Faecal composition after surgery for Hirschsprung’s disease

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Postuma, R., Corkery, J. J., Beetham, R., and Raine, D. N. (1976). Archives of Disease in Childhood, 51, 784. Faecal composition after surgery for Hirschsprung’s disease. Diarrhoea and perianal excoriation occur frequently after the endorectal pull-through operation for Hirschsprung’s disease. A new method of faecal analysis was performed on 3-day stool collections in 17 postoperative Hirschsprung patients and in 14 normal children, in order to define the faecal abnormality and to establish the cause of perianal excoriation in these patients.

Loose stools in postoperative patients were deficient in dry solid content and contained an excess of extractable faecal water. This also had a raised electrolyte concentration, particularly with respect to sodium. Total daily output of faecal water was normal. Formed stools from postoperative patients were also deficient in dry solids but had a normal extractable water content.

Excess extractable faecal water, the main abnormality of loose stools in these patients, is the result of abnormal water absorption from the distal colon. Perianal excoriation in these patients is most closely associated with the concentration of sodium in faecal water.

Patients who have undergone a pull-through operation for Hirschsprung’s disease may suffer from chronic diarrhoea and excoriation of the perianal skin (Ehrenpreis, 1971). In our experience these symptoms were present in over 70% of patients 3 months after the modified Soave procedure, and 32 months after operation half of the patients still had loose stools and perianal excoriation (Postuma and Corkery, 1975).

Little is known about the mechanism of diarrhoea after definitive surgery for Hirschsprung’s disease. Apart from the demonstration that faecal secondary bile acids were slightly increased in 4 of the patients with loose stools in the present series (Gaze et al., 1975), we have found only one other study of the subject (Swensson, Fischer, and Scott 1960). The bile acid studies suggest colonic malabsorption of these substances and hence other disorders of colonic function may be present in these patients.

This study was undertaken to define, using a new method of analysis of faecal water and solids, the faecal abnormality in diarrhoea, and the cause of perianal excoriation after definitive surgery for Hirschsprung’s disease.

Materials and methods

Three-day, urine-free faecal collections were performed on 14 healthy children, mean age 5 years (range 2–9 years) and on 17 patients who had undergone the modified Soave endorectal pull-through operation (Soave, 1964; Boley et al., 1968). Fig. 1 shows the length of colon resected. 6 collections were carried out at home and 11 in hospital. The mean length of follow-up at the time of faecal collections was 32 months (range 9–53 months and the mean age of the patients 4–5 years (range 2–10 years). 3-day, right transverse colostomy collections were also carried out in 3 patients with Hirschsprung’s disease awaiting pull-through operation (mean age 10 months).

Specimens were collected onto polyethylene sheets and their consistency and frequency noted. They were immediately deep-frozen and later analysed. After thawing, weighing, and homogenizing the faecal specimens, duplicate samples (1–2 g of the homogenate) were dried to constant weight over a boiling water bath. The lost weight represents the total faecal water content of the sample and the weight of the residue represents

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**Results**

The content and distribution of faecal water and solids in the 14 normal children and the 17 postoperative Hirschsprung patients are given in Fig. 2.

9 patients had formed stools and 8 had loose stools. There was no significant difference between the 'formed' and the 'loose' groups in age (mean 4·0 and 4·5 years, respectively) nor in duration of follow-up (mean 32 and 31 months, respectively).

The results in Fig. 2 are summarized in Table I and the mean values for the distribution of water and solids are shown in Fig. 3. Both groups of patients had less than the normal weight of dry faecal solids. However, the patients with formed stools passed proportionately less weight of faecal water so that the ratio of total faecal water to faecal solids remained normal (2:1). The patients with loose stools passed a normal weight of faecal water and so their ratio was significantly increased (3:1). The water content as a proportion of total faecal weight was 75% in loose stools and 67% in both normal children and patients with formed stools.

There was a marked difference in the weight and proportion of extractable faecal water between the

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**Fig. 1.—Diagram of the left colon and rectum showing the extent of resections in 8 patients with loose stools (A), and 9 patients with formed stools (B).**

The dry solid content. From the mean of these values the daily excretion of faecal water and dry solids was calculated.

Duplicate samples of faecal homogenate, approximately 35 g, were centrifuged at 35 000 g for 1 hour at 4 °C. The mean weight of supernatant fluid was used to calculate the total daily weight of what we have called extractable faecal water, that is extractable by centrifugation. The difference between the weights of total and extractable faecal water is the weight of water still bound to solids after centrifugation; this we have called nonextractable faecal water. The water binding capacity of the faecal solids after centrifugation was expressed as the ratio of the weights of nonextractable faecal water and dry solids.

The extractable faecal water was analysed for the concentration of sodium and potassium (BEL 450 Flame photometer), chloride (Schales and Schales), calcium (EDTA microtitration), inorganic phosphate (Gomori method), pH (capillary glass electrode), osmolality (Advanced Instrument Ltd., 4 L Osmometer), and sugar content (Clinistix, Benedict’s, and paper chromatography). Daily excretion of electrolytes in faecal water was calculated from the concentrations of electrolytes in extractable faecal fluid and the total daily output of faecal water. Electrolyte concentrations of faecal fluid extracted by centrifugation were identical with those of the fluid remaining associated with faecal solid (Tarlow and Thom, 1974).

Results are reported as the mean value and SD. Statistical analysis was performed using Student’s ‘t’ test.
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TABLE I

Analysis of 3-day faecal collections in patients with formed and loose stools, and normal children (mean ± SD)

<table>
<thead>
<tr>
<th>Formed stools (9 patients)</th>
<th>Loos stools (8 patients)</th>
<th>Normals (14)</th>
<th>Formed stools</th>
<th>Loose stools</th>
<th>Normals</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 ± 1*</td>
<td>2 ± 1</td>
<td>1 ± 0.5</td>
<td>39 ± 12†</td>
<td>67 ± 6</td>
<td>13 ± 6</td>
</tr>
<tr>
<td>3 ± 5*</td>
<td>6 ± 7†</td>
<td>14 ± 11</td>
<td>13 ± 5</td>
<td>67 ± 11</td>
<td>3 ± 3</td>
</tr>
<tr>
<td>3 ± 2</td>
<td>21 ± 18†</td>
<td>19 ± 6</td>
<td>3 ± 3</td>
<td>21 ± 18†</td>
<td>7 ± 6</td>
</tr>
<tr>
<td>13 ± 11</td>
<td>51 ± 19†</td>
<td>38 ± 11</td>
<td>7 ± 6</td>
<td>51 ± 19†</td>
<td></td>
</tr>
</tbody>
</table>

*P < 0.05, †P < 0.01 compared to normals.

two patient groups (Table I). 51% (range 24–79) of total faecal water in loose stools from patients was extractable by centrifugation compared with only 13% (range 1–35) in formed stools from patients and 7% (range 1–24) in normal children. Two of the patients in the 'loose' group passed frankly watery stools with extractable water content of 75 and 79% respectively. In the 3 colostomy patients extractable water ranged from 78 to 87%.

The water binding capacity of faecal solids (g nonextractable water per g dry faecal solids) was essentially similar in all groups: normal mean 1.9 (±0.6SD), formed 1.8 (±0.5), and loose 1.8 (±0.8). The net water absorption by the distal left colon, as measured by the difference in weight of water in the effluent of the colostomy patients and the faeces passed per rectum in the two postoperative groups, is significantly less in the patients with loose stools than in those with formed stools (Table II).

The concentrations of electrolytes in the faecal water for normal children and postoperative Hirschsprung patients are given in Table III. Na and Cl concentrations in the loose group are greater (P < 0.05) than normal and, unlike the formed group, resembled the concentrations in colostomy fluids. However, K concentration was

TABLE II

Comparison of total faecal water and solid excretion from R-transverse colostomies and patients with loose and formed stools after the pull-through operation (mean ± SD)

<table>
<thead>
<tr>
<th></th>
<th>Dry solid (g/d)</th>
<th>Total faecal water (g/d)</th>
<th>Net absorption form distal left colon (g/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-transverse colostomies (3 patients)</td>
<td>16 ± 6</td>
<td>127 ± 46</td>
<td>—</td>
</tr>
<tr>
<td>Loose stools (8 patients)</td>
<td>14 ± 11</td>
<td>42 ± 24</td>
<td>+ 85 ± 24*</td>
</tr>
<tr>
<td>Formed stools (9 patients)</td>
<td>13 ± 5</td>
<td>26 ± 7</td>
<td>+ 101 ± 7*</td>
</tr>
</tbody>
</table>

*P = 0.05.
normal in both patient groups and significantly greater than that in colostomy fluid. The concentration of Ca and P was normal in the loose group but reduced in the formed group. The faecal fluid of loose stools has a significantly higher osmolality and lower pH than that of formed stools whether from patients or normal children and resembles colostomy fluid in this respect.

There was a direct correlation in 10 patients with soiling between the severity of perianal excoriation and the concentration of Na in the faecal water (Fig. 4). Excoriation occurred only in patients with loose stools (6 out of 7). Patients with normal stools (3) had no excoriation.

The electrolyte excretion (mmol/24 h) in the two patient groups and colostomy patients are summarized in Table IV. In neither of the postoperative pull-through patient groups did the electrolyte excretion per rectum exceed that from the R-transverse colostomies. Thus there was a net absorption of faecal water and the electrolytes dissolved in it in the left colon of both the 'loose' and 'formed' groups. However, the excretion of Na, Cl, and Ca dissolved in faecal water was significantly increased in patients with 'loose' stools compared with those with formed stools. There were similar, but less significant increases in the

### Table III

| Electrolyte Excretion in Faecal Water from Colostomy and Post-Pull-Through Hirschsprung Patients and Normal Children (Mean ± SD) |
|---|---|---|---|---|---|---|
| | Na⁺ (mmol/l) | Cl⁻ (mmol/l) | K⁺ (mmol/l) | Ca²⁺ (mmol/l) | Po₄³⁻ (mmol/l) | Osmolality (mOsm/kg) | pH |
| R-transverse colostomy (3 patients) | 61 ± 22† | 37 ± 10† | 38 ± 5‡ | 31 ± 19 | 19 ± 13 | 552 ± 59* | 5.47* |
| Loose stools (8 patients) | 43 ± 35* | 34 ± 34* | 95 ± 33 | 15 ± 9 | 11 ± 6 | 533 ± 59* | 6.91* |
| Formed stools (8 patients) | 7 ± 4 | 14 ± 5 | 99 ± 18 | 8 ± 6 | 6 ± 2* | 425 ± 65 | 7.47 |
| Normals (8 patients) | 6 ± 3 | 8 ± 4 | 111 ± 21 | 15 ± 9 | 12 ± 7 | 459 ± 86 | 7.32 |

*P < 0.05, †P < 0.01 compared to normals.

### Table IV

| Electrolyte Excretion in Faecal Water from R-transverse Colostomy and Rectum after the Pull-through Operation in Hirschsprung’s Disease (Mean ± SD) |
|---|---|---|---|---|
| | Na⁺ | Cl⁻ | K⁺ | Ca²⁺ |
| R-transverse colostomy (3 patients) | 8.0 ± 4.9 | 4.9 ± 3.2 | 5.0 ± 2.5 | 3.4 ± 1.3 |
| Loose stools (8 patients) | 2.0 ± 2.0* | 1.5 ± 1.7* | 3.6 ± 2.2 | 0.7 ± 0.7* |
| Formed stools (8 patients) | 0.2 ± 0.1 | 0.4 ± 0.2 | 2.7 ± 1.0 | 0.2 ± 0.1 |

*P < 0.05, loose vs. formed group.
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excretion of K and P by patients with loose stools. Insignificant traces of sugar (<2.5 g/l total) were detected in faecal water in 5 patients with formed stools, 6 patients with loose stools, and in the 3 colostomy patients; however, one patient with loose stools had more at 4 g/l. There was no clinical evidence of steatorrhoea; fat globules were not found on stool microscopy in these patients. Stool culture grew no pathogens.

Discussion

The characteristics of the loose stools following the pull-through operation for Hirschsprung’s disease observed in the present study are (1) a reduction in the weight of dry solids (74% of normal); (2) a normal amount of faecal water per day but with an increased electrolyte concentration; (3) an increased ratio of water to solid (3:1) compared with normal; and (4) a marked increase in the amount of extractable faecal water.

In postoperative patients with formed stools, despite a similar reduction in dry solid content, the extractable faecal water fraction was normal. It is apparent therefore that the excess of extractable faecal water is the main abnormality associated with the loose stools of these patients. Furthermore, the proportion of extractable faecal water appears to determine stool consistency. Fig. 2 shows that in normal children except for 2 extractable faecal water is less than 10%. In patients with loose stools the extractable faecal water was >35% in all but one, and in 2 of these with frankly watery stools the proportion exceeded 75%.

Net water absorption from the residual left colon of these patients has been calculated by assuming that the volume of R-transverse colostomy effluent, as measured in the 3 Hirschsprung patients awaiting pull-through operation, represents the inflow into the left colon in all patients after the pull-through operation. If this assumption is valid, the increase in extractable water is the result of incomplete water reabsorption from the distal left colon. The length of resected colon was similar in both groups so that the difference in water absorption was not due to a discrepancy in the absorptive surface area (Fig. 1). The decrease in colonic water absorption in the ‘loose’ group is associated with an increased output of faecal water Na, Cl, and Ca per rectum compared to the formed group (Table IV). There are similar but less significant increases in output of K and P. No conclusion can be drawn about absorption of electrolytes since they were not measured in the faecal solid fraction.

Aaronson (1971) reported raised stool chloride concentrations exceeding the sum of those of Na and K, in 3 infants after bowel surgery; 2 of the patients had Hirschsprung’s disease and a colostomy. He suggested that the chloride-losing diarrhoea was secondary to a recent episode of intestinal obstruction and that this might be a common, previously unrecognized, condition. The faecal water electrolyte pattern he described did not occur in any of our patients, including those with colostomy, but none had evidence of recent intestinal obstruction. The primary cause of the colonic disturbance in water and electrolyte absorption has not been established in the study of these patients. We have published evidence (Postuma and Corkery, 1975) that it may be related to surgical technique; in particular we believe that ischaemia may play a part.

We observed that perianal excoriation occurs only in the presence of soiling and loose stools but not when soiling occurs with stools of normal consistency. Of the biochemical parameters measured in this study (Table III) only the Na concentration in the faecal water correlated with the severity of perianal excoriation (Fig. 4). This suggests that faecal water and particularly the Na it contains, is associated with excoriation. The observation that colostomy fluid, which has an even higher Na concentration, frequently causes excoriation around the stoma, seems to support this conclusion. However, the part played by other excoriating agents, such as proteolytic activity of faecal fluid have not been assessed.

Loose stools increase an underlying tendency of these postoperative patients to soil and cause perianal excoriation. It is therefore desirable to improve stool consistency. Oral administration of Isphagula husk fibre (Fybogel; Reckitt and Colman Pharmaceutical Division, Hull, H78 7DS) in 3 patients with diarrhoea decreased the extractable faecal water from 21, 75, and 35% of total water to 9, 30, and 1%, respectively; increased the weight of dry faecal solids from 7, 5, and 4 g/day to 9, 12, and 11 g/day; resulted in formed stools in 2 and improved the stool consistency in the third. Excoriation of skin was totally relieved in 2 patients and reduced to grade one in the third after treatment with Fybogel for less than 2 months (Postuma and Corkery, 1975).

To date, a precise definition of diarrhoea or what constitutes ‘loose stools’ has not appeared in published reports. Although descriptive terms based on the macroscopical appearance of a stool, such as its frequency, colour, consistency, odour, and bulk are useful in suspecting certain diseases such as cystic fibrosis and coeliac disease, they lack
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precision and do not measure specific properties. In this study of abnormal stools after definitive surgery for Hirschsprung's disease, specific alterations in faecal solids, water, extractable faecal water, and electrolytes have been identified. The new approach to faecal analysis presented in this study not only allows comparison of patients and normal subjects, but has also been useful in documenting changes in faecal composition in response to therapy designed to improve stool consistency.

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