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## Permanent Colostomy in the Rat

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Fistulas at various levels of the alimentary tract of different animals are of great value in nutritional studies. The rat, although frequently employed in nutritional investigations, does not yet appear to have been subjected to studies with the fistula technique although these offer the best, or only, means of solving certain problems. In order to study the microbiology of the caecum it became necessary to devise a technique for making a permanent fistula into the gut of the rat.

### EXPERIMENTAL

*Site of fistula.* The immediate object being a study of the microbiology of the caecal contents, the fistula had to be made either directly into the caecum or into the colon immediately distal to the caecum. The colon immediately distal to the caecum was chosen because greater thickness and muscularity made it more likely to withstand the operative technique.

*Type of fistula.* Because rats are inquisitive, it was decided not to use any form of cannula since the animal would probably subject the outer end to such abuses that success would be jeopardized. A 'complete' colostomy operation was devised and Fig. 1*a* indicates that sampling of the intestinal contents or the injection of various substances into the colon or caecum can be easily done with this method.

*Operative technique.* For a general account of rat surgery reference should be made to the comprehensive book of Griffith & Farris (1942). Fine nylon monofilaments (nos. 1 and 2) were used throughout the present work, even for buried sutures; Haxton's (1945) warm approval of this material is justified.

Young (2-8 months old) rats are suitable. Anaesthesia is induced with a small dose of 'Nembutal' (Abbott Laboratories Ltd.) (0.004 g./100 g. body-weight injected intra-peritoneally) and maintained, if necessary, with ether. The fur over the right side of

the abdomen is plucked and shaved. The animal is gently spread-eagled in the dorsal position on the operating board. It is convenient to place a pad of cotton wool in the small of the back in order to raise the level of the intestines. The shaved area is cleansed with a sterile swab dipped in a Dettol (Reckitt and Colman Ltd.) methylated spirit solution (1 vol. Dettol:3 vol. spirit). A right paramedian skin incision (1¼-1½ in.) is made and the skin dissected from the underlying connective tissue and muscle and

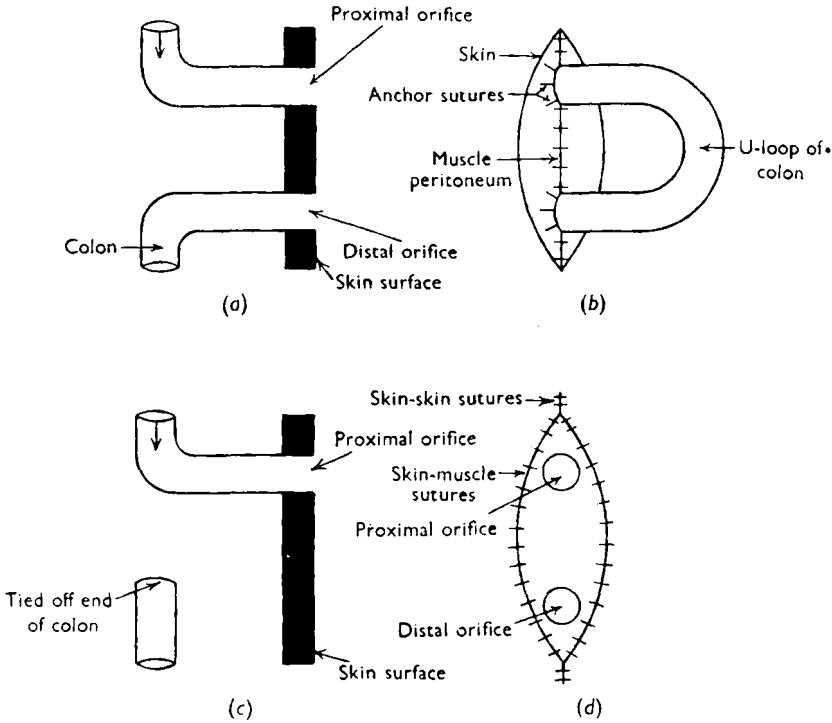
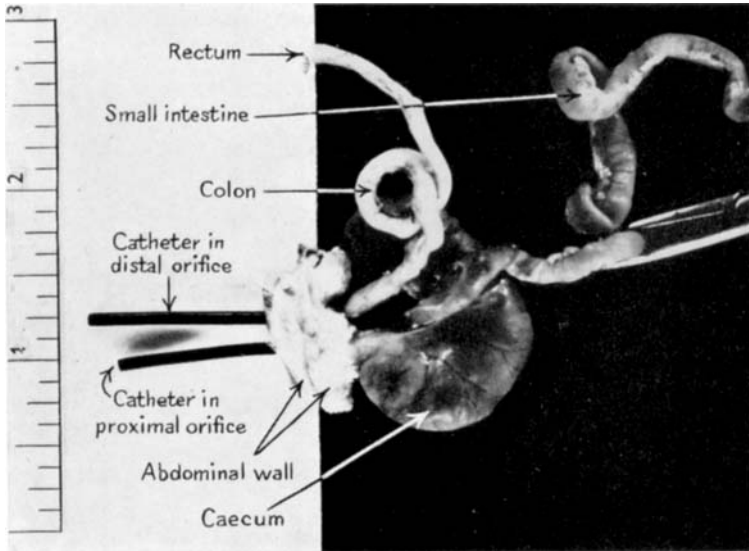
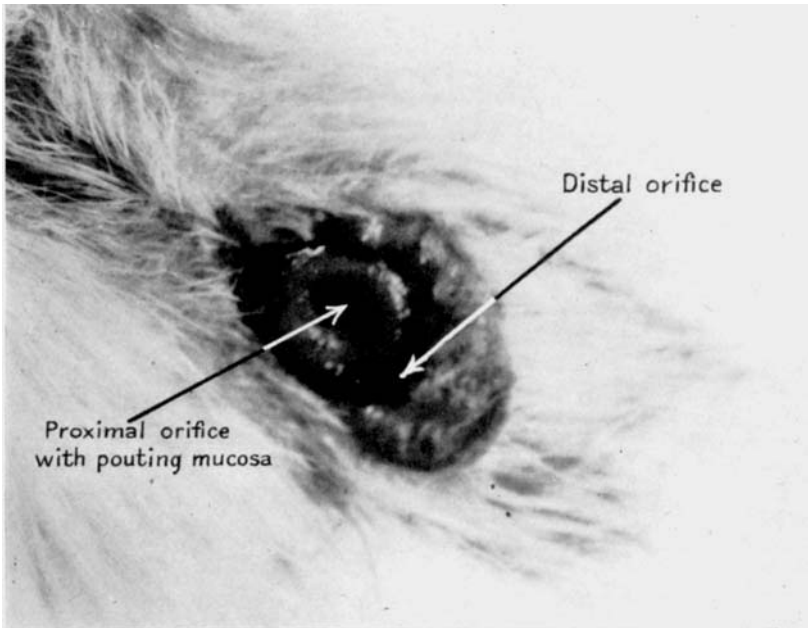


Fig. 1. Rat colostomy: different types and stages of operation. *a*, 'Complete' colostomy; *b*, closure of muscle-peritoneum incision in complete colostomy; *c*, exteriorization of proximal end of colon only in complete colostomy; *d*, relation of skin incision to colostomy openings in complete colostomy.

retracted. Bleeding points are dabbed firmly with dry gauze swabs. An incision is made through the abdominal muscles down to the peritoneum, no attempt being made to differentiate the various muscle layers. The peritoneum is carefully picked up with fine-toothed forceps and incised along the length of the incision. The sides of the muscle-peritoneum incision are retracted, and the abdominal cavity is gently explored. Undue pressure on, or stretching of, the intestines must be avoided. The caecum is identified and a U-shaped loop (each arm about ¼ in.) of the colon immediately distal to the caecum is delivered through the incision. It is important to select the loop as near the caecum as practicable, because the increased absorption of water from the faecal material as it progresses down the colon renders a complete colostomy liable to blockage with an inspissated faecal mass if the opening is made too far caudally (see remarks on rat 1, Table 1). Pl. 1, 1 indicates the correct level at which to select the loop. A hole is bluntly dissected in the mesentery of the loop, care being taken to



1. Dissection to show relation of colostomy orifices to caecum in rat no. 2, 221 days after operation. (Scale in inches.)



2. Colostomy area on abdominal wall to show proximal and distal orifices.

avoid damage to blood vessels. The loop is covered with a sterile gauze pad moistened with warm 0.9% sodium chloride solution. Penicillin-sulphonamide powder is insufflated into the abdominal cavity and the muscle-peritoneum incision closed around the loop of intestine as indicated in Fig. 1*b*. Each arm of the U is anchored by two or three fine (no. 1) nylon sutures to the muscle of the abdominal wall at the point of exit of the colon from the wound. The loop of exteriorized colon is removed, care being taken to avoid contamination of the wound with liquid faeces. Both ends of the colon are trimmed so that about  $\frac{1}{8}$  in. of each protrudes above the muscle level. The edges of these cuffs are sewn back on to the muscle, everting the mucosa. Each pouting orifice is tested for patency with a probe guarded with cotton wool. Only the proximal end of the colon need be exteriorized; the distal end can be tied off and left in the abdomen (see Fig. 1*c*). But if both ends are exteriorized, both colostomy openings can be used for a variety of experiments; further, there can be no possibility of exteriorizing the wrong end. The final stage of the operation is the closing of the skin incision. It is difficult to coapt the edges of the skin incision to the colostomy orifices, so the original incision is enlarged elliptically about the openings as in Fig. 1*d*. Penicillin-sulphonamide powder is insufflated under the flaps which are sutured together with interrupted nylon sutures, or clipped together with Michel clips, above and below the orifices, and the sides of the incision about the colostomy are sutured to the underlying muscle. The skin sutures or clips are removed in 7-10 days depending on the rate of healing. Epithelialization up to the margins of the orifices occurs in a few days.

*Post-operative care.* The animal should at all times have access to fluids such as milk or water or both. Faeces should be wiped off the skin surface with cotton wool moistened with 0.9% sodium chloride solution, and then with a dry pledget. A little vaseline is gently smeared over the openings and the surrounding depilated area. This colostomy dressing is required once daily. The animal usually licks itself quite clean after the gross faecal deposits are removed in this way. Hydrogen peroxide (20 vol.) is useful to soften dried faecal material on the fur or skin. The weight, which should be recorded daily, is a valuable gauge of the benefit, or otherwise, of the diet to the rat. Generally, weight has been well maintained in those rats fed either a stock diet (commercial rat cubes and greens) or a synthetic diet (e.g. sucrose 56, casein 24, lard or margarine 10, dried brewer's yeast 6 and salts 4%; and adequate amounts of vitamins A, D and E). The ideal to be achieved is a suitable combination of solid food and fluid which, apart from forming faeces which can be easily passed through the colostomy, maintains the animal in a satisfactory condition.

#### RESULTS

Six animals have been operated on so far with results summarized in Table 1. The appearance of successful colostomy openings is shown in Pl. 1, 2.

The first rat operated on failed to pass faeces through the colostomy which was made too far caudally from the caecum, and autopsy 48 hr. after operation revealed obstruction of the proximal orifice with an inspissated faecal mass.

The second rat survived for 221 days after operation. The position of the colostomy orifices relative to the caecum in this rat is shown in Pl. 1, 1. This rat was fed a variety of experimental diets. Its condition was never very satisfactory and examination after death revealed an intra-abdominal abscess.

Table 1. *Summary of results of colostomy operation in chronological sequence*

Rat no.	Sex	Age at operation (months)	Survival after operation (days)	Remarks
1	M	4	2	Colostomy placed too low. Proximal orifice blocked by an inspissated faecal plug
2	F	7.5	221	See text, p. 308
3	M	3	237	Still alive 12 October 1948
4	F	2	236	Still alive 12 October 1948
5	F	2.5	116	Died from prolapse and extroversion of caecum 48 hr. after the photograph reproduced in Pl. 1, 2 had been taken. (See text, p. 308)
6	M	2	133	Still alive 12 October 1948. One small abscess removed on 35th day

Rats nos. 3 and 4 presented no operative or post-operative problems and have now (16 July 1948) been alive for upwards of 150 days. (See end of paper, p. 309, for note added in proof.) The former animal has a bare area rather larger than usual around the orifices, and over the lower part of this area the skin is thickened, red and slightly rugose.

Rat no. 5, on the 116th day after operation, suddenly developed a complete prolapse and extroversion of the caecum. Loops of small bowel were found impacted in this sac, and the animal died 12 hr. after an attempt to repair the damage. This animal had been repeatedly spread-eagled for photography (see Pl. 1, 2) and this frequent handling, although not unduly rough, is considered to have caused the prolapse some 48 hr. later.

Rat no. 6, which is still alive (16 July 1948), developed a small abscess, which was subsequently removed, about the 35th post-operative day. Also, in this rat the colostomy orifices were placed too far laterally, and some excoriation of the inner aspect of the right foot which was at times tucked up against the moist orifices was noted. This, however, cleared up after treatment with penicillin-sulphonamide powder and vaseline.

Apart from their value in studies on the microbiology of the caecal contents, by direct sampling of faeces before or after introduction of food into the caecum by a thin rubber catheter, these rats may be of use in many other types of investigation. A few preliminary studies were made on the motility of the large intestine between the distal colostomy orifice and the anus. Although the colostomy prevents faeces from entering this part of the intestinal tract, peristalsis is maintained in this non-functioning segment of bowel. If a small ball of flour coloured with a non-irritant dye, e.g. rhodamine G, is pushed into the distal colostomy orifice, it is usually expelled from the anus after a period that ranges from 1 to over 3 hr. Usually, a long thick plug of mucus is passed with the intensely stained remnant of the flour ball embedded deep in mucus at the proximal end of the plug. Apparently the flour ball initiates peristalsis and pushes out a mucus plug from the non-functioning intestine ahead of it. This technique may be of

some use in assaying the activity of drugs believed to have some effect on intestinal motility. Finally, the carcinogenic effect of pellets of 20-methylcholanthrene, too small to initiate peristalsis when introduced into the colon through the distal colostomy orifice, is being studied.

## SUMMARY

1. A technique for one-stage permanent colostomy in the rat is described and the value of this procedure briefly indicated.
2. Five out of six animals have been operated on successfully and two rats have survived operation for 237 and 236 days respectively.

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*Note added in proof* (21 March 1949). Rats 3 and 6 are still alive and have survived operation for 397 and 293 days respectively. Rat 4 died 280 days after operation. Small pellets of 20-methylcholanthrene were inserted through the distal colostomy 21, 57 and 203 days after operation.