DUODENAL ILEUS AND INTESTINAL MALROTATION
A Report on Two Cases Occurring in Adults

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There has been a tendency for many years now to relegate the concept of duodenal ileus in adults to the limbo of forgotten things. Perhaps one reason why the diagnosis is unfashionable is that those who suffer from the condition often belong to that unhappy band of wanderers whose complaints of vague dyspepsia remain undiagnosed after repeated barium meals and cholecystograms. From time to time some of these patients have a 'bilious attack' and when, after a few days, the attack subsides spontaneously the doctor may be only too thankful and feel disinclined to investigate the patient yet again for fear of making him still more 'introspective'. The condition is one of extrinsic duodenal obstruction and Wilkie thought that it was due to the superior mesenteric artery being stretched tightly across the duodenum. This theory has now been largely discredited and replaced by one that postulates congenital bands as the obstructing agent; nearly always (89%, Louw, 1960) these bands are associated with an anomalous rotation of the gut, and this in turn is frequently but by no means invariably associated with a volvulus of the midgut. Thanks largely to the work of Dott (1923), Ladd (1933) and Ladd and Gross (1941), paediatric surgeons have for many years recognized rotational anomalies as a cause of intestinal obstruction, but general surgeons seem to be less familiar with it in adults. Findlay and Humphreys (1956) and Louw (1960) have drawn attention to the occurrence of the condition in adults.

This paper reports two adult patients with chronic duodenal ileus who were operated on in a phase of acute duodenal obstruction; both of them had suffered from 'digestive upsets' for many years (26 and 14 respectively) and both were cured by placing the bowel in the position of non-rotation.

Unless a surgeon is familiar with the anomalies of rotation that may occur and their treatment he is liable to be perplexed when suddenly confronted on the operating table with a case of malrotation.

At least this was certainly true in the first case reported below and the measures taken on that occasion were impromptu; the second patient also presented unexpectedly but by that time a study of the problems posed by the first case led to the operation being carried out in a more orthodox manner.

Normal Intestinal Rotation

For a full account of the rotation of the gut the reader is referred to the notable article by Dott (1923) but for the moment Fig. 1 may help to refresh the memory. The diagrams are intended to show how, with the aid of a couple of pipe cleaners, one may demonstrate the fundamentals of the mechanism of rotation of the midgut loop. Embryology does not lend itself to facile illustrations and the model is not a perfect representation of what happens but it nevertheless serves our present purpose well enough.

At the fourth week the enlargement of the intra-abdominal organs is so great that the gut is forced out through the umbilical orifice and into the umbilical sac as a physiological umbilical hernia. Rotation occurs partly there and partly as it returns to the peritoneal cavity.

The first point to note is that it is only the midgut that rotates and this is emphasized in A and C which show how the ring, middle and index fingers press the same bit of pipe cleaner on to the same bit of table-top throughout so that the beginning of the 'midgut', the beginning of the 'superior mesenteric artery' and the end of the 'midgut' remain fixed during the manipulations, as indeed they do in the embryo. The pre- and post-arterial mesenteries have been hatched-in in the diagrams but they have to be imagined in the model. 'B' illustrates how the midgut loop rotates anti-clockwise through three right angles from its initial position in the sagittal plane.

'C' illustrates how the duodenum comes to lie behind the superior mesenteric artery and how it acquires a further covering of peritoneum, namely that of part of the post-arterial mesentery. Nor-
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mally most of this post-arterial mesentery gets ‘plastered down’ against the posterior abdominal wall (and fuses with the peritoneum already there) right up to the line of the superior mesenteric artery. The pre-arterial mesentery, however, remains hanging free as the mesentery of the small bowel rather like the fly-leaf of a book. The long oblique attachment of the root of the mesentery across the posterior abdominal wall is thus explained. Fig. C also illustrates how, at the end of the second stage of rotation, the cæcum is subhepatic in position. The downward growth of the cæcum and the various fixations already mentioned constitute the third stage of intestinal rotation.

Abnormal Intestinal Rotation

A number of faults can occur during the process of rotation:

(i) The gut may never extrude at all; this occurs in extrversion of the cloaca.

(ii) If it does extrude it may fail to return; the child is then born with an exomphalos.

(iii) If it does return it may in so doing fail in a greater or lesser degree to rotate.

(a) Complete failure of rotation results in non-rotation wherein the duodenum runs straight down the right paracolic gutter to a small bowel that lies in the right iliac fossa. The small bowel ends by entering the large bowel from the right side. The ascending colon lies more or less in the midline and the transverse and descending colon are on the left side of the abdomen. The condition is rare.

(b) Partial failure of rotation: sometimes only the post-arterial loop rotates but cannot do so completely because the pre-arterial loop has failed to do so; the latter thus blocks the further progress of the former. On other occasions the pre-arterial loop rotates reversely in front of the artery but comes to a halt when it meets the post-arterial loop coming round in front of the artery from the other side.

The third stage of rotation is a misnomer because by the time it is reached all rotation should have been accomplished. The third stage really consists of various peritoneal fusions whereby the bowel is anchored in its proper position. If rotation has been imperfect then fixation will be abnormal (i.e. deficient or misplaced) and even when the bowel rotates properly fixation may yet be
abnormal. When fixation is deficient, volvulus is possible, and when it is misplaced obstruction is possible. It is most important to appreciate that both volvulus and obstruction by abnormally placed bands frequently occur in the same patient and in every case both causes must be looked for. The exact details of these errors of rotation and fixation are very variable and examples of this type are grouped together under the term *malrotation*.

(iv) As the gut returns it may rotate clockwise instead of anticlockwise and the discovery of a transverse colon running behind the superior mesenteric vessels and duodenum stigmatize the anomaly as *reversed rotation*. The condition is very rare.

**Case Reports**

**Case 1**

On March 5, 1961, a 29-year-old Cypriot was admitted to the Central Middlesex Hospital as an emergency complaining of colicky upper abdominal pain and vomiting of three days duration and of painful spasms of his hands of some eight hours duration. He had himself noticed visible gastric peristalsis. The pain was eased by vomiting and also if he lay semi-recumbent on his left side. The vomit contained food that he had eaten several days previously. He said that he had suffered from attacks of abdominal pain and vomiting for as long as he could remember and had been told by his father that he had had them ever since he was 3 years old. When he was 9 years old he was investigated in Cyprus and although the radiologist reported some abnormality of the bowel his own doctor discounted this as the cause of his symptoms and, attributing the attacks to subacute appendicitis, removed his appendix. The operation was done through a right lower paramedian incision and it took an unusually long time, doubtless due to the appendix being in the left iliac fossa. He derived no benefit from the appendicectomy and at the age of 12 he had his first attack of gastric tetany. While he was serving in the Royal Air Force he was investigated once again and was told that no abnormality had been discovered. The onset of the attacks was completely unpredictable although he usually had them at about monthly intervals. Between attacks he was perfectly well and maintained a constant weight. His bowels were opened regularly and the stools were normal. His appetite was good. He had occasional indigestion but had never had a hematemesi or melena.

*On examination* he was a thin, wiry young man with soft sunken eyeballs and a dry furred tongue. He had a typical *main d'accoucheur* and Chvostek's sign was present. His abdomen was soft and scaphoid except in the epigastrium where gastric peristalsis could be observed and whence a succession splash could be elicited. No other abnormalities were noted. Serum calcium 10.1 mg./100 ml., sodium 130 mEq./l., potassium 5.3 mEq./l., chloride 84 mEq./l., and urea 84 mg./100 ml. 20 ml. 10% calcium gluconate were administered intravenously and the tetany was relieved in about 20 minutes.

*Progress.* He was admitted to a medical ward with a provisional diagnosis of pyloric stenosis, dehydration and hypochloremic alkalosis. Further questioning...
correct treatment could be undertaken at leisure. These hopes were not fulfilled as he suddenly began to produce increasing quantities of aspirate and operation had to be undertaken as an emergency.

Operation. On opening the abdomen through a midline epigastric incision the stomach, which was not noticeably dilated, and the transverse colon presented. The middle colic veins were enormously varicose, some of them being as much as 1 cm. in diameter (Fig. 4). Something unusual was clearly present so the small bowel, which was of normal calibre and colour, was eviscerated and it then became obvious that a complete midgut volvulus was present. The volvulus was present. The volvulus was in a clockwise direction. Its turns were matted together, but they were peeled apart until the bowel was free from the duodeno-jejunal flexure to the beginning of the transverse colon and it was then possible to see that it possessed a common unattached mesentery. This long midgut loop was suspended from the superior mesenteric vascular pedicle. As the turns of the volvulus were being unravelled paraoesophageal sizeable varicosities of the tributaries of the superior mesenteric vein were encountered and it was observed that their distribution was patchy.

A rudimentary gastro-colic omentum was divided and a dilated duodenum was seen running behind the superior mesenteric vessels towards the root of the transverse mesocolon which it traversed by way of a narrow aperture with fibrous and unyielding margins. Lying at a tangent to the duodeno-jejunal flexure there was a curious calcified rod about 2 mm x 4 cm. whose nature was quite obscure, but which could be seen on some of the X-ray plates when looked for afterwards. There was no evidence of a duodenal ulcer.

Once the volvulus had been untwisted anxiety was felt about the possibility of its recurrence, for not only was that likely to lead to a recurrence of symptoms but the superior mesenteric vessels would once more be screwed up in the very eye of the volvulus and it seemed only a matter of time before melena resulted from the intestinal varices or, even worse, a more severe obstruction of the vessels resulted in infarction of the gut. Furthermore, it did not seem wise to leave the duodeno-jejunal flexure sharply angulated in a rigid tunnel. It was apparent that these difficulties could most readily be overcome by reflecting the hepatic flexure over to the left as it was felt that the resulting widening of the duodeno-colic isthmus would offer the best chance of preventing a recurrence of the volvulus and such a step would also enable the duodeno-jejunal flexure to be freed from its rigid surroundings. But after a few tentative snips had been made in the adhesions that ran across the duodenum from the under surface of the liver to the hepatic flexure the manoeuvre had to be abandoned because trying to find a plane in dense fibrous tissue that contained large varices soon proved altogether too hazardous an undertaking. Had it been possible to accomplish it the bowel would have ended up in the position of non-rotation (Ladd II operation)

The only solution appeared to be to mobilize the duodeno-jejunal flexure as it lay within the rigid tunnel in the root of the transverse mesocolon, transect it there and bring the ends round to the right of the hepatic flexure and as they lay upnomose them in the right paracolic gutter. This was done without difficulty and the duodenum then ran straight down the right paracolic gutter to the rest of the small bowel which lay entirely in the right iliac fossa, whilst the large bowel lay mostly in the left side of the abdomen, i.e. a state of non-rotation had been artificially produced. The most important consequence of this was that the duodenum could be seen to be completely free
of all possible sources of extrinsic obstruction. No attempt was made to fix any portion of the bowel and the abdomen was closed.

The patient made a smooth recovery and was discharged on the 11th post-operative day. Barium studies carried out four months after operation (Figs. 5a and 5b) showed: 'Normal position and appearances of the stomach and duodenal cap. Barium passed freely from the first part of the duodenum downwards and laterally into the jejunum which was shown lying entirely in the right iliac fossa. There was no evidence of obstruction at the site of the anastomosis. The barium was followed through and was shown entering the cæcum after three hours. The cæcum lay in the left iliac fossa. The ascending colon lay obliquely in the abdomen and the hepatic flexure was almost in the normal position'.

At the time of writing (one year after operation) he has been free of all symptoms and has gained a stone (6.3 kg.) in weight.

Case 2

At the age of 59 Mrs. E. M. had complained of abdominal pain, flatulence and vomiting. A barium meal was carried out and she was told that she had had an ulcer but that it was no longer present. Symptoms continued for 14 years until, on May 8, 1962, she was seized with a severe central abdominal pain that continued without remission until she was admitted to hospital the following afternoon. She vomited profusely from the moment the pain began. Four years previously she had had a left ovarian cystectomy for a cystadeno-carcinoma.

...
Examination showed a frail old woman who was debilitated, cyanosed, and somewhat collapsed. Her temperature was normal, her tongue dry and furred, and her abdomen slightly distended and tender, the tenderness being maximal in the right iliac fossa. Bowel sounds were sometimes normal and sometimes high-pitched. X-rays showed some distention of the small bowel but no free gas under the diaphragm.

Subacute high small-bowel obstruction was a possible diagnosis but one of 'senile appendicitis' was considered more probable despite her normal temperature and profuse vomiting.

Operation. After a preliminary period of resuscitation a McBurney incision was made. The peritoneal cavity contained a good deal of turbid green fluid. It was found that the appendix had been removed at her previous operation. The McBurney incision was closed and a right upper paramedian incision made. There was no evidence of peptic ulceration but the duodenum was seen to be dilated to about twice its normal size. To explore the abdomen properly it was necessary to divide the adhesions that bound the small bowel to the ovarian cystectomy scar, but in doing so the bowel was opened in two places. Repair of the holes was unsatisfactory and a foot of small bowel had to be resected. Once this had been done it was possible to eviscerate the whole of the small bowel and it was then immediately obvious that a small bowel volvulus was present. It was reduced by rotating it 180 degrees in an anti-clockwise direction. The viability of the small bowel was unimpaired and there was no congestion of the mesenteric veins. The small bowel was generally, but very moderately, distended. Further exploration revealed that the cecum and ascending colon (neither of which had taken part in the volvulus) had a mesentery and were fairly freely mobile. It was not a communal mesentery as that of the small bowel had an attachment but this was over rather a shorter distance than usual. There was no recurrence of her ovarian carcinoma.

Her history, the presence of a volvulus, the dilated duodenum and the evident congenital abnormality of the attachment of the mesentery seemed sufficient justification for attempting an extended Ladd operation (Ladd III; Louw, 1960) for it was clear that it was not the adhesions resulting from her ovarian cystectomy that were responsible for the obstruction since the only really distended part of the small bowel was from the pylorus to the duodeno-jejunal flexure. Accordingly, the mesenteric attachment was divided off the posterior abdominal wall right up to the duodenum and the small bowel rotated en masse in a clockwise direction so that it lay in the position of non-rotation with the duodenum running straight down the right paracolic gutter to the rest of the small bowel that lay mostly in the right iliac fossa. The ascending colon and cecum lay more or less in the midline with the terminal ileum entering the cecum from the right.

Apart from some paralytic ileus she made an uneventful recovery from the operation and was discharged after 22 days. When seen after her return from convalescence she said that she was glad to be rid of the abdominal pain and vomiting that had plagued her for so long although she still suffered from a good deal of wind. She had put on 11 lb. (5 kg.) in weight. A barium meal and follow-through showed no evidence of obstruction and that the position in which the bowel had been placed at operation had been maintained.

Discussion

Even those who are born with a major anomaly of intestinal rotation are not necessarily doomed to an untimely death. All of them, however, are under the constant threat of intestinal obstruction or volvulus, but fortunately in more than half of them the threat never materialises.

At least a third of those in whom it does have serious consequences are neonates. In others the condition characteristically causes repeated attacks of subacute duodenal obstruction from infancy onwards (Case 1). In yet others again symptoms appear unheralded and at any age, the oldest such patient being that recorded by Kimel and Harrower (1957) who was 79 when operated on for a midgut volvulus. In this third group the symptoms may be episodic as in the second group but they may consist instead simply of complaints of chronic flatulent dyspepsia. Finally mention may be made of what must be a very small group indeed, namely those in whom obstruction of the duodenum is only brought about when the patient with abnormal peritoneal attachments is placed in a plaster jacket in hyperextension. The bands may only then be made taut enough to compress the duodenum.

The first patient had had a complete midgut volvulus with intermittent attacks of duodenal ileus since his earliest years, and until his penultimate attack his symptoms had defied diagnosis. Gardner and Hart (1934) in an analysis of 88 cases of volvulus of the entire mesentery collected from the world literature found only 17 patients in the age-group 3 to 27 years. But there is probably an increasing awareness of the condition nowadays for Louw (1960) was able to report 54 cases of duodenal ileus seen over a period of only five years and no less than 19 of them were adults of whom nine had either an acute or chronic volvulus.

The cause of the attacks of intestinal obstruction in Case 1 was probably an intermittent worsening of the volvulus which, by 'taking up the slack' in the uppermost jejunum, caused a sharpening of the angulation at the rigidly fixed duodeno-jejunal flexure, and it is likely that constant slight tightening and loosening of the volvulus over many years was the cause of the scarring and contraction at the root of the common mesentery. In Louw's (1960) series there were 32 cases of chronic duodenal ileus and in the 11 who had an associated chronic midgut volvulus this fibrosis was present.

The rotation of the gut in the first patient had stopped part of the way through the third stage of rotation; that is to say, caecal descent had occurred but adhesion of the mesentery of the right colon to the parietal peritoneum on the posterior abdominal wall had not taken place except over a very short distance at the hepatic flexure. When such a complete failure of fusion
behind is intestinal obstruction of the duodenum in fact less though been merely over to demonstrate this operation that enabled Ladd (1933) and Ladd and Gross (1941) to revolutionize the surgery of the neonatal obstructions due to these developmental errors. The corollary is that if a volvulus is present a mere untwisting of it is unlikely to prove an adequate operation. What must be done is to demonstrate that the duodenum is free of all extrinsic obstructions. At least this may simply mean dividing congenital bands that obstruct the duodenum as they run laterally across it from an undescended subpyloric cæcum (Ladd, 1933). At most it may be necessary to mobilize the right colon (as for a right hemicolecotomy) and, if the root of the mesentery has achieved an attachment, to continue this mobilization over to the left behind the superior mesenteric vessels and then up over the front of the duodenum. In this way the duodenum can be seen in its entirety. If the bowel is then rotated in a clockwise direction the duodenum can be straightened out and made to lie in the right paracolic gutter in the position of non-rotation, whilst the colon lies towards the left side of the abdomen (Ladd IV; Louw, 1960). By such a manoeuvre the duodenum is free from all constricting agents and the duodeno-colic isthmus is made as wide as possible so that a recurrence of the volvulus is rendered less likely. The operation that was carried out in Case 1 resulted in complete freeing of the duodenum, but the duodeno-colic isthmus was not materially widened so that recurrence of the volvulus is perhaps a little more likely than if a Ladd II (Ladd and Gross, 1941) had been performed, though less probable than if the volvulus had been merely untwisted. A Ladd II operation was in fact attempted but the size of the varices and the difficulty of being sure of avoiding them in the dense scar tissue soon proved too great and the attempt was abandoned in favour of end-to-end duodeno-jejunostomy. The latter operation would be highly undesirable in an infant as it would involve the transection and anastomosis of bowel and one of the great advantages of the Ladd operation is that bowel is not opened. Other advantages are that even in its most extended form (Ladd IV, Louw, 1960) it can be carried out very rapidly and with virtually no blood loss. All these factors are of great importance when it is remembered that many of the patients who need the operation are neonates who are already seriously ill from intestinal obstruction.

The formidable intestinal varices were probably due to the superior mesenteric vein being subjected to more or less continuous partial obstruction. Such varices have been reported only on a few occasions (Aldridge, 1961; Findlay and Humphreys, 1956 (Case 13); Gardner and Hart, 1934; Lee and Nye, 1932) and only on one occasion have they caused melena (McIntosh and Donovan, 1939 (Case 20)), but nevertheless the fears felt at operation about the risk of bleeding or thrombosis seem justified on commonsense grounds. The patchy distribution of the varices has already been mentioned and at the time there seemed no obvious explanation for this, but it is possible that it was due to some of the radicles of the superior mesenteric vein being supported externally by virtue of being wrapped up in the volvulus, whilst others, not so well supported, were obliged to dilate in the face of increased venous pressure.

The rotation of the gut in the second patient had proceeded a little further than it had in the first, but the attachment of the mesentery was imperfect as evinced by the fact that it was over a shorter distance than usual and that the right colon had a mesentery. Some weeks after the operation she volunteered that it had been necessary to take her back to theatre a few days after her ovarian cystectomy because 'something had twisted'. Enquiries were made at the hospital concerned but unfortunately the operation notes were missing, but it was clear from the notes that remained that her abdomen was reopened on account of intestinal obstruction and it is tempting to deduce from that and from her use of the word 'twisted' that she had had a small bowel volvulus on that occasion too and that it had been treated by simple untwisting. If this deduction is correct then it would seem that her intestines were predisposed to volvulus.

If malrotation of the bowel is diagnosed as an incidental finding no treatment is required but once the condition has caused symptoms it is unwise to treat the patient conservatively, for of Gardner and Hart's 17 patients with chronic duodenal ileus no less than eight died during acute exacerbations of the attacks from which they had suffered intermittently throughout their lives. Furthermore, as Louw (1960) points out, the duodenum sags increasingly downwards as one
gets older, whilst the duodeno-jejunal flexure remains more constant in position, so that the angle at the flexure becomes progressively more acute; thus once symptoms have occurred the expectation must be that they will get worse as time goes by. It is now widely agreed that the ideal operation is one of the Ladd type and that such an operation is greatly to be preferred to a side-to-side duodeno-jejunoanastomosis. Louw (1960) has treated 30 cases of chronic duodenal ileus (18 children and 12 adults) by the Ladd operation or an extension of it and the results have been excellent. None of his patients has died.

A large number of operations have been described in the past for this condition but the operation carried out in Case 1 does not seem to have been used before; it was improvised to deal with an unfamiliar situation but it appears to have been a success and might perhaps again be of use if massive varices and dense scarring prevent the orthodox and highly satisfactory Ladd procedure from being carried out.

Those whose intestines are naturally in the position of non-rotation are liable to mid-gut volvulus and yet it is advocated that patients who run into trouble from an incompletely rotated bowel should have their intestines deliberately placed in a position of non-rotation. The explanation of the apparent paradox is that it is only by de-rotating the bowel that one can be certain that no bands occlude the duodenum; the risk of further trouble from undetected bands compressing an incompletely explored duodenum appears to be greater than the risk of a volvulus developing in an artificially de-rotated bowel. This is partly because bands and adhesions are so commonly the cause of the patient’s symptoms, partly because widening of the duodeno-colic isthmus that results from de-rotation reduces the likelihood of volvulus, and partly no doubt because the raw areas left in the more extended operations of the Ladd type result in the bowel being anchored by post-operative adhesions.

If the rare condition of reversed rotation should cause obstruction of the right colon then this complication should be treated by cæcostomy (to anchor the cæcum as well as to relieve the obstruction) and this should be followed by a transverse-sigmoid anastomosis for the condition is not amenable to a slight-of-hand anatomical correction along the lines of an extended Ladd operation.

Each case must be dealt with on its merits and certainly de-rotation of the bowel is not a universal panacea for all rotational anomalies but it is frequently applicable and it is essential to bear the procedure in mind when considering how best to disentangle an unfamiliar disposition of the bowels, for the exact cause of the intestinal obstruction is seldom apparent until the abdomen has been opened and it is then too late to ponder the problem in a library.

Summary

1. The normal mechanism of the rotation of the bowel and the derangements thereof are outlined.
2. Two adult cases of duodenal ileus associated with malrotation and volvulus are described.
3. The first case was treated in an unorthodox way (end-to-end duodeno-jejunoanastomosis) partly on account of ignorance of how such a case should be treated and partly because massive intestinal varices prevented the performance of what would have been an orthodox operation. The second case, which presented seven months after the first, was treated by an extended Ladd operation. In both the result has been satisfactory.

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