

Review

Research progress in CT imaging analysis for early diagnosis of appendicitis in children

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Abstract

Appendicitis is one of the common acute abdominal diseases in children. For the reason that acute appendicitis develops rapidly in children, early diagnosis has great significance. CT diagnosis is more precise. It can significantly reduce perforation rates and unnecessary resection rates. CT can also be used for differential diagnosis with other diseases to reduce the rate of misdiagnosis. And it can effectively predict the severity of the disease, to prevent the occurrence of various complications. In this paper, CT imaging findings and diagnostic criteria for acute appendicitis in children, common differential diagnosis, the diagnostic function of CT, time of CT examination of acute appendicitis in children and

limitations of CT diagnosis were summarized

Keyword

diagnosis; CT imaging; acute abdominal disease; computed tomography; appendicitis; pediatric; children

Introduction

Appendicitis is a common pediatric surgical disease characterized by acute abdominal pain. The appendix cavity in children is narrow and easily distorted. The stercus and food residues that enter the appendix cavity will cause obstruction of the appendix and inflammation of the appendix. The accumulation of secretions in the appendix blocks the blood of the appendix, which may easily lead to ischemic necrosis of the appendix wall. The thin wall of the appendix in children

makes the situation worse. And there are abundant lymphatic follicles. Therefore, perforation rates are high and symptoms are more severe than in adults. Appendicitis can be complicated by diffuse peritonitis, septic shock and even death. Children have less typical symptoms than adults because of their younger age. If patients do not receive treatment timely, some complications will immediately appear. So early diagnosis is very important. CT image analysis is of great value in the early diagnosis of appendicitis. And it can prevent unnecessary surgery in patients with false-positive appendicitis.

1. CT imaging findings of appendicitis

Appendix diameter (AD) is an important parameter in the diagnosis [1]. Most people agree that appendicitis can be diagnosed when the diameter of the appendix exceeds 6mm [2]. Recently, studies have shown that the increase of AD is positively correlated with age, height and weight. AD shows a constant rate of increase as height increases [3]. The mean diameter of the normal appendix is 5.6-5.7 mm, the normal range (95% CI) is 2.7-8.7 mm, and 34-39 percent of the normal appendix is larger than 6 mm. Nonpathological factors,

including pericecal fat, appendix content, and the presence of lymphoid stimulation, all affect appendix diameter in normal children. The size of the appendix increases due to lymphatic stimulation [1]. In the absence of obvious inflammation but only congestion, the appendix may enlarge, especially in the presence of content or stercus [4]. Trout proposes a 3-category interpretive scheme that takes two values of 6mm and 8mm. When normal, $<6\text{mm}, >8\text{mm}$ is positive. Between 6 and 8mm is ambiguous in young adult [5]. Scientists are looking for more meaningful imaging criteria for CT diagnosis of appendicitis. But there are no accepted diagnostic criteria for children. Therefore, the numerical diagnosis of appendicitis alone is not reliable. Thickening of the appendix wall and strengthening of the fatty chain around the appendix are important signs of appendicitis. Another sign of unenhanced CT is a 30% higher density of inflamed appendices relative to the adjacent cecal wall [6]. The accumulation of fat around the appendix, the intensification of the appendix wall, the enlargement of the appendix and the thickening of the appendix wall are valuable signs in the diagnosis of acute

appendicitis [7].

2. The differential diagnosis

Meckel's diverticulum, diverticulitis of the cecum, inflammatory bowel disease can lead to false positive ultrasound results. Depending on CT better than ultrasound on the normal appendix, CT can diagnosis precisely and differential diagnosis [8]. The following diseases have similar manifestations to appendicitis, mesenteric adenitis, Cecal Diverticulitis, Epiploic Appendagitis, Omental Infarction, Crohn's Disease, Infectious Terminal Ileitis. CT imaging features can clearly and accurately differentiate appendicitis from these diseases, which is of great significance for improving the accuracy of diagnosis. Nuno Pinto Leite has a clear description of the CT images and the characteristic of these diseases [9].

3. The diagnostic function of CT

CT scan can reveal inflammatory lesions around the appendix, including inflammatory fat retention, sputum, free fluid, free bubbles, abscess and adenopathy [8]. CT image analysis can help diagnose other diseases and complications, such as perforation and abscess formation [6]. Since the appendix is free, often in different locations, CT

images can help the surgeon confirm the location of the appendix (posterior cecal, subcecal, posterior ileal, anterior ileal, or pelvic). Studies have shown that a combination of CT images of the number of retroperitoneal space involved segments, CRP content, maximum appendix diameter, and the presence of appendicitis stones can predict the severity of appendicitis. Through the above signs, appendicitis is divided into complicated appendicitis and uncomplicated appendicitis [10]. Precise differentiation can reduce perforation rate and reduce unnecessary surgery [8,11].

4. Time of CT examination

The use of CT for appendicitis remains controversial. Some scientists believe that low-dose CT is an accurate diagnosis of acute appendicitis in children, regardless of age or BMI. Therefore, low-dose CT is recommended for the assessment of suspected acute appendicitis in children [12]. One view holds that PAS (pediatric appendicitis score) should be performed, and low-dose CT should be performed as the final protocol when PAS is between 3-6 and ultrasound examination is negative [13]. Another view is that CT is not

recommended because of the negative effects of radiation doses on children. When a patient is suspected to have appendicitis, MRI is used first. CT was finally used, When MRI was ineffective [14].

5. Limitations of CT diagnosis

CT radiation increases the risk of cancer in children. Exposure to radiation has become a factor that must be considered. A focused CT scan can be used to reduce the radiation dose [15]. The allergic reaction of iodine, the contrast agent commonly used in CT examination, has also become one of the shortcomings of CT.

Conclusion

CT is of great value in the early diagnosis of appendicitis, which is manifested in its accurate diagnosis. It can lower perforation rate and avoid the incidence of unnecessary surgery. And it helps surgeons locate the appendix. CT also has advantages in differential diagnosis. However, because of the CT radiation, the time of CT examination should be considered, and CT should be used in suspected patients to reduce radiation dose. CT has limitations such as radiation, focusd CT maybe a new way to lower radiation doses. In a word, CT

imaging analysis has significant meaning for the early diagnosis of appendicitis.

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