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Radiology

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COMPARISON OF SONOGRAPHIC ACCURACY OF DETECTING APPENDICITIS WITH POST OPERATIVE HISTOPATHOLOGY IN CLINICALLY SUSPECTED CASES

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ABSTRACT

OBJECTIVE. To determine the sensitivity and specificity of sonography in diagnosing acute appendicitis in patients with abdominal pain.

METHODS. All reports relating to appendicitis were retrospectively obtained from archived reports of our department between Agust 2018 to December 2019 and correlated with the histopathology reports.

RESULTS. Sonography reports for 667 patients were obtained. Of these, a total of 174 had pathologically proven appendicitis and 145 had posiitive findings for appendicitis on sonography. The accuracy was 92%; sensitivity, 83%; and specificity, 95%. The positive predictive value was 86%, and the negative predictive value was 94%.

CONCLUSION. The sensitivity, specificity, accuracy, positive and negative predicative values of sonography are comparable to statistics quoted in the literature. The most common error was the tendency to misclassify appendixes < 6 mm.

Introduction

Owing to its varying degree of presentations, acute appendicitis is a common but difficult diagnostic problem. The accuracy of the clinical examination has been reported to range from 71% to 97% and varies greatly depending on the experience of the examiner [1]. However, because missed ruptured appendixes have dire consequences, surgeons have traditionally accepted a 20% rate of negative findings at appendectomy and they prefer removal of a normal appendix [2]. The rate of negative appendectomy is reported to be between 20% and 30% [2, 3].

To reduce the rate of negative appendicectomy and to improve the diagnostic sensitivity, physicians use sonography, one of preferred technique. The method of graded compression sonography is well established by several large prospective trials that have reported sensitivities of 77–89% and specificities of 94–96% [4–8]. In all of these prospective studies, evaluations were performed directly by radiologists who often had sub-specialty training in sonography; The primary aim in this study was to evaluate the diagnostic accuracy, sensitivity, and specificity of sonography in the evaluation of acute appendicitis in teaching hospital setting.

Materials and Methods

Population

Our hospital is an acute care hospital with 900 beds. We retrospectively analyzed our digitally archived sonography transcription reports from August 2018 to December 2019. Using the presence of the keyword "appendicitis" in any section that is, Indication, Findings, or Impression—we identified 667 reports. All these reports had at least a specific inquiry (i.e., "rule out appendicitis") or a line in the impression stating "no evidence of appendicitis" or "consistent with appendicitis." CT is not used primarily for workup of appendicitis at our hospital; instead, this technique is used as a problem-solving tool. Appendicitis is diagnosed either clinically or sonograms are obtained.

Sonography Technique

All abdominal sonograms were obtained by radiologists with experience ranging from 2 to 15 years. Examinations were performed on an (Philips Medical Systems) using both curved array 3-5–MHz and linear array 7-10–MHz transducers. All radiologists used the graded compression technique previously described by Puylaert [7]. Three criteria were generally used for the diagnosis of appendicitis: enlargement, lack of compressibility, and having a blind ending. An appendix was considered enlarged when the maximal cross-sectional diameter under compression was greater than 6 mm.

Follow-Up Procedures

For patients who underwent appendectomy, the sonography findings were compared with the microscopy report as the gold standard. Of the patients with false-positive findings on sonography, each specific sonography report was obtained and analyzed for the presence of the diagnostic criteria described earlier if the patients went to surgery. If the patient did not undergo surgery based on the surgeon's opinion, so any negative examination without surgery was interpreted as a true-negative .

The outcomes of all 667 patients' reports were assessed.

Statistical Analysis

The sensitivity, specificity, accuracy, positive predictive value, and negative predictive value of sonography in the detection of appendicitis were calculated. Subsets of sensitivity, specificity, and positive predictive value were also analyzed using age as a discriminator (≤ 10, 11–18, ≥19 years).

Results

Table 1 shows the demographics of the study population. Table 2 provides the sensitivity, specificity, accuracy, positive predictive value, and negative predictive value obtained from this series. It also displays the statistics broken down by patient age groups. Of the 667 patients identified in the radiology database,

TABLE 1 Demographics of the Study Population

Parameter	Value
No. of patients	
Total	667
Male	243
Female	424
Age (yr)	
Range	6–93
Mean	34

174 had acute appendicitis and 493 did not. According to the pathology data- base, the total number of appendectomies performed during the study analysis was 250. One hundred forty-five of those 174 patients with appendicitis had positive findings on sonography, and 29 had negative findings. 31 of the 145 patients with true positive findings had a ruptured appendix at the time of surgery. Of the 29 patients with false-negative findings, four had suboptimal examinations due to obesity. The sonography reports for all four patients

recommended follow-up CT, which subsequently revealed acute appendicitis in two patients and a rup- tured appendix in the other two patients.

All of the 174 patients with acute appendi- citis had the diagnosis confirmed by surgery and the subsequent histopathology report. All 23 patients with false-positive sonography findings underwent surgery. 3 of the patients from the false-positive group needed surgery anyway: one had ruptured cecal cancer, another had an appendiceal mucocele, and the final patient had diverticulitis with abscess formation.

TABLE 2Sensitivity, Specificity, Accuracy, and Positive and Negative Predictive Values of Sonography in Assessing Acute Appendicitis

Statistical Parameter	All Patients (n = 667)	Patient age (yr)		
		≤ 10 (n = 42)	11–18 (n = 118)	≥ 19 (n = 507)
Sensitivity (%)	83	82	86	83
Specificity (%)	95	94	90	97
Accuracy (%)	92	90	89	93
Positive predictive value (%)	86	82	79	92
Negative predictive value (%)	94	94	95	94

The 470 patients with true-negative sonography findings were followed up by calling their surgeons. Table 3 shows the sonographic appearance of all the false posi- tive cases.

TABLE 3 False-Positive Cases of Appendicitis by the Size of the Appendix

Size of Appendix (cm)	No. of Cases with False-Positive Sonography Findings
No size given	4
5	7
6	4
7	3
8	3
9+	2

All surgeons stated that their use of sonography has increased over the past 4 years. Table 4 displays the factors that most positively influence them to refer a patient for sonography of the right lower abdomen. The top three factors ranked were if it were a pediatric case, a case with equivocal findings, or no increase in WBC was noted. Obesity was mentioned as a factor three times. Surgeons believed the sensitivity and specificity of sonography for the diagnosis of appendicitis to be between 70% and 90%. Surgeons indicated that they would increase their use of sonography if the sensitivity and specificity both were more than 85%.

TABLE 4Surgeon Self-Reported Positive Factors Most Likely to Affect Use of Sonography for Diagnosis of Acute Appendicitis

	No Of Cases		
Factor	Mentioned	Most Important	Second Most Important
Pediatric patient	3	2	1
Equivocal clinical findings	3	1	2
No increased WBC	0	0	2
Time of day	4	0	0
Obesity	3	2	0

DISCUSSION

The reported sensitivity, specificity, accu- racy, and positive and negative predictive val- ues fall well within the range of those reported from numerous prospective trialsAmerican Journal of Roentgenology 2005.184:1809-1812.(sensitivity, 77–89%; specificity, 84–96%; accuracy, 71–97%) [4–8].

Sonography has the inherent advantages of being relatively inexpensive, rapid, non- invasive, radiation-free, and dynamic, and no patient preparation is needed. Its drawback is that it is highly operator-dependent, thus requiring a high level of expertise and skill. A large set of appendiceal and periappendiceal criteria are used to diagnose acute ap pendicitis, with the most sensitive and specific being a diameter of 6 mm or greater (sensitivity, 98%; specificity, 98%), lack of compressibility (sensitivity, 96%; specificity, 98%), and inflammatory fat changes (sensi- tivity, 91%; specificity, 76%) [8]. In fact, a visualized appendix measuring less than 6 mm in diameter has a reported negative predictive value of 98–100% [8–10]. Indeed, seven of the 23 false-positives in our study had an appendix diameter of 5 mm, making it the most common error in cases of misdiagnosis A non visualized appendix also presents a major diagnostic difficulty because one can not confidently exclude appendicitis without examining the appendix. Conflicting rates of visualization have been reported for the visu- alization of normal appendixes—from 0–4% [11] to 64–72% [8, 10].

An important limitation of sonography in the examination of patients with perforated appendix is its lower sensitivity compared with nonperforated cases [13]. In addition, some authors have claimed the additional time of any imaging technique (most commonly CT and sonography) leads to longer times before definitive treatment and a higher risk of perforation.

Obesity is a well-recognized factor that severely limits the performance and interpretation of any sonographic examination, it may also hinder the physical examination, leading to diagnostic uncertainty. This factor would probably influence the surgeon to request sonography, even if sonography is known to be of low prognostic value. CT would be the preferred imaging method in this case; however, at our institution, CT for appendicitis is used only as a problem-solving tool because we have only one CT scanner. The limitations of this study include those of any retrospective study. However, the selection bias in this case favors a lower sensitivity, specificity, and accompanying predictive values because the cases for which sonography is performed will more likely be difficult with equivocal findings. In addition, cases of self- limiting and spontaneously resolving appendicitis have been reported in literature. [22,23]

In conclusion, the sensitivity, specificity, accuracy, and positive and negative predictive values of sonography performed by radiologists in a teaching hospital are comparable to statistics quoted in the literature. The most com- mon error was the tendency to misclassify appendixes less than 6 mm as appendicitis.

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