GASTROSTOMY FOR THE NEWBORN SURGICAL PATIENT*

A REPORT OF 140 CASES

BY

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It is the purpose of this paper to relate our experiences employing prophylactic gastrostomy in 140 consecutive newborn surgical patients born with a variety of life-endangering anomalies amenable to surgical correction, and admitted to the Children's Hospital, Los Angeles, California, 1957 to 1961.

The newborn surgical patient begins life exposed to many complications not confronting a normal healthy infant. Frequently, those congenital anomalies in the neonatal period, which require emergency surgery, affect either the abdominal viscera, the contents of the thorax, or both, with the result that, regardless of the success of the surgical procedure performed, these infants experience temporary periods of gastro-intestinal obstruction which in turn produce frequent vomiting of gastric contents. A delicate and meticulous primary anastomosis of segments of the gastro-intestinal tract—with great disparity in calibre—may be necessary to salvage an infant born with high intestinal obstruction. Leaks may develop at the site of these anastomoses and lead to a surgical catastrophe. All such newborn infants, regardless of their surgical pathology, may manifest particularly precarious respiratory function in the first few days of life and this may be further jeopardized by a prolonged or difficult anaesthesia. A distended abdomen due to intestinal obstruction or the reduction of viscera from the thoracic cavity into the abdomen, as in diaphragmatic herniae or the closure of an omphalocele, causes increased intra-abdominal pressure and splinting of the diaphragms, thus interfering with respiratory exchange. Indeed, if this intra-abdominal pressure is sufficiently great, impairment of venous return to the right heart occurs, resulting in circulatory collapse. Such hazards may occur separately or in combination during the postoperative course in the newborn

infant surgical patient. Together these complications account for a significant percentage of the mortality encountered in infants who today may be afforded life-saving surgical correction of formerly fatal congenital anomalies.

Originally, gastrostomy was used for purposes of feeding patients with obstruction of the gastro-intestinal tract above the level of the stomach. Subsequently, such tubes were employed in adults for decompression of a denervated stomach following vagotomy and pyloroplasty for duodenal ulcer (C. B. McVay, personal communication; Farris and Smith, 1956). Gastrostomy has been employed commonly in newborn surgical patients born with tracheo-oesophageal fistula and oesophageal atresia. The intention in these cases was to provide nourishment and at the same time to protect the oesophageal anastomosis from rupture, allowing adequate time for healing before attempting oral feedings. It soon became apparent to those caring for these babies that a very significant advantage was afforded by leaving the gastrostomy tube open in the early postoperative period so that retained gastric content would drain through the tube and not be retained and occasionally regurgitated across the fresh oesophageal suture line, thus resulting in pulmonary aspiration of vomitus. Further, it was an incidental finding that a gastrostomy tube left open vented swallowed air and decompressed the gastro-intestinal tract in these babies as shown in Fig. 1. With this experience gained in the management of gastrostomy tubes, we began employing them more frequently in place of nasogastric tubes in newborn infant surgical patients having a congenital anomaly capable of correction, either in the chest or the abdomen. It was apparent that they were far more effective than a long, slender-calibre Levine tube on continuous suction which might easily become plugged or adhere to the lining of the stomach when not irrigated frequently, thus

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FIG. 1a.—A 4 lb. 1 oz. (1.84 kg.) newborn infant after duodeno-jejunostomy and gastrostomy for duodenal obstruction.

FIG. 1b.—A 6 lb. (2.72 kg.) infant following division of H-type tracheo-oesophageal fistula with gastrostomy and attached plastic bag containing 1,000 ml. of air swallowed in the preceding six hours.

FIG. 1c.—A 3 lb. 7 oz. (1.5 kg.) infant with meconium peritonitis and atresia of the ileum following restoration of gastro-intestinal continuity and gastrostomy.

FIG. 1d.—A 7 lb. 1 oz. (3.2 kg.) infant after correction of a right diaphragmatic defect, gastrostomy, and creation of an intentional ventral hernia for decompression.

FIG. 1e.—A 5 lb. (2.3 kg.) infant after skin closure of an omphalocele which ruptured *in utero* with gastrostomy tube in place.

FIG. 1f.—A 4 lb. 4 oz. (1.9 kg.) infant after approximation of the skin around an omphalocele to the mucous membrane of an exstrophy of the bladder, with gastrostomy.

failing to decompress the stomach satisfactorily. In addition, damage to the naso-pharyngeal structures from naso-gastric suction, particularly in premature infants, was prevented by a gastrostomy tube (no. 14 or no. 16 French) left open and draining.

The indications for gastrostomy, the simple technique for performing gastrostomy, the post-operative management of such tubes, and results obtained in a wide range of surgical conditions in the newborn infant form the basis of this report.

Indications for Gastrostomy

Aspiration of Gastric Content. Infants born with various types of intestinal obstruction vomit copious amounts of retained gastro-intestinal secretions. It is apparent that when such infants, with a poor cough reflex, weak cry, and frequently immature respiratory function, aspirate gastric content, there may be immediate obstruction of the extremely narrow trachea and bronchi. Suctioning the oropharynx and induction of vigorous coughing may be done too late to be helpful in clearing the airway adequately before anoxia has taken its toll. Simple gastrostomy done at the time of surgery in a premature infant with duodenal atresia (Fig. 1a) will most effectively protect the child from possible aspiration of vomitus and maintain an empty stomach and upper gastro-intestinal tract.

Reduction of Gastro-intestinal Distension. Newborn infants, particularly those on 'nothing by mouth', cry vigorously, suck their fists, and swallow large quantities of air. A simple flat film of the abdomen of any newborn infant will normally demonstrate many air-filled loops of bowel only a few hours after birth. This finding has been corroborated in infant surgical patients on 'nothing by mouth' with gastrostomy tubes in place in whom more than 1,000 ml. of swallowed air has been collected in six hours (Fig. 1b). Without an adequate 'gastro-intestinal tract vent' in such infants, air rapidly fills and dilates loops of intestines proximal to any obstruction present and this is a major factor accounting for abdominal distension. When these loops remain distended, they become atonic, fill the abdomen completely and are unable to move about; dense adhesions may form fixing the bowel loops to themselves and to the parietal peritoneum potentiating intestinal obstruction already present. A gastrostomy tube will vent swallowed air and secretions and prevent their passage into the lower intestinal tract. The air remaining in the distended loops of bowel immediately following gastrostomy and definitive surgery (on occasion we also resort to decompression of the small

intestine by appendicostomy) is rapidly absorbed, the bowel becomes smaller and regains its tone. Free movement of the loops of bowel throughout the abdomen is possible, since no large dilated redundant loops of intestine remain to 'kink on themselves' producing further obstruction.

It can be anticipated that an infant with a massively distended abdomen following appropriate surgical intervention and gastrostomy will be relieved of gaseous distension in the first 12 to 24 hours, and the contour of the abdomen may even become relatively scaphoid, as shown in Fig. 1c, in a premature infant with meconium peritonitis. Frequent turning of the baby will constantly change the position of the collapsed loops of intestine and will help to minimize permanent adhesions, and reduce the incidence of subsequent obstruction.

Improvement of Respiratory Exchange. When massive abdominal distension is present with increased intra-abdominal pressure, as may occur in a diaphragmatic hernia after reduction of the abdominal viscera from the chest back into the abdomen (Fig. 1d) or on closure of a massive omphalocele (Fig. 1e), there may be splinting and significant immobilization of the diaphragms which reduce respiratory exchange (Fig. 2) and compression of the inferior vena cava which reduces venous return to the heart. If this situation is sufficiently severe and persists for many hours, it results in significant degree of tissue anoxia from pulmonary insufficiency and peripheral circulatory stasis. In certain instances, a respiratory acidosis may be encountered with the arterial blood pH as low as 7.1. By venting swallowed air and gastro-intestinal secretions in the immediate postoperative period, gastrostomy reduces the likelihood of these complications and assures the most ideal conditions for adequate respiratory exchange in a newborn infant recovering from anaesthesia following a major surgical procedure, often affecting both the abdominal and thoracic viscera.

Protection from Evisceration. In certain newborn infants with anomalies of development of the abdominal wall, such as omphalocele with exstrophy of the bladder (Fig. 1f), there may be little or no muscle or fascia for use in a surgical repair. In an omphalocele with exstrophy of the bladder, only skin and thinned-out mucous membrane of the everted bladder remain for closure of the abdominal wall. A gastrostomy tube will prevent abdominal distension from swallowed air, relieve intra-abdominal pressure and tension on the epithelial suture line, and permit wound healing of the pre-

FIG. 2.—Radiographs of a newborn baby with a tracheo-oesophageal fistula and oesophageal atresia, Type III, showing (*left*) elevation of the diaphragms and interference with respiratory exchange, and (*right*) the same patient 24 hours later after 'open tube' gastrostomy. Note on the right, the diaphragms are lower, there is better expansion of the lungs, and vastly improved air exchange.

carious abdominal wall closure. In other conditions where wound closure is precarious or evisceration is feared, gastrostomy will be similarly effective.

Facilitation of Oral Feeding. In the majority of infant surgical patients who have had operations affecting their gastro-intestinal tract, there is always a temporary period of uncertainty as to how well and when a baby will tolerate the oral feedings that are offered. With a gastrostomy tube in place, it is a simple matter to detect gastric retention and to drain the tube before each feeding, measure any retained formula and be guided accordingly in initiating oral feedings.

Technique of Gastrostomy

Simple gastrostomy when performed as an isolated intra-abdominal surgical procedure may be most easily and satisfactorily accomplished by the technique described by Gross (1953). When gastrostomy is performed in conjunction with correction of a primary underlying surgical condition, it is performed through the laparotomy incision and the tube is brought out through a separate stab wound. The approximate relationships of the gastrostomy tube, stomach and anterior abdominal wall stab wound may be planned carefully to avoid 'kinking'; curved clamps placed on the peritoneum, anterior rectus sheath and subcutaneous tissue will maintain these layers in normal anatomical relation. A finger is inserted beneath the abdominal wall in the appropriate position and a 4-5 mm. stab wound is made (Fig. 3a). As shown in Fig. 3b, two purse-string sutures of 4-0 black silk are placed in the anterior wall of the stomach and a small incision made only large enough to permit the insertion of a no. 14 or no. 16 mushroom rubber catheter (Fig. 3b), with the

tip or face cut off to prevent plugging by milk curds and mucus in the stomach. The catheter is clamped and stretched over a small curved snap introduced into the stomach, and the purse-string sutures tied exactly as shown in Fig. 3c and 3d, so as to invert the edges of the stomach around the tube and prevent slippage of the tube into the stomach. In tying these sutures, the 'bell' or tip of the catheter should not be passed further into the stomach and downward into a position where it might conceivably block the opening of the pylorus. To prevent this, the innermost purse string is tied a second time directly around the rubber catheter as shown in Fig. 3d. A curved clamp is passed bluntly through the stab wound in the abdominal wall musculature so as to impale the peritoneum on its tip (Fig. 3e). The outermost purse-string suture is passed through the peritoneum impaled on the tip of the curved forceps, and thereafter a knife is used to incise the peritoneum and permit the forceps to be passed through into the abdomen to grasp the end of the gastrostomy tube and draw it out (Fig. 3f). The anterior surface of the stomach is pulled up firmly against the under-surface of the abdominal wall. Once this is achieved, the purse-string suture is tied approximating the seromuscular coat of the stomach to the peritoneum immediately adjacent to the stab wound.

Management of Gastrostomy Tubes

Gastric Decompression and Reduction of Abdominal Distension. In the immediate postoperative period before oral feedings are started, it is important to decompress the stomach to prevent abdominal distension. This can be done best by irrigating the

FIG. 3.—Illustrations of the operative technique employed in establishing a gastrostomy during exploratory laparotomy for correction of the primary surgical lesion are shown opposite.

FIG. 3a.—An outline of the body of a small infant showing approximate position of the gastrostomy in relation to the underlying stomach and the anatomy of the anterior abdominal wall. Three large curved clamps are applied to the peritoneum, anterior rectus sheath, and subcutaneous tissue to maintain their normal anatomical relations, and these are held in the left hand while the index finger is introduced through the small laparotomy wound and pushed anteriorly establishing a stab wound through which the gastrostomy tube may be drawn.

FIG. 3b.—Two concentric 4-0 arterial black silk purse-string sutures have been placed in the anterior aspect of the stomach wall proximal to the pylorus. Note the insert drawing showing a no. 14 or no. 16 mushroom catheter with the end cut off, clamped and stretched taut over a small forcep to facilitate introduction into a small opening in the stomach.

FIG. 3c.—The arrow on the gastrostomy tube indicates that the tube is being pulled upwards to ensure that the 'bell' has not descended into a position which will obstruct the pylorus. Once the 'bell' lies immediately beneath the innermost purse-string suture, it is tied.

FIG. 3d.—The innermost purse-string suture has been tied again; this time, directly around the gastrostomy tube, silk to rubber, to prevent the tube (note the arrow) from sliding inward into the stomach and to ensure that the stomach wall will be invaginated, thus enhancing the leak-proof effectiveness of the second purse-string suture being tied.

FIG. 3e.—A curved clamp passed through the stab wound previously established in the abdominal wall. The layers of the abdominal wall are held in normal anatomical relation to each other by the curved clamps, while the outermost purse-string suture is passed through the peritoneum just above the point at which the abdominal wall is impaled on the forceps. Note these structures have not been incised nor the clamp forced through the layers into the abdominal cavity.

gastrostomy tube at least every three hours with 7 ml. of normal saline, aspirating it, noting the colour, and measuring the amount returned on each occasion. Between irrigations and aspirations, the tube should be left open in an inclined test-tube and allowed to drain freely with the volume and colour of the drainage fluid being recorded on the chart. Swallowed air will be seen to bubble out or 'vent' through the gastrostomy tube during episodes of vigorous crying. The volume of gastrostomy drainage should be replaced with its approximate equivalent volume of appropriate fluid and electrolyte.

Initiation of Feedings. Before administering the feed, an empty asepto-syringe is inserted into the tip of the gastrostomy tube and suspended in an elevated position over the baby. This permits overflow of any retained gastric content into the asepto-syringe (a 'second stomach') so that the content will not be lost and ultimately can be measured. At the same time, it permits swallowed air to bubble out through the tube, thus preventing

FIG. 3f.—The peritoneum and abdominal wall structures have been incised to permit the curved clamp to be pushed through the stab wound to grasp the gastrostomy tube and draw it outside the abdomen. The outermost purse-string suture is tied after the gastrostomy tube has been pulled upward to ensure accurate apposition of the gastric wall to the under-surface of the peritoneum in the region of the stab wound.

distension of intestinal loops beyond. Every three to four hours the gastrostomy tube should be drained and the amount of fluid obtained measured. When this becomes negligible (5 to 10 ml. every three to six hours) and not significantly more than the volume of irrigations being given, it can be assumed that intestinal secretions are passing through the gastro-intestinal tract and that it is safe to proceed with feeding small amounts, 5 to 10 ml., of clear fluid every two to three hours. The majority of infants are fed by mouth whenever possible, since it is believed this may exert a favourable effect on peristalsis. No formula or fluid is lost as long as the gastrostomy tube remains elevated. During the early phases of restoring alimentation, the tube is drained before each feed to note any residual formula or fluid that may have been retained in the stomach. Thus, immediate detection of any temporary failure to pass food from the stomach into the gastro-intestinal tract is possible and overfilling of the stomach is avoided. As a result, babies are neither fed too early in too large amounts nor is intake withheld unnecessarily long once their intestinal tract has demonstrated its capacity to function.

Removal of Gastrostomy Tube. Although gastrostomy tubes in adults are usually removed several days after insertion, we have adopted a rule of waiting 12 to 14 days before removing them from infants. This does not lengthen the period of hospital stay because the tube can be removed very simply by pulling it out two weeks after operation. When this is done, the small opening in the abdominal wall closes spontaneously. It is extremely rare for a fistula to develop at the site of gastrostomy.

Suction on Gastrostomy Tube Contraindicated. Intermittent low suction has been applied to these gastrostomy tubes on occasion much as one would do with a Levine tube. However, this has resulted in intermittent obstruction of the tube, failure to drain the stomach adequately, and a marked reduction in general effectiveness. From these observations, it is apparent that the best results are achieved by leaving a gastrostomy tube open at all times and not resorting to suction of any type. However, in certain cases, i.e. premature infants with tracheo-oesophageal fistula and oesophageal atresia, we have placed the gastrostomy tube on water-seal drainage initially (E. B. Scott, personal communication), never on suction, before the tracheo-oesophageal fistula was closed.

Results

A statistical analysis of the survival rates obtained in these 140 infant surgical patients (Table 1) in

TABLE 1
GASTROSTOMY IN 140 NEWBORN INFANT SURGICAL PATIENTS

Site	Pre-mature	Survived	Full-term	Survived
Diaphragmatic defects ..	1	0	16	14
Tracheo-oesophageal fistula ..	25	2	41	31
and oesophageal atresia ..	5	5	14	14
Duodenal obstruction ..	5	4	14	10
Jejunum-ileal obstruction ..	1	1	7	7
Colon obstruction ..	2	2	7	3
Omphalocele ..	0	0	2	2
Biliary atresia ..				
Total ..	39	14	101	81

whom prophylactic gastrostomy was employed, revealed that, if the 25 premature infants with tracheo-oesophageal fistula and oesophageal atresia are excluded, a long-term survival rate of 80% was achieved for all cases in this group treated with gastrostomy regardless of the nature of the surgical condition or the size of the patient or associated congenital anomalies. The survival rate of full-term babies in this group recorded in Table 1 slightly exceeded 80%. Finally, again excluding

the 25 premature infants with tracheo-oesophageal fistula and oesophageal atresia, the survival rate of premature infant surgical patients in whom gastrostomy was employed was 86%.

A somewhat similar analysis was made by Forshall and Rickham (1960) in Liverpool after they had established a Neonatal Surgical Unit specializing in the management and treatment of infant surgical patients. Their findings in comparable surgical conditions revealed a survival rate of 67% for comparable cases, excluding premature infants with tracheo-oesophageal fistula and oesophageal atresia. Their survival rate for comparable full-term infants was 79%, and finally their survival rate for premature infants excluding those with tracheo-oesophageal fistula and oesophageal atresia was 58%.

Interpretation of these two contemporary series seems to suggest the following conclusions: the survival rate of full-term infant surgical patients is greatly increased by consistently utilizing prophylactic gastrostomy in a hospital without a Neonatal Surgical Unit and offsets the great advantages afforded by a Neonatal Surgical Unit specializing in the total care of such infants. In view of Forshall and Rickham's survival rate of 58% of premature infants, excluding those with tracheo-oesophageal fistula and oesophageal atresia compared with our rate of 86%, it appears reasonable to presume that routine prophylactic gastrostomy offers particular advantages to these diminutive infants not afforded by a Neonatal Surgical Unit.

In conclusion, it is apparent that gastrostomy in no way reduces mortality in premature infants with tracheo-oesophageal fistula and oesophageal atresia and that another approach to the management of this anomaly in the premature infant must be considered if survival rates are to be improved. In contrast, survival of premature infants with surgical conditions other than tracheo-oesophageal fistula and oesophageal atresia is significantly higher when gastrostomy is performed in conjunction with the primary corrective surgical procedure. Finally, the statistics suggest that gastrostomy employed in full-term infant surgical patients compensates in part for the advantages afforded by a Neonatal Surgical Unit.

Complications have been negligible with no bleeding from gastric mucosa, perforation of the stomach, or stoma leakage. On rare occasions, in extremely debilitated babies in negative nitrogen balance, soft tissue erosion around the tube has been encountered, but in each instance has healed after tube removal or improvement of the infant's general condition.

Summary

Elective gastrostomy is recommended as an adjunct to major abdominal and thoracic surgical procedures required in certain newborn surgical patients. The indications, technique of performing gastrostomy, and the postoperative management of such tubes are described in detail. One hundred and forty consecutive cases of prophylactic gastros-

tomy in newborn surgical patients are presented without complications incident to gastrostomy.

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