in cases with acute non complicated appendicitis and 22 in complicated acute appendicitis cases. The dilated lumen ranged from 7.3mm to 18 mm (SD ± 2.4) and mean diameter of 11 mm. Wall enhancement and periappendiceal fat stranding were detected in 98 cases (96%).

The detection of appendicular dilatation was not seen using MDCT in 12 cases; eight out of these 12 cases were diagnosed as acute non complicated appendicitis and the diagnosis of acute appendicitis in these cases were made based upon the enhancing wall, periappendiceal fat stranding and the presence of intra luminal appendicolith. In one of the eight cases with no dilatation of the appendiceal lumen, the diagnosis of perforation was missing in MDCT which could be attributed to collapsed lumen with no appearance of the defect within the enhanced wall while the diagnosis of perforation was proved by surgery. In the remaining four cases; MDCT showed no appendicular dilatation, no appendicular wall enhancement and no periappendiceal fat stranding. In all these four cases, the diagnosis were appendicular mass due to abscess formation.

Isolated Intra luminal appendicoliths were seen in 52 cases; 35 of them were seen in cases with acute non complicated appendicitis and 13 of them were seen in cases with acute appendicitis with complications. A combination of intraluminal and extra luminal appendicoliths were present in four cases with complicated acute appendicitis.

"Focal defect within the enhancing wall" was seen in 20/26 patients (76.9%) of complicated acute appendicitis suggesting the diagnosis of perforated appendix, while this sign couldn't be recognized in six cases; four out of these six cases the diagnosis was appendicular mass with abscess formation with complete disappearance of the wall enhancement and consequently any focal enhancement defects within it. In the remaining two cases, the diagnosis of perforation was based upon other signs of perforation.

Fig. (1): MDCT abdomen and pelvis (A-C) (A&B): Axial slices and (C): MPR Coronal reformats revealed: Dilated appendix 9.4mm with thickened enhanced wall (thick arrow), intraluminal appendicolith (thin arrow), with surrounding periappendicular fat stranding, associated there is thickening of the wall of the caecum, with small enlarged Lymph nodes (open arrow). Diagnosis was acute non complicated appendicitis.
Fig. (3): MDCT abdomen and pelvis (A&B); (A): Axial slices and (B): MPR Coronal reformats revealed: multilocular lesion at the right lower quadrant with enhanced internal septations (arrow) with air loculi and calcified appendicolith (arrow head) inside the lesion. There is loss of fat planes with the surrounding pelvic muscles. Associated there is small enlarged Lymph nodes (open arrow). Diagnosis was complicated appendicitis.

Fig. (2): MDCT abdomen and pelvis (A-D): (A&B): Axial slices and (C&D): MPR Coronal reformats revealed: Dilated appendix 10.2mm. Small focal defect within enhanced wall (arrow), intraluminal appendicolith (arrow head), with surrounding periappendicular fat stranding, minimal pelvic fluid collection (Star) with small enlarged Lymph nodes (open arrow). Diagnosis was perforated acute appendicitis.

**Discussion**

Using contrast enhanced MDCT in pre--operative assessment of patients with acute appendicitis has major impact in differentiating acute non-complicated appendicitis from complicated appendicitis.

In the current study different MDCT signs were seen in the 76 cases diagnosed as acute non-complicated appendicitis; appendiceal dilatation in 68 cases (89.5%); thickened enhanced wall in 76 cases (100%), peri-appendiceal fat stranding in 76 cases (100%), isolated intra luminal appendicoliths in...
35 cases (46.1%) with the higher sensitivity seen with thickened enhanced wall and periappendiceal fat stranding (100%). In other study by Rao et al., they found in their study that periappendiceal fat stranding was (100%), appendiceal dilatation (93%) and the thickened enhanced wall in (69%) [19]. The higher percentage of detection of enhanced wall in this study may be attributed to the high quality machine used in this study 64 MDCT equipment compared with helical CT in their study but the other parameters of periappendiceal fat stranding and appendiceal dilatation are matched in both studies. Pooler et al., 2012 in his study stated that the use of contrast enhanced MDCT in diagnosing appendicitis shows an important sign of appendiceal wall enhancement that is considered an important and diagnostic sign for acute appendicitis [20].

MDCT also helped the diagnosis of perforated acute appendicitis by defining the defect within the enhanced wall besides other signs of perforation like extra luminal appendicoliths, extra luminal air and periappendiceal fluid collection. In the current study focal defect within the enhancing wall was seen in 20/26 patients (76.9%) with complicated acute appendicitis suggesting the diagnosis of perforated appendix. The sensitivity of the defect within the enhancing wall was higher in this study (76.9%) compared with the sensitivity in Foly et al., 2005 study (58.8%) which may be attributed also to the high quality machine in this study using the 64 MDCT compared with the helical CT machine in Foly et al., 2005 study [21]. The sensitivity of the defect within the enhancing wall was lower in this study compared with the results of Tsuboi et al., 2008 who found that the sensitivity of using the defect within the enhancing wall in the diagnosis of perforation reached 95%. This can be explained by the presence of four cases in this study that were diagnosed as appendicular mass with abscess formation which leads to complete disappearance of the wall enhancement and consequently any focal enhancement defects within it [22]. By excluding these advanced complicated cases due to abscess formation from the cases diagnosed as complicated acute appendicitis, this will lead to increase of the percentage of cases where the defect within the enhancing wall was seen in perforated cases raising the percentage of detection to 20/22 (90.9%).

The use of CE MDCT helped also in the diagnosis of enhanced septa within the localized collections or masses in the 6/26 (23%) cases diagnosed as appendicular abscess. The results in this study did not match the results of Foly et al., 2005 who defined acute appendicitis complicated with appendicular mass due to abscess formation in only 2/21 (9.5%) of cases. No definite explanation could be offered for these findings except that this study was done for 102 patients and Foly et al., study was done for 86 patients [21].

In the present study, one of the patients of the surgically proven appendicitis was diagnosed as appendicitis by identifying the pericaecal inflammatory fatty changes together with the appendicolith, yet failed to diagnose the appendiceal perforation, which was proven by surgery. Tsuboi et al., 2008 encountered the same false negative result due to the narrowing of the appendiceal lumen after perforation, which may result in shrinkage and obscuration of the defect, making detection impossible [22].

In this study the signs suggesting the diagnosis of acute appendicitis; like dilatation of the appendix, thickened wall, enhanced wall, periappendiceal fat stranding, appendicoliths and enlarged lymph nodes and the presence of localized thickening of the wall of the caecum, and also the signs of perforation; like the presence of focal defects within the enhancing wall, periappendiceal fluid collection were seen well with combination of the axial and coronal images. These results match the results of Paulson et al., 2005, who stated that the addition of coronal reformatted scans to axial images in MDCT increases confidence in identification of the appendix and the diagnosis or exclusion of acute appendicitis with its complications [16]. Kim et al., 2008, support the value of the coronal multi-planner reformatted images in diagnosing appendicitis in this study. They mentioned that the abnormalities of the appendix are often well depicted on axial images but can be difficult to show in their entirety on a single flat planar image. On the other hand, they reported that the coronal multi-planner images can highlight the findings in a way that are more readily appreciated by the referring physicians [11].

In the current study isolated Intra luminal appendicoliths were seen in 52 cases (50.9%) while a combination of intraluminal and extra luminal appendicoliths was seen in four cases (3.9%). These results were higher than results by study of Engin et al., 2012, who stated that the presence of appendicoliths were found in (31 %) of the studied cases and they recommended appendectomy to be done immediately in the presence of appendicoliths in scanning without any waste of time [23]. The higher percentage of detection of appendicoliths seen in this study (47%) compared to the (31%) of the Engin et al., study 2012 was attributed to the use
of pre-operative MDCT imaging data in this study compared to the use of intra operative data in Engin et al. study as no pre-operative imaging data in their study. Comparison of this study results and Engin et al., study results enforces the importance of preoperative MDCT assessment of cases with symptoms of acute appendicitis. The presence of appendicoliths is one of the important factors that influence the decision of treatment in patients with acute appendicitis. The presence of appendicolith recommend the urgent surgical interference either complicated and non-complicated cases.

It is very important to differentiate complicated appendicitis including perforation from non-perforated appendicitis preoperatively as it affects the choice of management options [24]. In this study according to the radiological, surgical and pathological findings; patients who diagnosed as acute appendicitis 76 cases (74.5%) or who diagnosed as perforated acute appendicitis with no mass or abscess formation 18 cases (17.6%) were subjected to open or laparoscopic appendectomies. In two cases (2.0%) the diagnosis was acute appendicitis complicated with appendicular mass due to phlegmonous inflammation and they were treated by conservative treatment with antibiotics with interval appendectomy judged by the clinical condition of the patients. In 6 cases (5.9%) the diagnosis was appendicular mass due to appendicular abscess formations. Five of them were subjected to percutaneous drainage for the abscess followed by IV antibiotics and interval appendectomy according to the clinical evaluation. The remaining one case was subjected to open appendectomy with drainage of the abscess based on the presence of appendicolith which was indicative for rapid intervention.

The incorporation of MDCT in the preoperative assessment of appendicitis has multiple clinical and economic benefits; it enables rapid and efficient diagnosis of appendicitis and reduce the unnecessary delay in intervention, leading to reduction in the risk of complications with its accompanying morbidity and increase in the time of hospital stay, also causes reduction of the rate of surgical site infection. If it is used routinely, it will reduce the number of cases that will be admitted to hospitals for clinical observation and consequently it will reduce the cost of hospitals' stay. It helps in diagnosis of mimics of acute appendicitis, so it will help to avoid unneeded surgeries and consequently reduce the cost. By its use it will reduce the rate of negative appendectomies compared with the diagnosis that based alone on clinical diagnosis.

Small bowel reactive dilatation were detected in 6 cases (5.8%). The results in the current study match the results of Foly et al., 2005 study who found the small bowel dilatation in 1/21 (4.8%) cases. The importance of the reactive small bowel dilatation that may associate the acute appendicitis as a secondary inflammatory changes may encroach upon the pericecal or periappendiceal fat, making the visualization of the appendix more difficult and could lead to missing the diagnosis of acute appendicitis or the diagnosis of defect within the enhancing wall that is characteristic for perforation.

Conclusion:

MDCT using the axial and coronal reformatted images improves the self-confidence in the preoperative diagnosis of acute appendicitis and its complications with high benefits on both the clinical outcome and cost-effectiveness for the patients presented to the hospitals with suspected appendicitis.

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