

Focused abdominal CT scan for acute appendicitis in children: Can it help in need?

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Abstract

Objective: To evaluate the focused abdominal CT scan [FACT] in clinically equivocal cases of acute appendicitis in paediatric population.

Methods: A cross-sectional study was conducted at the Radiology Department of Aga Khan Hospital, from August 2007 to November 2008.

A total of 84 patients (42 males & 42 females) with clinically equivocal signs and symptoms of acute appendicitis referred to radiology department for CT evaluation were studied. CT findings were compared with histopathology and clinical follow-up.

Results: The sensitivity of focused CT for acute appendicitis was 91%; specificity was 69% and accuracy of 76% while PPV and NPV were 58%, 94% respectively.

Conclusion: Focused unenhanced CT is a quick, accurate and non invasive modality for the assessment of clinically equivocal cases of acute appendicitis for ruling out patients and reducing negative appendectomies.

Keywords: Acute appendicitis, CT, Focused, Radiography (JPMA 61:474; 2011).

Introduction

Acute appendicitis is one of the commonest causes of acute abdomen in children needing surgical intervention. Historically, the diagnosis of appendicitis is primarily based on clinical evaluation which can lead to a high rate of negative appendectomies^{1,2} due to non-specific signs and symptoms particularly in children. Acute abdominal pain is a common complaint encountered in paediatrics and the prevalence of acute appendicitis amongst these patients ranges from 1 to 4% only.^{3,4} The clinical diagnosis of acute appendicitis in children may be difficult as compared to adults due to their inability to communicate their symptoms. It can be further difficult as approximately one-third of children present with non-specific clinical findings⁵ that lead to high missing rate of missed acute appendicitis at initial clinical examination in children.⁶ The introduction of modern techniques like ultrasound (U/S), computed tomography (CT) and magnetic resonance imaging (MRI) has proven helpful⁷⁻¹² in the diagnosis of appendicitis especially in clinically equivocal cases. Ultrasound is an ideal imaging modality for initial assessment in patients suspected with acute appendicitis.¹³ But it is operator dependent and at times unable to visualize through the bowel gases. Sonographic examination in children can also be difficult to perform due to extreme abdominal pain.

Focused appendiceal computed tomography (FACT) is a modified form of pelvic CT⁹ examination taking thin sections, focusing on the right lower quadrant, without

administration of contrast media. It has shown further increased in the diagnostic accuracy of CT scan for appendicitis and reduces the appendiceal perforation rates¹⁰ leads to minimal hospital stay by reducing delay in diagnosis.¹⁴ Focused CT also has the advantage of reduced radiation exposure which is even more important in paediatric population and has a lower cost compared to abdominal CT.¹⁵ FACT is a quick procedure and can also identify other intra-abdominal etiologies of pain in patients with acute abdomen.¹⁵

FACT is relatively a new technique in our country for acute appendicitis and to best of our knowledge no study has been done to evaluate its role in paediatric population in our part of the world. Therefore the objective of this study was to evaluate the focused abdominal CT scan in clinically equivocal cases of acute appendicitis in children.

Patients and Methods

The participants of the study were selected from the patients presenting to the Aga Khan University Hospital Karachi with acute abdomen and clinical findings suggestive of equivocal acute appendicitis from August 2007 to November 2008 and referred to radiology department for FACT examination. Equivocal acute appendicitis criterion included atypical signs and symptoms, and difficult clinical examination due to obesity, unco-operative patient or persistent pain in right iliac fossa without signs of localized peritonism. Most

common presenting symptom was acute abdominal pain. Focused CT scan was done after taking written consent by parents. Purposive sampling was done to achieve the objectives of the study. An inclusion criterion was patients from 1-15 years of age with clinical suspicion of appendicitis. They underwent focused CT abdomen and had histopathologic results or clinical follow-up. Exclusion criteria were known cases of appendicitis, patients had whole abdomen CT or received oral/rectal contrast. FACT was performed using a multi detector CT scanner (Toshiba aquiline). Scanning was performed from the L3 to pubic symphysis in all patients. No oral/rectal or IV contrast was given. No bowel preparation was advised. Collimation and image reconstruction was done at 5mm. Coronal and sagittal reconstruction was also performed. Images were reviewed on reporting console as well as on hard copies. Interpretation of images for either positive or negative findings for appendicitis was initially done by senior radiology resident and final report was made by consultant radiologist having experience of paediatric abdominal imaging. Appendicitis was diagnosed on CT,^{5,9,12,15,16} if the appendix did not fill completely with air and exceeded 6 mm in cross-sectional diameter or if an appendicolith, adjacent fat stranding /extra luminal air, complex fluid collection, or mass was noted.

The decision for operative intervention was made by the paediatric surgeon on clinical, imaging and laboratory findings. The final diagnoses were established by surgical and histologic evaluation of the appendix in patients who underwent surgery or by clinical follow-up in patients treated conservatively. Data was entered and analyzed in SPSS version 15. Sensitivity, specificity, accuracy, negative and positive predictive values of FACT for acute appendicitis was calculated.

Results

A total of 84 paediatric patients underwent focused abdominal CT scan for acute appendicitis. Of whom 13 (6%) patients were excluded due to non availability of follow-up or histopathologic findings. Finally our sample size comprises of 71 patients (Mean age 11.8 ± 2.5 years, M: F 1:1). Minimum age of patient with suspected appendicitis was 4 years while maximum age was 15 years. The prevalence of appendicitis on FACT was 51% (36/71) while over all prevalence in this study was 32% (23/71). There were 21(91%) true-positive diagnoses of appendicitis. Fifteen false-positive (42%) diagnoses of appendicitis were identified on FACT. There were 33 (69%) true-negative diagnoses for acute appendicitis. Two false-negative diagnoses (3%) of appendicitis were found in patients with surgically proved appendicitis. Focused

abdominal CT had a sensitivity of 91%, specificity of 69%, and accuracy of 76% for the diagnosis of appendicitis. Negative and positive predictive values were 94% and 58% respectively.

Discussion

The results of this study clearly showed the utility of focused CT scan abdomen in clinically equivocal cases of acute appendicitis in children and findings are consistent with published studies.^{9,10,14,15} The sensitivity of CT for appendicitis in this study was 91% which is comparable to published literature with pooled sensitivity of 94% in children.^{16,17} The specificity of CT scan in this study was 69% which is lower than published pooled specificity of diagnosing appendicitis in children of 95%.^{16,17} The reason might be due to presence of normal increased diameter appendix in our population as 6mm or more appendicular diameter was taken as positive for acute appendicitis on CT.^{5,9,12,15,16} Another large multi center study might be helpful for establishing the appendicular size criterion for appendicitis in our population. The other possibility of low specificity in this study was over reading of images and high level of suspicion by radiologists. There were fifteen false positive cases and only two false negative cases, the cause of these might be due to difficulty in interpretations of CT images in thin patients with absence of natural fat contrast. There was only one incidental finding of haemorrhagic ovarian cyst on CT scan in the absence of acute appendicitis, this reflects the best clinical practice and use of CT scan only in selective equivocal children. The results of this study showed that in selective cases where clinical suspicion is in doubt FACT might be helpful in decision of surgical intervention by excluding normal appendix or it may establish an alternative diagnosis.

Ultrasound is another modality that can be used in clinically equivocal cases of acute appendicitis. In comparison to CT, ultrasound has no risk of radiation exposure however, literature suggest a better accuracy of CT in diagnosing acute appendicitis.^{5,9,12,15,16} FACT is a focused exam without contrast and with minimal possible radiation exposure and its use can be justified by its higher diagnostic ability. Ultrasound sometimes may not give good results because of excessive fat or air filled bowels. CT is also better at visualizing the complications associated with appendicitis like presence and extent of abscess and inflammation. Since our study showed a low specificity for FACT, we need a regional comparative study between US and CT to look at their pre and post test probabilities to prove the superiority of one over the other.

This study has few limitations besides having single

centre, selection of patients biased towards only inclusion of patients referred to radiology for CT examination. Radiologists were bound to diagnose whether appendicitis was present or not, no room for intermediate diagnosis was given. Degrees of experience among the radiologists in analyzing CT for acute appendicitis were not taken into account. Inter observer variability of CT interpretation was not assessed. No other investigation was used to support the CT diagnosis. Only one month follow-up of patients is available. No cost-effective analysis was performed in this paper however CT fact reduces negative appendectomy rate and patient hospital stay that is indirectly reflective of cost effectiveness of CT fact.

Conclusion

Focused unenhanced CT has good sensitivity for ruling out appendicitis in children and provides important ancillary information thus reducing negative appendectomy rate resulting in minimal hospital stay of patient and burden of cost associated with surgical intervention. Since, FACT is a relatively new and underused modality to diagnose appendicitis, radiologists are being over cautious, which is one of the reasons for the low specificity observed. Other reasons may include a lack of customized criteria for diagnosing appendicitis using FACT in our population.

Based on the results of this study, in our setting FACT can be used to reduce the number of negative appendectomy rates.

References

1. Kaiser S, Mesas-Burgos C, Soderman E, Frenckner B. Appendicitis in children—impact of US and CT on the negative appendectomy rate. *Eur J Pediatr Surg* 2004; 14: 260-4.
2. Khan JS, Hassan H, Khan JA. Investigations for Acute Appendicitis: Can we rely on them? *Pak J Surg* 2002; 18: 27-30.
3. Brewer BJ, Golden GT, Hitch DC, Rudolf LE, Wangenstein SL. Abdominal pain. An analysis of 1,000 consecutive cases in a University Hospital emergency room. *Am J Surg* 1976; 131: 219-23.
4. Scholer SJ, Pituch K, Orr DP, Dittus RS. Clinical outcomes of children with acute abdominal pain. *Paediatrics* 1996; 98: 680-5.
5. Rao PM, Rhea JT, Rattner DW, Venus LG, Novelline RA. Introduction of appendiceal CT: impact on negative appendectomy and appendiceal perforation rates. *Ann Surg* 1999; 229: 344-9.
6. Rothrock SG, Pagane J. Acute appendicitis in children: emergency department diagnosis and management. *Ann Emerg Med* 2000; 36: 39-51.
7. Franke C, Bohner H, Yang Q, Ohmann C, Roher HD. Ultrasonography for diagnosis of acute appendicitis: results of a prospective multicenter trial. *Acute Abdominal Pain Study Group. World J Surg* 1999; 23: 141-6.
8. Hormann M, Paya K, Eibenberger K, Dorffner R, Lang S, Kreuzer S, et al. MR imaging in children with nonperforated acute appendicitis: value of unenhanced MR imaging in sonographically selected cases. *AJR Am J Roentgenol* 1998; 171: 467-70.
9. Rao PM, Rhea JT, Novelline RA, McCabe CJ, Lawrason JN, Berger DL, et al. Helical CT technique for the diagnosis of appendicitis: prospective evaluation of a focused appendix CT examination. *Radiology* 1997; 202: 139-44.
10. Sivit CJ, Siegel MJ, Applegate KE, Newman KD. When appendicitis is suspected in children. *Radiographics* 2001; 21: 247-62.
11. Teo EL, Tan KP, Lam SL, Ong CL, Wong CS. Ultrasonography and computed tomography in a clinical algorithm for the evaluation of suspected acute appendicitis in children. *Singapore Med J* 2000; 41: 387-92.
12. Wise SW, Labuski MR, Kasales CJ, Blebea JS, Meilstrup JW, Holley GP, et al. Comparative assessment of CT and sonographic techniques for appendiceal imaging. *AJR Am J Roentgenol* 2001; 176: 933-41.
13. Sohail S, Siddiqui KJ. Doptaus -- A simple criterion for improving Sonographic Diagnosis of acute appendicitis. *J Pak Med Assoc* 2009; 59: 75-9.
14. Todd J, Armon C, Griggs A, Poole S, Berman S. Increased rates of morbidity, mortality, and charges for hospitalized children with public or no health insurance as compared with children with private insurance in Colorado and the United States. *Paediatrics* 2006; 118: 577-85.
15. Rhea JT, Rao PM, Novelline RA, McCabe CJ. A focused appendiceal CT technique to reduce the cost of caring for patients with clinically suspected appendicitis. *AJR Am J Roentgenol* 1997; 169: 113-8.
16. Saleem OA, Khasawneh M. Role of CT scan in diagnosis of acute appendicitis. *Rawal Med J* 2007; 32: 39-40.
17. Doria AS, Moineddin R, Kellenberger CJ, Epelman M, Beyene J, Schuh S, et al. US or CT for Diagnosis of Appendicitis in Children and Adults? A Meta-Analysis. *Radiology* 2006; 241: 83-94.