

Diagnostic value for imaging studies (radiography, ultrasound and CT scan) in pediatric appendicitis in compare with adults

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Abstract

Back ground: Due to challenging in diagnosis of appendicitis in children many authors and experts believe that the ultrasound evaluation is the first screening test in suspected cases, we have arranged the present study to evaluate the diagnostic value of ultrasound imaging in the diagnosis of acute appendicitis in children in compare with adults.

Materials and Methods: This cross-sectional study (2008 -2014), done upon 30 children (mean 12.5 years), and 57 adults (mean age of 26 years) admitted 2 referral hospitals in Tehran (Iran). All cases evaluated with diagnosis of acute appendicitis. The ultrasound findings were compared with clinical and demographic criteria

Results:Children group: 15 children (50%) had the ultrasound findings of appendicitis in comparison with 20 children (66.7%) with positive CT scan and 25 pathologic changes in appendix tissue in favor of appendicitis. The sensitivity, specificity, positive and negative predictive values of CT scan were 76%, 80%, 95% and 40% in order; but, these values for ultrasonography were 56%, 80%, 93% and 26% respectively.

Adult group: in 32 cases (56.1%) positive results in favor of appendicitis in ultrasound studies and 53 (93%) had appendicitis in pathology reports. The ultrasound sensitivity and specificity were 96.9% and 75% respectively.

Conclusion: Although ultrasound has the same specificity with CT scan in diagnosis of pediatric appendicitis, it is less sensitive than CT scan (56% versus 76%). In pediatric cases which ultrasonography is negative, but there is a high suspicion of appendicitis, CT scan is preferred method in diagnosis of appendicitis in children. However, in adults, the ultrasound specificity was about 75%. This indicates that in 25% of adults, ultrasonography can falsely report appendicitis. Conversely, there is a good sensitivity in the diagnosis of acute appendicitis in children, moreover the specificity is also relatively good.

Introduction

Acute appendicitis is the most common abdominal emergency and cause of surgery in children. The clinical diagnosis of appendicitis in children in many cases is challenged because of delayed diagnosis or delay in referral to the emergency department. Totally up to 50% of perforated appendicitis have been reported in the initial visit. Symptoms of appendicitis are different in children. This diversity of manifestations causes a wide range of differential diagnosis, resulting in delayed or diagnostic errors, complications and even mortality. Many authors and experts believe that ultrasound is the first imaging test in pregnant women and children suspected of appendicitis. High-resolution spiral CT scan is also used to detect appendicitis. In CT scan, the inflamed appendix (more than 5 cm) is dilated and visible with a thick wall.

Several studies showed 85-90% sensitivity and 92-96% specificity for ultrasound to detect acute appendicitis. Some studies reported grading ultrasound in children with 85-90% sensitivity and 47 to 96% specificity.

The diagnostic findings in ultrasound include lack of compressibility, fecalith, loss of intestinal peristalsis, and increased appendix anterior-posterior diameter of more than 6 mm. The ultrasound study has positive and negative false results. The false positive results in ultrasound reports are detected in salpingitis, fecal impaction, overweight people and in cases where appendicitis is limited to the tip of the appendix, which large appendix is wrongly reported as ileum. If the appendix is torn, compressibility will be falsely reported normal (false negative).

The advantages of ultrasound study include: non-invasive method, short duration of imaging, no exposure to radiation, and the potential

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for recognizing other causes of abdominal pain. A major issue with ultrasound is its dependence on the operator. Many authors and experts believe that ultrasound is the first imaging test in pregnant women and children suspected of appendicitis [1-3].

Due to the ambiguities in this field, we decided to arrange the present study and to investigate the diagnostic value of ultrasonographic findings in the diagnosis of acute appendicitis in children and adolescents. The ultrasonographic findings were compared with the appendix pathology reports in patients and the sensitivity and specificity of the ultrasound was determined accordingly.

Methods and Materials

In this cross-sectional and retrospective study, total 30 children (mean age of 12.5 years with 4.5 years of standard deviation, 63.3% male and 36.7% female admitted to Rasool Akram and Ali Asghar hospitals during the years 2008 to 2012) and 57 adults (mean age of 26 years with a standard deviation of 9.9 years, 84.2% male, 15.8% female) admitted to Rasoul-Akram Hospital (during the years 2012 to 2014) were evaluated with the diagnosis of acute appendicitis.

Ultrasound findings were compared with patients' pathology reports and the ultrasound sensitivity was determined accordingly.

In this cross-sectional and retrospective study, the required information was extracted from medical archives of patients suspected to appendicitis referred to the Rasoul-e-Akram and Ali Asghar hospitals. The data gathering was carried out with a simple and continuous method.

The current study was approved by the Ethics Committee of the Children's Infectious Disease Research Center affiliated with the Iranian University of Medical Sciences. It adheres to the all principles of the Helsinki Declaration. Data extracted and the variables entered into the checklists including the age, gender, pathology report, diagnosis and ultrasound findings. Incomplete records of more than 20% of this information were excluded from the study. All patients who were undergone surgery, evaluated regarding their ultrasound results, pathology reports and description of surgery.

The Ultrasound changes based on diagnostic criteria: the lack of compressibility, fecalith, loss of intestinal peristalsis and increased posterior-anterior diameter of appendix more than 6 mm.

The information was gathered in the checklists. All data was entered into the SPSS13.00 statistical software. The descriptive analysis parameters including the mean, standard deviation and frequency were used to explain the descriptive variables. The student t-test was used to compare the mean of quantitative variables.

Results

The children group: In total 30 children, 15 patients (50%) were reported with ultrasound findings in favor of appendicitis, compared to 20 patients (66.7%) with CT scan findings and 25 patients with pathologic changes of appendicitis.

The sensitivity, specificity, positive and negative predictive values of CT scan were 76%, 80%, 95% and 40% in order and these parameters for ultrasonography were 56%, 80%, 93% and 26%, respectively.

In total 57 adult patients, 84.2% were male and 15.8% were female. The average age of patients was 26 years with 9.9 years of standard deviation. 32 patients (56.1%) had the ultrasound positive results in favor of appendicitis and 53 patients (93%) had pathologic results in

favor of appendicitis. Ultrasound sensitivity and specificity were 96.9 and 75%. 31 patients (54.4%) had end-loop in ultrasound, 26 patients (45.6%) were reported with non-compressible appendix and 6 patients (10%) with fluid accumulation around appendix in ultrasound study.

There was no correlation between the appendix pathologic findings with age, gender, appendix diameter, presence of end-loop, non-compressible appendicitis and fluid accumulation around appendix in patients ($P > 0.05$).

Discussion

In our study, the most common observed findings in ultrasound were the absence of appendix compressibility, the presence of end-loop and the increase in posterior-anterior diameters of the appendix. In 80% of children suspected of appendicitis, positive changes in the ultrasound and CT scan were able to definitely diagnose appendicitis with 80% specificity (Pathologic proof).

However, CT scan sensitivity was higher than ultrasonography. Although ultrasound has the same specificity as CT scan in children, it is less sensitive (56% vs. 76%). So, in cases where sonography is negative, but there is a high suspicion of appendicitis, CT scan is preferred in children.

In adults, CT scan was used less regarding the more convenient and accurate diagnosis of appendicitis by physical examination. In adults with suspected appendicitis, ultrasonography was used with high sensitivity in comparison with pathological findings (96.9%). By accurate clinical examination and ultrasonography, only 3% of patients would have missed the diagnosis of real appendicitis.

The ultrasound specificity was about 75%. So, in 25% of adults, the ultrasonography can falsely diagnose appendicitis. Conversely, there is a good diagnostic sensitivity in the diagnosis of acute appendicitis in children, and the specificity is also relatively acceptable.

Usually there is the evidence of inflammation associated with hyper echogenic fat, thickening of meso-appendix, and sometimes even presence of phlegmon. Fecal stools are readily visible, but their presence does not necessarily mean appendicitis. An unusual and important finding is "the arrowhead sign". This symptom is due to the thickening of cecum and then its congestion toward the opening of the inflamed appendix. CT scans are also a great technique to rule out the other inflammatory processes that appear like appendicitis.

Several studies have shown that the graded compression ultrasound in children has 85 to 90% sensitivity and 47 to 96% specificity that the observed specificity is significant.

The advantages of ultrasonography include non-invasive method of diagnosis, short duration of imaging, no exposure to radiation and the potential for diagnosis of other causes of abdominal pain. There are false positive and negative ultrasound results [4]. Although ultrasonography is easily able to diagnose intraabdominal abscesses in cases of appendix perforation, this technique has limitations and is dependent on the user.

The false negative ultrasound results are reported in circumstances such as appendicitis limited to the tip of appendix, the appendix located posterior to the cecum, the large appendix mistakenly considered as the intestine, and the perforated and compressible appendix.

Although the diagnostic accuracy of appendicitis with CT scan is proven, this imaging method is not recommended in all patients with right lower quadrant abdominal pain due to higher expenses, radiation exposure and possible danger of allergic reaction to contrast agents [4].

The high sensitivity obtained for sonography in our study is recommended as the first diagnostic method in children and can help to diagnose acute appendicitis in children. In cases where sonography is negative, but clinical symptoms are favorable for the disease, CT scan is required.

A number of studies have demonstrated the improvement of diagnostic accuracy of appendicitis when used freely from CT scans. CT scan reduces the amount of appendectomy in a study from 19 to 12% and appendectomy in women from 24% to 5% in another study.

The use of this imaging technique changed the treatment method in 24% of the patients studied, and half of the patients with normal appendicitis in the CT showed another diagnosis. Despite the potential benefits, this technique has significant disadvantages. CT scan is expensive, exposing the patient to high levels of radiation, and cannot be used during pregnancy.

Allergy contravenes intravenous contrast agents in some patients, and some patients, especially in the presence of nausea and vomiting, cannot tolerate oral contraceptives. Finally, all CT scan studies have not proved in all patients with right lower abdominal quadrant pain.

Different CT scan techniques, such as focused and non-focused CT scans, and spiral CT scans with or without contrast agents have been used. Spiral CT scan has a special position because it is one of the drawbacks of CT scan in assessing the lower right quadrant of the abdominal region of susceptibility to the contrast agent.

Interestingly, all of these techniques have an equivalent diagnostic accuracy of 92% to 97%, 85 to 94% specificity and a positive predictive value of 75% to 95%, and a negative predictive value of 95% to 99%. Similarly, the use of contrast agent does not improve the results of CT scan.

A number of studies have investigated the effect of gradual compression ultrasound compared with cyt scintigraphy in diagnosing appendicitis. Although the differences were minor, the CT scan was superior. For example, in one study, with 600 ultrasound and 317 CT scans, sensitivity was 80 and 97%, 93 and 94%, 89 and 95% accuracy, positive predictive value of 91 and 92%, and negative predictive value 88% and 98% respectively.

In another study, ultrasound had a positive effect on the treatment of 19% of patients, while this was 73% in the case of CT scan. Finally, in the third study, 17% of patients who had ultrasound had a negative appendectomy, The spiral CT scan was 2%.

One major issue with ultrasound is its dependence on the operator. The unresolved issue is which patient is a candidate for imaging studies. This question may not be as simple as CT scan is routinely requested by emergency medical professionals before consultation with surgeons.

The idea that CT scan should be performed in all patients with lower right lower abdominal pain is based on two reports provided by Rao and colleagues at the Massachusetts General Hospital.

A reduction in appendectomy from 20% to 7%, a perforation rate of 22% to 14%, and other diagnostic evidence in 50% of patients have been documented.

In a second study published in the New England Journal of Medicine, they proved that using CT scan prevented 13 unnecessary appendectomies, prevented 50 days of unnecessary admission and reduced \$ 447 per patient. Is. Conversely, numerous studies have not been able to prove the usefulness of routine use of CT scans. Logical

rationalization is a selective use of CT scan. This has been proven by numerous studies using CT scans according to a particular protocol or algorithm.

In the current study in adults, due to the simpler and more precise clinical symptoms of CT scan for less diagnosis, statistical analyzes were not considered. Therefore, the sensitivity and features of ultrasound were compared with pathology

The results obtained in 31 patients (54.4%) were endonography, 26 (45.6%) non-compressible appendix and 6 (10.5%) patients had ultrasonographic fluid accumulation. 32 (56.1%) in ultrasound had positive results in favor of appendicitis and 53 (93%) had appendicitis in pathology. The sensitivity of ultrasound was 96.9% and its specificity was 75%.

In this study, in adults with suspected appendicitis, ultrasound was more than ultrasound (in comparison with the high rate of pathology) (96.9%), ie by performing clinical examinations and performing accurate ultrasonography in only 3% of patients with real appendicitis We will lose. However, ultrasound was about 75%.

That is, in 25% of adults, ultrasound can falsely diagnose appendicitis; in contrast, it has a good diagnostic sensitivity to the diagnosis of acute appendicitis, and the feature is also relatively good. Of course, doing more studies in this area with a higher sample size can be a sign of the greater efficiency of this test as well as other detection methods such as CT scan.

Although several studies have shown ultrasound sensitivity in diagnosis of acute appendicitis of 85-90%, and its specificity is 92-96% [5], in the present study, the sensitivity of this method was higher and its characteristic was lower than the range.

It should be kept in mind that especially in adults, the presence of inflammation around the appendix can lead to a false positive result, a dilated fallopian tube can be mistaken for inflamed appendix, a thick stool can mimic appendicolith, In obese patients, the appendix can be unpressurised due to the presence of fat on it. Sonography has false positive and negative cases.

In case of salpingitis, fecal impaction and obese subjects are false positive, and in cases where appendicitis is limited to the tip of the appendix, the appendix is large and it is wrong with the ileum, and when the appendix is torn, its compression can be increased and false negatively.

Many analysts believe that ultrasound is the first imaging test in pregnant women and children suspected of opendicitis [3]. In other studies, diagnostic findings in ultrasound include lack of compressibility, fractal, loss of posture and anterior posterior diameter increase of more than 6 mm. In our study, the absence of compressibility, the presence of endloop, and the increase of the posterior anterior diaphragm of the appendix were the most commonly observed cases. [4]

Some studies have reported that gradual compression ultrasound has improved diagnosis in comparison with a clinical examination, and in particular the percentage of surgical deprivation for appendectomy has decreased from 37% to 13%. Ultrasound also saves time before surgery.

Ultrasound revealed appendicitis in 10% of patients who had a low probability of appendicitis with a clinical examination. The positive and negative predictive value of ultrasound has been reported surprisingly 91% and 92% respectively. However, in a prospective multicenter study,

the use of routine ultrasound scans compared with clinical evaluations improves diagnostic accuracy or No appendectomy or perforation. Conclusion: In 80% of children suspected of appendicitis, positive changes in ultrasound scan to 80% (attribute) can definitely determine the definitive diagnosis of appendicitis (pathologic proof). However, CT scan sensitivity was higher than ultrasonography. Although ultrasound has the same characteristics of children with CT scan, it is less susceptible (56% vs. 76%) in cases where sonography is negative, but there is a high suspicion of appendicitis. CT scan is preferred in children [5-9].

However, in the adult group, due to the simpler and more precise clinical symptoms, CT scan was used for less diagnosis. In adults with suspected appendicitis, ultrasonography was used that showed ultrasound sensitivity (compared to a very high pathology) 96%). By performing clinical examinations and performing accurate ultrasonography, only 3% of patients will lose real appendicitis.

But the ultrasound feature was about 75%. That is, in 25% of adults, ultrasonography can falsely diagnose appendicitis. Conversely, there is a good diagnostic sensitivity in the diagnosis of acute aphthytic disease in children, and the feature is also relatively good [10,11].

Conclusion

In 80% of children suspected of appendicitis, positive changes in ultrasound and CT scan can highly determine the definitive diagnosis of appendicitis (80% specificity). However, CT scan sensitivity was higher than ultrasonography. Although ultrasound has the same specificity with CT scan in diagnosis of appendicitis, it is less sensitive than CT scan (56% versus 76%). In cases which ultrasonography is negative, but there is a high suspicion of appendicitis, CT scan is preferred method in diagnosis of appendicitis in children.

However, in the adult group, due to easier diagnosis and more precise clinical symptoms, CT scan was used less than ultrasound in diagnosis. In adults, ultrasound was used in suspected appendicitis. The ultrasonography sensitivity was so high compared to pathology (96%). It means that with accurate clinical examination and performing

ultrasonography, only 3% of patients with appendicitis will be missed in diagnosis of real appendicitis.

But the ultrasound specificity was about 75%. This indicates that in 25% of adults, ultrasonography can falsely report appendicitis. Conversely, there is a good sensitivity in the diagnosis of acute appendicitis in children, moreover the specificity is also relatively good.

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