THE METABOLIC UTILITY OF RECTAL FEEDING.*

BY

N. MUTCH, M.A., M.B., B.C.,

BEANEY RESEARCH STUDENT IN MATERIA MEDICA, GUY'S HOSPITAL,
AND

J. H. RYFFEL, M.A., B.C., B.Sc.,

DEMONSTRATOR OF PHYSIOLOGY, GUY'S HOSPITAL,

In order to alleviate starvation, when a patient cannot be fed by the stomach, it is the custom to introduce various food materials into the rectum. This procedure depends on the assumption that such materials can be absorbed by the colon and are metabolized in a normal manner when absorbed. When given in this way saline solution is undoubtedly useful as a source of water. Dextrose solution is fairly well absorbed, but starch and fat are probably of no value. The utility of protein is doubtful. Langdon Brown found no increase in urinary nitrogen as a result of giving partly predigested protein by the rectum, and concluded that earlier observations, showing that as much as 50 per cent. of the protein given might be absorbed, were largely fallacious owing to the notorious difficulty of washing out the colon completely.

1. The Disappearance of the Nitrogen of Peptonized Milk and of Dextrose from the Colon.

To a girl 6 years of age, who could not be fed by the mouth, 10 per cent. dextrose was given per rectum for two days. Peptonized milk was then given for two days, and then 10 per cent. dextrose again for two days. The whole of each enema was retained; but, as is customary, the colon was washed out at the end of each day with saline solution. The nitrogen recovered in this way up to fifty-eight hours after the last administration of milk amounted to only 0.34 gram out of a total of 2.80 grams given in the milk, so that 88 per cent. of the nitrogen was apparently absorbed. Of the dextrose 99 per cent. was absorbed. The urine showed a good reaction for indican on the days when milk was given, and none when dextrose was given, so that evidently some bacterial decomposition of the protein preceded absorption.

It may very well be the case that bacterial decomposition is necessary before protein can be absorbed in this way. As various toxic substances may thus be produced, it becomes doubtful whether rectal feeding with protein is desirable, even when considerable absorption takes place.

2. The Influence on Metabolism of Dextrose Administered by the Rectum.

The abnormalities in the urine during starvation, which are due to lack of carbohydrate, are: (a) The presence of creatin†; (b) the presence of acetone, diacetic acid and oxybutyric acid with the resulting acidosis and increase in the proportion of nitrogen as ammonia.

Cathcart has shown that, when a diet consisting only of carbohydrate is taken, these abnormalities are largely prevented, and the total daily nitrogen of the urine is less than in starvation, and that, when carbohydrate alone is taken after starvation, the creatin and acetone bodies disappear rapidly, but the fall in urinary nitrogen and in the proportion of nitrogen present as ammonia is much less rapid.

We have investigated the changes produced in the urine by the administration of dextrose per rectum in four cases—a girl, a boy, and two men. The girl has already been referred to. No definite changes were observed on giving dextrose by the rectum, but the periods were probably too short. As is usual with children in starvation, the acetone bodies were present in considerable quantity, as much as 0.57 gram total acetone and 1.94 grams oxybutyric acid being obtained on one day by Shaffer's method of estimation. On the first day of the second period of dextrose the urine contained 0.05 per cent. lactic acid, or 0.36 gram per diem, which fact

indicates that there was considerable formation of lactic acid from dextrose by bacteria in the gut.

In the other 3 cases 10 per cent. dextrose was given by the rectum for various periods, of which the greatest was six days. In one case the effect of increasing the dextrose was observed; in another dextrose was given by the rectum after a period of starvation and followed by milk given by the stomach; in the last case the effects of salines per rectum, dextrose per rectum, dextrose by the mouth, and milk and eggs by the mouth were compared. Dextrose absorbed from the rectum was found to cause a reduction in the daily amount of creatin and of total nitrogen in the urine roughly equivalent to that of similar amounts of dextrose, or other carbohydrate, when given by the mouth, but to be far less efficient than that given by the mouth in reducing acidosis and the formation of the acetone bodies. In these cases the lactic acid in the urine was scarcely above normal, and only traces of lactic acid were found in the material returned from the rectum, so that the failure of the dextrose enemata to influence the acetone bodies can scarcely be accounted for by bacterial change occurring in the alimentary canal, and we have no other explanation to offer.

One of the adult cases had had rectal salines, but no food, for a week, owing to oesophageal obstruction, which was probably malignant. He was then given 10 per cent. dextrose per rectum, so that he received and retained 114 grams dextrose on the first day and 170 grams on the second, third, and fourth days. On the third day the operation of gastrostomy was performed with chloroform anaesthesia. On the fifth day feeding by the stomach was begun, so that he received on this day protein nitrogen 0.95 gram, fat 6.1 grams, carbohydrate 37 grams. The allowance of food was increased day by day, so that on the eighth and seventeenth days he was receiving 100 grams and 210 grams of carbohydrate respectively.

No diacetic acid was detected at any time. When dextrose was given by the rectum the daily creatin fell continuously. The anaesthetic on the third day caused a distinct acidosis, but no increase in the creatin. The nitrogenous excretion was probably influenced by the anaesthetic. It showed no diminution up to the fourth day. On the fifth day the carbohydrate given by the stomach was much less than that given previously by the rectum. A marked rise in the creatin occurred, and a rise in the nitrogen greatly in excess of the nitrogen in the food.

Table showing Results Obtained.

Day.	Grams per Diem.				Acetone.	Acidity cc. N/10 per Diem.	Ammonia Ratio per Cent.
	Total Nitrogen.	Creatinin.	Creatin.	Oxybutyric Acid.			
2	9.95	0.92	0.37	0.070	+	292	5.3
3	8.97	0.80	0.31	—	+	419	8.5
4	9.56	0.88	0.28	0.061	+	358	10
5	17.4	1.48	0.93	0.049	Trace	505	8.5
6	15.8	1.27	0.32	—	0	173	5.6
7	12.0	1.06	0.47	—	0	207	5.5
8	11.9	1.17	0.31	—	0	325	6.9
17	—	1.28	0.00	—	0	—	—

In these experiments 10 per cent. dextrose was employed in order to obtain as large an absorption of dextrose as possible, but for general use a 6 per cent. solution in tap water, which is isotonic with blood, would be found more convenient as it is less irritating; 15 oz. or more of this solution given four times a day is frequently well retained by an adult, if the rectum is thoroughly washed out once a day with saline solution. It is more useful than saline solution in that:

(a) The 100 grams or more of dextrose which is thus daily supplied to the body causes a diminution of nitrogenous waste.

(b) The substance employed to render the solution

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† Some creatin is normally present in the urine of children, but not in that of adults.

isotonic is oxidized in the body, so that isotonic dextrose solution is more efficient as a source of water than an equal volume of isotonic salt solution.

In conclusion we desire to thank Dr. Hale White, Mr. Symonds, and Mr. Steward, of Guy's Hospital, for permission to publish the results of investigations made on patients under their care.

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RENAL CALCULUS IN CHILDHOOD.

WITH A REPORT OF TWO SUCCESSFUL CASES OF NEPHRO-LITHOTOMY IN YOUNG CHILDREN.

BY

ROBERT OLLERENSHAW, B.Ch., F.R.C.S.Eng.,

HONORARY SURGEON TO SALFORD ROYAL HOSPITAL; HONORARY SURGEON TO MANCHESTER NORTHERN HOSPITAL FOR WOMEN AND CHILDREN.

As to the infrequent occurrence of stone in the kidney in young children all writers are agreed. Sir Henry Morris,¹ in an analysis of 283 cases of renal calculus, met with only one case in a patient under 10 years of age. Drew records the removal of a uric acid stone from the kidney of a child aged 6 years. The rarity of calculi causing symptoms at this period of life seems somewhat extraordinary, when one remembers that at autopsies on the bodies of infants it is extremely common to find small brown granules of uric acid deposited in the pelvis and calyces of the kidneys. Holt² considers that very small calculi are common in infancy, but in a series of 1,000 autopsies made by him on the bodies of children under 12 years only one stone of any noteworthy size was found.

It is probable that the almost exclusively fluid diet of the first two years of life is responsible for the solution, or washing out, of these uric acid granules, though the earlier histories of certain cases which come to operation in later years make it extremely likely that the calculi were present in childhood. Morris records that on several occasions he has met with a history of symptoms dating back from twenty to thirty years, showing that the calculi existed in quite early life. Amongst his cases also are those of children of 13 and 11 years who had presented symptoms of calculus for seven and three years respectively.

Heaton³ gives an account of the successful removal of a uric acid stone weighing 35 grains from a female child of 11 years; the patient suffered severely from shock after the operation, but ultimately recovered. Amongst cases in which calculi were found at autopsies are three reported by Newton Pitt.⁴ These were all uric acid stones, and weighed 2 grains, 4 grains, and 2 grains respectively, being found in children under 2 years of age who died of diphtheria and bronchopneumonia. In the second of these cases the mother noticed polyuria but no haematuria; in the last case haematuria was observed, but in the first case there were no renal symptoms at all. A similar case is noted by Partridge⁵; at autopsy a stone of 4 grains weight was found in the pelvis of the left kidney. The child had shown no symptoms suggesting the presence of a calculus, and no examination of the urine was made. Death occurred from pneumonia.

The reputed uncommon occurrence of stone in the kidney in children is probably the chief reason why it is overlooked when actually present. Again, renal pain is practically always referred, by a child, to the abdomen, and so is ascribed to gastro-intestinal disturbance, the most common of the complaints of childhood. The pain may also be referred to the hip or spine, and produce simulation of disease in these regions to such an extent that the kidneys are never suspected, and escape examination. Pain due to renal calculus depends on the position and mobility of the stone or stones; the kidney substance is insensitive, the pelvis and calyces highly sensitive. The pain is frequently referred to the groin; in boys it is accompanied by retraction of the testicle, which is much more commonly seen at this stage of life than in later years.

It is obvious, from what has already been said, that in children, as in adults, calculi may be present without causing any symptoms. The most constant and reliable symptom, however, is haematuria. Lumbar pain is not common in children. The presence of fine uric acid sand should be looked for in suspected cases; the urethral irritation caused by this substance is sometimes a cause of nocturnal incontinence, and the urine of patients suffering from this trouble should always be carefully examined for uric acid crystals. Transient haematuria may be caused by the effect of these small grains on the tender kidney tubules, and is not of much importance; if it persists it must be regarded as serious and especially so if there be pain along with the haemorrhage.

In infants from 6 to 18 months old the commonest cause of haematuria is scurvy, and it must be borne in mind that blood may be present in the urine for some days before tenderness of the limbs becomes noticeable. In Drew's case, mentioned above, intermittent lumbar pain was the only symptom; there was no haematuria, but a skiagram revealed the presence of a calculus.

In May, 1912, Dr. J. J. Cox asked me to see the following case:

A little girl, aged 3 years, who had been suffering from intermittent haematuria for some weeks. In May, 1911, there had been a similar attack, and I am informed that on one or two occasions the child complained of some slight lumbar pain. From that time until January, 1912, there was no further evidence of any disease, the child appearing to be in perfect health. For three months before the time when I saw her the general health had been failing, though the child looked well nourished. Dr. Cox noticed the presence of slight haematuria and a little tenderness in the back; on some days blood was absent, but a trace of albumen was always there. On no occasion were casts or pus cells present.

Cystoscopic examination showed the escape of clear urine at regular intervals from both ureteric orifices. Nothing abnormal was seen beyond some slight congestion round the orifice of the left ureter. A skiagram showed the presence of a calculus in the left kidney, the rest of the urinary tract being quite clear.

Operation.

On May 20th, 1912, the usual lumbar incision was made, the kidney exposed and brought out on the loin. Careful palpation afforded no indication as to the whereabouts of the stone, but the radiogram showed that the stone lay about 1 in. above the lower pole. The cortex was incised along its convex border over the position of the shadow and a rough spiculated stone about $\frac{3}{4}$ in. in diameter was removed. The cortex was sewn up by interrupted catgut stitches, the muscles brought together and the wound closed, a small rubber drainage-tube with gauze filling ("cigarette" drain) being placed down to the kidney.

After-History.

The drain was removed in forty-eight hours. The wound was quite sound at the end of ten days and the child pursued a quite uninterrupted convalescence. On the fifth day after the operation there was but a mere trace of blood in the urine and by the end of the week it had disappeared entirely.

Calculi removed (actual size).

Case I.—Composition, uric acid; weight 4 grains.

Case II.—Composition, calcium oxalate and phosphate; weight $16\frac{1}{2}$ grains.

The second case came under observation on June 26th, 1912.

A boy, aged 8 years, a patient of Dr. Mumford, had suffered from occasional attacks of abdominal pain in the left side for twelve months; during the last three months the attacks had been more severe. The pain was of an aching character and was frequently accompanied by vomiting. On examination nothing abnormal was found except some little tenderness below the twelfth rib in the left lumbar region and also by deep pressure on the kidney from the front. The urine contained 0.05 per cent. of albumen but no blood. Microscopic examination was negative and the cystoscope showed no abnormality. A skiagram was taken and showed a calculus in the lower pole of the left kidney, which was slightly enlarged.

Operation.

On June 28th, 1912, a rounded, very hard spiculated stone weighing $16\frac{1}{2}$ grains was removed from the lower part of the left