Print ISSN: 2321-6379
Online ISSN: 2321-595X

Original Article

An Analysis of Role of Computed Tomography Scan Abdomen in Differentiating Perforated from Non-perforated Appendicitis Accurately and Comparing with Histopathology Reports

Jose Kuruvilla[1], M Sunil[2]

[1]Assistant Professor, Department of Radiodiagnosis, Al Azhar Medical College, Thodupuzha, Kerala, India, [2]Associate Professor, Department of Radiodiagnosis, Al Azhar Medical College, Super Specialty Hospital, Thodupuzha, Kerala, India

Abstract

Background: Acute appendicitis is one of the most common abdominal surgical emergencies requiring accurate diagnosis. It is characterized by obstruction of its lumen, leading to inflammation and finally perforation. To define its prognosis, choose an appropriate surgical procedure and to decide non-surgical treatment, the pre-operative diagnosis of perforated or non-perforated appendicitis is very important.

Aim of the Study: This study aims to analyze the diagnostic accuracy of computed tomography (CT) scan abdomen in differentiating perforated from non-perforated appendicitis using histopathology as the final diagnosis.

Materials and Methods: A prospective, cross-sectional analytical study, wherein 85 patients diagnosed with acute appendicitis referred to the radiological department for CT scan abdomen were included in the study. Patients aged between 15 and 70 years were included in the study. CT scan abdomen with and without contrast was performed on a Toshiba 64 Multislice CT scanner (Toshiba Medical Systems Corp., Tokyo, Japan) which was used for all the patients. All the CT scans were interpreted by the same consultant radiologists with a minimum of 5 years of experience. The radiological features for the diagnosis of non-perforated acute appendicitis by CT were based on swollen appendix, thickened enhancing wall, and smudging of surrounding fat planes, whereas the radiological features for perforated appendicitis used were, with abscess formation, phlegmon, extraluminal air, extraluminal appendicolith, and focal defect in the appendicular wall. Histopathology of the specimen collected following surgery was undertaken by the hospital consultant pathologist of more than 5-year experience.

Observations and Results: Among the 85 patients included in this study for the analysis of CT scan abdomen features, there were 57 (67.05%) males and 28 (32.94%) females with a male-to-female ratio of 2.03:1. The mean age of the patients was 38.90 ± 6.70 years. The incidence of non-perforated appendicitis was 66/85 (77.64%) including males 44/85 (51.76%) and females 22/85 (25.88%). The incidence of perforated appendicitis was 19/85 (22.35%) and males were 12/85 (14.11%) and 7/85 (8.23%) were female. Patients aged 15–45 years of both genders constituted to 63/85 (74.11%) of the total patients. Among these patients, presenting with non-perforated appendicitis was 51/85 (60%) and perforated appendicitis was 12/85 (14.11%).

Conclusions: Multislice CT scan abdomen was considered as the modality of choice for acute appendicitis not only to confirm the diagnosis but also it plays an important role in assessment of appendicular complication, particularly in the detection of perforated appendix. Using one or more of the five radiological signs of CT scan abdomen to identify appendicular perforation raised the sensitivity significantly reaching 94.12%.

Key words: Abscess formation, Appendix, Extraluminal air and phlegmon, Multislice computed tomography scan, Perforated appendix

Access this article online

www.ijss-sn.com

Month of Submission : 12-2019
Month of Peer Review : 01-2020
Month of Acceptance : 02-2020
Month of Publishing : 02-2020

INTRODUCTION

Appendicitis being the most common abdominal surgical emergency with an incidence 7–12% of the general population demands accurate diagnosis which is essential for taking a surgical decision in its management. The management may be either medical or surgical in

Corresponding Author: Dr. M Sunil, Department of Radiodiagnosis, Al Azhar Medical College, Super Specialty Hospital, Ezhalloor, Thodupuzha, Kerala, India.

nature.[1] Usually, appendicitis starts with block in the lumen or its opening followed by accumulation of fluid within its lumen.[2,3] As the disease process continues, the appendix becomes swollen and the inflammatory process involves its wall and progresses into the periappendicular fat planes.[4] The most common complications are appendicular perforation, abscess formation, peritonitis, and bowel obstruction.[5] The characteristic clinical features of appendicitis are pain in the right lower quadrant of abdomen fever, vomiting, and rebound tenderness.[6,7] Laboratory finding of increased white blood cell count has a low predictive value for the diagnosis of appendicitis.[8] Even though clinical and laboratory findings are helpful in the diagnosis of acute appendicitis, about 30% of patients have atypical presentation that can be misleading.[9] In such critical times, computed tomography (CT) scan is the modality of choice to diagnose the acute appendicitis and differentiate it from the other causes of acute abdomen. The progressive use of CT scan in such situations has resulted in significant reduction in the negative appendectomy rates from 30% to 2%.[10] The differentiation between the non-perforated and perforated appendicitis is important because the perforation of appendix is associated with higher mortality rate.[11] The incidence rate of post-operative complications in patients with perforated appendectomy is high compared to non-perforated appendectomy (28.4% vs. 4.7%).[12] In one study, the mean length of hospital stay in the perforated group was 6.3 days while it was 2.9 days in the non-perforated group.[13] The advantages of CT scan of abdomen are that it is non-operator dependent, widespread non-invasive technique, and easy detection of the diseased or non-diseased appendix even in its different positions.[11] Ultrasound sound abdomen appears less sensitive and less accurate in diagnosing in acute appendicitis when compared to the CT scan,[12,13] especially in those patients with severe pain, marked gaseous distension, and in obese patients. The progress in CT scanners is allowing shortening of the scan time and multiplanar reformatted images with high spatial resolution.[14] The radiological features for diagnosis of non-perforated acute appendicitis by CT are based on swollen appendix, thickened enhancing wall, and smudging of surrounding fat planes,[12,14] whereas the diagnosis of perforated appendicitis was suggested with abscess formation, phlegmon, extraluminal air, extraluminal appendicolith, and focal defect in the appendicular wall.[15] In one study, the sensitivity and specificity of CT to diagnose perforated appendicitis was 69% and 97%, respectively.[16] In the present context, this study was conducted to analyze the diagnostic accuracy of CT scan abdomen in differentiating perforated from non-perforated appendicitis using histopathology as the final diagnosis.

Type of Study

This was a prospective, cross-sectional, and analytical study.

Duration of Study

This study was from October 2015 to October 2018.

Institute of Study

This study was conducted at Al Azhar Medical College and Super Specialty Hospital, Thodupuzha, Kerala.

MATERIALS AND METHODS

A prospective, cross-sectional analytical study was conducted at a tertiary teaching hospital of Kerala, wherein 85 patients diagnosed with acute appendicitis referred to the radiological department for CT scan abdomen were included in the study. An ethical committee clearance was obtained before the commencement of the study. An ethical committee accepted pro forma was used for this study.

Inclusion Criteria

1. Patients aged between 15 and 70 years were included in the study
2. Patients with symptoms of pain in the abdomen, fever, and vomiting were included in the study
3. Patients with rebound tenderness in the right lower quadrant of the abdomen were included in the study
4. Patients of both the genders were included in the study.

Exclusion Criteria

1. Patients aged below 15 and above 70 years were excluded from the study.
2. Those patients who were refused surgery in this same hospital and referred to other hospitals or with deranged renal function were excluded from the study.

CT scan abdomen was performed on a Toshiba 64 Multislice CT scanner (Toshiba Medical Systems Corp., Tokyo, Japan) which was used for all the patients. The scanning protocol included the acquisition of axial helical CT sections before and after the administration of intravenous contrast, extending from the xiphoid process of the sternum to the pubic symphysis pubis at 120 kVp and 210 mA. At the time of scanning, intravenous contrast was administered using a power injector at a rate of 5 mL/s followed by the acquisition of axial cuts at 4-mm slice thickness in the portal venous phase (60–70 s after injection of bolus contrast). Sagittal and coronal multiplanar reconstruction was also performed. All the CT scans were interpreted by the same consultant radiologists with a minimum of 5 years of experience. The radiological features for the diagnosis of non-perforated acute appendicitis by CT were based on swollen appendix, thickened enhancing wall, and smudging of surrounding fat planes, whereas the radiological features for perforated appendicitis used were, with abscess formation, phlegmon,

extraluminal air, extraluminal appendicolith, and focal defect in the appendicular wall. Histopathology of the specimen collected following surgery was undertaken by the hospital consultant pathologist of more than 5-year experience. All the data were analyzed using descriptive statistics, frequency, and percentage which were computed for gender, CT scan findings, and histopathology findings. Mean ± standard deviation for age was calculated. Sensitivity, specificity, positive and negative predictive values, and diagnostic accuracy of perforated appendicitis on CT scan were calculated using histopathology as the final diagnosis. The accuracy through Chi-square test, $P < 0.05$ was considered statistically significant.

OBSERVATION AND RESULTS

Among the 85 patients included in this study for the analysis of CT scan abdomen features, there were 57 (67.05%) males and 28 (32.94%) females with a male-to-female ratio of 2.03:1. The youngest patient was aged 16 years and the eldest patient was aged 70 years with a mean age of 38.90 ± 6.70 years. The incidence of non-perforated appendicitis was 66/85 (77.64%) observed in this study. Among the 66/85 non-perforated appendicitis, males were 44/85 (51.76%) and 22/85 (25.88%) were female. The incidence of perforated appendicitis was 19/85 (22.35%) and among them, males were 12/85 (14.11%) and 7/85 (8.23%) were female. Patients aged 15–45 years of both genders constituted to 63/85 (74.11%) of the total patients. Among these patients, presenting with non-perforated appendicitis was 51/85 (60%) and perforated appendicitis was 12/85 (14.11%), [Table 1].

CT scan abdomen features suggestive of non-perforated appendicitis includes enlarged appendicular diameter (>6 mm) with an occluded lumen was observed in 27/85 (40.90%), appendicular wall thickening (>2 mm) in 14/85 (21.21%), periappendicular fat stranding in 12/85 (18.18%), appendicular wall enhancement in 9/85 (13.63%), and appendicolith in 4/85 (6.06%) was observed [Table 2].

Specific signs for perforated appendicitis on CT scan abdomen included a defect in enhancing the appendicular wall was observed in 7/85 (36.84%), focal area of non-enhancement with enhancing of the remaining appendicular wall was observed in 5/85 (26.31%), extraluminal air in 3/85 (15.78%), extraluminal appendicolith in 2/85 (10.52%), and abscess formation in 2/85 (10.52%) patients [Table 3].

CT scan abdomen reports in this study showed that there were 19/85 (22.35%) patients that had perforated and 66/85 (77.64%) had non-perforated appendicitis while histopathology reported 14/85 (16.47%) with perforated appendicitis and 53/85 (83.52%) with non-perforated appendicitis. That leaves us with 5/85 (5.88%) false-positive cases among the perforated appendicitis cases and 13/85 (15.29%) false-positive cases among the non-perforated appendicitis. Hence, in the present study, the sensitivity of CT scan abdomen in the diagnosis of perforated appendicitis was 94.12% and sensitivity ion the diagnosis of non-perforated appendicitis was 84.71%. Positive predictive value of non-perforated appendicitis was 62.35% and positive predictive value of perforated appendicitis was 73.68%. The accuracy of CT in the detection of perforated appendicitis was 85.4% in male cases and 92.2% in female cases.

DISCUSSION

In addition to rapid and accurate diagnosis of acute appendicitis, the surgeon needs to know accurately whether any associated complication is associated with it, especially whether it is perforated or non-perforated. This information would be of great value to the operating surgeon so that he could be sure of the prognosis. Localization of the inflamed appendix can be determined by the radiologist in most of the cases before surgical interference. High sensitivity and specificity in detection of acute appendicitis ranging between 94 and 98% were reported by many authors with the help of CT scan abdomen increasing its diagnostic value.[17] Even though surgical treatment

Table 1: Incidence of types of appendicitis in different age groups (*n*=85)

Age group	Non-perforated appendicitis – 66 (77.64%)	Perforated appendicitis – 19 (22.35%)	Percentage
15–30 (38)	Total – 31 (24.70) Male – 21, female – 10	Total – 7 (8.23) Male – 4, female – 3	44.70
31–45 (25)	Total – 20 (23.52) Male – 13, female – 7	Total – 5 (5.88) Male – 3, female – 2	29.41
46–60 (11)	Total – 8 (9.41) Male – 5, female – 3	Total – 4 (4.70) Male – 3, female – 1	12.94
61–75 (11)	Total – 7 (8.23) Male – 5, female – 2	Total – 3 (3.52) Male – 2, female – 1	12.94
Total	Total – 66 (51.76) Male – 44, female – 22	Total – 22 (25.88) Male – 12, female – 7	100

Table 2: Incidence computed tomography scan abdomen findings in non-perforated appendicitis (*n*=66)

Radiological features	Number	Percentage
Enlarged appendicular diameter with occluded lumen>6 mm	27	40.90
Appendicular wall thickening (>2 mm)	14	21.21
Periappendicular fat stranding	12	18.18
Appendicular wall enhancement	9	13.63
Appendicolith	4	6.06

Table 3: Incidence computed tomography scan abdomen findings in perforated appendicitis (*n*=19)

Radiological features	Number	Percentage
Enhancing the appendicular wall	7	36.84
Focal area of non-enhancement with enhancing of the remaining appendicular wall	5	26.31
Extraluminal air	3	15.78
Extraluminal appendicolith	2	10.52
Abscess formation	2	10.52

is adopted for uncomplicated acute appendicitis, few surgeons treat non-complicated appendicitis or appendicitis without palpable mass by conservative medical treatment instead of surgical interference. The medical conservative treatment and antibiotic therapy if administrated in the first 12 h are considered effective method for treatment with 68–84% success rate.[18,19] In situations, where a clinical examination reveals complication of acute appendicitis such as perforation choosing a non-surgical management depends on accurate and reliable CT scan abdomen interpretation. Review of current literature reveals that the sensitivities and specificities for CT scan abdomen for the diagnosis of acute appendicitis are around 90%, resulting in significantly reduced negative appendectomy rates from 15–20% to 2–12%.[20,21] In spite of high sensitivity, the differentiation between perforated and non-perforated appendicitis is not as accurate as it should be because differentiating perforated from non-perforated appendicitis is decided on by a wide range of radiological signs of CT scan abdomen. They include the presence of free fluid, phlegmon, abscess, extraluminal air, and bowel wall thickening; each of these characteristics favors perforation.[21,22] In this study, CT scan abdomen features suggestive of non-perforated appendicitis includes enlarged appendicular diameter (>6 mm) with an occluded lumen was observed in 27/85 (40.90%), appendicular wall thickening (>2 mm) in 14/85 (21.21%), periappendicular fat stranding in 12/85 (18.18%), appendicular wall enhancement in 9/85 (13.63%), and appendicolith in 4/85 (6.06%) was observed [Table 2]. Specific signs for perforated appendicitis on CT scan abdomen included a defect in enhancing the appendicular wall was observed in 7/85 (36.84%), focal area of non-enhancement with enhancing of the remaining appendicular wall was observed in 5/85 (26.31%), extraluminal air in 3/85 (15.78%), extraluminal appendicolith in 2/85 (10.52%), and abscess formation in 2/85 (10.52%) patients [Table 3]. In the present study, the sensitivity of CT scan abdomen in the diagnosis of perforated appendicitis was 94.12% and sensitivity ion the diagnosis of non-perforated appendicitis was 84.71%. Positive predictive value of non-perforated appendicitis was 62.35% and positive predictive value of perforated appendicitis was 73.68%. The accuracy of CT in the detection of perforated appendicitis was 85.4% in male cases and 92.2% in female cases. In another study, the sensitivity and specificity of CT to diagnose perforated appendicitis was 69% and 97%, respectively.[13] In the Fraser *et al.* study,[23] CT scan abdomen had a sensitivity of 62% with a specificity of 81% in predicting appendicular perforation.

CONCLUSIONS

Multislice CT scan abdomen was considered as the modality of choice for acute appendicitis not only to confirm the diagnosis but also it plays an important role in assessment of appendicular complication, particularly in detection of perforated appendix. Using one or more of the five radiological signs of CT scan abdomen to identify appendicular perforation raised the sensitivity significantly reaching 94.12%. However, individual CT scan abdomen finding showed relatively low-to-moderate sensitivity in diagnosis of perforated appendicitis.

REFERENCES

1. Taourel P, Baron MP, Pradel J, Fabre JM, Seneterre E, Bruel JM. Acute abdomen of unknown origin: Impact of CT on diagnosis and management. Gastrointest Radiol 1992;17:287-91.
2. Pieper R, Kager L, Tidefeldt U. Obstruction of appendix vermiformis causing acute appendicitis. An experimental study in the rabbit. Acta Chir Scand 1982;148:63-72.
3. Berry J Jr., Malt RA. Appendicitis near its centenary. Ann Surg 1984;200:567-75.
4. Morrow SE, Newman KD. Current management of appendicitis. Semin Pediatr Surg 2007;16:34-40.
5. Birnbaum BA, Wilson SR. Appendicitis at the millennium. Radiology 2000;215:337-48.
6. Siewert B, Raptopoulos V, Mueller MF, Rosen MP, Steer M. Impact of CT on diagnosis and management of acute abdomen in patients initially treated without surgery. AJR Am J Roentgenol 1997;168:173-8.
7. Nemcek AA Jr. CT of acute gastrointestinal disorders. Radiol Clin North Am 1989;27:773-86.
8. Calder JD, Gajraj H. Recent advances in the diagnosis and treatment of acute appendicitis. Br J Hosp Med 1995;54:129-33.
9. Poh AC, Lin M, Teh HS, Tan AG. The role of computed tomography in clinically-suspected but equivocal acute appendicitis. Singapore Med J 2004;45:379-84.
10. Jones K, Peña AA, Dunn EL, Nadalo L, Mangram AJ. Are negative appendectomies still acceptable? Am J Surg 2004;188:748-54.

11. Blomqvist PG, Andersson RE, Granath F, Lambe MP, Ekbom AR. Mortality after appendectomy in Sweden, 1987-1996. Ann Surg 2001;233: 455-60.
12. Barreto SG, Travers E, Thomas T, Mackillop C, Tiong L, Lorimer M, *et al*. Acute perforated appendicitis: An analysis of risk factors to guide surgical decision making. Indian J Med Sci 2010;64:58-65.
13. Siddiqui AH, Afzal S. Perforated appendicitis: Accuracy of ct diagnosis and correlation of CT findings with the length of hospital stay. J Coll Physicians Surg Pak 2007;17:721-5.
14. 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.
15. Balthazar EJ, Birnbaum BA, Yee J, Megibow AJ, Roshkow J, Gray C. Acute appendicitis: CT and US correlation in 100 patients. Radiology 1994;190:31-5.
16. Ghiatas AA, Kritikos N. CT of appendicitis. In: Baert AL, Sartor K, Chapman AH, editors. Radiology and Imaging of the Colon. Berlin Heidelberg: Springer-Verlag; 2004. p. 157-63.
17. Davies S, Peckham-Cooper A, Sverrisdottir A. Case-based review: Conservative management of appendicitis are we delaying the inevitable? Ann R Coll Surg Engl 2012;94:232-4.
18. Varadhan KK, Neal KR, Lobo DN. Safety and efficacy of antibiotics compared with appendicectomy for treatment of uncomplicated acute appendicitis: Meta-analysis of randomised controlled trials. BMJ 2012;344:e2156.
19. Vons C, Barry C, Maitre S, Pautrat K, Leconte M, Costaglioli B, *et al*. Amoxicillin plus clavulanic acid versus appendicectomy for treatment of acute uncomplicated appendicitis: An open-label, non-inferiority, randomised controlled trial. Lancet 2011;377:1573-9.
20. Applegate KE, Sivit CJ, Salvator AE, Borisa VJ, Dudgeon DL, Stallion AE, *et al*. Effect of cross-sectional imaging on negative appendectomy and perforation rates in children. Radiology 2001;220:103-7.
21. Yeung KW, Chang MS, Hsiao CP. Evaluation of perforated and nonperforated appendicitis with CT. Clin Imaging 2004;28:422-7.
22. Foley TA, Earnest F 4th, Nathan MA, Hough DM, Schiller HJ, Hoskin TL. Differentiation of nonperforated from perforated appendicitis: Accuracy of CT diagnosis and relationship of CT findings to length of hospital stay. Radiology 2005;235:89-96.
23. Fraser JD, Aguayo P, Sharp SW, Snyder CL, Rivard DC, Cully BE, *et al*. Accuracy of computed tomography in predicting appendiceal perforation. J Pediatr Surg 2010;45:231-4.

How to cite this article: Kuruvilla J, Sunil M. An Analysis of Role of Computed Tomography Scan Abdomen in Differentiating Perforated from Non-perforated Appendicitis Accurately and Comparing with Histopathology Reports. Int J Sci Stud 2020;8(2):32-36.

Source of Support: Nil, **Conflicts of Interest:** None declared.