Use of Low Osmolar Contrast for Gastrointestinal Studies in Low-Birth-Weight Infants

Robert V. Dutton, MD, Edward B. Singleton, MD

Metrizamide is a safe, water-soluble contrast medium suitable for bedside gastrointestinal studies in low-birth-weight infants. We describe our experience with 26 patients and 34 examinations. We present illustrative cases and indicate the clinical applications. Similar results are anticipated when less expensive nonionic contrast agents are approved by the Food and Drug Administration for pediatric use.

In 1978, Berner and Johansen and Johansen and Kolmannskog published their results on the physiologic and histologic effects of metrizamide on the small intestine and peritoneum in laboratory animals. They showed that it compared favorably with other water-soluble contrast agents as well as with barium sulfate suspensions. They concluded that metrizamide should be a suitable contrast medium for gastrointestinal studies because of its low osmolarity, solubility in gastric juices, and low toxicity. From 1980 to 1984, Cohen et al. have had extensive experience utilizing this material for gastrointestinal studies in neonates and infants. We present our experience with this contrast medium.

PATIENTS, MATERIALS, AND METHODS

With informed consent and approval by the Committee for Clinical Research, Texas Children's Hospital, Houston, 26 patients were studied during an eight-month period from January to October 1984. There were 14 males and 12 females with an average weight of 1600 g.

Accepted for publication Nov 18, 1986.
From the Department of Radiology, Texas Children's Hospital, Houston.
Reprint requests to Department of Radiology, Texas Children's Hospital, 6621 Fannin, Houston, TX 77030 (Dr Dutton).

Thirty-four contrast studies were performed: 27 gastrointestinal (upper gastrointestinal tract and small bowel [UGI-SMB]), four esophagus, and three rectumograms. Sixteen of the 27 UGI-SMB studies were done to follow up previous episodes of necrotizing enterocolitis (NEC), and results of three of these studies were abnormal. Eleven of the UGI-SMB studies were done for a variety of reasons (abdominal distension, vomiting, and inability to feed). Results of six of these studies were abnormal. Four enemas were done, two of which were to follow up NEC. Three esophagograms were done, two after repair of tracheoesophageal fistula and one for study of a pharyngeal cleft, esophageal atresia, and tracheoesophageal fistula variant. All UGI-SMB roentgenograms were performed in the neonatal intensive care unit with a capacitor-discharge x-ray unit, mobile type (model KCB-10M-6CB, Toshiba). Metrizamide (Amipaque, Winthrop-Breon Laboratories, New York) diluted to a concentration of 170 milligrams of iodine per milliliter (170 grams of iodine per liter) was instilled into the stomach by nasogastric tube in a dosage of 4 to 5 mL/kg. Portable roentgenograms were obtained at five, ten, and 15 minutes, and subsequent timing was individually monitored until the colon was opacified or a specific diagnosis became evident. Most of the studies were completed in four to five hours, but some extended for several days. Although intubated and on respirators, the patients were kept on their right side with their heads elevated between roentgenograms to facilitate the passage of contrast medium.

Gastric emptying time varied widely from 40 minutes to nine hours with an average of three to four hours. Small-bowel transit time varied from two to eight hours but in several instances was prolonged for two to three days. There were no observable adverse effects. Often, small intraluminal bubbles of gas were noted in proximal segments of small bowel. These bubbles degraded the images (Fig 1, left) but otherwise were of no consequence. The quality of contrast was judged to be good to excellent, without dilution or flocculation.

The density of the contrast appeared to improve as it progressed distally into the colon. The esophageal and colonic studies were done in the radiology department with fluoroscopy in a conventional manner using the same contrast.

PATIENT REPORTS

PATIENT 1.—Patient 1 was the secondborn twin of a 34-week gestation and weighed 1.43 kg. A small calcification in the right upper quadrant suggested meconium peritonitis. The metrizamide UGI-SMB study showed a normal stomach, small bowel, and colon (Fig 1).

PATIENT 2.—A 3.2-kg product of a 36week gestation had small-bowel obstruction due to multiple atresias (Fig 2, left), which were resected with end-to-end anastomosis. Three weeks after surgery the abdomen remained distended, and oral feedings were not successful. Metrizamide study showed a dilated proximal small bowel, but continuity to the distal undistended small bowel and colon was demonstrated (Fig 2, center). The patient was maintained by parenteral alimentation, and at 7 months of age, results of a barium UGI-SMB study (Fig 2, right) were normal. The patient is growing normally and is receiving oral feedings.

PATIENT 3.—A 0.77-kg product of a 28week gestation had abdominal distension at 8 days of age. The stomach and duodenum were normal. At 24 and 48 hours, contrast medium filled dilated loops of small bowel in which retained meconium could be seen (Fig 3, left). At surgery, meconium ileus was reduced. A follow-up study showed successful decompression of the small bowel and opacification of the colon (Fig 3, right).

PATIENT 4.—Patient 4 was the 1.56-kg product of a 34-week gestation. There was immediate respiratory distress at birth, requiring intubation. At this time a pharyngeal cleft and esophageal atresia were demonstrated. The right upper lobe of the lungs remained nonaerated. Clinical management was very difficult. A metrizamide study was performed during bronchoscopy (Fig 4).
Fig 1.—Patient 1 had normal study results. Left, 30-Minute roentgenogram shows normal stomach, duodenal bulb, and small bowel. Intraluminal bubbles (arrow) are frequently seen. Right, Five-hour study shows small amount of residual contrast in distal ileum and excellent opacification of colon.

Fig 2.—Patient 2 had multiple small-bowel atresias that were resected. Bowel continuity was established by end-to-end anastomosis. Postoperative stenosis developed. Left, Newborn with small-bowel obstruction and microcolon. Center, At 5½ hours there is opacification of undilated distal small bowel (arrow at bottom). Water-soluble contrast allows one to see through dilated proximal bowel and identify contrast in descending colon (small curved arrow at right). Right, Barium study at 7 months of age shows normal small bowel and colon.
Fig 3.—Patient 3 had meconium ileus. Left, Delayed study at 24 hours shows distal small-bowel obstruction with large intraluminal filling defects due to inspissated meconium. Right, Postoperative roentgenogram shows passage of residual contrast into normal colon.

Fig 4.—Patient 4 had pharyngeal cleft and esophageal atresia in addition to broncho-esophageal fistula and atelectasis in right upper lobe of lungs. Bronchoscope is positioned in lower trachea. Tracheobronchogram of major bronchi and subsegments shows metrizamide opacification of proximal atretic esophagus (arrow at top). Distal fistula is seen between right main bronchus and distal esophagus and stomach (arrow at center). Right upper bronchus did not fill, and right upper lobe remained atelectatic.

COMMENT

The first patient illustrated the normal appearance of stomach, small bowel, and colon. There was uniformly good quality of contrast throughout the intestinal tract notwithstanding the small bubbles noted. In the second patient, we were able to show a segment of distal small-bowel stenosis, but there was no obstruction, and further surgery was avoided. It was possible to see through overlapping loops of bowel and to distinguish distended from undistended bowel. It is doubtful that one could do this with barium. In patient 3 we diagnosed meconium ileus by upper gastrointestinal tract examination, a diagnosis that is usually determined by contrast study of the colon, requiring fluoroscopy. Patient 4 showed the versatility of metrizamide in the investigation of a complex anomaly. The infant was surprisingly tolerant to spillage into the tracheobronchial tree.

Most of the studies were performed in infants who had had a prior episode of NEC. With three exceptions (in which mild stenotic lesions were demonstrated), these infants were normal. Metrizamide studies were very helpful and reassuring in the clinical management of these infants, who had transient periods of difficult feeding and distension.

Although barium suspensions have stood the test of time for most gastrointestinal studies, complications can occasionally occur. Spillage into the peritoneal cavity may result in granulomas that never completely resolve. Small amounts of barium in the tracheobronchial tree are usually not harmful, but large amounts may be fatal. Flocculation of barium in the small bowel of infants is common, and it makes the interpretation of small bowel pathologic findings difficult. In addition, retained barium in the colon may become impacted.

Radiologists have long sought an ideal water-soluble contrast. Meglumine and sodium diatrizoate oral solution has been widely used but has disadvantages. As conventionally used, it is hyperosmolar, resulting in large shifts of fluid into the bowel lumen with resulting degradation of
contrast quality, bowel distension, and hypovolemia, to which the small infant is especially vulnerable. Extreme degrees of bowel distension can result in necrosis and perforation. It is potentially toxic to the bowel mucosa and peritoneum. Pulmonary edema may occur if meglumine and sodium diatrizoate oral solution is aspirated.11

Metrizamide is a nonionic watersoluble contrast medium that underwent extensive preclinical trials in the early 1970s in Scandinavia. An extensive experience in myelography has accumulated, and it has been successfully used in angiography, angiocardiography,12 and excretory urography.13-14 Its first reported use for gastrointestinal studies was in 1980 in small infants.6 It is isotonic with blood at concentrations of 170 milligrams of iodine per milliliter (170 grams of iodine per liter). It may be given intravenously, and it is subsequently excreted by the kidneys. Intraperitoneal spillage is harmless and is absorbed and excreted by the kidneys. No significant fluid shift or hypovolemia is associated with gastrointestinal administration. There is minimal gastrointestinal absorption, and metrizamide is not known to be toxic to the gastrointestinal mucosa or peritoneum. There is prolonged visualization of the intestinal tract, and good contrast is maintained. Small aspirations into the lungs do not appear to be harmful,13 and our one experience suggests that metrizamide could be used in a limited way for bronchography.

Our experience indicates that metrizamide is a very safe gastrointestinal contrast suitable for the low-birth-weight infant when conventional studies are not feasible or are contraindicated. Its prolonged visualization of the gastrointestinal tract is unique. Metrizamide permits study of the small and large bowel when it is administered orally without the disadvantages of barium or a hypertonic water-soluble contrast agent.

Perforations due to NEC have been demonstrated in previous studies.8 The diagnosis of small-bowel obstruction due to stenosis may be subtle, due to the low viscosity of metrizamide and its ability to penetrate very narrow pathways.

Our studies have often been of value in infants with obstructive symptoms, which in our experience were frequently due to ileus and not mechanical obstruction. In many instances, successful oral feeding was possible after normal findings of small-bowel studies.

The cost of metrizamide is significant. A 3.75-g vial costs $151. A diluent of 8.9 mL is needed to provide a concentration of 170 mg/mL (170 g/L). However, the cost should not be the deciding factor in view of the low risk and valuable information that may be obtained. Also, small quantities of contrast medium are used, which minimizes the cost. When it is approved for pediatric application, a less expensive nonionic contrast material (iodhexol) will undoubtedly replace metrizamide.

This study was supported by a grant from Winthrop-Breon Laboratories, New York.

References


CORRECTION

Incorrect Phrasing.—In the Ambulatory Pediatric Association abstract entitled “Hepatitis B Virus Markers and Antigenemia in Adolescents,” published in the April 1987 AJDC (1987;141:368-369), an error in phrasing appeared in the second sentence in the third paragraph. That sentence should have read as follows: "The difference in the HBV marker rate for Puerto Ricans, five (3.7%) of 136, vs Dominican Republicans, six (12.8%) of 47, was significant (P<.05)." We regret this error.