Radiology

ORIGINAL RESEARCH ■ GASTROINTESTINAL IMAGING

Acute Appendicitis: Clinical Outcome in Patients with an Initial False-Positive CT Diagnosis[1]

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Purpose: To investigate the clinical outcome in patients with a diagnosis of appendicitis at computed tomography (CT) in whom treatment is deemed unnecessary after clinical evaluation.

Materials and Methods: After institutional review board approval, 2283 patients (856 men, 1427 women; mean age, 46 years; age range, 18–99 years) who underwent CT because they were suspected of having appendicitis between 2002 and 2007 were retrospectively identified. CT reports were reviewed, and the likelihood of appendicitis was assigned a score on a five-point scale: score 1, definitely absent; score 2, nonvisualized appendix with no secondary signs of inflammation; score 3, equivocal; score 4, probable; and score 5, definitely present. Diagnosis of appendicitis at CT was considered a false-positive result if the CT report was classified as probable or definite appendicitis but the patient was not treated within 4 days. Cases with false-positive results were reviewed by two readers blinded to patient outcome, supporting clinical data, and prospective scan interpretation, and a grade was assigned by using the same scale. Medical records were reviewed to determine outcomes. Descriptional statistics were used.

Results: Overall, 516 (23%) of 2283 patients had CT findings of probable or definite appendicitis. Thirteen (3%) of 516 patients did not receive immediate treatment for appendicitis. Of these, five (38%; 95% confidence interval: 18%, 65%) underwent later appendectomy with proved appendicitis after a mean interval of 118 days (range, 5–443 days). Seven (54%) of 13 patients never developed appendicitis across a mean follow-up of 583 days (range, 14–1460 days). One (8%) of 13 had a normal appendix at eventual surgery.

Conclusion: Five of 13 patients with CT findings of appendicitis and reassuring clinical evaluation results in whom immediate treatment was deferred ultimately returned with appendicitis. In patients with CT results positive for appendicitis and benign or atypical clinical findings, a diagnosis of chronic or recurrent appendicitis may be considered.

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Computed tomography (CT) is frequently used as a diagnostic tool among patients with abdominal pain, particularly when a patient is clinically suspected of having appendicitis. For the diagnosis of acute appendicitis, CT has high sensitivity and specificity, with values in the range of 87%–100% and 83%–100%, respectively (1–12). There is an extensive body of literature documenting the effect of CT on surgical practice patterns in patients who are suspected of having appendicitis (13–18). Currently, of patients who are suspected of having appendicitis, relatively few directly undergo surgery without preoperative imaging evaluation, with use of preoperative CT most recently reported in the range of 85%–95% (19–21). Before the use of CT, surgeons accepted a false-positive rate (or negative appendectomy rate) of 20% to avoid missing cases of appendicitis. Among some groups, particularly women, the negative appendectomy rate has been even higher, reportedly as high as 42% (18,22). However, the negative appendectomy rate among patients with preoperative CT is much lower, in the range of 3%–6% in some studies (20,21,23–25).

In previous studies, the false-positive rate of CT for appendicitis was based on a pathologic reference standard: a normal appendectomy specimen in patients who undergo surgery. An unknown number of potential false-positive results have been observed among patients in whom the clinical suspicion of appendicitis is raised and who subsequently receive a diagnosis of appendicitis at CT but do not undergo appendectomy after evaluation by a surgeon. Occasionally, we have encountered such patients at CT with typical findings of acute appendicitis (enlargement in combination with secondary signs of inflammation) for whom treatment was deferred after surgical evaluation because of discordant clinical findings. To our knowledge, there are no prior studies in which this subgroup of patients has been evaluated. Therefore, we performed this study to investigate the clinical outcome in patients with a diagnosis of appendicitis at CT in whom treatment was deemed unnecessary after surgical evaluation.

Advances in Knowledge

- A substantial proportion of patients (five [38%] of 13) with CT findings positive for appendicitis who were not treated after clinical evaluation eventually returned with appendicitis.
- Among patients with initially deferred treatment who later presented again and underwent appendectomy, the mean interval was 118 days.

Materials and Methods

Patients

This single-institution retrospective study was approved by our institutional review board and complied with requirements of the Health Insurance Portability and Accountability Act. The requirement for informed consent was waived. To investigate the clinical outcome in patients with a diagnosis of acute appendicitis at CT in whom treatment was initially deemed unnecessary, one author (J.W.S.) used a computerized search of the radiology information system to retrospectively identify all CT examinations performed in patients who were suspected of having appendicitis between July 1, 2002, and July 1, 2007. Search terms included the words “appendix” and “appendicitis,” as well as the character sequence “appendic.” Patients were excluded if they were younger than 18 years. For patients with repeat imaging after an initial CT diagnosis or treatment, only the first CT examination was included. CT reports in 2283 consecutive patients (856 men, 1427 women; mean age, 46 years; range, 18–99 years) were reviewed. For 856 men, the mean age was 47 years (range, 18–99 years), and for 1427 women, the mean age was 45 years (range, 18–97 years). The consecutive sampling of patients yielded proportionally more women because women more frequently undergo imaging for abdominal pain at our institution owing to more diverse differential diagnoses, inclusive of gynecologic disease. Women who underwent CT were also slightly younger than the men studied (45 vs 47 years, P = .03). A computerized search of the surgical pathology database also was performed to identify all patients who were 18 years or older with nonincidental appendectomy specimens across the same period (n = 564). The search filter “nonincidental appendectomy specimens” automatically excluded cases in which appendectomy was part of a larger colon resection or cases in which appendectomy was incidental during surgery for another indication. The radiology and pathology databases then were compared with determined surgical outcomes, as well as identification of patients who did not undergo surgery.

Implication for Patient Care

- The decision to forego surgery in patients with CT findings compatible with appendicitis but reassuring surgical evaluation findings often results in missed appendicitis and increased risk of perforation.

Because ultrasonography (US) is used only occasionally to diagnose appendicitis in adult patients at our institution, in this study, we focused solely on CT diagnosis of appendicitis. However, to quantify potential selection bias, when pathology records indicated appendicitis

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Abbreviation:
CI = confidence interval

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Guarantors of integrity of entire study, J.W.S., E.M.W., F.V.C.; study concepts/study design or data acquisition or data analysis/interpretation, all authors; manuscript drafting or manuscript revision for important intellectual content, all authors; approval of final version of submitted manuscript, all authors; literature research, J.W.S., E.M.W.; clinical studies, J.W.S., L.P., B.M.Y., R.S.; statistical analysis, J.W.S., E.M.W., L.P., R.S.; and manuscript editing, all authors

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in a patient with no history of preoperative CT, radiology records were reviewed to determine whether US was performed preoperatively instead.

CT Technique

All 2283 retrospectively identified patients underwent scanning with multi–detector row CT with four, 16, or 64 detectors (HiSpeed Advantage or LightSpeed; GE Medical Systems, Milwaukee, Wis) with 1.25- or 5-mm section thickness. Scans obtained at 1.25-mm collimation were reconstructed to 5-mm section thickness. The peak tube voltage was 120 kVp, and the milliampere setting was adjusted automatically to attain a noise index of 12. For 2044 patients, 150 mL of intravenous contrast material (iohexol, Omnipaque 350; Nycomed Amersham, Princeton, NJ) was injected at a rate of 3–5 mL/sec. Two hundred thirty-nine patients underwent scanning without intravenous contrast material. Positive oral contrast material was administered routinely in scans obtained before 2006. In 2006, positive oral contrast material was replaced by oral water for routine CT examinations performed for abdominal pain. Rectal contrast material was not administered.

Data Interpretation

All 2283 CT reports were reviewed by one reader (J.W.S.) who classified the likelihood of acute appendicitis on the basis of the following five-point scale: score 1, definitely absent; score 2, nonvisualized appendix with no secondary signs of inflammation; score 3, equivocal; score 4, probable; and score 5, definitely present. Pathology reports of all nonincidental appendectomy specimens and electronic medical records were reviewed to determine patient outcome. A CT diagnosis of acute appendicitis was considered a false-positive result if the CT report was classified as probable or definite appendicitis (score of 4 or 5) but the patient was not treated for appendicitis with surgery, antibiotics, or percutaneous abscess drainage within 4 days after the CT study and did not undergo elective interval appendectomy. Electronic medical record data were incomplete in one patient who subsequently had a diagnosis of appendicitis but for whom no physical examination findings were available for review (Table 1). The incidence of surgically confirmed appendicitis also was determined for patients with CT scans initially interpreted as normal (score of 1), in cases in which the appendix was not visible but no inflammatory signs were present (score of 2), and in cases deemed equivocal at CT (score of 3).

Image Interpretation

Thirteen false-positive CT cases were identified from the database search: Four of the cases were in men (mean age, 46 years; range, 34–67 years) and nine were in women (mean age, 44 years; range, 24–66 years), with a combined mean age of 45 years (range, 24–67 years). Two radiologists (J.W.S., L.P.), with 2 and 6 years, respectively, of subspecialty experience in abdominal imaging, independently reviewed CT images for these 13 patients on a picture archiving and communication system workstation (IMPAX, version

Table 1

Clinical Data at Presentation in 13 Patients with False-Positive CT Results for Appendicitis

Patient No./Sex/Age (y)	Location at Presentation	Symptoms	Physical Examination Result	WBC Count ($\times 10^9$/L)	Outcome at Clinical Follow-up *
1/M/44	Outpatient clinic	RLQ pain	RLQ tender, improved in ED	NA	Appendicitis (17)
2/F/34	ED	RLQ pain	RLQ tender, improved in ED	7.8	Appendicitis (120)
3/F/66	ED	Diffuse abdominal pain	RLQ tender, improved in ED	7	Appendicitis (443)
4/F/47	ED	RLQ pain	NA	15	Appendicitis (5)
5/F/31	ED	RLQ pain	RLQ tender, improved during 1-day hospitalization	5.4	Appendicitis (6)
6/M/34	ED	RLQ pain	RLQ tender, improved during 3-day hospitalization	7.4	Negative appendectomy (10)
7/F/51	ED	RLQ pain, nausea/vomiting	RLQ tender, improved during 1-day hospitalization	4.9	No appendicitis (173)
8/M/67	Outpatient clinic	Abdominal pain, weight loss	Nontender	NA	No appendicitis (547)
9/F/57	Outpatient clinic	Abdominal pain, nausea/vomiting	Lower abdomen tender, resolved across several weeks	9.5	No appendicitis (453)
10/F/59	ED	RLQ pain, nausea/vomiting	RLQ tender, improved during 1-day hospitalization	8.4	No appendicitis (341)
11/M/39	Outpatient clinic	RLQ pain	Discharged from ED	14	No appendicitis (1093)
12/F/26	ED	RLQ pain, nausea/vomiting	RLQ tender, improved during 3-day hospitalization	6.7	No appendicitis (1460)
13/F/24	ED	RLQ pain	RLQ rebound tenderness, improved during 1-day hospitalization	5	No appendicitis (14)

Note.—Data were not available for all variables for all patients. ED = emergency department; NA = not applicable; RLQ = right lower quadrant; WBC = white blood cell count.

* Data in parentheses are numbers of days.

4.5; Agfa, Mortsel, Belgium). In addition, CT scans for two control groups were identified from the original 2283 patients: 13 consecutive true-positive cases of appendicitis in nine men and four women (mean age, 42 years; range, 28–71 years) and 13 consecutive true-negative cases in three men and 10 women (mean age, 31 years; range, 21–54 years). False-positive scans and control scans were presented in a random fashion, and readers were aware of the scan indication (ie, rule out appendicitis) but were blinded to prospective scan interpretation, supporting clinical data, and patient outcomes. Images were reviewed at 5-mm section thickness. Each reader independently recorded the maximal appendiceal diameter and noted the presence or absence of the following secondary signs: periappendiceal fat stranding, appendiceal wall thickening, wall hyperenhancement, and fluid-filled lumen. Appendiceal enlargement was defined as a diameter greater than 1 cm from outer wall to outer wall. Because of the thin dimensions of the appendiceal wall, CT attenuation was not measured quantitatively with a region of interest. Appendiceal wall thickening was defined quantitatively as a single wall diameter greater than 3 mm or qualitatively as "too thick" given the degree of luminal distention. A particular sign was considered present only if identified by both readers independently. In addition, reviewers were asked to assign a score to their overall suspicion for appendicitis in each case on the basis of the following five-point scale: score 1, definitely normal; score 2, nonvisualized appendix with no secondary signs of inflammation; score 3, equivocal; score 4, suspicious for appendicitis; and score 5, definite appendicitis. Cases with a score of suspicious for appendicitis had at least two CT signs of appendicitis, and cases in which appendicitis was considered to be definitely present had at least three CT signs of appendicitis. In addition, cases had to meet the readers' subjective threshold level as those in which appendicitis was considered to be either probable or definite.

Five of 13 patients with false-positive CT results for appendicitis underwent subsequent CT imaging. Two readers, an author (L.P., with 6 years of subspecialty experience in abdominal imaging) and a nonauthor with 2 years of the same kind of experience, who were blinded to prospective scan interpretation, supporting clinical data, and patient outcomes, retrospectively reviewed both the initial and subsequent CT scans to evaluate for any interval change in the appearance of the appendix. Readers compared individual signs of appendicitis (enlargement, periappendiceal fat stranding, appendiceal wall thickening, wall hyperenhancement, and fluid-filled lumen) between scans and assigned a score to each as follows: score 1, improved; score 2, stable; and score 3, worse. In addition, the overall appearance of the appendix was assigned a score by using the same scale. Individual signs were considered improved or worse when they were assigned a score as such by both readers independently. If there was disagreement as to whether a particular sign was improved or worse, it was considered stable.

Statistical Analysis

Statistical analysis was performed by using a software package (Stata, version 8.0; Stata, College Station, Tex). The Student *t* test was used to compare the mean ages of men and women who underwent CT because they were suspected of having appendicitis. The Fisher exact test was used to compare the proportions of men and women between groups who received treatment within 4 days after positive CT results versus those who did not. The Wilcoxon rank sum test was used to compare the scores for reader suspicion of appendicitis between the group with false-positive findings and the controls with true-positive and true-negative findings. The Student *t* test was used to compare the mean values of appendiceal diameter between the cases with false-positive findings and both control groups. The Fisher exact test was used to compare the proportion of patients with periappendiceal fat stranding, appendiceal wall thickening, appendiceal wall hyperenhancement, or fluid-filled appendiceal lumen among the groups. The modified Wald method was used to determine the confidence interval (CI) of the proportion of patients with appendicitis diagnosed among those with delayed treatment after an initial CT diagnosis of appendicitis. The Fisher exact test was also used to compare the proportion of patients with versus those without appendiceal perforation who received treatment within 4 days after positive CT results versus those who did not. *P* values less than .05 were considered to indicate a significant difference.

Results

Overall, 516 (23%) of 2283 patients had CT findings of probable or definite appendicitis. Among patients with positive CT results, most (450 [87%] of 516) were treated surgically within 4 days or fewer, and 95% (426 of 450) had confirmed acute appendicitis. Forty-nine (10%) of 516 patients had nonsurgical treatment initially. Twenty-eight patients were treated with antibiotics, usually because of surgical comorbidities such as malignancy, chemotherapy, or neutropenia. Twenty-one had perforated appendicitis and were treated with percutaneous abscess drainage. An additional four of 516 patients were lost to follow-up.

By contrast, appendicitis was diagnosed in only 15 patients at US (without confirmation with CT results) during the same interval. These patients accounted for approximately 3% (15 of 564) of appendectomies in which findings were positive for appendicitis.

Thirteen (3%) of 516 patients mentioned above were not treated with surgery, antibiotics, or percutaneous drainage within 4 days after diagnosis of appendicitis at CT: four men and nine women with a mean age of 46 years (age range, 24–67 years). Although there were more women ($n = 9$) than men ($n = 4$) in the group that did not receive immediate treatment, this difference was not significant ($P = .16$). Scanning technique among the cases with false-positive findings was as follows: 12 of 13 received intravenous contrast material, eight of 13 received positive oral contrast material, and five of 13 received oral water. One patient who did not receive intravenous contrast material underwent scanning with positive enteric contrast material. Clinical features of these 13 cases, including symptoms, physical examination findings, and white blood cell count, are presented in Table 1. In most cases with false-positive findings, patients had a white blood cell count within normal limits, and their symptoms improved either in the emergency department or after inpatient admission to the surgical service for observation.

CT Scan Interpretation

At review of these 13 scans by two independent readers, all cases were assigned a score as either probable or definite appendicitis. Likewise, among the control group of true-positive scans, all 13 cases were assigned a score either as suspicious for appendicitis or as definite appendicitis. Reader confidence was slightly higher for the cases with true-positive findings (mean score, 4.9) than for the cases with false-positive findings (mean score, 4.3; $P < .01$). By contrast, in all cases with true-negative findings, the findings were interpreted as appendicitis definitely absent, with the exception of two cases in which the findings were classified as appendicitis definitely absent by one reader and as nonvisualized appendix with no secondary signs of inflammation by the second reader (mean score, 1.1; $P < .001$).

There was no significant difference in mean appendiceal diameter between the cases with false-positive findings (11.5 mm) and the control group cases with true-positive findings (12.6 mm; $P = .26$). However, the mean diameter in the cases with false-positive findings was much larger than that in the control group cases with true-negative findings (5.2 mm; $P < .001$) (Table 2). The frequency of specific CT signs of appendicitis also was compared between the group with false-positive findings and the control groups (Table 2). There was no significant difference in the proportion of patients with periappendiceal fat stranding ($P = .09$), wall thickening ($P = .67$), wall hyperemia ($P = .68$), and fluid-filled lumen ($P = .24$) between those with false-positive and those with true-positive CT scans. By contrast, none of these signs were present in any case with true-negative findings, and the comparative absence of periappendiceal fat standing ($P < .001$) and wall thickening ($P < .01$) among cases with true-negative findings was significant.

Table 2

Comparison of Mean Appendiceal Diameter and Secondary Signs of Appendicitis among Groups of 13 Patients Each

CT Appearance	False-Positive CT Scan Group	True-Positive CT Scan Control Group: Value	True-Positive CT Scan Control Group: *P* Value	True-Negative CT Scan Control Group: Value	True-Negative CT Scan Control Group: *P* Value
Mean widest diameter of appendix (mm)*	11.5 (7–16)	12.6 (10.5–16)	.26	5.2 (3–6.5)	<.001
Right lower quadrant fat stranding	9 (69)	13 (100)	.09	0	<.001
Wall thickening†	8 (62)	10 (77)	.67	0	<.01
Wall hyperemia‡	4 (31)	6 (46)	.68	0	<.1
Fluid-filled lumen	4 (31)	8 (62)	.24	0	<.1

Note.—Data were not available for all variables for all patients. Unless otherwise indicated, data are numbers of patients, and numbers in parentheses are percentages.

* Numbers in parentheses are ranges.

† Appendiceal wall thickening was defined quantitatively as single wall diameter greater than 3 mm or qualitatively as “too thick” given the degree of luminal distention.

‡ Because of the thin dimensions of the appendiceal wall, the CT attenuation was not measured quantitatively with a region of interest.

Outcomes in Cases of False-Positive CT Results

Five (38%; 95% CI: 18%, 65%) of 13 patients with false-positive scans subsequently underwent appendectomy for appendicitis after a mean interval of 118 days (range, 5–443 days) (Fig 1). For two cases, there was pathologic evidence of acute inflammation only. In another two cases, there were acute and chronic inflammation; and in one case, only chronic changes were seen. In these five cases with false-positive findings that were ultimately diagnosed as appendicitis, perforated appendicitis was determined in three cases at the time of the eventual appendectomy. Perforation was twice as common among patients in whom treatment initially was deferred, seen in 23% (three of 13) compared with 11% (55 of 499) in those who were treated within 4 days after obtaining positive CT results, but the difference was not significant ($P > .1$). Two of these five patients underwent subsequent CT between the initial false-positive scan and eventual appendectomy (mean scan interval, 224 days; range, 6–442 days). In both cases, the appearance of the appendix was similar to that at initial CT, but there was an interval increase in appendiceal enlargement and interval worsening of at least two secondary signs of appendicitis (Fig 1).

Seven (54%) of 13 patients never developed appendicitis across a mean follow-up of 583 days (range, 14–1460 days) (Fig 2). In only one patient was the follow-up of fewer than 90 days. Three of these seven patients underwent subsequent CT after initial false-positive CT results (mean scan interval, 16 days; range, 1–46 days). In all three cases, the appearance of the appendix was stable between scans, with no change in either appendiceal enlargement or secondary signs of inflammation.

The remaining one (8%) of 13 patients presented again after 10 days with recurrent right lower quadrant abdominal pain and then underwent appendectomy. However, the appendix was normal at pathologic examination,

Figure 1

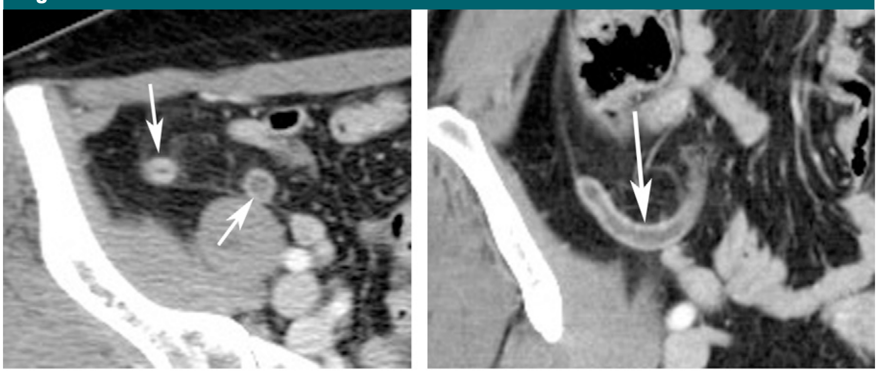
a. b. c.

Figure 1: CT images in 68-year-old woman with right lower quadrant pain. **(a)** Intravenous contrast material–enhanced transverse CT image demonstrates findings of acute appendicitis, including an enlarged appendix with a fluid-filled lumen (long arrow) 1.2 cm in diameter. The tubular structure (short arrow) anterior to the appendix is a collapsed loop of small bowel. **(b)** Adjacent transverse CT image also demonstrates appendiceal wall thickening, periappendiceal fluid, and fat stranding (arrows, also on **c**). Findings on scan were deemed false-positive after clinical evaluation by a surgeon, and the patient was not treated. **(c)** After 442 days, the patient returned with perforated appendicitis. An intravenous contrast-enhanced transverse CT image demonstrates an appearance similar to that at the initial presentation.

and no alternate diagnosis was found at surgery (Fig 3).

By contrast, only 15 of 1460 patients with CT scans categorized as definitively normal subsequently received a diagnosis of appendicitis during the study—a false-negative rate of just 1%. In cases in which the appendix was not visible but the scan was assumed to be normal because of lack of inflammatory changes, appendicitis subsequently was diagnosed in only two (1%) of 146 patients. Only 12 (7%) of 161 of patients with equivocal scans subsequently received a diagnosis of appendicitis during the study.

Figure 2



a. b.

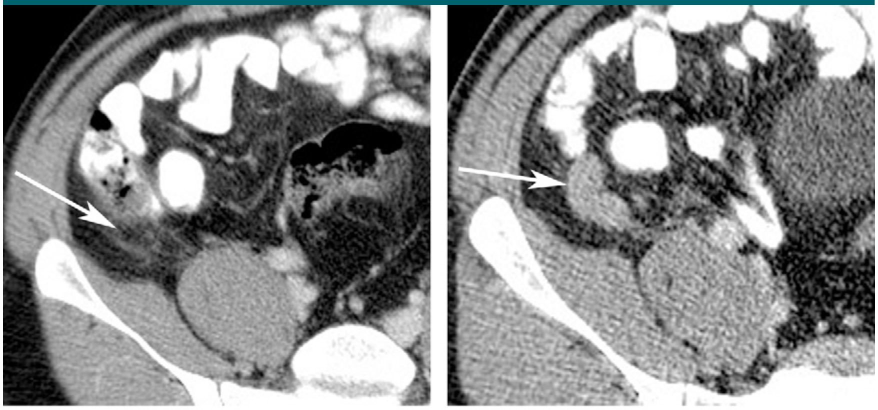
Figure 2: CT images in 51-year-old woman with right lower quadrant pain. **(a)** Intravenous contrast-enhanced transverse CT image demonstrates findings of acute appendicitis, including a borderline enlarged appendix (arrows) 0.9 cm in diameter and periappendiceal fat stranding. **(b)** Coronal reformation allows better appreciation of additional secondary signs of appendicitis, including a distended fluid-filled lumen and wall hyperenhancement (arrow). Although the scan was interpreted as showing possible appendicitis, findings were determined as false-positive because of discordant clinical findings. The patient was discharged home, with subsequent spontaneous resolution of symptoms, and did not return with appendicitis across follow-up of 387 days.

Discussion

In recent years, surgeons increasingly have used CT as an important adjunct to physical examination in the diagnosis of acute appendicitis. This approach has improved patient care markedly by decreasing the negative appendectomy rate compared with that in patients assessed by using clinical examination alone (13,15–18,20,21,23–25). However, in some cases, CT may complicate treatment when the imaging results and the findings of the surgeon's clinical assessment are discordant. We occasionally have encountered such patients with typical findings of acute appendicitis at CT for whom treatment was deferred after surgical evaluation because of incompatible clinical findings, such as normal appetite or absence of nausea and vomiting, a white blood cell count within normal limits, and limited or resolving tenderness at physical examination.

In our study, we found that five (38%; 95% CI: 18%, 65%) of 13 patients with CT findings of appendicitis, for whom immediate treatment was deferred, ultimately returned with appendicitis. When compared with the annual incidence of 0.23% of appendicitis in the United States (26), it is clear that this group of patients is at orders of magnitude greater risk of acute appendicitis than is the average population. These findings suggest that a considerable percentage of patients with presumed false-positive CT findings for appendicitis actually may represent patients

Figure 3



a. b.

Figure 3: CT images in 34-year-old man with right lower quadrant pain. **(a)** Intravenous contrast-enhanced transverse CT image demonstrates right lower quadrant fat stranding (arrow). **(b)** On an adjacent transverse CT image, the appendix (arrow) is enlarged to 1.2 cm in diameter. Although the scan was interpreted as showing acute appendicitis, the patient initially was not treated because of improving symptoms and white blood cell count (within normal limits) of 7.4×10^9/L. He returned after 10 days with same symptoms and underwent appendectomy. Appendix was normal at pathologic examination, and no alternate cause of pain was identified at surgery.

with chronic or recurrent appendicitis. Chronic appendicitis is uncommon and thought to be caused by partial obstruction of the appendiceal lumen (27). It is generally a milder form of appendicitis, and symptoms may be diminished, atypical, or even absent (27–29). If appendectomy is performed, specimens may demonstrate chronic inflammatory changes and varying degrees of fibrosis (27). In our study, three of five patients with appendicitis diagnosed after a treatment delay had evidence of chronic appendiceal inflammation at pathologic examination. Recurrent appendicitis differs from chronic appendicitis in that results of histologic analysis and surgical pathologic examination demonstrate only acute inflammation (opposed to chronic appendicitis) at eventual appendectomy. Therefore, recurrent appendicitis likely represents acute appendicitis with spontaneous resolution and eventual recurrence (29). We saw this pattern of inflammation in the remaining two of five patients with delayed diagnosis and treatment of appendicitis. Although clinical symptoms can be vague and difficult to recognize in both chronic and recurrent appendicitis, the CT appearance is indistinguishable from that of acute appendicitis and is characterized by appendiceal enlargement, luminal distention with fluid, and periappendiceal inflammation (30,31). This finding could account for the positive scans, but white blood cell counts within normal limits, and waning symptoms were seen in most study patients who later had appendicitis diagnosed. Furthermore, the long mean interval of 118 days between initial patient presentation and eventual treatment seen in this study is more compatible with a chronic or relapsing condition than with a clinical misdiagnosis at the outset.

Our study had several limitations. Because treatment initially was deferred in patients with presumed false-positive CT results, pathologic proof of appendicitis was not obtained at the time of the first scan. It is impossible to be sure whether all five of the 13 patients who returned with appendicitis had appendiceal inflammation initially or whether the eventual diagnosis of appendicitis in some of these patients could be an independent event. However, given the low annual incidence of appendicitis in the population at large, it is unlikely that even one of these patients would have developed appendicitis independently across the follow-up of 5–443 days. Second, despite the large patient population evaluated at CT for possible appendicitis (n = 2283), the number of patients who had positive CT results but deferred surgical or conservative treatment among this group was small (n = 13). The small sample size is the result of the rarity of this clinical scenario. Furthermore, because the patient group was limited to those who underwent imaging between July 1, 2002, and July 1, 2007, we do not have extended clinical follow-up in all seven patients with apparent false-positive CT results and subsequent clinical resolution of symptoms. The average follow-up in these patients was 583 days (range, 14–1460 days). Some of these patients also may return with appendicitis after a longer delay, or the patients with a shorter follow-up (eg, 14 days) may have presented to another institution for care. However, this uncertainty does not detract from the findings of this study and, in fact, discovery of additional patients who received a diagnosis of appendicitis after initially deferred treatment would only substantiate our results. Also, we studied only patients who were evaluated for appendicitis by using CT (as opposed to US), which could introduce a selection bias. However, because US is used relatively rarely to evaluate adults for appendicitis at our institution, the effect is unlikely to be consequential. Finally, the CT reports were reviewed and classified by one reader. This same reader also participated in the subsequent image review, which could have introduced recall bias. However, report review and scan review were performed more than 9 months apart, and it is unlikely that CT images from 39 cases (group with false-positive findings and control groups) would be recognizable from 2283 previously reviewed reports, particularly across this interval.

In summary, we found that five (38%; 95% CI: 18%, 65%) of 13 patients with false-positive CT findings for appendicitis and reassuring surgical evaluation results eventually returned with appendicitis. The decision to forego surgery in these patients often results in missed appendicitis, with a possible increased risk of perforation.

In patients with CT results positive for appendicitis and benign or atypical clinical findings, a diagnosis of chronic or recurrent appendicitis may be considered.

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