Advances in the Management of Gastroschisis

ELLEN E. HRABOVSKY, M.D., F.A.C.S., J. BARRY BOYD, M.D, RONALD A. SAVRIN, M.D., E. THOMAS BOLES, JR., M.D., F.A.C.S.

Twenty-eight cases of gastroschisis have been treated over a five-year period. Twenty-two silos were placed and 19 infants had uncomplicated silo closure. Enlargement of the abdominal wall defect to allow optimum reduction of the edematous bowel was essential to closure in less than a week. Rapid removal of the prosthesis and strict adherence to aseptic technique prevented septic complications. Inability to return the bowel to the abdominal cavity within five to six days mandated re-exploration to determine the cause for failure to reduce the silo. Accordingly, three infants were re-explored. Two patients had unrecognized intestinal lesions and a third infant, whose defect had not been enlarged, had infarction of the midgut. Six infants underwent primary closure; two with perinatal evisceration and four who had concomminant cutaneous enterostomies performed for intestinal atresia. Intestinal atresia or stenosis occurred in 25% of these infants. Postoperative management was facilitated by insertion of a gastrostomy tube, early peripheral venous nutrition and later insertion of a central venous catheter for nutrition. The one postoperative death (3.5% mortality rate) resulted from failure to follow the principles of silo management as outlined in this report.

From the Department of Surgery, West Virginia University, Morgantown, West Virginia and The Department of Surgery, The Columbus Children's Hospital and The Ohio State University, Columbus, Ohio

THE MORTALITY FROM gastroschisis has decreased dramatically over the last 40 years due to advances in neonatal intensive care, intravenous nutrition and infection control. Watkins[15] reported the first successfully managed infant with gastroschisis in 1943. The defect was closed primarily, but in general primary closure is associated with a high mortality because of respiratory insufficiency and compression of the abdominal viscera. Moore and Stokes[11] reported two cases managed successfully by a modification of Gross'[6] method of omphalocele closure. This skin flap closure was widely employed but the morbidity and mortality of gastroschisis remained high.[8,11,13]

In 1967, Schuster[14] introduced the use of a silastic sheet to cover large omphaloceles. This technique was rapidly adapted for use in gastroschisis closure.[2,4] However, serious wound complications, sepsis, and a subsequent high mortality rate persisted. Hollabough and Boles[7] found no significant difference in mortality comparing their experience with skin flap closure and the use of the silastic silo. As recently as 1977, reported mortality rates using the silo technique are as high as 20 to 35%.[1,12]

Intestinal anomalies including malrotation,[11,14] midgut volvulus with necrosis[5,9,14] and intestinal atresia[1] have been seen in association with gastroschisis. Amoury[3] reported a 13% incidence of intestinal atresia both in his own series and in a review of the literature. He found the mortality rate more than double in those infants having an intestinal atresia compared with uncomplicated gastroschisis. The presence of an atresia complicates the closure technique and the postoperative care.

The primary advantage of closure with a silastic prosthesis is elimination of the respiratory embarrassment and compression of the abdominal contents caused by either primary or skin flap closure. The major objection to the use of silastic is the high rate of septic complications. All reports of the silo closure technique describe a one-to three-week interval required for reduction of the bowel and removal of the silo. This prolonged presence of a foreign body predisposes the infant to sepsis and major wound complications.

A personal experience with gastroschisis is reviewed. A method of management is described which allows early and safe closure of the abdomen with no mortality or significant morbidity.

Materials and Methods

Twenty-nine consecutive patients with gastroschisis managed between July 1974, and June 1976, at the Columbus Children's Hospital, and between July 1976, and June 1979, at West Virginia University Hospital, are reviewed. All babies had a typical gastroschisis with the major portion of the midgut eviscerated through a 2–4 cm defect to the right of the umbilicus (Fig. 1A).

Reprint requests: Ellen E. Hrabovsky, M.D., Department of Surgery, West Virginia University, Morgantown, West Virginia 26505.

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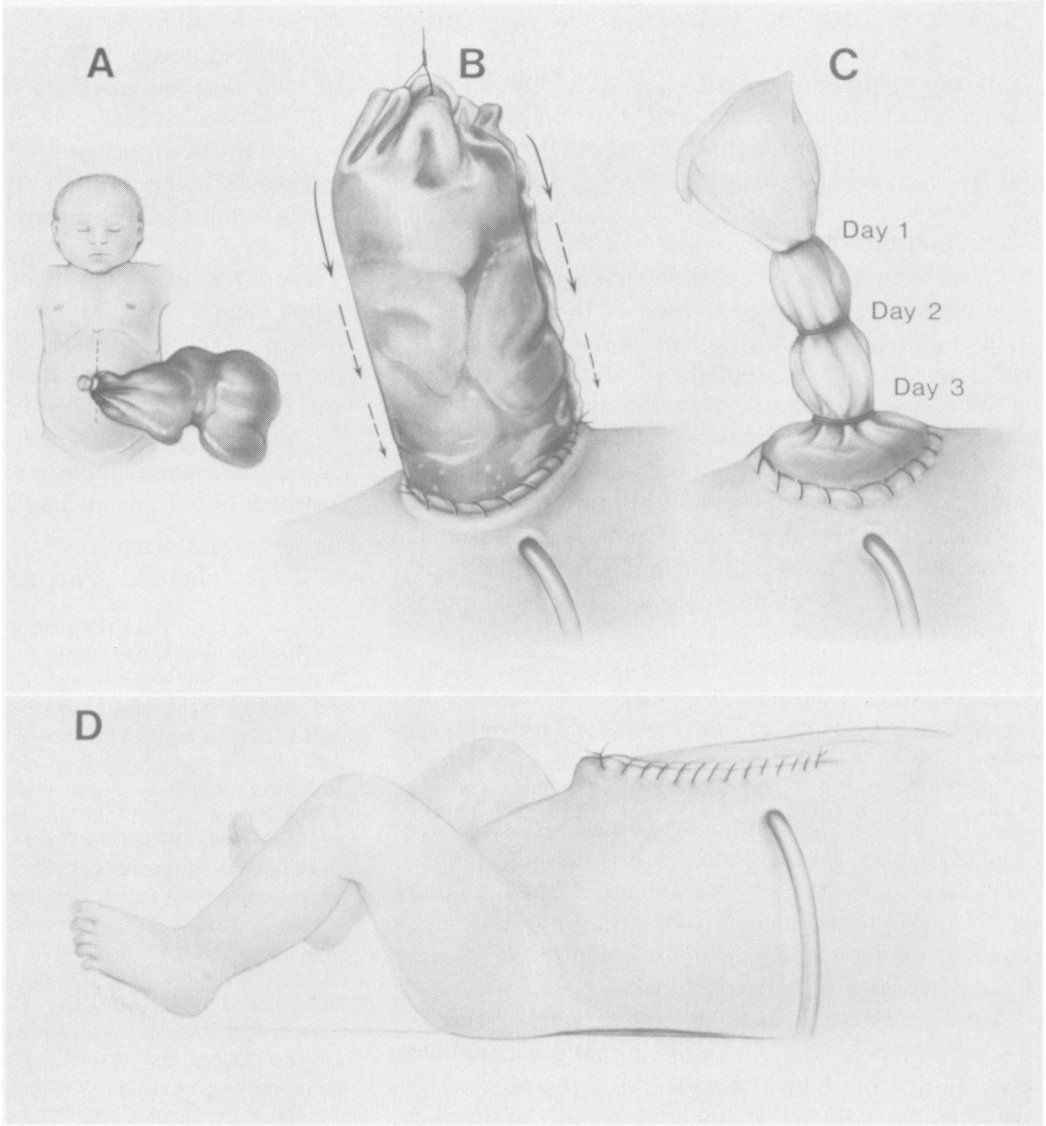

FIG. 1. (A) Typical gastroschisis. Dashed line indicates direction of enlargement of defect. (B) Silo and gastrostomy tube in place. (C) Silo at day three ready for closure. (D) Defect closed at day five.

Preoperative management included temperature regulation, insertion of a nasogastric tube, fluid replacement, antibiotics (Ampicillin and Gentamicin) and vitamin K administration. The referring physicians and our transport team were urged to wrap the bowel in a sterile dry dressing for transport. Whenever wet dressings were used, despite the use of an outer plastic wrap and transport in a warmed isolet, the baby arrived hypothermic.

As soon as the infant was stabilized, operative repair was undertaken. In 22 babies, a silastic prosthesis was placed to cover the exposed abdominal contents. The abdominal wall defect was enlarged cephalad and caudad to at least double its initial size. The peritoneal cavity was inspected and the abdominal wall gently stretched. Reduction of the bowel into the abdominal cavity was attempted at this time. Noticeable changes in ventilatory compliance or evidence of inferior vena caval compression prevented complete reduction of the bowel in all babies undergoing silo construction. Muscle relaxants mask the amount of tension required for reduction and closure and therefore are not used in the anesthetic management of these patients. In 14 patients, a gastrostomy tube was inserted and brought out through a separate stab incision in the left upper quadrant as far lateral as possible. The exposed bowel was inspected for continuity, viability, and other anomalies. If the bowel appeared to be intact, silastic sheeting was sutured to the enlarged abdominal wall defect using large caliber (1-0 to 2-0) nonabsorbable sutures. No attempt was made to create a water tight suture line. Closure of the sides of the developing silo resulted in an open-ended cylinder containing the thickened exposed bowel. After the bowel was reduced as

much as possible, the end of the silo was sutured closed (Fig. 1B).

At the completion of the procedure, the silo was coated with an iodofore ointment, covered with a bulky dressing and suspended from the top of the incubator. Postoperatively, the dressings were changed at least once daily in the nursing unit using aseptic technique. The top of the silo was compressed manually at each dressing change to accomplish reduction of the exteriorized bowel. The emptied portion of the silo was tied with umbilical tape after each reduction (Fig. 1C). The end point of each attempted reduction was a change in the baby's respiratory status or signs of vena caval compression. After complete reduction of the bowel, the baby was taken to the operating room within 24 hours for removal of the prosthesis and fascial closure (Fig. 1D). If the majority of the bowel was not reduced within five days, unrecognized anomalies of the gastrointestinal tract were suspected and the baby was returned to the operating room for re-exploration.

Seven infants had associated anomalies of the gastrointestinal tract. Four patients with bowel atresia underwent cutaneous enterostomy (three patients) or enteroenterostomy (one patient) and primary fascial closure. In one baby with a colon atresia, a colostomy was performed and a concominant silo was placed. Two infants (one small bowel atresia, one colonic stenosis) were managed initially by the silo technique but failure of the bowel to reduce led to re-exploration, at which time a cutaneous enterostomy and primary closure were performed in both instances.

Two patients without gastrointestinal anomalies were closed primarily. One other infant presented with gangrene of the entire midgut due to an intrauterine volvulus. No salvagable small bowel was present and no operative repair was attempted.

Antibiotics were routinely begun preoperatively and continued for 24 hours after removal of the silo. Peripheral intravenous nutrition with glucose, amino acids and fat was instituted postoperatively, and a central venous catheter was placed only after antibiotics were discontinued and the baby showed no signs of infection.

Results

Twenty-eight patients underwent operative repair. Primary closure was performed in six infants. In two patients, complete reduction of the abdominal contents was accomplished at the initial operative procedure without cardiovascular or pulmonary compromise, and the fascial closure was performed. Ventilatory support was not required postoperatively and no wound complications occurred. Four infants with bowel atresia underwent cutaneous enterostomy, decompression of the bowel, and primary fascial closure. Two of these babies required ventilatory support postoperatively. In each case, enterostomy closure to re-establish normal gastrointestinal continuity was performed as a separate procedure without complication.

The silo technique was used in 22 infants. Two patients required short-term ventilatory support postoperatively because of meconium aspiration at birth. There were no wound complications, no local or systemic sepsis and no gastrointestinal complications related to the prosthesis. In 19 patients, reduction of the bowel was accomplished in an average of 4.0 days, and the fascia was closed in an average of 5.3 days.

Three patients initially managed by the silo technique developed complications postoperatively. Each case illustrates important management considerations.

Case Reports

Case 1. M.F., a 3200 g full-term female, presented to the Columbus Children's hospital in 1974 with a typical gastroschisis and no other anomalies. A silo was constructed without enlarging the abdominal wall defect and the resultant silo resembled an inverted cone. Postoperatively, the bowel would not reduce. On the eighth postoperative day, the baby began to demonstrate signs of sepsis, and inspection of the silo suggested a change in the color of the underlying bowel. Within 24 hours, the baby continued to deteriorate and the appearance of the bowel worsened. Re-exploration was performed. Upon removal of the silo, necrosis of the entire midgut due to vascular compromise was found. The patient died 24 hours postoperatively.

Case 2. J.B., a 3260 g full-term male infant, presented to the Columbus Children's Hospital in 1976 with a typical gastroschisis. At exploration, the ascending and transverse colon were narrowed but appeared to be patent. The defect was enlarged, a gastrostomy inserted and a silastic silo constructed. His postoperative course was complicated only by inability to completely reduce his bowel. Large volumes of gastric drainage suggested an intestinal obstruction and on the fifth postoperative day, he was returned to the operating room. The narrow portion of colon was now even more stenotic and small bowel fluid could not be milked through this segment. The involved colon was resected, a colostomy performed and fascial closure accomplished. His postoperative course was uneventful. The lumen of the resected colon was patent by markedly stenotic. Microscopically, diffuse fibrosis was present.

Case 3. M.V., a 2200 g 36 week male presented to the West Virginia University Hospital in 1978 with gastroschisis. The bowel was encased in a thick pseudomembrane suggesting long-term antenatal exposure. Dissection of this membrane to inspect the bowel resulted in excessive bleeding and this effort was abandoned. The defect was enlarged, a gastrostomy tube inserted and a silo constructed. Peripheral intravenous nutrition was instituted postoperatively. Attempts to reduce the exteriorized bowel were unsuccessful and on the fifth postoperative day re-exploration was performed. The pseudomembrane was dissected from the matted loops of bowel disclosing a small bowel atresia and no identifiable ileocecal valve. A cutaneous enterostomy was performed and fascial closure accomplished. Since only 50 cm of proximal small bowel was present, closure of the enterostomy and restoration of the gastrointestinal continuity was required for adequate enteric nutrition. This was accomplished without difficulty and the patient was discharged home at two months of age.

Discussion

Gastroschisis can be managed in several ways. Primary closure is always preferred it if can be accomplished without causing a significant increase in intra-abdominal pressure. Despite improved ventilatory techniques, artificial ventilation is inferior to the baby's own respiratory mechanisms and should be avoided if possible. If the bowel is not particularly edematous and the peritoneal cavity relatively large (*i.e.*, perinatal evisceration) primary fascial closure may be performed. Most babies with gastroschisis, however, have a long course of antenatal bowel exposure. As a result, the peritoneal cavity is small, and the bowel edematous. Primary closure of these infants causes significant respiratory and vascular compromise. An alternative method of closure, providing coverage for the exposed bowel without returning it entirely into the peritoneal cavity, is necessary.

Skin flap closure partially accomplishes this goal of decreasing intra-abdominal pressure without necessitating placement of a foreign body. This technique still results in increased intra-abdominal pressure and considerable tension on the wound itself. Skin flap closure is a staged approach requiring subsequent operative procedures for repair of the ventral hernia. Adhesions of the bowel to overlying skin often makes the secondary procedure quite difficult.

A third means of closure employs the creation of a silastic silo. The modifications of the silo technique described in this report have resulted in decreased morbidity and mortality. The silo provides coverage for the exposed bowel and allows adequate lymphatic and venous drainage with little risk to the baby. The rapid reduction of the bowel into the peritoneal cavity and early removal of the silo minimizes the risk of sepsis. Enlargement of the defect to at least double its original size is critical. This prevents compression of the vascular pedicle of the intestine against the edges of a small defect. If the usual 2–4 cm defect is not opened, the silo often resembles an inverted cone and the bowel reduces very slowly if at all. A review of the silo closures performed at the Columbus Children's Hospital between 1972 and 1974, during which time the fascial defect was not enlarged, showed that an average of 6.7 days was required for bowel reduction and 8.2 days for fascial closure and four deaths can be directly attributed to complications with the silo. In the present series, in which all but one of the defects were enlarged, earlier reduction (4.0 days) and fascial closure (5.3 days) were possible. Since enlargement of the defect has been employed routinely, septic complications due to the silo have been nearly eliminated, and there have been no deaths related to the silo since Case 1.

The use of the gastrostomy tube in conjunction with silo closure is controversial because of the possibility of wound infection. However, gastrostomy drainage provides excellent intra- and postoperative decompression of the upper gastrointestinal tract. More important are the long-term advantages of the gastrostomy tube. Many babies have a prolonged ileus and require several weeks of gastric decompression. Gastrostomy eliminates the need for a nasogastric tube in the nose-breathing baby. One infant in this series (Case 3) had severe malabsorption due to short bowel syndrome. Initially, enteric feeding of this baby could be accomplished only by constant drip infusion of an elemental formula. Hourly feedings with small volumes of formula were necessary for six weeks before he could tolerate large enough volumes to be fed orally. The use of the gastrostomy tube made feeding easier and safer than with a nasogastric tube. In this series, there have been no complications arising from the gastrostomy.

Strict aseptic technique must be followed to insure minimal infectious complications. Wet dressings encourage bacterial contamination and therefore only an iodofore ointment is used to coat the silo. Frequent dressing changes allow close inspection of the wound edges and the contents of the silo. With adequate enlargement of the defect, and optimal decompression of the bowel, the edema usually resolves within 72 hours. As a result the bowel can usually be reduced by the fourth postoperative day and fascial closure accomplished within the next 24 hours.

Another factor important in the improved management of gastroschisis is the use of intravenous nutrition. Since the silastic silo and a central venous catheter are both associated with an increased incidence of sepsis, adequate nutrition is often delayed until the silo is removed. However, the availability of intravenous fat allows nutrition by peripheral vein, thereby eliminating both the septic risk of a central venous line and early malnutrition. Using peripheral venous nutrition, 70–90 calories/kg/day can be infused. After the silo is removed and the fascia is closed, a central venous line may be inserted if necessary to provide increased caloric intake.

Twenty-five per cent of the patients in this series (7/28) had intestinal atresia or stenosis. This high incidence of associated intestinal lesions makes careful inspection of the bowel mandatory. Primary anastomosis of the edematous, dilated bowel is hazardous. The only patient in this series who underwent enteroenterostomy at the initial operative procedure developed a stricture which was later revised. Resection of the abdominal segment and cutaneous enterostomy is preferred. Stomal closure to restore intestinal continuity may be performed as soon as the edema resolves to

provide adequate enteric nutrition. In many cases, stomal closure can be delayed until the baby is in optimum condition for a second operative procedure. There were no complications in this series due to this staged approach to intestinal lesions.

The operative mortality for babies with gastroschisis should be negligible. These infants are usually full-term or small for gestational age and, except for the gastrointestinal tract, have no other major anomalies. Intestinal atresia and stenosis are common but easily managed if recognized and treated appropriately. Careful preoperative preparation and management of the patient with gastroschisis including wide extension of the defect, meticulous dressing care, and aggressive attempts at bowel reduction will minimize morbidity and mortality. If the bowel fails to reduce in five to six days, prolonged observation encourages infection and death, and re-exploration should be performed.

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