

Original article

# Improved diagnostic accuracy in patients with suspected appendicitis

B. Tingstedt<sup>1</sup>, R. Andersson<sup>2</sup>

## SUMMARY

**Background:** Studies during the 1990s showed that it was possible to reduce the rate of negative appendectomies by using various diagnostic methods. The present study aims to evaluate the effect on diagnostic accuracy of implementation of repeated clinical examination and blood tests in a small county hospital without possibilities of radiological assistance on a 24-hour basis.

**Methodology:** Prospective study of all appendectomies performed at Ystad General Hospital, Sweden. Leukocyte count and C-reactive protein levels were analysed in all patients. Patients with suspicion of acute appendicitis were admitted for active observation, repeated clinical examination and analyses of leukocyte counts and CRP levels.

**Results:** 533 appendectomies were performed during 1996-2000 and compared with the index year 1995. Diagnostic accuracy increased from 73% to 90% ( $p < 0.01$ ). The rates of perforations and complications did not change during the study period, being 12.4% and 5.1%, respectively. Coinciding with the increased accuracy, a drop in the number of appendectomies performed and a longer time interval from admittance to the start of operation was seen.

**Conclusion:** Through repeated clinical examinations and blood tests it was prospectively possible to achieve an increase in diagnostic accuracy in patients with suspicion of acute appendicitis without any noticeable side effects.

**Key words:** appendicitis, repeated examinations, blood tests, diagnostic accuracy

## INTRODUCTION

Suspicion of acute appendicitis is the most common cause of laparotomy in the western world<sup>1</sup> and the life-time cumulative risk of having an appendectomy has been reported to approximate 7%.<sup>2</sup> It is difficult to achieve a correct preoperative diagnose of acute appendicitis and diagnostic accuracy has historically been 70-80%,<sup>3,4</sup> thus frequently subjecting patients to an "unnecessary" laparotomy. A serious disadvantage of exploration in the case of a non-inflamed appendix is the risk of abdominal adhesions and postoperative ileus. The risk of postoperative ileus after appendectomy has previously been reported to be as high as 10.7%,<sup>5</sup> but more recent studies have shown a lower incidence, in the range of 1%.<sup>6,8</sup>

In the late 1980s and 1990s, research concerning appendicitis has focused on possibilities of improving the diagnostic accuracy. Studies using various methods such as scoring systems, blood analyses, ultrasound and computed tomography all report an increase in diagnostic accuracy.<sup>9-15</sup>

The present study aims to evaluate the effect on diagnostic accuracy of repeated clinical examination and blood tests in a small country hospital without possibilities of radiological assistance on a 24-hour basis.

## MATERIAL AND METHODS

A prospective study of all appendectomies performed at the Department of Surgery at Ystad General Hospital, Sweden, was carried out during the years 1996-2000. Incidental appendectomies were excluded. From

Department of Surgery, <sup>1</sup>Ystad General Hospital and <sup>2</sup>Lund University Hospital, Sweden

Author for correspondence:

Roland Andersson, MD, PhD, Department of Surgery, Lund University Hospital, SE-221 85 Lund, Sweden, Tel. +4646172359, Fax: +4646147298, e-mail: Roland.Andersson@kir.lu.se

1996 repeated clinical examination and blood tests, as described below, were carried out on patients with suspicion of acute appendicitis. The results were analysed yearly and compared with the result from 1995, the year prior to introduction of the protocol, when the diagnostic accuracy of acute appendicitis was 73%. Ystad is a small county hospital serving a population of 95 000 inhabitants. The hospital has had a computerized medical journal system since 1992. From 1996 the hospital and all general practitioners within the county have been completely computerized, giving an open record of all contacts a patient has had with any doctor in the district.

All patients with suspicion of acute appendicitis had C-reactive protein (CRP) and leukocyte counts determined. CRP below 10 mg/L and leucocytes less than  $9.0 \times 10^9/L$  were considered normal.

If clinical signs did not require an immediate operation, the patients were admitted for active observation with repeated clinical assessment and new blood tests every 4-6 hours. As far as possible patients were examined by the same surgeon who made the primary evaluation, even though this was not possible for all patients, particularly for those who had a longer evaluation period. Patients with 3 repeated normal blood analyses were dismissed, as were those with improving clinical status and normalizing blood tests. The surgeon's opinion could naturally override the protocol in case of discrepancies or if the clinical assessment strongly suggested exploration.

Through the computerized journals we obtained the time when the patient was admitted to the emergency ward and, if the patient was operated upon, the starting time of the operation was noted. The time intervals were then calculated.

Histological examination was not routinely performed and the appendices were evaluated by the surgeon during operation and judged as normal (non-inflamed), acute (phlegmonous or gangrenous) or perforated (perforated or abscess-forming). Consultants or senior registrars performed all appendectomies. Those surgeons familiar with the technique performed diagnostic laparoscopy and laparoscopic appendectomy.

Patients with signs of local peritonitis were given intravenous antibiotics preoperatively. Postoperatively, patients with normal or acute appendicitis neither received antibiotics nor were seen in the outpatient clinic. Patients with a perforated appendix or appendiceal abscess were given antibiotics (cephalosporin + metronidazole) intravenously and/or orally for a total period of 7-10 days and were subjected to postoperative follow-up.

Statistical comparison was performed using Fisher's exact test for 2x2 tables. A probability level of  $p < 0.05$  was considered statistically significant.

## RESULTS

A total of 533 appendectomies were performed during the study period 1996-2000. At operation all appendices including the non-inflamed, were removed. The rate of appendectomies performed decreased during the period (Table 1). Median age was 27 (4-92) years, 298 (56%) patients were male and 235 (44%) female. Diagnostic laparoscopy was performed in 12%, with complete laparoscopic appendectomy performed on 9% of all patients. Median hospital stay was 2 (1-22) days during the study period. Twenty-seven complications (minor as well as major) occurred in a total of 27 patients (5.1%) with no variation between the years (Table 2).

Two patients (0.38%) developed early (within 30 days) signs of small bowel obstruction. One was reoperated five days postoperatively while the other patient was treated conservatively. There were no complications seen in the group subjected to laparoscopy. Overall, no hospital mortality was encountered.

**Table 1.** Number of appendectomies performed and macroscopical diagnosis

<b>No. (%) Macroscopical diagnosis and total number of appendectomies</b>				
<b>Year</b>	<b>Normal</b>	<b>Acute</b>	<b>Perforated</b>	<b>Total</b>
1995	33 (27%)	77 (63%)	12 (10%)	123
1996	28 (23%)	79 (66%)	13 (11%)	120
1997	23 (23%)	62 (63%)	14 (14%)	99
1998	20 (18%)	75 (66%)	18 (16%)	113
1999	14 (14%)	76 (77%)	9 (9%)	99
2000	10 (10%)	80 (78%)	12 (12%)	102

**Table 2.** Total complications after appendectomy

<b>Diagnosis</b>	<b>No (%)</b>
Intraabdominal abscess	8 (1.5%)
Wound abscess	4 (0.8%)
Minor wound infection	6 (1.1%)
Wound haematoma	2 (0.4%)
Small bowel obstruction	2 (0.4%)
Pneumonia	2 (0.4%)
Perforation of the small intestine	1 (0.2%)
Urinary tract infection	1 (0.2%)
<b>Total</b>	<b>27 (5.1%)</b>

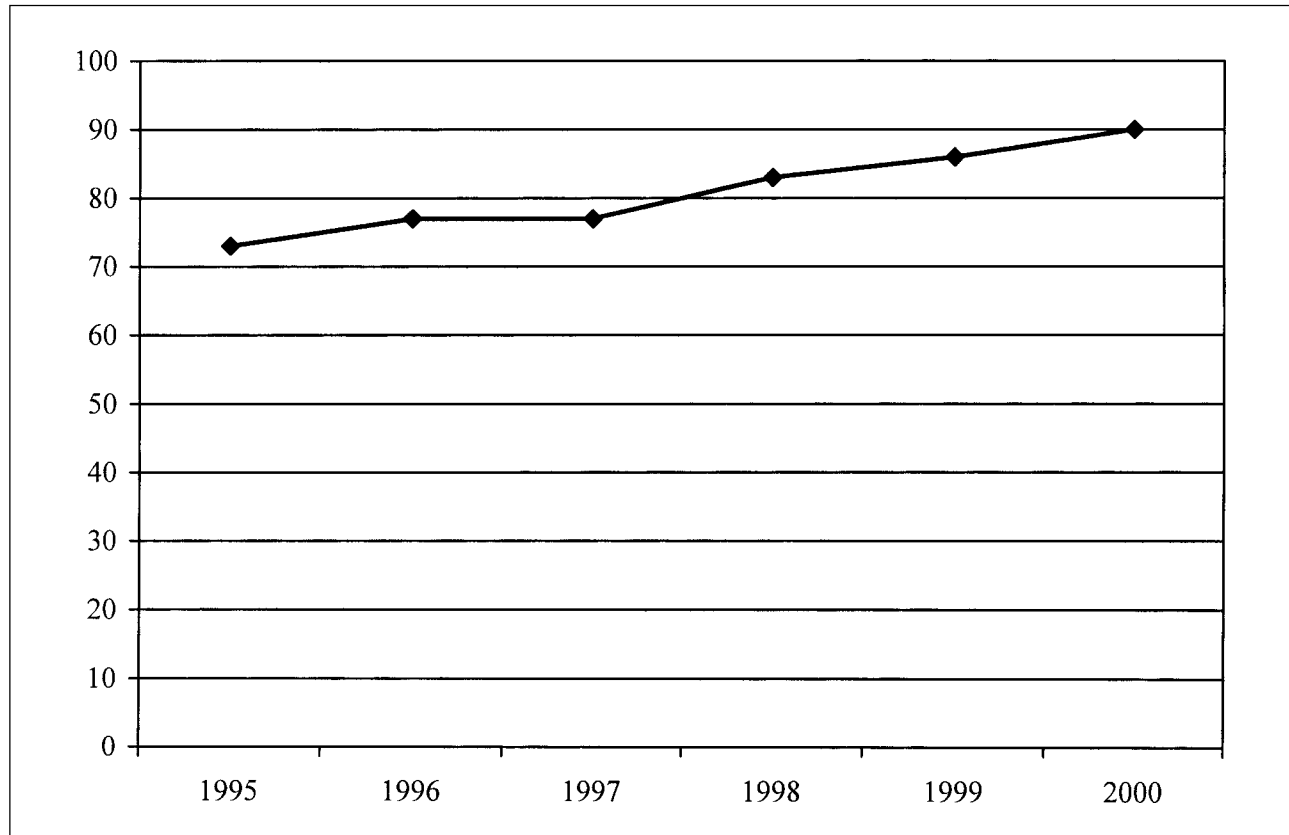
The diagnostic accuracy gradually increased over the whole period ( $p < 0.01$ ) (Fig. 1). The recorded time from admittance to the emergency ward to the operation theatre increased over the study period from 4.2 (1-72) hours 1995 to 11.0 (1-68) hours in 2000 (mean values and ranges).

There was no increase seen in the number of perforated appendices or appendiceal abscesses during the period and perforations or abscesses were totally diagnosed in 12.4% of all patients (Table 1).

Thirteen of the total of 533 (2.4%) patients who underwent appendectomy had normal leucocyte counts and CRP levels (leucocytes  $< 9.0 \times 10^9/L$  and/or CRP  $< 10 \text{ mg/l}$ ). Three of these 533 patients (0.5%) had phlegmonous appendicitis. The other ten had a normal appendix and other causes of their abdominal complaints that per se did not necessitate surgical intervention. In the index year 1995, 10 (8.1%) patients without evaluated CRP or leucocyte levels were operated on, all with non-inflamed appendices. The final diagnoses in patients with non-inflamed appendix at operation are listed in Table 3.

## DISCUSSION

The preoperative diagnostic accuracy for acute appendicitis has historically been approximately 70%.<sup>4</sup> This comparatively low rate of accuracy would probably not be accepted for any other surgical operation. During the last decade several studies have shown that the rate of negative explorations for suspected appendicitis could be lowered with the use of scoring systems and retrospective analyses of different combinations of blood tests or diagnostic radiological examinations, like ultrasound or computed tomography.<sup>9-16</sup> Even though ultrasound and computed tomography have been shown to reduce the rate of negative explorations,<sup>13-15</sup> both these investigations have disadvantages. Ultrasound is investigator-dependent and computed tomography exposes the patient to radiation. A major concern is the lack of availability of radiological diagnostic services on a 24-hour basis. The associated costs and prioritising difficulties of available resources for these tools makes a regime of active observation and repeated clinical assessment together with blood tests to be considered as comparably cheap and readily available.



**Figure 1.** Diagnostic accuracy over study period (%) Increase from 1995 (73%) to 2000 (90%);  $p < 0.01$

**Table 3.** Patients with normal appendix operated on due to suspicion of acute appendicitis. Final diagnosis

Diagnosis	No	(% of all appendectomies)
Mesenteric adenitis	40	(7.5%)
Non specific abdominal pain (NSAP)	11	(2.1%)
Diverticulitis in sigmoid colon	10	(1.9%)
Rupture of ovarian follicular cysts	9	(1.7%)
Endometriosis	3	(0.6%)
Gastroenteritis	3	(0.6%)
Crohn's disease	3	(0.6%)
Meckel's diverticulum	2	(0.4%)
Torsion of epiploicae	2	(0.4%)
Torsion of omentum majus	2	(0.4%)
Cholecystitis	2	(0.4%)
Right/Cecal coloncancer	2	(0.4%)
Salpingitis	1	(0.2%)
Gynaecological cancer	1	(0.2%)
Ileus	1	(0.2%)
Bacterial ileitis	1	(0.2%)
Perforated bladder cancer	1	(0.2%)
Urinary tract infection	1	(0.2%)

The main purpose of the present protocol was primarily to identify patients who should not be operated on and thus not so much to find a final correct diagnosis for every patient with right iliac or lower abdominal pain.

If the rate of negative explorations is high in patients with suspicion of acute appendicitis, the number of patients at risk of developing abdominal adhesions and subsequent ileus is not negligible. It has also been reported by Andersson that the risk for postoperative small bowel obstruction (SBO) depends on the type of diagnosis and stage of acute appendicitis. The highest cumulated risk for SBO after 10 years was noted after perforated appendicitis and non-specific abdominal pain (NSAP), being 2.10% and 1.30%, respectively, whereas the cumulated risk for SBO was 0.50% after non-perforated acute appendicitis.<sup>8</sup> Furthermore, it has also been shown that perforated appendicitis carries a much higher incidence of complications, 19% vs. 6% in non-perforated appendicitis.<sup>25</sup> This emphasizes the importance of achieving as high a diagnostic accuracy as possible without increasing the rate of perforations.

Our treatment policy challenges the attitude of early exploration on suspicion of acute appendicitis. The fear of perforation due to rapid progression of the inflamed appendix has been debated.<sup>17</sup> Many authors advocating active observation have, however, shown that active ob-

servation does not increase the rate or the total number of perforated appendices.<sup>16,18,19</sup> Most perforated appendices are reported to have occurred already at the time of arrival at hospital<sup>20</sup> and the number of explorations has not been found to influence the number of perforations found.<sup>21,22</sup>

In the present study, we evaluate the outcome following implementation of a protocol based on active observation and repetitive examinations and blood tests. Patients not obviously in need of an immediate exploration had repeated clinical examinations and blood tests (CRP and leucocytes) performed every 4-6 hours.

The absence of histopathological examination is a weakness in this study, since some authors have reported on misdiagnosis<sup>23</sup> and the net error is calculated to be an overestimation of acute appendicitis in 6% of cases.<sup>22</sup> The distribution of the severity of appendicitis in the present study is, however, comparable to other series where histopathological examinations were performed.<sup>10,20,21</sup> The rate of perforations (12.4%) and the total number of patients with a perforated appendix was thus comparable with that reported in other studies<sup>3,21,22</sup> and did not change during the study period. Neither did the complication rate differ from that of other studies,<sup>21,24</sup> with an overall incidence of complications of 5.1%. Through the computerized journal system, almost all patients with

complications were identified, since it was possible to search through journals in all departments and the whole health district, including gynaecologists, general practitioners and district nurses.

Without any noticeable negative effects of risks, the diagnostic accuracy increased from 73% the index year 1995 to 90% in 2000. The only detectable differences during the study period were a decrease in performed appendectomies and an increase in time from admittance to the emergency ward to the start of operation, both observations coinciding with the introduction of the new policy of active observation in patients with suspicion of acute appendicitis.

In conclusion, we have shown that it is possible to increase the preoperative diagnostic accuracy of acute appendicitis even in a small hospital without the facilities of a larger hospital by using a protocol based on repeated clinical examination and determination of CRP and leukocyte counts. The study was performed prospectively and without obvious side effects and required very limited additional resources. By adding other modalities, such as ultrasound and computed tomography if available, the diagnostic accuracy could probably be further improved.

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