of all the chromatograms leaves no question that there is a gross amino-aciduria associated with the galactosuria, which rapidly becomes more normal under treatment with the milk-free diet. The especially unusual characteristics (as against those of the already known amino-acidurias) are the disproportionately large quantities of serine, threonine, methyl histidine, lysine, and tyrosine. It could be that this pattern is specific for the disease. Of especial interest is the fact that the common liver diseases, so far as they have been investigated, display urine amino-acid patterns quite different from those shown by these two cases (Dent and Walshe, 1951). On the other hand, the pattern shows some resemblance to that occurring in the renal amino-acidurias, especially that of Wilson's disease."

Discussion

Pathological excretion of amino-acids in urine has recently been reviewed by Dent (1950, 1951), and it appears that there are two possible mechanisms by which this may occur. The first is the "overflow" mechanism whereby the excretion is the result of a raised plasma level; this occurs to varying extents in both acute and chronic liver disease and in phenylketonuria. The second is a true "renal" mechanism whereby the excretion occurs in the presence of normal plasma levels, presumably as the result of a lowered kidney threshold—that is, raised clearance; this occurs in cystinuria, in the Fanconi syndrome, and in Wilson's disease, all of which have a genetic background. There is also an acquired form of renal amino-aciduria which occurs occasionally as the result of the action of poisons such as lead and uranium on the renal tubules.

No reports have as yet appeared in which a disorder of amino-acid metabolism has been implicated in galactosaemia, but it is possible that this amino-aciduria may be specific and an expression of a "renal" mechanism.

It is hoped to publish the results of further work on these lines in the near future.

We are grateful to Dr. C. E. Dent and his assistant, Miss Dorothy Fowler (University College Hospital Medical School), for their generous help with the sugar and amino-acid chromatography and its interpretation; to Miss Jean Summerscales for her assistance in the chemical identification of the galactose; and to Professor Wilfrid Gaisford for his interest and criticisms.

REFERENCES

- Dent, C. E. (1950). *Schweiz. med. Wschr.*, **80**, 752.
 — (1951). "Quelques désordres du métabolisme des acides aminés." *Exposés Annuels de Biochimie Médicale*. Masson, Paris.
 — and Walshe, J. M. (1951). In *Conference on Liver Diseases*. p. 22. Ciba Foundation, London.

The Central Council for the Care of Cripples recently produced a *Summary of Legislation and Directory of Organizations for the Care of the Physically Handicapped* (Heinemann Medical Books, price 5s. 6d.), which, in spite of its unwieldy title, is a useful little book of over 100 pages which should be close to the hand of everyone, medical or lay, concerned in the treatment and care of the disabled or crippled. The addresses and functions of many local voluntary societies are included, as well as clear summaries of the provisions of the National Assistance and National Health Service Acts, and other forms of Government aid. There is also a section on the training of orthopaedic nurses and welfare workers as well as of the handicapped themselves.

EXTENSIVE RESECTION OF THE SMALL INTESTINE

A SHORT REVIEW, WITH TWO NEW CASES

BY

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Resection of a large part of the small intestine is called for infrequently and usually unexpectedly. The occasion may be an emergency operation for adhesion obstruction, strangulated hernia, mesenteric vascular occlusion, or mesenteric injury. Less often the indication is widespread tuberculous or other disease of the small intestine, while occasionally it is malignant disease or a benign tumour involving the mesentery. In any case, the need for so drastic an operation has seldom been foreseen and a decision has to be made on the spot. Textbooks on operative surgery give little information, and although many articles on this subject have been published it is still not easy to find out what risk there is of serious impairment of health after an extensive resection. The satisfactory results in the two cases here reported and a review of some of the literature have considerably increased my optimism with regard to this operation.

Extent of Removal

It is true that in most cases the amount of bowel removed is decided by the disease rather than by the surgeon, but even in these there is sometimes room for judgment in deciding whether an extra foot or two of bowel is better removed or left behind. In a minority of cases the extent of removal is far more a matter for individual opinion. The surgeon's decision on how far he should jeopardize the patient's future health by increasing the scope of the operation must be based on his knowledge of the likely effects of removing a large part of the small bowel. If they were to be almost inevitable chronic invalidism, diarrhoea, and misery, then he would serve his patient best by conserving as much as possible. If he knew that several feet more or less would make little difference as regards future health, he would plan the operation accordingly, for long resections are no more difficult or dangerous than short ones.

The case records surveyed support the view that resections of up to one-half of the small intestine are not followed by serious metabolic disturbance. When they exceed three-quarters, then serious metabolic disturbance is probable but by no means certain. There is no clear indication whether resection from the proximal or the distal end is likely to have the greater effect. In practice most massive resections are distal, and the bowel remaining is jejunum. This would be expected from a consideration of the blood supply, as well as from the greater liability of the distal bowel to disease generally and to gangrene from mechanical causes.

A resection of 6 ft. (1.8 m.) is taken by most authors as the minimum qualifying for the term extensive or massive. When less than this is removed the problem of later metabolic upset, in the absence of other disease, never seems to arise. One patient of Jerauld and Washburn's (1929) had only 6 ft. (1.8 m.) resected for polyposis and later had diarrhoea after milk or anything containing fat, but there may well have been polyposis of the

remaining bowel. In their other case the distal 19 ft. (5.8 m.) was resected for mesenteric embolism, leaving 10 ft. (3 m.), and the patient gained weight and was perfectly well two and a half years later. Comparatively few of the cases reported are as informative as this one about the late effects of resection. Most reports give no indication of how much or which part of the small bowel remained; in a few some chronic disease such as tuberculosis makes it impossible to regard the patient as having merely a shortened intestine, and many were followed for a few weeks only. For one or more of these reasons most of the case reports studied do not help greatly in trying to correlate the extent of removal with the late result.

However, the following cases of resection for conditions which would be expected to leave a shortened but otherwise healthy bowel are worth noting. Littlefield (1919) resected the proximal 13 ft. (4 m.), leaving only 6 in. (15 cm.) of jejunum and 4 ft. 1.2 m.) of ileum: the patient was in good health three months later. Sinclair (1924) resected the middle 12 ft. (3.7 m.), leaving several feet above and below, with perfect health three years later. Brenizer (1929) removed the distal 9 ft. (2.7 m.), leaving 6 ft. (1.8 m.), with good health a year later. Holman (1944) removed the distal 19 ft. (5.8 m.), leaving a few feet only, with good health one and a half years later. Cosh (1944) reported a death from diarrhoea and inanition eight months after resection of an unknown length but with only 3 ft. (0.9 m.) of jejunum remaining. Cogswell (1948) resected the distal 10 ft. (3 m.), leaving only 14 in. (36 cm.) of jejunum, with fair health but some diarrhoea six months later. These are representative cases, selected for mention because the reports of them are complete and readily accessible.

Other cases, in which it is not stated how much bowel remained, but with a reasonably long follow-up period, include resections of 11 ft. (3.4 m.) (Turck, 1914), 10 ft. (3 m.) (Turner, 1937), 8 ft. (2.4 m.) (Prioleau, 1944), and 7 ft. (2.1 m.) (Wood, 1920; Watson, 1923), all in good health two or more years later. The loss of 12 ft. (3.7 m.) resulted in poor health and diarrhoea at two months (Brougham, 1907) and at four months (Prioleau, 1944), but in good health with only occasional diarrhoea at 10 months (Addison, 1917). From these and other accounts it seems that diarrhoea in the early weeks is common after the longer resections, with a strong tendency to improve as the months pass. Weight loss, as would be expected, accompanies the diarrhoea and recovers with it. Tetany has occurred in several cases.

Results in the Literature

Collected series from the literature have been published from time to time. Flint (1912) presented 59 cases and Haymond (1935) no fewer than 257. Haymond gives many references, and includes tables of pathology, age, sex, length of resection, type of anastomosis, period of survival, and results in terms of function. Unfortunately, owing to lack of details in the original reports, each table deals with only a proportion of the cases, and few conclusions can safely be drawn from the figures. The condition of only half the survivors had been reported upon three months or more after operation. It is significant of the incompleteness of the information available to him that Haymond was not able even to consider the influence on the result of the anatomical part of the small intestine resected or of the length of intestine remaining—two factors which are likely to be of major importance.

It is clear that considerable variation exists in the response to removal of a large part of the small intestine. Brenizer (1929) stated: "We must conclude that the minimum extreme resection may fail in time and the maximum offers good results, and that there are always possibilities for good and bad between the two extremes." This is true so far as it goes, but the possibility for good is a very strong probability when the resection is not much above 6 to 8 ft. (1.8 to 2.4 m.), or when some 6 to 8 ft. (1.8 to 2.4 m.) is known to remain, and the chances diminish only as these limits are passed. There is certainly an important element of unpredictable and individual variation, but the final result depends to a very great extent on the length of bowel left to the patient.

The actual length of the bowel resected is of much less importance than the fraction it represents of the whole, just as the functional result of a limb amputation depends on how much remains and not on what has been removed. However, perhaps rather naturally, because of the positive nature of this measurement and the dramatic appeal of the very long resections, a disproportionate amount of attention has been given to such lengths as measured. The competitive spirit is exemplified by one author who, having removed 11 ft. (3.4 m.), claimed that this was not only the most extensive resection on record for mesenteric thrombosis, but also the second largest for any cause in the American literature and the tenth largest in the entire literature. Length resected, as an isolated observation, is of course of some importance, as in certain circumstances it may not be practicable to ascertain how much bowel has been left.

A surgeon finding himself obliged, at such an operation, to remove 15 ft. (4.6 m.) of small bowel can only hope his patient has at least an average length of it. This is usually taken as 22 ft. (6.7 m.), the range of variation being from 15 to 32 ft. (4.6 to 9.8 m.) (Brenizer, 1929). Exceptionally, a healthy small intestine may measure less than 15 ft. (4.6 m.) and it is well known that in some cases of chronic jejuno-ileitis of the "total" rather than the "regional" type extreme shortening occurs. In a case of this kind, not reported here, which recently came to necropsy, the whole small intestine measured only 6 ft. (1.8 m.) in length. The measurement of a contractile muscular organ such as the small intestine is obviously a difficult matter. Spasm reduces it considerably, which was very evident during the operation on Case 2, below. The length of jejunum not requiring removal was marked off and noted to measure between 4 and 5 ft. (1.2 and 1.5 m.); when ready for anastomosis it was so obviously shorter that it was remeasured and found to be only just over 3 ft. (0.9 m.). Clamping of the mesentery and the manipulations involved in resecting the distal intestine were presumably responsible for the shortening.

Case 1

A man aged 29 was seized with violent abdominal pain at 8 p.m. on July 6, 1939, and admitted to the Bristol Royal Infirmary the following afternoon. He was cold and appeared very ill, with a pulse rate of 144. He obtained some relief from his pain by sitting up, a position he insisted on maintaining while being examined. His abdomen was rigid and tender. There was a history suggesting a chronic duodenal ulcer of several years' duration, and a diagnosis of "probably perforation" was made. Some doubt was felt on account of the position of relief from pain which he adopted, also because of his restless movements. He was given

morphine and intravenous saline, and after four hours his condition, though still very poor, had improved enough to allow operation.

Operation.—This was performed on July 7, 23 hours after the onset. The peritoneal cavity contained blood-stained fluid. The stomach was large. There was no perforation, only a healed duodenal ulcer with scarring and stenosis. The lower abdomen was filled by black coils of small intestine, which had passed from right to left through a slit, apparently congenital, in the mesentery. The margin of the aperture was divided so that the coils of bowel could be withdrawn. There was no difficulty in judging them non-viable from their appearance and from the absence of pulsation in the mesenteric arteries. The affected bowel was resected, leaving behind a few inches of ileum and 4 to 5 ft. (1.2 to 1.5 m.) of jejunum. After cutting away its mesentery the resected bowel was found to be just over 14 ft. (4.3 m.) in length. The cut ends of the remaining bowel were closed and the jejunum was anastomosed side to side with the caecum. The patient's condition continued to cause anxiety for several days after the operation.

During convalescence he was greatly troubled by diarrhoea, up to 10 times daily, which was unaffected by drugs or changes of diet. On discharge from hospital, five weeks after operation, he weighed 85 lb. (38.5 kg.), compared with his normal 130 lb. (59 kg.). He continued weak and generally unwell for some weeks, but gradually improved and the diarrhoea lessened. Three months after operation his condition was fair and the bowels acted only three or four times a day. He was, however, getting increasing symptoms from his duodenal ulcer. A radiograph showed that this was active, and that the meal passed rapidly to the caecum. He improved with medical treatment, and five months after operation was in much better health. Ulcer symptoms then recurred more severely than ever.

He was admitted to another hospital, where partial gastrectomy was carried out six months after the first operation. This was in the early months of the war, when some confusion existed, and it does not appear to have been known at the second hospital that most of the small intestine had been removed. He made an excellent recovery and returned home well a month later. The diarrhoea had by this time entirely ceased, the bowels acting on an average once daily with an occasional day missed. It was not until after the war that an attempt was made to trace this patient. Unfortunately it has not been possible to examine him, but he is known to have been in good health and at work in December, 1949, more than 10 years after resection of the small intestine.

Case 2

A married woman aged 41 attended the Bristol Royal Infirmary with a carcinoma of the caecum, for which a right hemicolectomy was carried out on October 28, 1948. A chain of carcinomatous glands had to be dissected off the superior mesenteric vessels. She remained well for a year, but another mass then appeared in the right iliac fossa and she was readmitted to hospital.

Operation.—On December 9, 1949, the recurrent mass was excised with the iliacus fascia, right ureter, and external iliac artery. Metastatic spread was, as at the first operation, confined to the mesenteric glands, but this time they were so bound up with the superior mesenteric vascular trunk that dissection was out of the question. The superior mesenteric artery and vein were divided clear of the highest affected gland, and the mesentery, with the devascularized small intestine, was excised in a block with the main tumour mass. The resected bowel was later measured and found to be 11 ft. (3.4 m.) in length. Between 4 and 5 ft. (1.2 and 1.5 m.) of jejunum remained, and 1 in. (2.5 cm.) of ileum, the latter being just proximal to the end-to-side anastomosis of ileum to transverse colon carried out at the original hemicolectomy. Continuity of the alimentary canal was restored by end-to-end anastomosis of the jejunum to the stump of the ileum. Recovery was uneventful.

During convalescence there was little trouble with diarrhoea. At first there were three stools daily, but after three weeks they were reduced to two. No drugs were given, but a diet high in carbohydrate and protein and low in fat was found to be most satisfactory. The stools were never more than semi-formed, and, unless fat was kept to a minimum, were pale and obviously fatty. Her weight on leaving hospital a month after operation was steady at 98 lb. (44.5 kg.), compared with 120 lb. (54.4 kg.) before operation, and she felt remarkably well. The tendency to looseness of the bowels diminished and she gradually found herself able to take the ordinary meals of her home, avoiding more than a minimum of green vegetables. She slowly regained weight, and two months after the operation weighed 103 lb. (46.7 kg.), the bowels acting twice daily. She felt very well and was already doing all her housework. Seen at intervals, she continued well and appeared to be in excellent health in November, 1950. Shortly afterwards she began to feel discomfort in the right iliac fossa. When examined a little over a year after the operation a hard fixed mass was palpable, without doubt a further recurrence of growth.

Discussion of Cases

In Case 1 it was obvious how much intestine would have to be removed. It seemed a great deal, but there was no alternative. In Case 2 the decision was a much more difficult matter. Less radical, but still perhaps adequate, surgery for the malignant glands would have permitted the leaving of twice as much small intestine. It would have been possible to enucleate the uppermost of the affected glands, instead of taking them in a block with the rest, and so to divide the superior mesenteric vessels more distally. In both cases the opportunity was taken to estimate the length of bowel remaining. The first patient was so ill that the estimate was made only by the appearance of the bowel coils *in situ*. In Case 2 the bowel was carefully examined and the measurements were as accurate as those of living bowel are likely to be. The shortening of the residual bowel which occurred from muscular contraction has already been mentioned. The length remaining was of the same order in both cases, if anything less in Case 2. This patient had a rather shorter small intestine originally, so that the proportion removed was about the same in both.

Case 1 certainly had a great deal more trouble with diarrhoea in the post-operative period and was in real distress from this for some weeks. His case was complicated by the presence of a duodenal ulcer. The diarrhoea, which had already lessened, was completely relieved after the partial gastrectomy. Case 2 might have been expected to have more trouble with diarrhoea than she did, seeing that she had previously lost the right half of her colon. A striking contrast between the two patients was in their personalities. Case 1 was throughout a difficult patient, anxious and always complaining. Admittedly he had reason to be so in his severe illness, but Case 2 was the exact opposite, quietly determined to get well and with never a complaint from start to finish. It is possible that an unusually stable nervous system was a factor in the mildness of her intestinal symptoms and in the rapidity with which physiological adjustment took place.

Conclusions

Removal of more than three-quarters of the small intestine is likely to be followed by serious permanent effects, but there is considerable variation between individuals. Up to one-half of the intestine can be resected without fear of metabolic disturbance.

If the circumstances preclude an estimate of one half, then 6 ft. (1.8 m.) can be considered safe to remove. Except when the small bowel is shortened by disease it is rarely less than 15 ft. (4.6 m.) in length.

In the more extensive resections it should be possible to estimate the length of the remaining bowel. To leave 8 to 10 ft. (2.4 to 3 m.) is ample, and the taking of the slightest risk in order to leave more cannot be justified, while 5 ft. (1.5 m.) or less may be enough for subsequent good health.

Tetany should be watched for as a possible post-operative complication.

The general tendency is for health and weight to improve, and for diarrhoea to lessen, with the passage of time.

Extensive resections give better results than one might expect, and should not be allowed to fail through being insufficiently radical.

Summary

Extensive resections of the small intestine are discussed and an attempt is made to give some guidance on how much can be removed in certain circumstances. Emphasis is placed on the proportion of the whole removed, and the amount left behind, in determining the result, rather than on the actual length resected. Two new cases are reported in which the result was satisfactory ten years and one year after a resection of the order of 70%. In each of them some 4 to 5 ft. (1.2 to 1.5 m.) of small intestine remained.

REFERENCES

- Addison, O. L. (1917). *Brit. J. Surg.*, **5**, 173.
 Brenizer, A. G. (1929). *Ann. Surg.*, **89**, 675.
 Brougham, E. J. (1907). *Surg. Gynec. Obstet.*, **4**, 782.
 Cogswell, H. D. (1948). *Ann. Surg.*, **127**, 377.
 Cosh, J. A. (1944). *Lancet*, **2**, 596.
 Flint, J. M. (1912). *Bull. Johns Hopk. Hosp.*, **23**, 127.
 Haymond, H. E. (1935). *Surg. Gynec. Obstet.*, **61**, 693.
 Holman, C. C. (1944). *Lancet*, **2**, 597.
 Jerauld, F. N. C., and Washburn, W. W. (1929). *J. Amer. med. Ass.*, **92**, 1827.
 Littlefield, J. R. (1919). *Ibid.*, **73**, 835.
 Prioleau, W. H. (1944). *Ann. Surg.*, **119**, 372.
 Sinclair, N. F. (1924). *W. Lond. med. J.*, **29**, 24.
 Turck, R. C. (1914). *N.Y. med. J.*, **99**, 316.
 Turner, G. G. (1937). *Lancet*, **1**, 802.
 Watson, P. (1923). *Trans. med-chir. Soc., Edinb.*, **102**, 164. (*Edinb. med. J.*, n.s., **30**.)
 Wood, W. Q. (1920). *Edinb. med. J.*, **25**, 61.

At the Royal Society of Tropical Medicine, on December 13, Dr. D. B. Jelliffe, senior lecturer in medicine, University College, Ibadan, Nigeria, speaking on the African child, described a form of infective gangrene of the mouth which differs from cancrum oris, since it infects the bones. This terrible and destructive disease, which may strip the tissues from half the side of the face, can be cured by penicillin if taken early, but, although in such cases a remarkable degree of replacement of lost tissue takes place, there is usually gross permanent disfigurement. The aetiology is not clear, but infection and malnutrition must both be important. The newborn baby may have to share his mother's (or grandmother's) milk with a brother 2 or 3 years old, and the milk may be thin, though often unexpectedly rich in protein. Congenital syphilis and relapsing fever are common, and congenital deformities, appearing with a frequency about that observed in Europe, lead not rarely to a fatal bronchopneumonia. The estimated infant mortality rate in Nigeria is somewhere between 300 and 500 per 1,000 live births.

ORCHITIS IN BORNHOLM DISEASE

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In the light of the reported widespread outbreak of Bornholm disease in this country an account of its occurrence in a family and in a contact may be of interest, since epididymo-orchitis figures prominently as a complication.

That Bornholm disease may affect several members of a family is well known. Dabney (1888) describes a family of six children, five of whom had the disease; Payne and Armstrong (1923) cite a family of ten, all developing symptoms, within a fortnight; and further examples are given by Pickles (1933), Sylvest (1934), and Howard (1938).

The incidence of orchitis differs markedly in the various epidemics. Sylvest (1934) gives a good account of epidemic myalgia. He states that orchitis was first described as a complication by Bacher in 1896. He reviews the literature and reports 93 personal cases, only one of which had orchitis. Jamieson and Prinsley (1947) describe orchitis as the commonest complication of an outbreak at Aden. It affected 12 out of 30 male cases and was usually unilateral. Orchitis appeared between the 8th and 36th days. The duration of pain and swelling was two to six days, but in one case it was ten days. Huss (1934) states that in the Swedish epidemic of 1931 the incidence of orchitis was 50 in 884 cases. He quotes three further outbreaks with orchitis, notably one at Håby in 1931 in which an epidemic of "benign orchitis" was followed by typical myalgia. On the other hand, Scadding (1946), giving an account of an outbreak in the Middle East, makes no mention of orchitis in his cases. We can find no direct reference to this complication occurring in members of a family.

Case 1

A 52-year-old officer was taken ill on September 17, 1951, just after returning from a three-weeks holiday with his family in Devonshire. (Cases of Bornholm disease had occurred in the locality but had not been associated with orchitis.) He felt shivery and unwell and ached all over. His temperature was 103° F. (39.4° C.). Pain in the left side of the chest appeared on the 20th, and next day had spread across the front to the right. This was severe on moving or deep breathing. He was treated at home by his family doctor. On October 3 he returned to work, but aching pain started in the left testicle and lasted for 48 hours. On October 6 the pain had appeared in the right testicle, and by the 9th discomfort was acute and the organ had become swollen. On October 12 the pain across the chest returned, pleuritic in type and more severe on the right side. Next day he was admitted to hospital. His past history included the usual childhood ailments, mumps, paratyphoid, and malaria.

On examination there was no fever, but he was in some discomfort, complaining of pain in the right side of the chest and in the right shoulder. There was diminished movement of the right lower chest and at the right base air entry was