Intestinal Obstruction. I. Causes and Management in Infants and Children*

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THE MANAGEMENT OF intestinal obstruction in infants and children is not a simple matter. The surgeon whose practice is limited largely to adults may be unfamiliar with certain anomalies which are often encountered in infants. Above all, it is important for the surgeon to have a thorough knowledge of the causes of intestinal obstruction in infants and children. Ladd,[5] Miller,[7] Gross,[4] and Glover[3] are among those who have made contributions to such knowledge. The primary objective of the present report is to review the causes of intestinal obstruction in children admitted to the teaching hospital of the Medical College of the University of Tennessee during a five year period (1949 to 1953). In addition, several cases of unusual interest but admitted since 1953 are also presented (Table I). It is the purpose, furthermore, to emphasize certain of the diagnostic and technical points which we consider to be of particular assistance in the management of intestinal obstruction in infants (Tables II and III).

With the exception of infants operated upon for atresia of one or more portions of the small bowel, in which the results were poor, the mortality rates in this series were essentially equivalent to those usually reported.

The three major causes of obstruction of the gastro-intestinal tract during early life were strangulated inguinal hernia, congenital hypertrophic pyloric stenosis, and ileocecal intussusception (Table I). Pyloric stenosis represented the most common cause of obstruction requiring surgical intervention during the first two months of life. Abnormalities of gut rotation, atresia or imperforate anus, and intestinal adhesions following infection or surgery accounted for an additional 25 cases. The other pathologic conditions were rare, each being represented by only one or two cases.

CONGENITAL HYPERTROPHIC PYLORIC STENOSIS

There were no deaths in the 17 patients operated upon. The success achieved in the management of this condition was due to a number of factors, among these being the promptness with which this condition was diagnosed by the house staff, and the special interest of our pediatric colleagues in fluid therapy.

The signs and symptoms of hypertrophic pyloric stenosis usually do not appear until at least two or three weeks after birth. The

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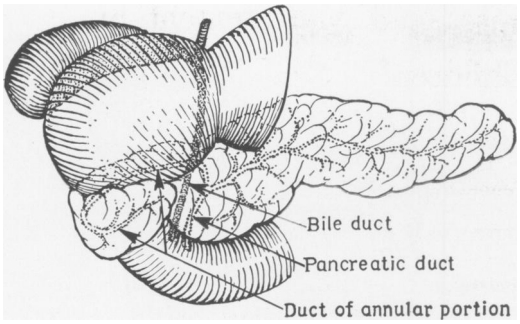

FIG. 1. Annular pancreas. Duodenojejunostomy is the treatment of choice.

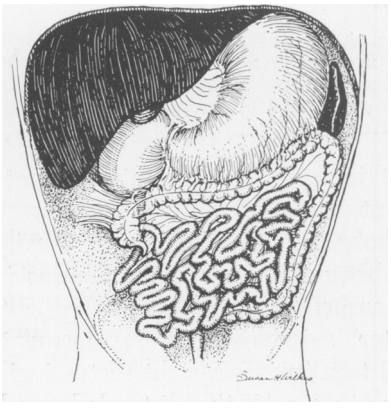

FIG. 2. Undescended cecum. Note the distention of the proximal duodenum and the fact that the distal duodenum pursues a downward course as it merges into the jejunum. Division of the peritoneal bands between the cecum and the right posterior abdominal wall relieves the obstruction.

TABLE I. *Causes of Intestinal Obstruction in Infants and Children.*

Cases from 1949–1953, Inclusive

	No.	Average Age
Strangulated Inguinal Hernia	41	2 yrs.
Congenital Hypertrophic Pyloric Stenosis	17	1 mo.
Ileocecal Intussusception	16	6 mos.
Anomalies of Rotation	6	1 mo.
Undescended Cecum 5		
Volvulus of Small Bowel 1		
Adhesions	8	5 yrs.
Postoperative 5		
Post-peritonitis 3		
Congenital Atresia or Stenosis	6	2½ mos.
Duodenum 3		
Ileum 2		
Jejunum 1		
Imperforate Anus	6	<1 day
Annular Pancreas	4	5 mos.
Meckel's Diverticulum Obstructing Ileum	2	7 yrs.
Hirschsprung's Disease with Obstruction	2	36 days
Colono-colic Intussusception (Polyp)	1	4 yrs.
Strangulated Umbilical Hernia	1	2 yrs.
Total	110	
Some Additional Causes Since 1953		
Ascaris Lumbricoides	2	
Adhesive Band Obstructing Sigmoid Colon	1	
Gangrene and Perforation of Transverse Colon	1	
Siamese Twins, Functional Obstruction	1	

patient then begins to vomit his feedings. Initially this vomiting may be minimal, but after a few days it may become severe. In the majority of instances an olive-sized mass can be palpated in the epigastrium or the right upper quadrant and this, with vomiting, almost clinches the diagnosis. In doubtful cases the diagnosis may be made roentgenologically. Gaseous distention of the stomach may outline the point of obstruction. If a contrast medium is required, iodized oil offers certain advantages but should be used sparingly, lest iodism be precipitated.

Occasionally a right rectus incision is used for the exposure, but more commonly we employ a short transverse or a muscle splitting ("gridiron") incision. If, in dividing the hypertrophied pyloric muscle at the duodenal extension, there should occur a perforation of the duodenal mucosa, this is simply oversewn and, if considered necessary, the pyloric musculature is incised at a different point. In our experience no untoward effects have followed the careful closure of mucosal penetrations. Actually, the point at which the duodenum is inadvertently entered is usually just distal to the hypertrophied pyloric muscle, and the closure of this defect need not impair the efficacy of the pyloromyotomy. The peritoneum and posterior rectus sheath are closed in one layer with a continuous suture of chromic catgut. The fascia and/or muscle layers are closed with interrupted sutures of 0000 silk. The use of subcuticular sutures in closing the skin spares both the

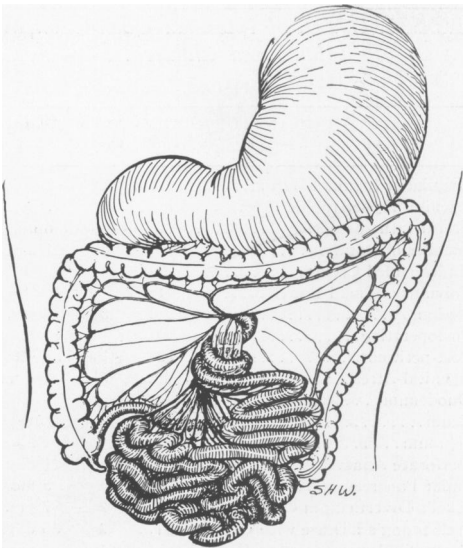

FIG. 3. Volvulus of the small bowel. A vertical incision of generous length facilitates delivery of the bowel onto the abdominal wall to permit counter-clockwise reduction of the volvulus. If the cecum is found to be in the right upper quadrant overlying the duodenum, its peritoneal connections to the right posterior abdominal wall should be severed.

surgeon and the patient the ordeal of removing sutures postoperatively.

ANNULAR PANCREAS

In 1933 McNaught[6] reviewed the 40 cases of annular pancreas previously reported and added an additional case. Since then this condition has been widely recognized as a comparatively rare but serious cause of duodenal obstruction in the newborn. The severity of the symptoms will depend upon the extent to which the encircling head of the pancreas obstructs the duodenum. Since his experience with the first case reported from our clinic,[12] our radiologist, Dr. David S. Carroll, has diagnosed three additional cases accurately. The characteristic roentgen picture is that of a smooth, concentric, incompletely obstructing lesion in the mid-portion of the duodenum at the level of the ampulla of Vater. Complete obstruction is more suggestive of atresia than of annular pancreas. According to Gross,[4] stenosis of the duodenum at this particular point may

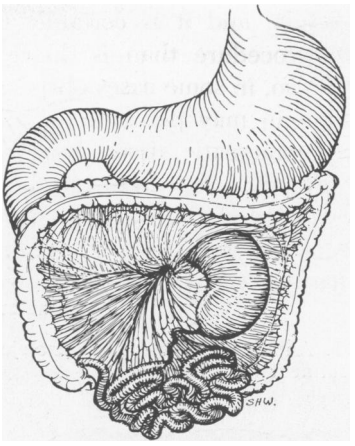

FIG. 4. Jejunal atresia. This defect is by-passed by an isoperistaltic side-to-side anastomosis. End-to-end anastomosis is also employed where feasible. Multiple sites of atresia may be present and all must be corrected.

result in jaundice, but this has not been present in any of the four cases treated in our hospital. The duodenum proximal to the obstructing pancreatic annulus is usually markedly dilated (Fig. 1).

After suitable fluid replacement and blood transfusion, a right rectus incision is made. As a rule, the distended duodenum proximal to the obstruction is anastomosed to the jejunum just distal to the ligament of Treitz, using a retrocolic approach. It is unnecessary and often unwise to resect the annulus of pancreatic tissue. Resection of the head of the pancreas may cause a pan-

TABLE II. *Technical Points of Importance.*

1. Preoperative gastro-intestinal suction and fluid replacement.
2. Adequate roentgen examinations.
3. Insertion of polyethylene tubing at ankle for infusion of fluids (including blood) at operation.
4. Open drop ether anesthesia; prevent extremes of body temperature.
5. An incision of adequate length.
6. Avoid use of clamps on bowel.
7. Injection of saline with syringe and hypodermic needle may reveal additional sites of obstruction and facilitate anastomoses.
8. For exploration a longitudinal paramedian or rectus muscle-splitting incision is satisfactory.
9. Side-to-side isoperistaltic anastomosis if diameter of lumen is small; otherwise, end-to-end. Decompression of distended loops, if judged obligatory to close abdomen, should be done with hypodermic needle and with great care.

creatic fistula, and it is certainly a more extensive procedure than is duodenojejunostomy. Also, in some cases obstruction of the duodenum may persist even after the encircling pancreatic tissue has been removed. Finally, the duodenojejunostomy avoids exposure of the jejunum to the acid contents of the stomach, as would occur were a gastrojejunostomy to be performed.

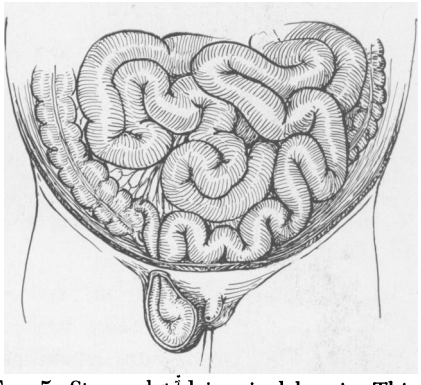

FIG. 5. Strangulated inguinal hernia. This was the most common cause of obstruction in the series herein presented. Operation is advised as soon as the diagnosis of inguinal hernia is made, regardless of age.

TABLE III. *Diagnostic Points: Obstruction in Infants.*

1. Date of onset suggestive:
   - Immediately after birth
     - a. Atresia of duodenum, jejunum, ileum or colon
     - b. Malrotation: volvulus of small bowel
     - c. Congenital bands or adhesions
     - d. Imperforate anus
   - At two weeks or more
     - a. Hypertrophic pyloric stenosis (most common)
     - b. Annular pancreas
     - c. Undescended cecum
   - After one month
     - a. Strangulated hernia
     - b. Intussusception
2. If vomitus contains bile, obstruction is below ampulla of Vater.
3. May pass meconium and still be obstructed.
   (Farber test: search center of stool microscopically for epithelial cells which have traversed bowel in utero).
4. Roentgenogram:
   - a. Site of high obstruction usually indicated by distribution of gas in gastro-intestinal tract. If need contrast medium, use Lipiodol or thin barium.
   - b. If gas in colon, invert infant to demonstrate distal extent of gas in low obstruction.
   - c. Free air suggests perforation.
   - d. Barium enema often helpful in ruling in or out colon obstruction or intussusception. Absence of cecum from usual position suggests malrotation, perhaps associated with other anomalies.
   - e. Dilated small bowel but collapsed colon—atresia to be suspected.
   - f. Granulated or "ground-glass" appearance suggests meconium ileus, but may also be associated with low atresia.

OBSTRUCTION DUE TO DEFECTIVE ROTATION OF THE BOWEL

Undescended cecum with duodenal obstruction. Five cases of undescended cecum were treated during the five year period. The diagnosis was usually made after some delay, since the obstruction was usually incomplete. The obstruction is actually due to a compression, rather than to an atresia or to a true adhesive band. Accordingly, the infant may vomit only a portion of its feeding and thus lose weight gradually. However, once the diagnosis is suspected from a history of vomiting and a physical examination showing weight loss and dehydration, roentgenologic examination will usually result in the correct diagnosis. A plain film of the abdomen or a film using a contrast medium will show an obstruction in the second portion of the duodenum, confirming the clinical suspicion made on the basis of the fact that the vomitus contained bile. A barium enema will then demonstrate that the cecum is in the right upper quadrant instead of in the right lower quadrant.

We have commonly used a right rectus incision in exploring these patients. The cecum is found in the right upper quadrant (Fig. 2), with distention of the first and second portions of the duodenum. It will be noted that, instead of the usual generally transverse course of the third and fourth portions, the duodenum descends in a straight line from the right upper quadrant towards the right lower quadrant, and continues into the jejunum without any definite ligament of Treitz. At times it may appear improbable that the rather thin peritoneal connections between the cecum and the right posterior abdominal wall can be obstructing the duodenum, but when these are divided and the cecum reflected medially, the remainder of the duodenum will

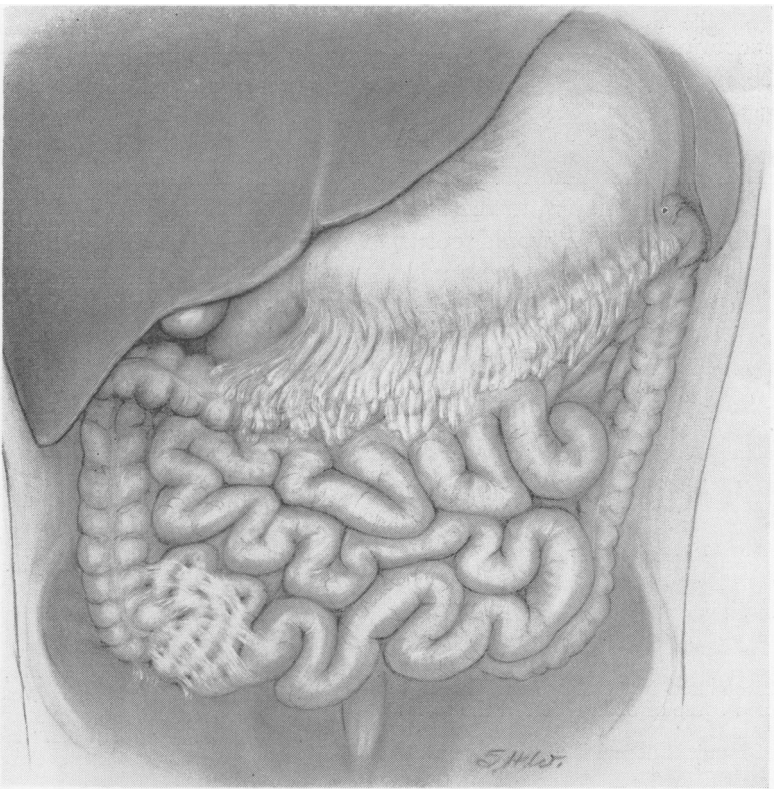

FIG. 6. Small bowel adhesions. The majority of instances of small bowel obstruction due to adhesions can be managed without surgery, but conservative measures should not be continued indefinitely. Certain of these individuals must be operated upon.

be seen to fill with gas and the obstruction will be relieved. The cecum is not sutured in any particular position. It is of course sound practice to examine the remainder of the gastro-intestinal tract for other anomalies.

Volvulus of the midgut. A second and related defect due to improper rotation of the bowel, that of volvulus of the midgut (Fig. 3), is, in our experience, a much more rare finding than is undescended cecum alone. However, here, too, the cecum will commonly be found in the right upper quadrant and, after the volvulus has been reduced, it is important to sever the peritoneal connections between the cecum and the right posterior abdominal wall which may be obstructing the second portion of the duodenum. Otherwise, the correction of the volvulus may not result in a complete relief of the obstruction.

When a volvulus is suspected or when there is obviously widespread distention of the bowel due to other cause, it is imperative to make an incision of sufficient length to bring the bowel out upon the abdominal wall. It is quite difficult through a short incision, of whatever type, to visualize the pathologic condition which is present, and to avoid overlooking additional defects that may nullify the gains in an otherwise successful operation.

ATRESIA OF THE BOWEL

Our more discouraging cases have been those of atresia (Fig. 4) and, of course, the most disappointing results have been in those patients who had multiple areas of

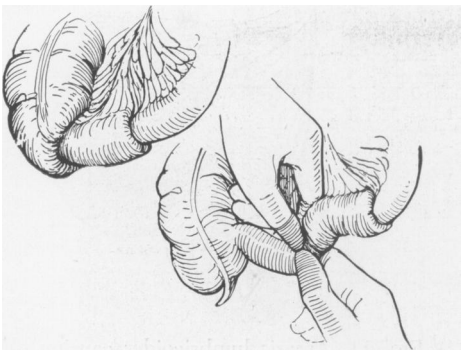

FIG. 7. Ileocecal intussusception. Operative management is preferred. Recurrence is rare.

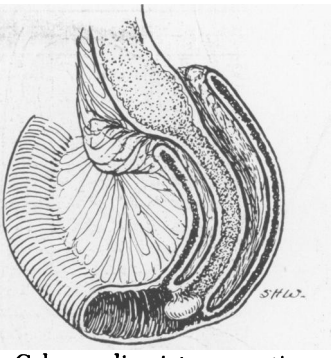

FIG. 8. Colono-colic intussusception due to polyp. Such instances of intussusception with obstruction have been noted to reduce spontaneously or with barium enema—but then to recur.

atresia. While the duodenum has been the segment most commonly involved, all major divisions of the small bowel were represented in our series. One patient had an atresia just proximal to the ileocecal valve. In another infant the proximal jejunum ended in a blind pouch just beyond the ligament of Treitz; the other, or distal, end of the jejunum began as a blind stump and was located in the right lower quadrant, at a considerable distance from the proximal jejunal pouch. Almost invariably a right rectus or a paramedian incision has been employed.

Only under very rare circumstances has the atretic bowel been resected. An attempt has usually been made to anastomose around the obstructed point with an entero-enterostomy in an iso-peristaltic fashion. Although end-to-end anastomosis is being employed with increasing frequency in our clinic, the majority of the anastomoses are still of the side-to-side type. Usually two rows of sutures are employed, but a one-layer anastomosis is used when it appears that an additional row of sutures would result in occlusion of the stoma. In our opinion, a side-to-side anatomosis is usually satisfactory, is more likely to remain patent, and is certainly more readily performed with technical success by the less experienced surgeon.

For atresia of the duodenum proximal to the ampulla of Vater a posterior gastrojejunostomy is employed. For those which are distal to the ampulla of Vater a duodenojejunostomy is used. Needless to say, it is extremely important to be certain that no point of obstruction is overlooked. Unless gas can be advanced along the bowel to identify any further occlusion due to atresia, stenosis, or septa, one should inject saline through a hypodermic needle and force it along the bowel. One of the most common causes of death following operations for atresia is the fact that one or more additional points of obstruction are not identified at the time of operation, and thus not corrected.

STRANGULATED HERNIA

The most frequent hernias in children are inguinal, umbilical, and diaphragmatic her-

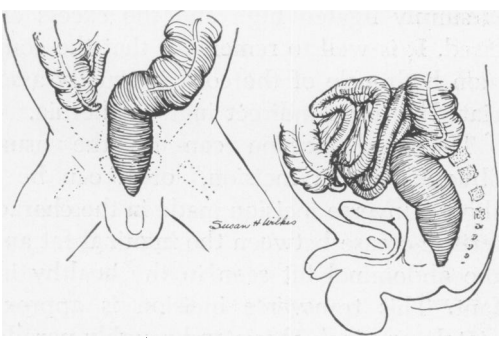

FIG. 9. Imperforate anus. This is an example of a simple type and could likely be corrected from below, the rectal pouch being freed up and brought through the external sphincter and sutured to the skin with a minimum of tension.

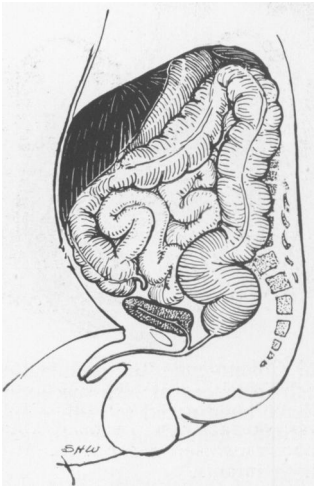

FIG. 10. Imperforate anus with recto-urethral fistula. The abdomino-perineal approach would facilitate the mobilization and advancement of the rectum and repair of the recto-urethral fistula.

nias. Of these, inguinal hernias are more common and account for more cases of obstruction. In our series, strangulated inguinal hernia (Fig. 5) accounted for 41 of the 110 cases listed. The average age at which these children were operated upon was approximately two years, but the condition was also encountered in very young infants. As pointed out by Dunavant and Wilson,[2] these patients withstand surgery well, and operation is now recommended as soon as the diagnosis has been made, regardless of age. A repair in infancy requires a minimum of anesthesia and dissection. The sac is simply ligated high and the excess excised. It is well to remember that the common hydrocele of the cord is usually associated with an indirect inguinal hernia.

The skin incision can be the usual oblique "hernia incision," or it can be a short tranverse incision made in the characteristic crease between the inguinal fat and the abdominal fat seen in the healthy infant. This transverse incision is approximately one inch above and roughly parallel to the inguinal ligament. It is readily closed with a subcuticular suture and is covered with colloidin. A diaper should not be used for several days, to avoid soaking the wound with urine.

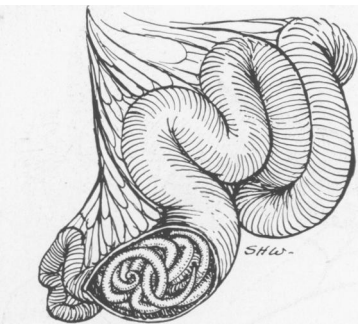

FIG. 11. Ascaris lumbricoides causing obstruction. Since these parasites are reported to have a capacity for penetrating the suture line and causing a chemical peritonitis, opening of the bowel to remove the worms is associated with some risk but may be necessary in certain cases.

SMALL BOWEL ADHESIONS

Adhesions which followed abdominal surgery or peritonitis due to appendiceal rupture (Fig. 6) accounted for eight of the 110 cases. Numerous other patients who had incomplete obstruction and were successfully treated with intubation and continuous suction have not been included in the series.

It is extremely difficult to set an arbitrary limit upon the time which should be devoted to conservative management in the

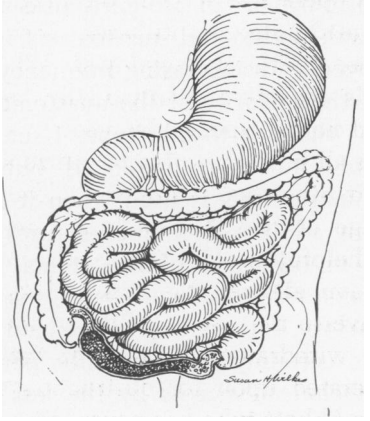

FIG. 12. Inspissated meconium obstructing terminal ileum. Dilute hydrogen peroxide has been reported to facilitate the removal of meconium from the small bowel.

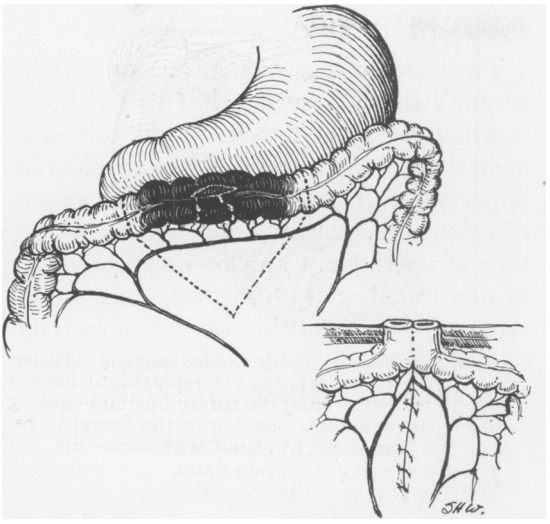

FIG. 13. Gangrene and perforation of the transverse colon in the newborn. A Mikulicz type of resection was performed, and the colostomy was later closed successfully. The cause of the necrosis was not determined.

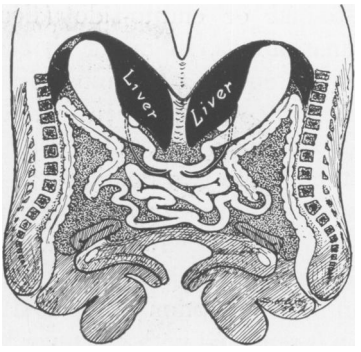

FIG. 14. Siamese Twins. The two infants had separate foreguts and hindguts but a common midgut. Only one infant passed meconium. Also of interest was the fact that the heart anomalies permitted blood transfused into one infant to circulate through both infants.

hope of avoiding operation in these patients. Most cases of obstruction which occur within one to three weeks following operation or suppurative peritonitis are due to fibrinous adhesions, and can be treated successfully with intestinal suction and intravenous fluid. Nevertheless, there exist tremendous variations in the time allowed for conservative management in different clinics. Some surgeons continue conservative therapy for as long as one month, while others operate as soon as the diagnosis has been made, before intubation with suction has been seriously employed. While each case is considered individually, operation should not be unduly delayed.

It is all but impossible to utilize a Miller-Abbott tube successfully in children below the age of two, but such suction can be most helpful in older children. On occasion we have allowed the Miller-Abbott tube to traverse the entire length of the bowel, to be withdrawn *per anus*. If the patient is operated upon for obstruction and the Miller-Abbott tube has never left the stomach, the tip should be passed manually far into the duodenum. The balloon should then be inflated and the tube allowed to advance as rapidly as it will to the large bowel or even to the rectum, where it remains until the patient is eating a soft diet without difficulty. The Y-connection can then be removed at the nose and the entire tube drawn through the bowel and removed *per anus*. If the tube is not advanced far into the intestinal tract the adhesions may quickly reform, and the patient may develop obstruction again following the second operation.

Occasionally, in operating upon a patient for postperitonitis adhesions, an abscess will be found. Drainage of such abscesses transperitoneally has been accompanied by remarkably little systemic reaction since the broad-spectrum antibiotics have been available.

INTUSSUSCEPTION

Ileocecal intussusception (Fig. 7). This was the third most common cause of obstruction encountered in the five-year series. In the vast majority of instances it was possible to reduce the intussusception in a retrograde fashion by "milking" it backward along the colon to the cecum. Recurrences are, of course, uncommon. Occasionally there has been gangrene of a segment of bowel, and this has ben resected with either

an end-to-end or end-to-side (ileum to colon) anastomosis. In one such case the appendix presented at the anus.[1] In no instance has the bowel been exteriorized on the abdominal wall. In the 17 cases treated there were two deaths.

Intussusception due to polyp. There was one colono-colic intussusception due to traction by bowel peristalsis on a polyp (Fig. 8). When an intussusception is due to a polyp, the polyp is removed with whatever base of bowel is considered to be indicated. If the general condition of the patient or the local condition of the bowel is not satisfactory, the polyp should be removed at a second operation. Enterotomy or colotomy for the removal of polyps has been followed by few complications.

IMPERFORATE ANUS

Six cases were encountered. Our methods for managing the various types of this condition are much the same as those generally employed throughout the United States (Fig. 9). If the roentgenograms taken with the infant upside-down show that the distance from the tip of the rectal pouch to the skin is apparently not greater than 2 cm., the operation is done from below. Working within the confines of the divided external sphincter, one exposes the rectal pouch and brings it down, suturing it to the skin under as little tension as can be achieved. On the other hand, if roentgen studies show that the distance from the anal dimple to the bowel is apparently greater than approximately 2 cm., the abdomino-perineal approach advocated by Rhoads[9] is employed. If the rectum is not adequately freed and brought down, the upward traction exerted by the bowel may result in separation of the suture line joining the bowel mucosa to the anal skin, producing a perineal fistula (Fig. 10). Regardless of the type of operation used, however, a careful follow up of these patients will reveal that the functional results obtained often leave much to be desired.

CONGENITAL MEGACOLON

Two cases of obstruction due to Hirschsprung's disease are listed. This condition is usually managed by the "pull-through" operation of Swenson.[10] It is considered important to determine the proper extent of colon resection by frozen section at the time of operation. Ganglion cells should be demonstrated at the proximal point of resection. By way of diagnosis, it is important to distinguish "psychic constipation" from true, aganglionic Hirschsprung's disease.

ASCARIS LUMBRICOIDES

Within the past 18 months two cases of obstruction in children have been encountered which were due to masses of *ascaris lumbricoides*. In the first of these cases the diagnosis was made when a large worm, approximately eight inches long, emerged from the anus. The patient was treated with vermifuge and a number of large worms were obtained, relieving the obstruction. The second patient was operated upon when a mass was palpated in the lower abdomen which was thought to represent intussusception. At operation the mass was found to consist of a large number of Ascarides (Fig. 11). The worms not removed at operation were passed *per anus* following the administration of a vermifuge. According to Wangensteen,[11] the *ascaris lubricoides* has a predilection for escaping through a suture line, and thus opening of the bowel would appear to be somewhat hazardous.

MECONIUM ILEUS

No case of meconium ileus was recorded during the five-year period surveyed. However, we have recently had experience with several cases in Memphis. The clinical findings were those of intestinal obstruction with vomiting in the newborn, and the roentgen examination of the abdomen showed the stippled, mottled, granular, or "ground-glass" appearance which is rather characteristically observed in this disease.

The removal of meconium from the bowel constitutes a difficult technical problem. The tenacity of this material is legendary, and various efforts have been made to facilitate its removal. Instead of a very thick glue-like substance, one may encounter an extremely inspissated material which is occasionally calcified, and which may resemble bird-shot in consistency (Fig. 12). If this material is encountered in the terminal ileum, it may be possible to force it into the colon. At other times it may be necessary to do an enterostomy, and in this way to clean the bowel. In a patient recently reported by Olim,[8] when all else had failed a dilute solution of hydrogen peroxide was injected into the bowel; this solution caused the meconium to separate from the intestinal wall and its removal was accomplished. The deficient formation of pancreatic exo-enzymes is, of course, frequently only one part of the picture, and numerous cystic defects may involve the lungs, liver, or other organs. The mortality associated with this condition is high.

GANGRENE OF THE TRANSVERSE COLON WITH PERFORATION

In Figure 13 is shown diagrammatically a condition encountered in a newborn who was operated upon for intestinal obstruction and peritonitis. It was found that the transverse colon was gangrenous over a distance of several centimeters, and that material from the colon was leaking into the peritoneal cavity. The precise cause of the gangrene was not determined. The necrotic portion of the colon was resected, and the two ends of the bowel were brought out as a double-barreled Mikulicz type of colostomy, which was later successfully closed.

OBSTRUCTION OF SPLENIC FLEXURE BY CONGENITAL ADHESIVE BAND

One of the most unexpected causes of obstruction that we have encountered in infants was that recently revealed at operation in a newborn. The patient was operated upon approximately 40 hours after birth, and the entire large and small bowel proximal to the splenic flexure was greatly distended. At this point the bowel was sharply kinked by peritoneal bands, and the descending and the sigmoid colon were collapsed. The splenic flexure was mobilized by dividing the adhesions, and thereafter gas passed readily.

FUNCTIONAL OBSTRUCTION IN A SIAMESE TWIN

In Figure 14 are shown diagrammatically the findings encountered in Siamese twins when they died several days after birth. It may be seen that while separate foreguts and hindguts were present, the midgut was common to both infants. The surprising fact was that while one twin passed virtually no meconium during life he seemed to thrive as well as did the other twin, though both were taking feedings. The explanation for this would appear to lie in the fact that, contrary to our thought that one twin was obstructed, the other twin was having bowel movements for both. Of interest also was the fact that they had a common vascular apparatus. That is, the transfusion of one twin improved the condition of both twins, as noted during the night of admission when a large common oomphalocele was closed with transfusion of only one twin, due to infusion difficulties. The infants developed pneumonitis and died, but it would have been impossible to separate them surgically.

SUMMARY

1. Important differences in intestinal obstruction occurring in infants and children from that found in adults are emphasized.

2. An analysis is given of 110 cases of obstruction in infants and children over a five year period.

3. Certain criteria which aid in the diagnosis are cited.

4. Technical factors of importance in the successful management of these cases are outlined.

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DISCUSSION.—DR. CHARLES H. MAGUIRE, Louisville, Ky.: Being intensely interested in pediatric surgery, I have run across a few unusual things which I think might be worth mentioning. One is, so far as I am concerned, a relatively new roentgenologic sign that is diagnostic of one of the conditions we heard mentioned by Dr. Alrich this afternoon, that is, incomplete rotation of the cecum with volvulus of the mid-gut. I have not put this in the literature, being too busy or too lazy or something, but I thought this a good place to present it.

(Slide) As a rule I am against giving infants barium by mouth if they are vomiting bile-stained fluid. This is a roentgenogram taken on the third day of a youngster that had vomited bile-stained fluid since his second day and, as you can see, there is a tremendously dilated stomach; there is the duodenal cap, and coming down here is this twisted column of barium.

(Slide) Again you see the twisted column of barium which might be called a "corkscrew sign," and the only congenital condition of which I am aware that will give this particular picture is incomplete rotation of the cecum, with the cecum either in the left upper quadrant or plastered to the midportion of the transverse colon with the volvulus of the mid-gut around the superior mesentery artery.

(Slide) This shows the corkscrew effect in a clockwise direction, and you unwind it in a counterclockwise direction to relieve the obstruction. There is the cecum and ascending colon resting medial to the volvulus. Interestingly enough, we untwisted it in this boy and did nothing more than detach the cecum, put it up over the left upper quadrant. One month later he did the same thing, twisted the entire mid-gut again around the superior mesenteric artery. The second time we went back and tacked the descending limb of the second part of the duodenum and first part of the jejunum along the right ileac fossa.

(Slide) This shows a relatively unusual type of intestinal obstruction in a six-month-old boy who had recurrent episodes of partial obstruction and melena. We thought the diagnosis of Meckel's diverticulum was easy, and that he had intussuscepted from time to time. We found this in the terminal ileum; this is normal terminal ileum, this is a double-barreled affair, and this pouch-like affair went down into the mesentery of the terminal ileum.

(Slide) At operation we found the normal lumen of normal terminal ileum here, with reduplication of the ileum here. This was a reduplication of the stomach entirely covered with gastric mucosa; there was duodenal mucosa here, each of the little buds of white tissue are pancreatic tissue; this is normal jejunal mucosa, and here is ileal mucosa, so he had complete reduplication of most of the gastro-intestinal tract.

The second case was a youngster with a persistent draining sinus from the umbilicus, and he had had recurrent episodes of intestinal obstruction. We were able to inject lipiodol through the sinus down into small bowel. At operation we found a persistent vitelline duct attached to a rather long Meckel's diverticulum, around which