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of the magnet in the reticulum can be checked by means of a compass.

The results of experiments carried out in the USA (Carroll 1956, Van Hoosen and Isham 1958), in Germany over a period of seven years (Stöber and Fischer 1970), and in Czechoslovakia over a period of four to five years (Jagos 1974), show that the extensive use of a reticular magnet as a preventive measure can reduce the number of cases of traumatic indigestion by approximately 90 to 98 per cent. It cannot give 100 per cent protection in that some of the foreign bodies are too large or consist of non-ferromagnetic material such as copper, brass, aluminium, lead and cellulose.

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Intestinal flora studies in rabbit mucoid enteritis

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The clinical and bacteriological examination of spontaneous and experimental cases of mucoid enteritis on a large rabbit farm indicated that the mucin accumulations in the colon are a consequence of constipation. This opinion is supported by the results obtained following ligation of the proximal colon. These findings suggest that rabbit mucoid enteritis is not a specific disease entity but a general response to the factors which cause constipation. Studies of the bacterial flora of the gut in spontaneous and experimental cases suggest that while there is a notable increase in the number of coliforms and clostridia over the healthy controls, these organisms only play a secondary role.

WHILE there has been general agreement on the symptoms and gross pathology of rabbit mucoid enteritis (Hurt 1949; Ostler 1961; Greenham 1962) opinions have varied on the aetiology of this condition. Blount (1957), Paterson (1956), Leontyuk (1959) and others have regarded dietary irregularities as the primary causal factor while Innes and O'Steen (1957) have incriminated some clostridial species. Vetesi (1970) has implicated certain serotypes of *Escherichia coli*. Van Kruiningen and Williams (1971) have produced an experimental disease 11 to 33 days after the administration of a "mucoid enteritis" inoculum. Pout (1971) has emphasised the importance of endogenous factors, on the basis of his clinical and histological observations.

Recently an outbreak of mucoid enteritis occurred in the large rabbit farm at Bikal, Hungary. The annual output from this unit is 340-350,000 rabbits (New Zealand—Californian) produced by a breeding colony of 10,000 females.

Materials and methods

Three groups of rabbits were used:

Group 1.—Control group of 16 healthy rabbits;
Group 2.—Group of 16 clinical cases of mucoid enteritis;
Group 3.—Experimental group of 14 healthy rabbits each of which was subjected to a median laparotomy to expose the colon which was ligated at its junction with the caecum.

Thereby, the passage of intestinal contents into the colon was prevented ("artificial constipation"). After surgery these rabbits were placed in single cages, provided with food and water.

All the rabbits used in this experiment weighed approximately 2 kg. They were housed in single cages to facilitate clinical observation, the recording of food and water consumption and the collection of faeces samples in perforated PVC bags suspended under each cage.

Immediately after death or euthanasia in the terminal stages of the disease, the abdomen was opened and each anatomical segment of the intestine was ligated *in situ* before removal from the carcase.

Samples for bacteriological examination were taken from the stomach, duodenum, jejenum, ileum, caecum and colon, employing stringent sterile techniques at all stages. An anaerobic glove box was utilised in the preparation of cultures of anaerobic organisms (Sinkovics 1973).

One gram chyme was collected from each segment and was homogenised in pre-reduced Mitsouka buffer (Mitsouka and others 1965) not containing Tween 80. This material was further diluted in tenfold serial steps and 0·1 ml of the appropriate dilutions inoculated onto 5 per cent bovine blood and an RCM plate (Oxoid CM149) containing 100 g per ml neomycin, prepared under anaerobic conditions, for the isolation of organisms of the bacteroides group. After inoculation, the media was incubated for three days at 37°C in a BBL GasPAK Anaerobic System. The growth was transferred to MacConkey plates (Difco B57) and SA medium to isolate coliforms as well as the vegetative cells and spores of clostridia (Sinkovics 1971). The counts of aerobic spore formers were

TABLE 1: Main intestinal flora components of healthy rabbits and those suffering from mucoid enteritis

	Group 1 Healthy controls						Group 2 Spontaneous mucoid enteritis						Group 3 Experimental mucoid enteritis					
	S	D	J	IL	C	R	S	D	J	IL	C	M	S	D	J	IL	C	M
Coliforms	0	0	0	0	0	0	2·4	6·1	7·0	6·8	7·0	5·5	—	—	—	7·0	9·1	9·0
Aerobic sporeformers	1·7	2·0	1·9	2·5	3·6	3·2	1·0	2·1	3·6	5·6	5·4	6·0	—	—	—	5·3	6·1	6·0
Bacteroides	3·5	3·6	5·1	8·6	9·9	9·2	2·5	0	0	8·6	10·5	9·0	—	—	—	8·7	10·9	9·6
Vegetative clostridia	0	0	0	0	1·0	0·7	3·0	6·3	7·2	7·8	5·3	3·8	—	—	—	6·8	5·8	2·5
Spores of clostridia	0	0	0	0	0·8	0	2·9	4·9	7·0	3·5	4·0	1·0	—	—	—	2·0	2·0	1·0

S = stomach D duodenum J jejunum IL ileum C caecum M pure mucine R rectum— = segment not studied 0 No viable micro-organisms in 0·01 g chyme

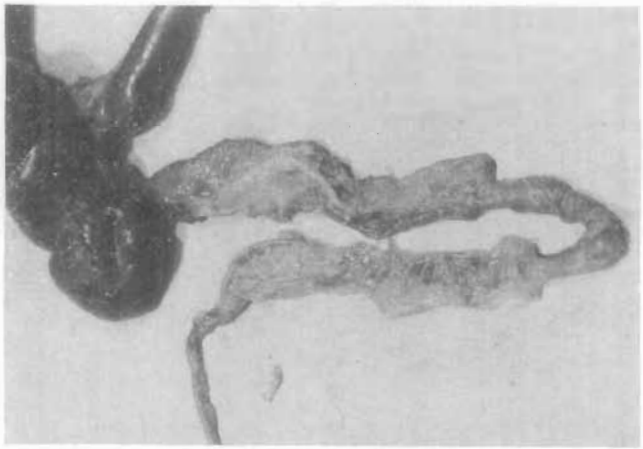

FIG 1: Accumulation of mucin in the colon of rabbit with experimental mucoid enteritis

established on nutrient agar to which the samples had been transferred after heat treatment at 80°C for 15 min. The bacterial counts are shown in Table 1 as logarithmic mean values related to 1 gram chyme.

Results

The post mortem findings in 11 of the 14 rabbits subjected to ligation of colon (group 3) were similar in every respect to those seen in naturally occurring cases (group 2). These 11 rabbits died six to eight days after surgery. At post mortem examination, they showed a mild catharral enteritis of the small intestine, dried contents with gas production in the caecum and considerable accumulations of mucin in the colon and rectum (Fig 1). The pathological changes seen in the three other rabbits in group 3 were less dramatic as only minimal quantities of mucin were seen in the colon. However, it was concluded that mucoid enteritis could be produced experimentally by ligation of the intestine in 70 to 80 per cent of cases. The controls (group 1) showed no abnormality.

The main components of the intestinal flora in all three groups are shown in Table 1. As can be seen, the most common organisms of the normal intestine (group 1) are bacteroides, aerobic spore-forming organisms and small numbers of clostridia, in some cases. In groups 2 and 3 increased numbers of coliforms compared with the controls are seen in all the segments and an increase in the numbers of clostridia in the colon although these counts bore no relation to the amount of mucin in the colon. There was no significant difference between the results obtained in spontaneous cases (group 2) and experimental cases (group 3). The types and counts of bacteria found in the mucinous content of the colon were also similar, except in one case in which an unidentified aerobic spore-former was present in large numbers. In certain group 2 cases large numbers of clostridia (10 g 10·5 to 11·0) were found especially in the ileum and large intestine. Similar bacterial counts were found in two of the three atypical experimental cases (group 3).

Discussion

It has been shown that by ligating the proximal colon one induces a state of "artificial constipation" which in turn results in an accumulation of mucus in the colon and many of the other features that are associated with spontaneous mucoid enteritis in the rabbit. This phenomenon was produced in 70 to 80 per cent of a series of 14 rabbits. These findings suggest that accumulations of mucin in the colon and rectum may be a consequence of chronic constipation. In other words, mucoid enteritis should not be regarded as an independent disease entity but only as a general symptom occurring as a sequel to constipation.

Our experience suggests that constipation may be a consequence of some cases of rabbit enteritis, due to changes in caecal fermentation. Gas chromatographic analysis of the contents of the large intestine of healthy rabbits has shown the presence of propionic acid, acetic acid and butyric acid as fermentation products in the caecum. Similar investigations in scouring rabbits have shown a preponderance of butyric acid which indicates a non-physiological fermentation in the caecum in these cases and could account for the development of a mucoid enteritis at a later stage.

Other factors may also play a part in the development of constipation, eg, lack of exercise in caged does, inadequate fibre in the diet.

The *E coli* and clostridial strains demonstrable in the intestinal contents of clinical cases (group 2) do not seem to play a notable role in the aetiology of rabbit mucoid enteritis. Previous experiments, not reported here, have shown that the inoculation of *E coli* and clostridia into the caudal intestine after ligation, did not give rise to accumulations of mucin in the colon, whereas simple ligation of the colon without inoculation of organisms produced the experimental disease as described above.

Isolated loop preparations (Gyles 1967) using live cultures of *E coli* gave negative results in two series of tests. Each was performed on four rabbits using 10 different strains.

Semjen (personal communication 1973), after isolating LT fractions from *E coli* strains derived from pigs, moved on to four rabbit strains without similar success. The frequent, if by no means regular, appearance of coliforms in the intestines of cases of rabbit mucoid enteritis is nevertheless an established fact which requires an explanation.

One possibility is that coliforms, being present in very low numbers in the intestinal flora of most rabbits, multiply when a spontaneous constipation or a ligature of the colon occurs. Although coliforms were not demonstrable in the intestines of healthy rabbits by the usual dilution method they were nearly always found on culturing in MacConkey's enrichment broth. Therefore, it is suggested that the multiplication of *E coli* may be a consequence rather than a cause of the disease.

This view is supported by the lack of a clinical response to broad-spectrum antibiotic therapy despite careful testing for antibiotic resistance in the earlier stages of the disease.

The use of symptomatic treatment (enema with lukewarm water, parenteral laxatives) in the early stages of the disease was only successful in 40 to 60 per cent of cases.

Experience suggests that the addition of meadow hay to the pelleted diet and the provision of well dimensioned cages appear to be important preventive measures.

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