Blood pH: a test for assessment of severity in proctocolitis

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SUMMARY Acid base balance was studied in 58 patients with active idiopathic proctocolitis; the condition of 10 of them was complicated by toxic megacolon. Arterial blood pH increased progressively with increased severity of the colitis and as the lesions became more widespread. Statistically significant differences were observed in pH values between the mild/moderate and severe forms and between the severe and complicated forms ('toxic megacolon'). A linear correlation was found between pH and the amount of intestinal gas, pulse rate, and plasma albumin.

In determining prognosis and choice of treatment in proctocolitis a correct evaluation of the severity of the disease is of prime importance. There is no one single parameter on which to base this estimation. Various clinical and haematochemical features are usually taken into consideration, although in a recent statistical analysis only high temperature, tachycardia, bowel actions, and plasma albumin appeared to be of real value in predicting the outcome of the disease (Lennard-Jones *et al.*, 1975).

Current classifications of colitis into mild, moderate, and severe (Caprilli *et al.*, 1975a; Truelove and Witts, 1955) do not indicate that, of the severe forms, some are more severe than others and, when untreated, are almost invariably fatal within a few days. These forms are better known as 'fulminating colitis' and indicate complications such as 'toxic megacolon', perforation of the bowel, and massive haemorrhage (Zer *et al.*, 1972). 'Toxic megacolon', however, is not a sudden event but a situation which gradually develops over a few days or even weeks. Its early signs may be recognized before gross dilatation of the bowel occurs (Caprilli *et al.*, 1975b; Torsoli, 1975).

Previous investigations revealed the presence of metabolic or mixed alkalosis, hypochlorhaemia, and hypocalcaemia both in the severe form of colitis and in 'toxic megacolon' (Caprilli *et al.*, 1974; Caprilli *et*

al., 1975b). The present study was therefore carried out to analyse the relationship between blood pH and the severity of the colitis, the extent of the lesions, and the distribution of gas in the intestine.

Methods

Studies were carried out in 58 patients with active idiopathic proctocolitis, admitted to the GI Unit of the University of Rome during the period 1973-75. Diagnosis was based on clinical, endoscopic, radiological, and histological findings. Colitis was classified as mild, moderate, or severe according to semiquantitative criteria previously described (Caprilli *et al.*, 1975a). Diagnosis of 'toxic megacolon' was applied to cases presenting distension of the colon of more than 6 cm (plain abdominal radiography). The extent of the lesions was established from radiological (double contrast enema), colonoscopic, and histological findings. In the patients with 'toxic megacolon' the extent of the lesions was established from the surgical specimen removed. Classification of patients according to the clinical severity of the disease and the extent of the lesions is shown in Table 1.

Arterial blood pH, pO₂, and pCO₂ were determined directly on admission using pH/blood gas analyser 313 (Instrument Laboratory, Italy). Tests were repeated every day in patients with severe colitis and 'toxic megacolon'. Of the various data on acid-

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Table 1 *Classification of patients*

<i>Active idiopathic proctocolitis</i>		(58 patients)
Severity		
Mild		14
Moderate		13
Severe		21
Toxic megacolon		10
Extent		
Rectosigmoid		12
Left colon		19
Total colon		27

base balance, only blood pH was taken into consideration in this study. pCO_2 values were used only to define the metabolic alteration.

Blood pH was compared with the following factors: number of stool evacuations, body temperature, pulse rate, haemoglobin, WBC, ESR, and blood albumin. Intestinal gaseous distension was also planimetrically measured on plain abdominal films. Analysis of variance, Duncan's test, and correlation analysis were used for the statistical evaluation of data.

Results

ACID-BASE ANALYSIS

Acid-base data are reported in Fig. 1. In most patients values were within the range corresponding to metabolic and mixed alkalosis and only a small percentage were within the respiratory alkalosis and normal range. Patients with 'toxic megacolon' tended to fall within the mixed alkalosis range.

pH AND SEVERITY OF COLITIS

pH values recorded in various degrees of severity of colitis are shown in Fig. 2. No significant difference was found between mild and moderate forms. As the severity of the disease increased, pH appeared to become progressively higher, the highest values being observed in 'toxic megacolon'. Figure 3 shows that normal pH was present only in the mild and moderate forms. A pH over 7.50 invariably indicated severe colitis or 'toxic megacolon'. 'Toxic megacolon' was occasionally found in patients with slight alkalosis, but 50% of patients were affected in cases of severe alkalosis.

pH AND EXTENT OF COLITIS

pH values were seen to increase significantly with the increase in the extent of colonic lesions (Fig. 4). pH values over 7.50 usually corresponded with total colitis.

pH AND CLINICAL FINDINGS

Blood pH and other clinical features selected for assessment of the severity of colitis are reported in Table 2. A significant difference in pH values can be noted between both moderate and severe forms and between severe forms and 'toxic megacolon'.

Figures 5, 6, 7, and 8 show the various degrees of correlation between pH and pulse rate ($r = 0.6036$), body temperature ($r = 0.4806$), ESR ($r = 0.4826$), and plasma albumin ($r = 0.5778$). No correlation was found between pH and bowel frequency, haemoglobin, and WBC.

Fig. 1 Arterial pH- pCO_2 diagram (modified from Siggaard-Andersen) in active proctocolitis. The central rectangular area, indicated by the thick line, corresponds to normal values. Of the remaining areas, each of which refers to a specific modification of acid-base balance, only those of metabolic, mixed, and respiratory alkalosis are indicated.

Fig. 2 Arterial pH and severity of colitis. The thick part of the vertical lines refer to the range of normal levels. Values in individual observations, mean values, and SEM are given for each clinical form. Statistical significance of the differences (P) between the values in the four groups are shown below.

Fig. 3 Incidence of clinical forms with respect to the degree of arterial pH modification.

pH AND INTESTINAL GAS

A correlation was found between pH and gas in the small and large bowel ($r = 0.5652$) (Fig. 9). Table 3 shows the amount of intestinal gas in uncomplicated colitis and 'toxic megacolon'. Gas in the large bowel increased progressively as colitis became more severe; there was also a significant difference in the amount of small bowel gas between moderate and severe forms.

Discussion

It is widely accepted that the most common acid-base disturbance in patients with diarrhoea is metabolic acidosis and that diarrhoea rarely leads to a metabolic alkalosis (Editorial, 1966). A metabolic alkalosis typically occurs in congenital chloridiorrhoea (Evanson and Stanbury, 1965), but it has been observed also in a variety of diarrhoeal diseases

Fig. 4 Arterial pH and extent of colitis. Explanation as in Fig. 2.

Table 2 Main clinical findings (mean values $\pm$ SEM) in four degrees of severity of colitis

Clinical findings	Mild	P	Moderate	P	Severe	P	Toxic megacolon
Bowel actions/24 h	2.71 $\pm$ 0.37	0.05	5.40 $\pm$ 0.65	NS	6.50 $\pm$ 1.22	NS	3.70 $\pm$ 1.41
Max temperature ($^{\circ}$ C)	36.6 $\pm$ 0.07	NS	36.8 $\pm$ 0.16	0.05	37.3 $\pm$ 0.15	NS	37.6 $\pm$ 0.35
Max pulse rate/min	78.8 $\pm$ 2.05	NS	82.7 $\pm$ 2.37	0.05	93.8 $\pm$ 3.46	NS	100.0 $\pm$ 6.6
ESR 1st hr	9.08 $\pm$ 1.9	0.05	30.3 $\pm$ 9.4	NS	27.7 $\pm$ 6.1	NS	44.7 $\pm$ 9.0
Hb g/dl	12.7 $\pm$ 0.29	NS	11.2 $\pm$ 0.81	NS	10.7 $\pm$ 0.55	NS	10.05 $\pm$ 0.98
WBC/mm ³	7426 $\pm$ 676	NS	8522 $\pm$ 1146	NS	11552 $\pm$ 930	NS	10690 $\pm$ 1268
Serum albumin (g/100 ml)	3.75 $\pm$ 0.11	0.01	3.23 $\pm$ 0.10	0.01	2.57 $\pm$ 0.15	NS	2.38 $\pm$ 0.22
Arterial blood pH	7.43 $\pm$ 0.01	NS	7.42 $\pm$ 0.02	0.01	7.50 $\pm$ 0.01	0.01	7.55 $\pm$ 0.02

Statistical significance of the differences (P) is given.

Fig. 5 Arterial pH—pulse rate correlation.

(Caprilli and Vernia, 1975), including proctocolitis (Caprilli *et al.*, 1974, 1975b). In proctocolitis metabolic alkalosis mainly results from intestinal loss of water, sodium, and chloride; a respiratory component, probably due to intracellular acidosis, may be present.

Data obtained in the present investigation confirm that changes in blood pH, expressed as metabolic or mixed alkalosis, is a characteristic feature of both severe and complicated colitis ('toxic megacolon'). Normal pH values were observed only in colitis of mild or moderate severity.

pH appeared to increase not only with the severity of the disease but also with the extent of the lesions. The increase in pH showed a close correlation with gaseous distension of the intestine, pulse rate, and plasma albumin and, to a lesser degree, with body temperature and ESR. No correlation was found between pH and frequency of bowel motions. In the 'toxic megacolon' patients of the present series, all of whom required surgery, the number of bowel motions varied from none to six.

Measurement of blood pH levels and plain x-ray films of the abdomen have been found to be the most reliable single methods for rapid detection of the

Fig. 6 Arterial pH—body temperature correlation.

Fig. 7 Arterial pH—ESR correlation.

early phases of intestinal dilatation, which may be associated with clinical signs that are only mild. A progressively increasing amount of intestinal gas, even though distension of the colon is less than 6 cm in diameter, and a blood pH above 7.50 should be

regarded as 'alarm signs' that 'toxic dilatation' of the colon is impending. Further deterioration of this condition—'impending megacolon'—(Caprilli *et al.*, 1975b; Torsoli, 1975) may be prevented by intensive medical care.

Fig. 8 Arterial pH—plasma albumin correlation.

Fig. 9 Arterial pH—intestinal gas correlation (32 cases).

Table 3 Intestinal gas, measured planimetrically (cm² mean values $\pm$ SEM) in four degrees of severity of colitis

Intestinal gas (cm ²)	Mild	P	Moderate	P	Severe	P	Toxic megacolon
Small bowel	25.2 $\pm$ 9.05	NS	30.3 $\pm$ 4.21	0.05	74.0 $\pm$ 11.8	NS	76.8 $\pm$ 8.0
Colon	29.2 $\pm$ 3.65	0.05	44.8 $\pm$ 4.47	NS	65.3 $\pm$ 7.5	0.01	252.4 $\pm$ 31.8
Total	54.4 $\pm$ 4.81	0.05	75.1 $\pm$ 6.93	NS	139.3 $\pm$ 18.5	0.01	339.3 $\pm$ 27.8

Statistical significance of the differences (P) is given.

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