PAPERS AND ORIGINALS

Computer-aided prediction of gangrenous and perforating appendicitis

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Summary

The clinical details of 100 patients with proved acute appendicitis were compared with those of 100 patients with perforating or gangrenous appendicitis. Twenty features were found to be significantly different between the two groups. This information was incorporated into a computer data base and used in the differential diagnosis of abdominal pain. A program written to predict the probability that gangrene or perforation was present in patients with appendicitis gave a diagnostic accuracy over 91%. A clinical scoring index, which accurately predicted the state of the appendix in 88% of patients, was constructed from the significant differences between the two groups.

When clinical scoring or computer analysis predicts a high probability of perforation or gangrene in patients with appendicitis, surgery should be performed without delay.

Introduction

Appendicectomy is the commonest intestinal operation. Mortality is low (0.26%),¹ but morbidity remains a problem. Although intraperitoneal sepsis is uncommon, over 20% of patients develop wound infections,²⁻⁵ whose onset depends on the severity of the appendicular inflammation.⁶ About half the patients with perforating appendicitis develop wound sepsis, which delays recovery and thus increases the socioeconomic costs. Antibiotic prophylaxis reduces the incidence of wound infection after appendicectomy,⁷⁻¹⁰ but the choice of drug, route of administration, and duration of treatment remain controversial. Some antibiotic regimens appear to be less effective

when the appendix is gangrenous or perforating.⁸⁻¹¹ Morbidity and mortality increase with the interval between onset of symptoms and operation.¹² Thus patients with gangrenous or perforating appendicitis require both early surgery to prevent spread of infection and antibiotic prophylaxis to minimise the risk of wound sepsis.

Early diagnosis of appendicitis and accurate assessment of the state of the appendix must make treatment of the high-risk patient more effective. A study was therefore designed to analyse the differences in symptoms, signs, and laboratory results between patients with acute appendicitis and those with perforating or gangrenous appendicitis.

Patients and methods

Some 1100 patients with acute abdominal pain are referred to Bangour General Hospital each year, and of these, about 240 have appendicectomy. Since 1972 a specially designed proforma, similar to that used in Leeds,^{13,14} has been used for documentation, which records the history and results of physical examination of each patient at presentation and increases diagnostic accuracy.^{14,15}

During 1972-6, 860 patients underwent appendicectomy. Complete records were obtained for 52 patients with gangrenous appendicitis and 48 with perforating appendicitis. For comparison, the records of 100 patients with acute appendicitis were chosen at random. Patients whose appendix was removed during another procedure or in whom histopathological examination failed to confirm the diagnosis were not included.

Five major categories of clinical information—namely, age and sex; details of pain (type and site at onset and on examination, duration, progress, aggravating and relieving factors, and previous history); presence of associated symptoms (anorexia, nausea, vomiting, indigestion, bladder or bowel disturbance or both) and previous surgery or drugs; results of examination (temperature, pulse, and abdominal and rectal findings); and laboratory results (total and differential white cell counts)—comprising 186 items were taken from the proformas and from pathological and haematological reports and stored in a computer. The computer then delivered a cumulative printout listing the frequency with which each symptom and sign occurred in each type of appendicitis.

The results showed significant differences (χ^2 test, $P < 0.05$) between the patients with acute appendicitis and those with gangrenous or perforating appendicitis, but no significant differences between the groups with gangrenous and perforating appendicitis. For the

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analysis, therefore, these two groups were combined and compared with the acute appendicitis patients.

Computer-aided system—The PDP11/10 desk-top computer was programmed as described^{14, 16} to analyse the clinical details of patients with acute abdominal pain. Each patient's details were compared with data obtained from a large series of patients that were already stored in the computer's memory, and a mathematical analysis based on Bayes's theorem¹⁷ gave a prediction of the diagnosis. The data base for appendicitis in the memory bank was then altered to incorporate details of the patients in this study. The program was modified to predict the probability that perforation or gangrene was present in patients with appendicitis.

Clinical scoring index—A clinical scoring index was used, based on seven features showing significant differences between the two groups ($P < 0.05$)—namely, lower abdominal pain at onset; history exceeding 24 hours; pain increasing in severity; presence of guarding and rebound tenderness; temperature over 37.5°C; pulse rate greater than 90 beats/min; and white cell count exceeding $14 \times 10^9/l$. The presence of each feature scored one point. In over 80% of a small series of cases in which the index was tested, patients with acute appendicitis scored two points or less, while those with perforation or gangrene scored three points or more.

Blind analysis—The computer program for preoperative differential diagnosis of perforating or gangrenous appendicitis and the clinical scoring index were tested by blind analysis of 390 patients admitted with appendicitis (278 cases acute; 112 perforating or gangrenous).

Results

Twenty symptoms and signs were found to occur significantly more often in one or other of the acute appendicitis and perforating or gangrenous appendicitis groups. Four of the symptoms and two of the signs were more common in the acute appendicitis group (tables I and II). In general, patients in this group had shorter histories, less severe pain, and fewer abnormal physical signs than had those in the perforating and gangrenous appendicitis group. Patients in the perforating and gangrenous group commonly had histories of dull, progressive lower abdominal pain of increasing severity, lasting for 24 hours or more and associated with nausea and dysuria. Lower abdominal rebound tenderness with guarding and right-sided rectal

tenderness were significantly more common in this group. Patients in this group also showed greater constitutional disturbance, with temperatures above 37.5°C and concomitant tachycardia. The total leucocyte counts and percentages of polymorphs were higher than those in patients with acute appendicitis.

The probabilities of the differential diagnoses and states of the appendix listed by the computer were expressed in percentage terms—for example: "Diagnosis: appendicitis 91%, non-specific abdominal pain 8%," and "State of appendix: acute inflamed 73%, perforated or gangrenous 27%." Since a computer prediction of 50% represented only a one in two chance that the disease was present, a diagnosis was taken as correct only when the computer probability was greater than 75%.

BLIND ANALYSIS

Out of 278 cases of proved acute inflammation of the appendix, 260 (93.5%) were correctly diagnosed by computer analysis; the pathological state was correctly predicted in 258 (92.8%). Of the 112 confirmed cases of perforating or gangrenous appendicitis, 102 (91.1%) were correctly diagnosed by computer analysis, and prediction was correct in 101 cases (90.2%). Prediction was inaccurate in 31 patients (20 with acute appendicitis and 11 with perforating or gangrenous appendicitis). In eight of the 20 patients with acute appendicitis equivocal predictions of 48-55% were obtained. In the remaining 23 patients prediction was incorrect.

When analysed by clinical score, 257 patients scored two points or less and 133 patients three points or more. Two hundred and forty-five (88.1%) of the 278 patients with acute appendicitis scored two points or less, and 100 (89.3%) of the 112 with perforating or gangrenous appendicitis three points or more. Thus the index had an overall prediction accuracy of 88.5%.

Discussion

Clinical descriptions of acute appendicitis suggest that a wide spectrum of disease exists, ranging from mild appendicular colic to perforation and peritonitis. Appendicular colic and catarrhal appendicitis were not studied in this trial because of the difficulty in differentiating them from other causes of pain in the right iliac fossa and because patients often recover spontaneously without operation. If the concept of a disease spectrum is accepted, the progression of acute appendicitis to gangrene and perforation implies time-dependence associated with worsening symptoms and signs of a progressive inflammatory response and systemic disturbance. In this study the factors that were significantly different between the two groups supported this concept. Patients with an acutely inflamed appendix presented with a relatively short history and minimal constitutional disturbance, while those with a perforating or gangrenous appendix had experienced progressive pain of longer duration and greater severity. The progression of inflammation, assessed by the presence of rebound tenderness and guarding, was more evident in patients in the perforating and gangrenous group. These patients also showed greater constitutional disturbance, raised temperatures and tachycardia being more common. The haematological response to the inflammation was a significant increase in the total leucocyte count and percentage of polymorphs in patients with perforating or gangrenous appendicitis.

The concept of time-dependent progress of inflammation is further supported by the histological findings in the eight patients for whom computer prediction of the state of the appendix was equivocal. In each patient the acute inflammation had advanced to microabscess formation, with local areas of necrosis in the appendix spreading into the mesoappendix. This pathological condition may have been the transition stage between acute and gangrenous appendicitis, in which delay in removing the organ leads ultimately to gangrene or perforation.

The clinical diagnosis of appendicitis in classical cases presents little difficulty, and the more florid the signs, and therefore the greater the degree of inflammation, the easier the diagnosis becomes. Differentiation from other causes of abdominal pain,

TABLE I—Frequency of 10 symptoms in the two groups

	Group		χ^2	P
	Acute appendicitis (n = 100)	Perforating and gangrenous appendicitis (n = 100)		
Lower abdominal pain at onset	12	26	6.4	< 0.025
Central pain on examination	10	3	3.9	< 0.05
Pain improving	23	6	11.6	< 0.001
Pain worsening	52	77	13.6	< 0.001
Pain lasting 24 hours	12	64	57.4	< 0.001
Steady dull pain	31	50	7.5	< 0.01
Sharp pain	14	5	4.7	< 0.05
Nausea	75	92	10.5	< 0.001
Vomiting	39	17	12.0	< 0.001
Dysuria	6	15	4.6	< 0.05

TABLE II—Frequency of 10 signs in the two groups

	Group		χ^2	P
	Acute appendicitis (n = 100)	Perforating and gangrenous appendicitis (n = 100)		
Tender right lower quadrant	92	77	8.6	< 0.01
Tender lower half	4	16	8.0	< 0.01
Rebound tenderness	66	90	16.8	< 0.001
Guarding	61	89	20.9	< 0.001
Normal bowel sounds	94	79	9.6	< 0.01
Right-sided rectal tenderness	41	55	3.9	< 0.05
Temperature > 37.5°C	18	72	28.1	< 0.001
Pulse > 90/min	44	68	11.6	< 0.001
WBC > $14 \times 10^9/l$	16	57	40.7	< 0.001
Polymorphs > 70%	71	93	20.2	< 0.001

however, may be difficult in the early stages. The computer-aided diagnosis of appendicitis used at this hospital increased the diagnostic accuracy of the medical staff from 84.4% to 93.5%, with the result that fewer unnecessary laparotomies were carried out. There may be considerable overlap between the symptoms and signs at presentation of acute appendicitis and the more serious perforating and gangrenous appendicitis. Perforation may occur in a patient with a short history or be associated with minimal signs and constitutional disturbance. Similarly, acute appendicitis may be accompanied by major constitutional disturbance.

Computer-aided diagnosis is known to increase diagnostic accuracy in appendicitis. This analysis of patients showed that significant differences existed between the two pathological groups of acute and perforating or gangrenous appendicitis, and that a computer may use these differences to predict the state of the appendix. The clinical index method of prediction has an accuracy similar to that of a computer. Under ideal conditions a normal appendix should not be removed, but appendectomy should be performed before the onset of gangrene or perforation so that postoperative morbidity is reduced. Immediate surgery is not always feasible, but urgent appendectomy should be performed if computer analysis or clinical scoring predicts gangrene or perforation.

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Early assessment of severity of acute pancreatitis using peritoneal lavage

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Summary

Diagnostic peritoneal lavage using one litre of isotonic saline was performed on 27 patients with acute pancreatitis as soon as possible after diagnosis. There were no complications. Severe attacks (defined retrospectively according to the progress of the attack) were characterised by the presence of free peritoneal fluid and by dark-coloured and often opalescent return fluid. The concentrations of albumin, aspartate aminotransferase (SGOT), and total protein in the return fluid provided good discrimination between severe and mild attacks, and there were also significant differences in the concentrations of amylase, urea, calcium, potassium, bilirubin, alkaline phosphatase, and the white cell count. Lavage successfully predicted severe disease in five patients whose condition had been clinically assessed as mild.

Introduction

The mortality rate for attacks of acute pancreatitis has fallen below 10% in many centres. It is still difficult, however, to

assess the severity of an attack before pulmonary oedema, renal shutdown, and circulatory failure develop. The deceptiveness of the initial signs has long been recognised by clinicians, and in a recent postmortem study of 116 patients who died from acute pancreatitis¹ the point was made that "to judge from the clinical records, the severity of the disease seems to have been underestimated in several patients." Clearly, to treat all patients in the manner appropriate to haemorrhagic pancreatitis would be costly, unnecessary, and unwise, but preventable deaths in the early stages of the disease will continue to occur unless vigorous and timely treatment is given to patients who need it.

Many of the clinical signs of acute pancreatitis are thought to be due to the release of a "vaso-active enzyme-rich broth," which enters the circulation by absorption from the peripancreatic tissue and through the peritoneum. Thus we thought that diagnostic peritoneal lavage might detect evidence of severe disease before its clinical appearance. We report the findings of diagnostic peritoneal lavage carried out soon after admission in 27 patients with acute pancreatitis.

Patients and methods

The study was carried out on 27 patients in whom a diagnosis of acute pancreatitis was made on or shortly after admission, on the basis of a consistent clinical picture and a serum amylase concentration greater than 1000 Somogyi units per dl. The severity of an attack was classified retrospectively on clinical grounds. A severe attack was defined as one which necessitated more than two weeks' stay in hospital; one giving rise to complications (pseudocyst, abscess, renal failure, etc); or one resulting in death. There were 10 severe and 17 mild attacks. Before lavage, we tried to predict the severity of the attack on the basis of the clinical presentation.

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