Application of Multi-detector CT Multiplanar Reconstruction Technique in the Diagnosis of Appendicitis: Postprint

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Abstract

Objective: To investigate the clinical value of multiplanar reconstruction technique based on multi-slice spiral CT in diagnosing acute appendicitis.

Methods: Fifty-five cases clinically suspected of acute appendicitis were collected. 16-slice spiral CT scanning and multiplanar volume reconstruction image post-processing were performed. CT manifestations were summarized and analyzed, and the display rates of various signs in acute appendicitis diagnosis were compared between reconstructed and non-reconstructed images.

Results: Among 55 patients with suspected acute appendicitis, 50 were confirmed by surgical pathology, with 1 case of right ovarian cyst, 1 case of right lower ureteral stone, 1 case of cholecystitis, 1 case of colon tumor, and 1 case of pelvic inflammatory disease. The display rates of the entire appendix (100% vs 80%), appendiceal wall thickening (92% vs 70%), and ileocecal bowel wall thickening (50% vs 26%) were all higher in reconstructed images than in non-reconstructed images, with statistically significant differences ($P<0.05$).

Conclusion: Multi-detector spiral CT combined with multiplanar reconstruction technique can significantly improve the diagnostic accuracy of acute appendicitis, enabling rapid and accurate diagnosis of appendicitis and other lesions, which is worthy of clinical application.

Full Text

Application of Multiplanar Reconstruction with Multi-slice Spiral CT in the Diagnosis of Appendicitis

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Abstract

Objective: To investigate the clinical value of multiplanar reconstruction (MPR) with multi-slice spiral CT in diagnosing acute appendicitis. **Methods:** Fifty-five patients with clinically suspected acute appendicitis were enrolled. 16-slice spiral CT scanning and multiplanar volume reconstruction post-processing were performed. CT findings were summarized and analyzed, and the display rates of various signs in diagnosing acute appendicitis were compared between reconstructed and non-reconstructed images. **Results:** Among 55 patients with suspected acute appendicitis, 50 were confirmed by surgical pathology, with one case each of right ovarian cyst, right distal ureteral stone, cholecystitis, colon tumor, and pelvic inflammatory disease. The display rates of entire appendix visualization (100% vs 80%), appendiceal wall thickening (92% vs 70%), and ileocecal wall thickening (50% vs 26%) were all significantly higher in reconstructed images than in non-reconstructed images ($P<0.05$). **Conclusion:** Multi-slice spiral CT combined with MPR technology can significantly improve diagnostic accuracy for acute appendicitis, providing rapid and accurate diagnosis of appendicitis and other lesions, and is worthy of clinical application.

Keywords: appendicitis; tomography; X-ray computed; multiplanar reformation

Acute appendicitis is one of the most common acute abdominal emergencies in clinical practice, and most cases can be definitively diagnosed based on clinical manifestations and laboratory tests. However, other diseases occurring in the right lower quadrant can cause similar clinical symptoms and signs, leading to misdiagnosis if relying solely on clinical evaluation. Ultrasound examination has been widely used as an adjunctive diagnostic tool for acute appendicitis due to its simplicity and low cost, but its diagnostic accuracy is reduced by factors such as patient body habitus, bowel gas, and operator experience. In recent years, with the continuous development of multi-slice spiral CT (MSCT) and three-dimensional post-processing techniques, CT has become an accurate and effective imaging method for evaluating acute appendicitis[1-2]. MSCT offers extremely high accuracy and sensitivity, providing important basis for patient diagnosis and treatment planning[3]. However, current reports on the use of MSCT three-dimensional post-processing techniques for displaying signs of appendicitis show considerable variation[4-6]. This study retrospectively analyzed the CT data of 55 patients with clinically suspected acute appendicitis to investigate the diagnostic value of multi-slice spiral CT three-dimensional reconstruction for acute appendicitis.

1.1 General Information

From January 2013 to January 2017, CT data from 55 patients who underwent plain and enhanced CT scanning for clinically suspected acute appendicitis due to right lower quadrant pain at Guangzhou Twelfth People' s Hospital were collected, including 33 males and 22 females with an age range of 16-85 years (mean 48.34 years). Surgical pathology confirmed acute appendicitis in 50 patients, while CT diagnosed acute appendicitis in 50 patients. The 5 cases diagnosed as non-appendicitis by CT did not undergo surgery and included one case each of right ovarian cyst, right distal ureteral stone, cholecystitis, colon tumor, and pelvic inflammatory disease. All cases underwent multiplanar reconstruction and curved planar reconstruction.

1.4 Statistical Methods

CT scanning was performed using a Toshiba Aquilion 16-slice spiral CT with the following parameters: voltage 120 kV, current 200 mAs, volume acquisition of 1 mm × 16, pitch 1.0, rotation time 0.5 s per revolution, slice thickness 1.0 mm, interval 0.5 mm, and matrix 256×256. Patients were scanned in supine position from the diaphragmatic dome to the pubic symphysis. All patients underwent plain scanning followed by dual-phase enhanced scanning. For enhanced scanning, 80-100 mL of iohexol was injected intravenously via a high-pressure injector at a flow rate of 3-3.5 mL/s. Arterial phase scanning was performed 25 seconds after injection began, and venous phase scanning was performed at 65 seconds.

1.3 Image Analysis

The thin-slice reconstructed images were transferred to a Vitrea2 (version 4.1.2) workstation for coronal, sagittal, and curved planar reconstruction along the course of the appendix. Two radiologists with attending physician qualifications or above independently interpreted the conventional+MPR+CPR images on the workstation using a double-blind method and made diagnoses. Diagnostic criteria for multi-slice spiral CT included direct and indirect signs. Direct signs were: (1) appendiceal diameter >6 mm; (2) appendiceal wall thickness >2 mm. Indirect signs were: (1) inflammatory mass in periappendiceal tissue; (2) appendicolith visible within the appendiceal lumen; (3) blurred contour of the anterior psoas muscle margin; small amount of intraperitoneal fluid or thickening of the right anterior renal fascia; (4) localized cecal wall thickening.

Data were processed using SPSS 19.0 software. Count data were expressed as percentages. The diagnostic results of conventional CT scanning and MPR/CPR for acute appendicitis were compared, and count data were compared using the ^{2} test. A P-value <0.05 was considered statistically significant.

2.1 CT Findings of Appendicitis

CT findings of acute appendicitis mainly include direct and indirect signs. Direct signs refer to morphological changes of the appendix, manifested as appendiceal enlargement and blurred wall thickening. Indirect signs mainly include periappendiceal inflammation, appendicolith, ileocecal wall thickening, periappendiceal abscess, and free gas, which may be complicated by acute peritonitis and low small bowel obstruction[7-10]. Among the 50 confirmed cases, 46 patients showed obvious circumferential appendiceal wall thickening with marked circumferential enhancement after contrast administration (Figure 1 [Figure 1: see original paper]). Twenty-eight patients showed blurred periappendiceal and ileocecal spaces with high density, appearing as strip-like or flocculent shadows, or combined with appendiceal and periappendiceal abscess formation (Figure 2 [Figure 2: see original paper]). Ten patients showed marked appendiceal enlargement with fluid accumulation and stones within the appendiceal lumen (Figure 3 [Figure 3: see original paper]).

Figure 1. Acute appendicitis case. A: Contrast-enhanced axial CT shows appendiceal thickening (white arrow), wall thickening with circumferential enhancement, and fat stranding around the appendix; B: MPR reconstruction shows part of the appendiceal course; C: CPR reconstruction completely displays the entire appendix and its relationship with surrounding structures. The appendix is located in a subhepatic position, representing a positional variation.

Figure 2. Appendicitis complicated by periappendiceal abscess. A: Contrast-enhanced axial CT shows irregular appendiceal thickening (black arrow) with marked wall enhancement. Below it, an irregular thick-walled abscess is seen (white arrow) with obvious abscess wall enhancement; B: MPR reconstruction shows the relationship between the appendix (black arrow) and surrounding abscess (white arrow).

Figure 3. Appendicitis with stone. CPR reconstruction shows the entire course of the appendix and a long, high-density stone shadow within the lumen (white arrow).

2.2 Comparison of Conventional CT Scanning and MPR/CPR for Acute Appendicitis Diagnosis

The display rates of various signs and ileocecal wall thickening were significantly higher with MPR/CPR than with conventional CT images ($P<0.05$, Table 1). MPR/CPR reconstruction improved the visualization of the entire appendiceal course, wall thickness, appendiceal stones, presence of surrounding exudate, inflammatory encapsulation, and abscess formation. This provides valuable assistance for clinical treatment planning and surgical decision-making. The study results demonstrate that MPR/CPR application improved the display rates of entire appendix visualization, wall thickening, and ileocecal wall thickening, all significantly higher than conventional CT images.

Table 1. Comparison of CT sign display rates between conventional CT and MPR/CPR for acute appendicitis [n(%), n=50]

CT Sign	Conventional CT	MPR/CPR	[2]
Entire appendix display	40 (80)	50 (100)	–
Appendiceal wall thickening	43 (86)	48 (96)	–
–	35 (70)	46 (92)	–
–	26 (52)	28 (56)	–
–	8 (16)	10 (20)	–
Ileocecal wall thickening	13 (26)	25 (50)	–

3 Discussion

Appendicitis is the most common acute abdominal emergency, ranking first among all acute abdominal conditions. Its diagnosis primarily relies on clinical history, physical signs, and laboratory tests. However, atypical clinical presentations of appendicitis and similar clinical manifestations of other diseases make diagnosis challenging[11-12]. Reports indicate that relying solely on clinical data results in a 20% negative appendectomy rate and a 25% missed diagnosis rate for appendicitis[13-14]. Due to equipment limitations, previous CT studies of appendicitis were mostly limited to simple axial, coronal, or sagittal images. However, the appendix is often curved, variable in morphology, and has highly variable orientation, making it difficult to be contained within a single plane. Therefore, simple coronal, sagittal, or even oblique images are often inadequate. In recent years, widespread application of multi-slice spiral CT scanning and post-processing techniques has significantly improved preoperative diagnostic and differential diagnostic accuracy for acute appendicitis, greatly reducing the negative laparotomy rate and decreasing complications from delayed diagnosis such as appendiceal perforation[15-16]. Multi-slice spiral CT can obtain high-quality MPR/CPR images with rapid reconstruction and real-time display, clearly showing appendiceal location, size, course, and surrounding tissue changes from multiple perspectives. It can display the overall appendiceal condition and its orientation from various angles, providing important reference information for acute appendicitis diagnosis. Curved planar reconstruction can display the entire appendix in most cases, accurately identifying the appendix and enabling timely diagnosis of acute appendicitis[17-20]. In this series, MPR/CPR reconstruction intuitively displayed the specific location and course of the appendix. Through adjustment of window width and level, it could also demonstrate appendiceal lumen diameter, wall thickness, intraluminal stones, presence of surrounding exudate, inflammatory encapsulation, and abscess formation, providing valuable assistance for clinical treatment and surgical planning. The study results show that MPR/CPR application improved the display rates of entire appendix visualization, wall thickening, and ileocecal wall thickening, all significantly higher than conventional CT images.

In summary, multiplanar reconstruction with multi-slice spiral CT can accurately identify the appendix and its various abnormal manifestations, directly displaying the entire appendiceal structure and enabling reliable diagnosis. It has important value for early diagnosis of acute appendicitis and should be used as a routine preoperative examination for patients with clinically suspected acute appendicitis.

References

Kamel IR, Goldberg SN, Keogan MT, et al. Right lower quadrant pain and suspected appendicitis: nonfocused appendiceal CT-review of 100 cases[J]. Radiology, 2000, 21(7): 159-63.

梁虹. MSCT 三维重建诊断不典型急性阑尾炎的价值 [J]. 上海医学影像, 2011, 20(2): 107-8.

王瑞芳, 李春志, 廖威, 等. MSCT 在阑尾炎诊断中的应用 [J]. 中国中西医结合影像学杂志, 2013, 11(3): 299-300.

赵静, 李健, 郭庆乐, 等. 非增强 64 层 VCT 在急性阑尾炎诊断中的价值 [J]. 中国临床医学影像杂志, 2012, 23(3): 211-3.

刘文, 强金伟, 廖治河, 等. 多层螺旋 CT 增强扫描及多平面重建诊断急性阑尾炎 [J]. 中国医学计算机成像杂志, 2012, 18(4): 337-41.

余河, 杨峰, 胡磊, 等. 64 层螺旋 CT 平扫诊断成人急性阑尾炎的价值研究 [J]. 中国 CT 和 MRI 杂志, 2013, 11(3): 30-2.

王礼同, 薛贞龙, 李澄, 等. MSCT 多平面及曲面重组技术诊断急性阑尾炎 [J]. 放射学实践, 2008, 23(6): 643-6.

陈海荣, 杨军, 高淳, 等. 32 层螺旋 CT 三维重组在急性阑尾炎症诊断及鉴别诊断中的价值 [J]. 放射学实践, 2010, 25(5): 540-2.

陈发祥, 王卉, 张树桐. CT 对急性阑尾炎的诊断价值 [J]. 实用放射学杂志, 2008, 24(6): 845-9.

王康, 赵泽华, 王之, 等. 应用多层螺旋 CT 多方位重建技术诊断断急性阑尾炎的价值 [J]. 中华放射学杂志, 2005, 39(2): 177-80.

杜秀琴, 孙勇, 闫迪, 等. 多层螺旋 CT 对不典型阑尾炎 22 例诊断价值分析 [J]. 中国误诊学杂志, 2012, 12(13): 3295-8.

价值 [J]. 实用放射学杂志, 2012, 28(7): 1048-51. 龚静山, 徐坚民, 周康荣. 急腹症的螺旋 CT 评价 [J]. 国外医学: 临床放射学分册, 2002, 25(1): 25-8. 64 层螺旋 CT 多平面及曲面重组在急性阑尾炎诊断中的 Kim K, Lee CC, Song KJ, et al. The impact of helical computed tomography on the negative appendectomy rate: a multi-center comparison[J]. Am J Emerg Med, 2008, 34(1): 3-6.

欧玲, 兰宁, 李兮力, 等. 非增强 MSCT 多平面重组技术对急性阑尾炎诊断价值探讨 [J]. 中国 CT 和 MRI 杂志, 2009, 7(5): 64-6.

Neville AM, Paulson EK. MDCT of acute appendicitis: value of coronal reformations[J]. Abdom Imaging, 2009, 34(1): 42-8.

Pinto LN, Pereira JM, Cunha R, et al. CT evaluation of appendicitis and its complications: imaging techniques and key diagnostic findings[J]. AJR Am J Roentgenol, 2005, 185(2): 406-17.

苏金亮, 徐兆龙, 纪建松, 等. 多层螺旋 CT 及后处理技术在急性阑尾炎诊断中的价值 [J]. 中国临床医学影像杂志, 2006, 17(1): 15-17. 64 层螺旋 CT 多平面及曲面重建在急性阑尾炎诊断中的应用 [J]. 中国伤残医学, 2014, 6(20): 138-41.

刘景旺, 赵静, 郭庆乐, 等. 64 层螺旋 CT 曲面重建技术在急性阑尾炎诊断中的价值 [J]. 中国医学影像学杂志, 2011, 19(8): 585-8.

Note: Figure translations are in progress. See original paper for figures.