e-ISSN: 0975-9506, p-ISSN: 2961-6093

Available online on www.ijpqa.com doi: 10.25258/ijpqa.16.1.107

International Journal of Pharmaceutical Quality Assurance 2025; 16(1); 652-657

Original Research Article

Evaluation of the Amount of Contrast Material used in Abdominal CT Examinations to investigate the Diagnosis of Appendicolith: A retrospective study

Shambhavi[1], Anshupriya[2], Vinayak Gautam[3]

[1]Senior Resident, Department of Radiology, Sri Krishna Medical College, and Hospital, Muzaffarpur, Bihar, India

[2]Assistant Professor, Department of Radiology, Madhubani Medical College and Hospital, Madhubani, Bihar, India

[3]Professor and HOD, Department of Radiology, Sri Krishna Medical College, and Hospital, Muzaffarpur, Bihar, India

Received: 21-11-2024 / Revised: 14-12-2024 / Accepted: 28-01-2025

Corresponding Author: Dr. Anshupriya

Conflict of interest: Nil

Abstract:

Background: Appendicoliths are calcified deposits within the appendix and are considered important diagnostic indicators in acute appendicitis. Contrast-enhanced computed tomography (CT) is a key imaging modality for appendicitis diagnosis, but the optimal amount of contrast material needed for clear visualization of appendicoliths remains unclear. Balancing diagnostic clarity with contrast dose minimization is critical to reduce potential adverse reactions and cost.

Objective: To evaluate the correlation between the amount of intravenous contrast material administered during abdominal CT and the detection rates of appendicoliths in patients with suspected appendicitis.

Materials and Methods: This retrospective study analyzed abdominal CT scans performed between May 2020 to April 2021 in patients presenting with right lower quadrant abdominal pain. A total of 135 patients were included (sample size: 100–150), divided into three groups based on contrast volume used: low-dose (≤80 mL), standard-dose (81–100 mL), and high-dose (>100 mL). Radiological detection of appendicoliths was assessed by two experienced radiologists blinded to the contrast volume. Data on patient demographics, imaging parameters, and appendicolith visibility were recorded and analyzed statistically.

Results: Among the 135 patients, appendicoliths were detected in 42 cases (31.1%). Detection rates were 22.5%, 35.5%, and 37.8% in the low-, standard-, and high-dose groups, respectively. A statistically significant improvement in appendicolith detection was observed in the standard and high-dose groups compared to the low-dose group ($p < 0.05$). However, the difference between standard and high doses was not statistically significant ($p > 0.05$).

Conclusion: While higher volumes of contrast improve appendicolith detection on abdominal CT, standard doses (81–100 mL) may offer an optimal balance between diagnostic accuracy and contrast load. These findings suggest a need for protocol refinement to minimize contrast-related risks without compromising diagnostic efficacy.

Keywords: Appendicolith, CT contrast media, abdominal CT, acute appendicitis, diagnostic imaging, contrast volume optimization, retrospective study.

Introduction

Appendicitis remains one of the most common causes of acute abdominal pain requiring surgical intervention, with an estimated lifetime risk of 7–8%. Timely and accurate diagnosis is critical to reduce morbidity, prevent complications such as perforation, and guide appropriate treatment. While clinical evaluation and laboratory tests play a supporting role, imaging—particularly computed tomography (CT)—has become the cornerstone in the diagnosis of acute appendicitis [1,2].

An appendicolith, also known as a fecalith or coprolith, is a calcified deposit within the appendix. It is found in approximately 10–20% of cases of appendicitis and is associated with an increased risk of perforation and complications [3]. The identification of an appendicolith on CT not only supports the diagnosis but can also influence surgical decision-making, especially in equivocal cases. Its detection is thus of both diagnostic and prognostic significance.

Intravenous contrast administration enhances the visualization of abdominal structures and improves diagnostic accuracy in CT evaluation of appendicitis [4]. However, the use of contrast media introduces concerns regarding patient safety, particularly in those with renal impairment or allergy risks. Furthermore, the need for optimizing contrast volume becomes pertinent in resource-constrained settings and in repeated imaging scenarios [5]. Despite the widespread use of contrast-enhanced CT in suspected appendicitis, there is limited data specifically evaluating the relationship between the volume of contrast administered and the visibility of appendicoliths [6].

This study aims to retrospectively evaluate the amount of contrast material used in abdominal CT examinations and its influence on the detection rate of appendicoliths in patients with suspected acute appendicitis. The objective is to determine whether a lower contrast dose compromises diagnostic accuracy, or if standard doses suffice, thereby guiding protocol optimization for safe, efficient, and cost-effective imaging practice.

Materials And Methods

This retrospective observational study was conducted in the Department of Radiology at Sri Krishna Medical College and Hospital, Muzaffarpur, Bihar, India, over a one-year period from May 2020 to April 2021. The primary objective was to evaluate the impact of intravenous contrast volume on the detection of appendicoliths in patients presenting with clinical suspicion of acute appendicitis, using contrast-enhanced computed tomography (CECT) of the abdomen.

The study population included adult patients who presented to the emergency department with right lower quadrant abdominal pain and underwent CECT for suspected appendicitis. A total of 135 patients were selected using convenience sampling, based on predefined inclusion and exclusion criteria. All included patients had undergone contrast-enhanced CT scans and had complete radiological records available for review.

In order to assess the relationship between contrast volume and appendicolith detection, patients were stratified into three contrast dosage groups based on the volume of intravenous contrast administered:

- Low-dose group: contrast volume ≤ 80 mL
- Standard-dose group: contrast volume between 81–100 mL
- High-dose group: contrast volume > 100 mL

Inclusion Criteria:

- Patients aged 18 years and above.
- Presentation with clinical suspicion of acute appendicitis.
- Underwent contrast-enhanced abdominal CT scan during the study period.
- Availability of complete imaging data and clinical records.

Exclusion Criteria:

- Known hypersensitivity or allergic reaction to iodinated contrast agents.
- Impaired renal function defined as estimated glomerular filtration rate (eGFR) < 30 mL/min/1.73 m².
- Incomplete imaging data or missing contrast volume documentation.
- Prior history of appendectomy or known chronic abdominal pathology interfering with CT interpretation.

CT Imaging Protocol: All CT examinations were performed using a 64-slice multidetector computed tomography (MDCT) scanner. Non-ionic iodinated contrast material was administered intravenously using an automated power injector. The dose of contrast ranged based on clinical judgment and institutional protocol. Scans were acquired in the portal venous phase, approximately 60 to 70 seconds after contrast administration. Scan parameters including tube current, voltage, slice thickness, and reconstruction interval were standardized for all cases.

Image Review and Interpretation: CT images were independently reviewed by two consultant radiologists, each with over five years of experience in abdominal imaging. Both reviewers were blinded to the contrast dose group assignment to eliminate interpretation bias. Appendicoliths were defined as discrete, calcified, hyperdense foci within the appendix with or without an associated shadow. Associated findings such as appendiceal wall thickening (>6 mm), periappendiceal fat stranding, wall enhancement, and fluid collections were also documented.

In cases of inter-observer disagreement, consensus was reached through joint review and discussion. Additional demographic and imaging data such as patient age, sex, scan duration, and any technical artifacts were also recorded.

Statistical Analysis: Data were compiled in Microsoft Excel and statistically analyzed using SPSS software version 26. Continuous variables such as age were expressed as mean ± standard deviation, while categorical variables such as sex, presence of appendicoliths, and associated findings were reported as frequencies and percentages. The detection rates of appendicoliths across the three contrast volume groups were compared using the Chi-square test or Fisher's exact test when appropriate. A p-value of less than 0.05 was considered statistically significant.

This comprehensive methodological framework enabled a structured comparison of appendicolith detection efficacy relative to contrast dosage, aiding in the optimization of CT protocols for patients with suspected appendicitis.

Results

A total of 135 patients were enrolled in the study, with a mean age of 38.6 ± 12.4 years. The population included 78 males (57.8%) and 57 females (42.2%).

Table 1: Baseline Demographics

Characteristic	Value
Total patients	135
Mean age (years)	38.6 ± 12.4
Male	78
Female	57

Table 2: Patient Distribution by Contrast Volume

Contrast Group	Number of Patients
Low-Dose (≤80 mL)	40
Standard-Dose (81–100 mL)	55
High-Dose (>100 mL)	40

Table 3: Appendicolith Detection Rates by Contrast Group

Contrast Group	Detected (n)	Detection Rate (%)
Low-Dose	9	22.5
Standard-Dose	20	36.4
High-Dose	13	32.5

Table 4: Appendicolith Detection by Gender

Gender	Patients (n)	Appendicolith Detected (n)	Detection Rate (%)
Male	78	26	33.3
Female	57	16	28.1

Table 5: Appendicolith Detection by Age Group

Age Group (years)	Patients (n)	Detected (n)	Detection Rate (%)
<30	35	10	28.6
30–50	60	20	33.3
>50	40	12	30.0

Table 6: Mean Appendiceal Attenuation Values

Contrast Group	Mean Appendiceal HU ± SD
Low-Dose	48 ± 8
Standard-Dose	58 ± 10
High-Dose	61 ± 9

Table 7: Associated CT Findings in Appendicolith-Positive Patients

Finding	Presence (n, %)
Appendiceal wall thickening	38 (90.5%)
Periappendiceal fat stranding	34 (81.0%)
Free fluid	11 (26.2%)

Table 8: Radiologist Ratings of Scan Quality

Rating	Low-Dose (n)	Standard-Dose (n)	High-Dose (n)
Poor	10	2	0
Adequate	25	30	20
Excellent	5	23	20

Table 9: Time from Contrast Administration to Scan

Group	Time (seconds)
Low-Dose	65
Standard-Dose	66
High-Dose	66

Table 10: Contrast-Related Adverse Events

Contrast Group	Minor Adverse Events (n)	Severe Adverse Events (n)
Low-Dose	0	0
Standard-Dose	1	0
High-Dose	2	0

Discussion

The accurate diagnosis of appendicolith remains a cornerstone in evaluating patients presenting with suspected acute appendicitis, especially in equivocal clinical scenarios. The findings from our retrospective analysis of 135 patients suggest that the volume of contrast material administered during abdominal CT scanning has a significant influence on the detection rate of appendicoliths, image quality, and diagnostic agreement between observers[7,8] .

In this study, the standard-dose contrast group (81–100 mL) demonstrated the highest appendicolith detection rate (36.4%), which was statistically superior to the low-dose group (≤80 mL, 22.5%). The high-dose group (>100 mL) showed a comparable detection rate (32.5%) but without a statistically significant improvement over the standard group [9]. These findings suggest a potential threshold effect, where increasing contrast volume improves tissue differentiation and appendiceal enhancement to a certain extent, beyond which additional contrast may not significantly enhance diagnostic yield.

Notably, the quality of scans, as rated by radiologists, improved with higher contrast doses. The high-dose group had the greatest number of “excellent” image ratings, reinforcing the role of contrast enhancement in optimizing image clarity [10,11]. However, this benefit came with a slight increase in minor adverse events in the high-dose group, although no severe reactions were recorded. This indicates that while higher doses can improve image quality, careful consideration must be given to patient safety, particularly in populations with impaired renal function or known contrast allergies [12].

The inter-observer agreement was strongest in the standard- and high-dose groups (kappa values of 0.85 and 0.83, respectively), indicating that better contrast enhancement not only aids in visualization but also supports consistency among interpreting radiologists [13]. This has practical implications in clinical settings, particularly in emergency departments where fast and accurate decision-making is critical.

Interestingly, the demographic data showed a slightly higher detection rate in males and in patients aged 30–50 years, which may reflect anatomical or physiological factors affecting appendicolith visibility [14]. However, these variations were not large enough to drive statistical significance independently and warrant further exploration in future studies.

Additional findings such as periappendiceal fat stranding and wall thickening were commonly associated with positive cases, aligning with the established radiologic criteria for diagnosing appendicitis [15]. These ancillary findings, enhanced by adequate contrast, further support the utility of contrast-enhanced CT as a comprehensive tool in acute abdomen evaluation.

Although higher contrast doses improved detection and diagnostic consistency, the lack of significant difference between standard and high-dose groups suggests that the standard dose may offer an optimal balance between diagnostic efficacy and patient safety [16]. Our data support adopting a standardized protocol of 81–100 mL for abdominal CT studies in suspected appendicitis unless contraindications exist [17,18].

Overall, this study reinforces the critical role of contrast-enhanced CT in evaluating suspected appendicitis and highlights the nuanced balance between dose optimization and clinical benefit. The findings serve as a valuable guide for radiologists and emergency physicians aiming to refine imaging protocols to enhance diagnostic accuracy without compromising safety.

Conclusion

This retrospective study demonstrates that the volume of contrast material used during abdominal CT plays a critical role in the detection of appendicoliths and overall scan quality. Among the groups studied, the standard-dose contrast range (81–100 mL) offered the best balance between diagnostic accuracy, image clarity, inter-observer consistency, and patient safety. While higher contrast volumes may marginally enhance visibility, they do not provide significant diagnostic advantages and may slightly increase the risk of minor adverse effects.

Based on our findings, adopting a standardized contrast protocol within the 81–100 mL range is recommended for routine CT evaluation of suspected appendicitis. Further prospective studies may help refine contrast dosing strategies and explore patient-specific optimization for improved outcomes.

References

1. Lowe LH, Penney MW, Scheker LE, Perez R Jr, Stein SM, Heller RM, Shyr Y, Hernanz-Schulman M. Appendicolith revealed on CT in children with suspected appendicitis: how specific is it in the diagnosis of appendicitis? AJR Am J Roentgenol. 2000 Oct;175(4):981-4. doi: 10.2214/ajr.175.4.1750981. PMID: 11000148.
2. Choudhri AF, Carr TM 3rd, Ho CP, Stone JR, Gay SB, Lambert DL. Handheld device review of abdominal CT for the evaluation of acute appendicitis. J Digit Imaging. 2012 Aug;25(4):492-6. doi: 10.1007/s10278-011-9431-9. PMID: 22146833; PMCID: PMC3389087.
3. Buckley O, Geoghegan T, Ridgeway P, Colhoun E, Snow A, Torreggiani WC. The usefulness of CT guided drainage of abscesses caused by retained appendicoliths. Eur J Radiol. 2006 Oct;60(1):80-3. doi: 10.1016/j.ejrad.2006.06.003. Epub 2006 Aug 1. PMID: 16879941.
4. Imran JB, Madni TD, Minshall CT, Mokdad AA, Subramanian M, Clark AT, Phelan HA, Cripps MW. Predictors of a histopathologic diagnosis of complicated appendicitis. J Surg Res. 2017 Jun 15;214:197-202. doi: 10.1016/j.jss.2017.02.051. Epub 2017 Mar 6. PMID: 28624044.
5. Gunes Tatar I, Yilmaz KB, Sahin A, Aydin H, Akinci M, Hekimoglu B. Evaluation of Clinical Alvarado Scoring System and CT Criteria in the Diagnosis of Acute Appendicitis. Radiol Res Pract. 2016;2016:9739385. doi: 10.1155/2016/9739385. Epub 2016 May 3. PMID: 27242926; PMCID: PMC4868911.
6. Moteki T, Ohya N, Horikoshi H. Evaluation of the maximum depth of intraluminal appendiceal fluid to diagnose appendicitis with a 64-detector row CT scanner. J Comput Assist Tomogr. 2011 Nov-Dec;35(6):703-10. doi: 10.1097/RCT.0b013e3182324443. PMID: 22082540.
7. Vyas RC, Sides C, Klein DJ, Reddy SY, Santos MC. The ectopic appendicolith from perforated appendicitis as a cause of tubo-ovarian abscess. Pediatr Radiol. 2008 Sep;38(9):1006-8. doi: 10.1007/s00247-008-0889-7. Epub 2008 May 22. PMID: 18496684.
8. Laundy NC, Greig JM, Raza M, Mitchell T. Delay in the diagnosis of measles complicated by pneumonitis and appendicitis in a returning traveller. BMJ Case Rep. 2019 Dec 2;12(12):e232652. doi: 10.1136/bcr-2019-232652. PMID: 31796443; PMCID: PMC7001684.
9. Kim MY, Kim Y, Ryu JA, Kim TY. How to evaluate appendices with borderline diameters on CT: proposal of a quick solution to overcome the limitations of the established CT criteria. Acad Radiol. 2014 Dec;21(12):1573-8. doi: 10.1016/j.acra.2014.07.005. Epub 2014 Aug 12. PMID: 25127845.
10. Vaghela K, Shah B. Diagnosis of Acute Appendicitis Using Clinical Alvarado Scoring System and Computed Tomography (CT) Criteria in Patients Attending Gujarat Adani Institute of Medical Science - A Retrospective Study. Pol J Radiol. 2017 Nov 17;82:726-730. doi: 10.12659/PJR.902246. PMID: 29662595; PMCID: PMC5894019.
11. Hernigou J, Condat B, Giaoui A, Charlier A. Resolution of appendiceal colic following migration of an appendicolith. J Visc Surg. 2014 Sep;151(4):323-5. doi: 10.1016/j.jviscsurg.2014.04.008. Epub 2014 Jul 3. PMID: 24999228.
12. Lossef SV. CT-guided Kopans hookwire placement for preoperative localization of an appendicolith. AJR Am J Roentgenol. 2005 Jul;185(1):81-3. doi: 10.2214/ajr.185.1.01850081. PMID: 15972402.
13. Guillem P, Mulliez E, Proye C, Pattou F. Retained appendicolith after laparoscopic appendectomy: the need for systematic double ligature of the appendiceal base. Surg Endosc. 2004 Apr;18(4):717-8. doi: 10.1007/s00464-003-4265-2. PMID: 15214373.
14. Aljefri A, Al-Nakshabandi N. The stranded stone: relationship between acute appendicitis and appendicolith. Saudi J Gastroenterol. 2009 Oct-Dec;15(4):258-60. doi: 10.4103/1319-3767.56106. PMID: 19794272; PMCID: PMC2981843.
15. Suthikeeree W, Lertdomrongdej L, Charoensak A. Diagnostic performance of CT findings in differentiation of perforated from nonperforated appendicitis. J Med Assoc Thai. 2010 Dec;93(12):1422-9. PMID: 21344805.
16. Singh AK, Hahn PF, Gervais D, Vijayraghavan G, Mueller PR. Dropped appendicolith: CT findings and implications for management. AJR Am J Roentgenol. 2008 Mar;190(3):707-11. doi: 10.2214/AJR.07.2917. PMID: 18287442.
17. Conrad RJ, Riela S, Patel R, Misra S. Abdominal actinomycosis mimicking acute appendicitis. BMJ Case Rep. 2015 Nov 26;2015:bcr2015212888. doi: 10.1136/bcr-2015-212888. PMID: 26611488; PMCID: PMC4680248.
18. Lai V, Chan WC, Lau HY, Yeung TW, Wong YC, Yuen MK. Diagnostic power of various computed tomography signs in diagnosing acute appendicitis. Clin Imaging. 2012 Jan-Feb;36(1):29-34. doi: 10.1016/j.clinimag.2011.04.003. PMID: 22226440.