

Abdominal Sonography of Suspected Appendicitis

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Purpose : To decrease the high negative appendectomy rate in addition to the traditional history-taking, physical examination, and laboratory findings, additional sensitive examinations are necessary. The authors conducted a study to evaluate the value of ultrasonographic examination in the diagnosis of acute appendicitis in patients clinically suspected appendicitis.

Methods : During 18 months from July 1, 1998 through December 31, 1999, a total of 290 patients were enrolled into the study. Altogether 110 abdominal sonographic examinations were performed by the staff radiologist cases of clinically suspected appendicitis. The impact of diagnostic accuracy was compared with the historical control group of 240 patients during the period 10 months from January 1, 1997 through June 30, 1998.

Results : Clinical diagnosis (without sonographic confirmation) was made in 180 patients (157 appendicitis, non-appendicitis). Negative appendectomy was performed in 24 patients. Sonographic diagnosis was made in 181 patients with clinically suspected appendicitis (99 appendicitis, and 82 non-appendicitis). Negative appendectomy was done in 9 patients. Nineteen patients without positive sonographic findings of appendicitis could be spared negative appendectomy. Abdominal sonography for detecting acute appendicitis had a sensitivity of 75.0%, specificity of 67.9%, an accuracy of 91.0%, a positive predictive value of 90.1% and a negative predictive value of 100.0%. By adding ultrasonographic examinations to the cases of clinically suspected appendicitis, diagnostic accuracy was increased significantly over the historical control group ($P < 0.01$).

Conclusions : Although the value of meticulous history-taking, physical examination, and laboratory tests is overemphasized, our experience suggests that routine abdominal sonographic examinations, performed by experienced radiologists and surgeons, to further decrease

negative appendectomy rates. JKSCP 2001;17:59-63

Key Words : Appendicitis, Sonography

Group	Number of Patients	Number of Appendicitis Cases	Percentage of Appendicitis Cases	Reference
Historical Control Group (negative laparotomy)	240	71	29.2%	1-6
Study Group (negative appendectomy rate)	181	15	8.3%	7-10
Study Group (sensitivity)	75	90%		11
Study Group (specificity)	73	98%		6, 12-17
Study Group (accuracy)	76	96%		

가 가 , 가 가
 ,
 가 1997 1 1
 1998 6 30 1 6
 215 (1)
 1998 7 1 1999 12 31 1 6
 248 (2)
 . 1

가 , 가
 , 1 2 가
 가 .
 (accuracy), (sensitivity),
 (specificity), (positive predictive value),
 (negative predictive value)

, 2
 : $(CP + CN) / (CP + CN + FP + FN) \times 100\%$
 : $CP / (CP + FN) \times 100\%$
 : $CN / (CN + FP) \times 100\%$
 가 : $CP / (CP + FP) \times 100\%$
 : $CN / (CN + FN) \times 100\%$
 (C=correct, F=false, P=positive, N=negative)

가 11,000/mm³ 가 가
 ,
 81% , X-
 (cecal ileus)

, 48 1997 1 1 1998 6 30 1 6
 1 250 ,
 . 2 25 , (X-)
 , 가 , 2
 가 가 225 10
 가 5.0-MHz curved array
 transducer (Diasonic, Gateway, USA)
 (graded compression technique) , 215
 가 (longitudinal and transverse scan) . 180
 1) 7 , 35 가
 mm (compression) , 2) 가 24 , 11
 (appendicolith), 3)
 (interruption in the continuity of the
 echogenic submucosa), 4) 4 , 3 , 2 ,
 (localized periappendiceal fluid collection) 2 (Table 1).
 1998 7 1 1999 12 31
 290

18,19

23 , (X-)
 , 가 , 2

157
 133
 가 13, 10
 2, 2, 2
 2, 110
 91

9 가
 가 4, 3
 가 2, 19
 가 13
 2
 6
 4
 2

82 (Table 2).

Table 1. Calculated result of clinical diagnosis

Clinical Dx	Pathologic Dx	
	Appendicitis (n=180)	Non appendicitis (n=60)
Appendicitis (n=215)	180*	35* [†]
Non appendicitis (n=25)	0	25

Sensitivity 100%; specificity 41.7%; positive predictive value 83.7%; negative predictive value 100%; accuracy 85.4%.

* Proved by pathologic examinations; [†] Normal (n=24); mesenteric lymphadenitis (n=4); terminal ileitis (n=3); cecal diverticulitis (n=2); pelvic inflammatory disease (n=2).

1) 100%, 67.9%, 91%, 90.1%, 100%
 1, 2 (P < 0.01), 가
 2) 1 가 100%, 가
 41.7%, 가 85.4%, 83.7%, 100%, 가 100%, 가 56%, 가 88.6%, 86.7%, 100%
 2 (P < 0.01), 가

Table 2. Calculated result of clinical and sonographic diagnosis

Sonographic diagnosis		No. of patients	Appendicitis	Nonappendicitis
Clinically	Appendicitis	157	133*	24* [†]
	Nonappendicitis	23	0	23
Sonographically	Appendicitis	91	82	9* [‡]
	Nonappendiciti	19	0	19 [§]
Total	Appendicitis	248	215	33
	Nonappendicitis	42	0	42

Clinical diagnosis: sensitivity 100%; specificity 48.9%; accuracy 88.9%; positive predictive value 85.1%; negative predictive value 100%; Sonographic diagnosis: sensitivity 100%; specificity 67.9%; accuracy 91.0%; positive predictive value 90.1%; negative predictive value 100%; Total: sensitivity 100%; specificity 56.0%; accuracy 88.6%; positive predictive value 86.7%; negative predictive value 100%.

* Proved by pathologic examinations; [†] Normal (n=13), fecal impaction (n=2), acute salpingitis (n=2), mesenteric lymphadenitis (n=2), terminal ileitis (n=2), cecal diverticulitis (n=2); [‡] Normal (n=4), fecal impaction (n=3), acute salpingitis (n=2); [§] Normal (n=13), pelvic inflammatory disease (n=4), ovarian cyst (n=2).

가

9 (8.8%)

REFERENCES

1. Chen SC, Chen KM, Wang SM, Chang KJ. Abdominal sonography screening of clinically diagnosed or suspected appendicitis before surgery. *World J Surg* 1998; 22:449-52.
2. Thompson MM, Underwood MJ, Dockeran KA, Lloyd DM, Bell PR. Role of sequential leukocyte counts and C-reactive protein measurements in acute appendicitis. *Br J Surg* 1992;79:822-4.
3. Dueholm S, Bagi P, Bud M. Laboratory aid in the diagnosis of acute appendicitis. *Dis Colon Rectum* 1989; 32:855-9.
4. Eriksson S, Granstrom L, Bark S. Laboratory tests in patients with suspected acute appendicitis. *Acta Chir Scand* 1989;155:117-20.
5. Chen SC, Wang SM. C-reactive protein in the diagnosis of acute appendicitis. *Am J Emerg Med* 1996;14:101-3.
6. Wade CD, Morrow SE, Balsara ZN, Burkhard TK, Goff WB. Accuracy of ultrasound in the diagnosis of acute appendicitis compared with the surgeon clinical impression. *Arch Surg* 1993;128:1039-46.
7. Berr J, Malt RA. Appendicitis near its centenary. *Ann Surg* 1984;200:567-75.
8. Hoffman J, Rasmussen OO. Aids in the diagnosis of acute appendicitis. *Br J Surg* 1989;76:774-9.
9. Pieper R, Kager L, Nasman P. Acute appendicitis: a clinical study of 1018 cases of emergency appendectomy. *Acta Chir Scand* 1982;148:51-62.
10. Lewis FR, Holcroft JW, Boey J, Dunphy E. Appendicitis: a critical review of diagnosis and treatment in 1000 cases. *Arch Surg* 1975;110:677-84.
11. Deutsch A, Leopold RG. Ultrasonic demonstration of the inflamed appendix. *Radiology* 1981;140:163-4.
12. Crady SK, Jones JS, Wyn T, Luttenton C. Clinical validity of ultrasound in children with suspected appendicitis. *Ann Emerg Med* 1993;22:1125-9.
13. Chesbrough RM, Burkhard TK, Balsara ZN, Goff WB II, Davis DJ. Self-localization in US of appendicitis: an addition to graded compression. *Radiology* 1993;187: 349-51.
14. John H, Neff U, Kelemen M. Appendicitis diagnosis: clinical and ultrasonic deductions. *World J Surg* 1993; 17:243-9.
15. Adams DH, Fine C, Brooks DC. High-resolution real-time ultrasonography a new tool in the diagnosis of acute appendicitis. *Am J Surg* 1988;155:93-7.
16. Schwerk WB, Wichtrup B, Rothmund M, Ruschoff J. Ultrasonography in the diagnosis of acute appendicitis: a prospective study. *Gastroenterology* 1989;97:630-9.
17. Puylaert JBCM, Rutgers PH, Lalisang RI, deVries BC, Van der Werf SDJ, Dorr JPI, et al. A prospective study of ultrasonography in the diagnosis of appendicitis. *N Eng J Med* 1987;317:666-9.
18. Jeffrey RB, Jain KA, Nghiem HV. Sonographic diagnosis of acute appendicitis: interpretive pitfalls. *Am J Radiol* 1994;162:55-9.
19. Yacoe ME, Jeffrey RB. Sonography of appendicitis and diverticulitis. *Radiol Clin North Am* 1994;32:899-912.
20. Jeffrey RB, Laing FC, Townsend RR. Acute appendicitis: sonographic criteria based on 250 cases. *Radiology* 1988; 167:327-9.
21. Puylaert JBCM. Ultrasound of appendicitis and its differential diagnosis. Berlin, Springer, 1990.
22. Puylaert JBCM, Zant FM, Rijke AM. Sonography and the acute abdomen: practical considerations. *Am J Radiol* 1997;168:179-86.
23. Lim HK, Lee WJ, Kim TH, Namgung S, Lee SJ, Lim JH. Appendicitis: usefulness of color Doppler US. *Radiology* 1996;201:221-5.
24. Quillin SP, Siegel MJ. Appendicitis: efficacy of color Doppler sonography. *Radiology* 1994;191:557-60.