Prenatal Diagnosis of Gastroschisis: Development of Objective Sonographic Criteria for Predicting Outcome

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Objective: To determine which sonographic findings predict intestinal damage in fetuses with gastroschisis, and to develop objective criteria that may be useful in selecting candidates for preterm delivery.

Methods: Twenty-four consecutive fetuses at two perinatal centers were assessed retrospectively or prospectively. Maternal, perinatal, and sonographic data were recorded and correlated with postnatal outcome.

Results: Bowel diameter of at least 18 mm was associated with a significantly longer time to oral feeding and with significantly greater need for bowel resection. When gestational age was plotted against bowel diameter, a threshold curve was generated, above which all patients had prolonged hypoperistalsis and below which only 30% had prolonged hypoperistalsis. Two infants were delivered at 33 weeks' gestation, both of whom had complications potentially related to prematurity. Only one of 22 patients who delivered later than 33 weeks had similar complications.

Conclusions: Bowel dilatation may be a marker of prenatal bowel damage in fetuses with gastroschisis, especially when it presents late in gestation. Prenatal sonography may be useful in selecting appropriate fetuses for preterm delivery. (*Obstet Gynecol 1993;81:53–6*)

Prognosis for the infant born with gastroschisis depends mainly on the condition of the bowel at birth.[1,2] Many infants have only a mild degree of bowel damage and do well after primary surgical repair. However, a substantial proportion with gastroschisis have more severe intestinal damage, requiring staged repair or resection of necrotic or atretic segments. These infants often have severe intestinal hypoperistalsis and poor absorptive capacity[3,4] and may require prolonged or permanent parenteral nutrition, with its attendant

risks of infection, growth retardation, metabolic disturbances, and severe liver disease.

The recent popularity of routine prenatal screening, using maternal serum alpha-fetoprotein and obstetric sonography, has led to the detection of gastroschisis before birth in many cases.[5] Gastroschisis has been identified as early as 12 weeks' gestation[6] and can be readily differentiated from omphalocele.[7] Accurate prenatal diagnosis provides an opportunity to alter the mode and timing of delivery to prevent intestinal damage. Thus far, no studies have clearly demonstrated an advantage to routine cesarean delivery for gastroschisis.[8–10] Three groups have suggested that preterm delivery may prevent ongoing damage and improve outcome, although the data have not been convincing.[11–13]

The etiology of intestinal damage in gastroschisis is unclear. Recent experimental studies[14,15] in the fetal lamb have suggested the following: 1) Most of the damage is caused by constriction of the bowel at the abdominal wall defect; 2) maximal damage occurs late in gestation; and 3) preterm repair partially reverses the damage. The mechanism of constriction-induced damage appears to be mechanical obstruction rather than ischemia (Langer, unpublished data).

Mechanical obstruction can be identified prenatally by sonographic evidence of bowel dilatation and bowel wall thickening. Bond et al[16] found an increased incidence of intestinal necrosis and atresia and a longer period of hypoperistalsis in fetuses who subjectively had dilatation and thickening of the bowel wall. Other authors[17,18] have found these characteristics to be unreliable in small preliminary studies. We conducted the present study to assess the accuracy of objective sonographic features in predicting outcome for the fetus with gastroschisis.
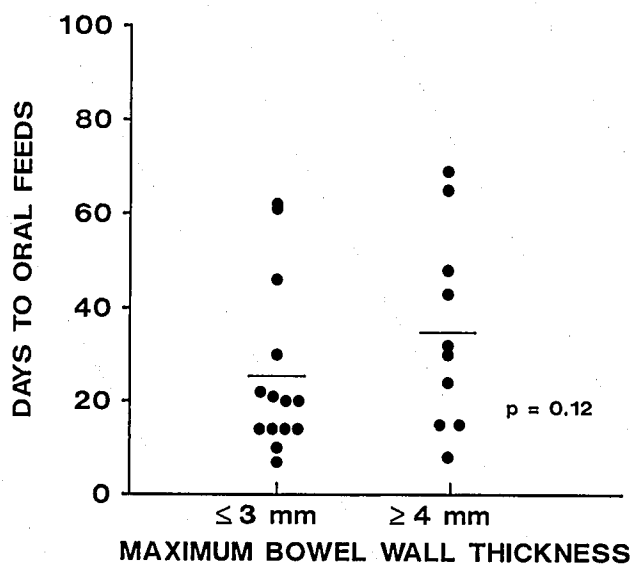
Figure 1. Effect of maximal bowel wall thickness on intestinal motility, as measured by time to full oral feeding. Although there was a trend toward shorter time to feeding with thickness of 3 mm or less, this was not statistically significant (mean time to oral feeding 25.4 ± 5 versus 34.9 ± 7 days).

Materials and Methods

A combined retrospective and prospective study was done at two perinatal centers, McMaster University Medical Centre in Hamilton, Ontario, Canada, and Harris Birthright Research Centre in London, England. We studied all consecutive cases with a prenatal diagnosis of gastroschisis (in Hamilton, 14 cases in 1986–1991 inclusive; in London, 16 cases in 1990 and 1991). Six cases were excluded (one therapeutic abortion, five with insufficient data), leaving 24 cases for analysis.

Maternal factors recorded included age, mode of delivery, length of labor, and complications during pregnancy and delivery. In retrospective cases, we carefully studied the sonograms before reviewing the infant's chart for outcome. In all others, information was accumulated prospectively. For each examination, we noted gestational age (calculated and estimated by ultrasound), estimated weight, maximum bowel wall thickness, maximum bowel diameter, stomach diameter, presence of debris in the lumen and amniotic fluid, bowel wall brightness (present or absent), abdominal circumference, head circumference, biparietal diameter, femur length, heart rate, movement, and respirations. In particular, maximum bowel wall thickness and diameter were measured from multiple scans, using calipers in retrospective cases and internal measuring devices in prospective cases.

Outcome was assessed by reviewing the infant's chart. Details of the initial resuscitation, method of

abdominal wall closure (primary or staged), length of time intubated, and the length of time to full oral feeding and discharge were recorded.

Statistical comparison of means used the Student t test, and comparison of population proportions used the z test.[19] $P < .05$ was considered significant.

Results

Because the most devastating result of bowel damage is intestinal hypoperistalsis, we used number of days to full oral feeding as our primary outcome measure. We divided the infants into groups based on feeding before or after 2 weeks from closure of the defect. The following factors were found not to correlate with outcome: maternal and perinatal factors, including mode or timing of delivery; nonintestinal sonographic findings; luminal and amniotic fluid debris; bowel wall brightness; and stomach diameter (data not shown). Therefore, we focused our analysis on bowel wall thickness and diameter.

Figures 1 and 2 show the effect of bowel wall thickness and dilatation on intestinal motility. Although maximal thickness greater than 3 mm was associated with an increase in time to oral feeding, the difference was not statistically significant. However, there was a significant effect of bowel diameter on motility using the limit of 17 mm suggested by Spear et al (paper presented at the 1990 meeting of the Radiology Society of North America).
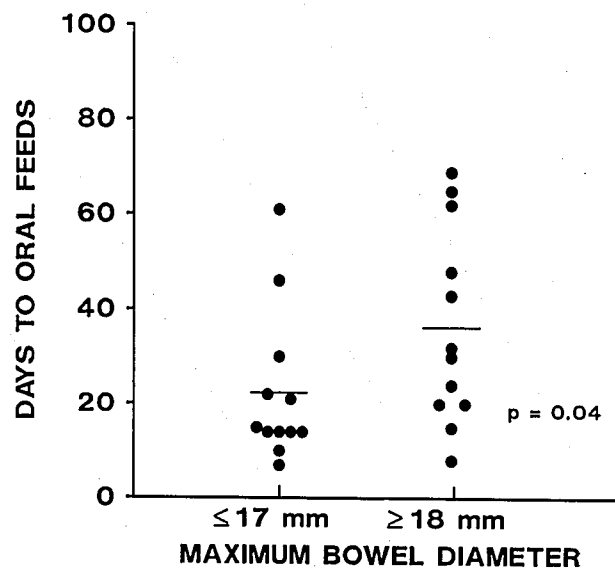

Figure 2. Effect of maximal bowel diameter on intestinal motility, as measured by time to full oral feeding. Infants with bowel diameter of 18 mm or greater had a significantly longer period of ileus than those without dilatation (mean time to oral feeding 36.3 ± 6 versus 22.3 ± 5 days).

Figure 3. Effect of gestational age and maximal bowel diameter on intestinal motility. A "threshold" line has been drawn, above which all infants had a prolonged period of hypoperistalsis and below which only 30% of infants had prolonged hypoperistalsis. The four infants with intestinal atresia are also shown. This graph could potentially be used as a guide in predicting outcome in a prospective fashion.
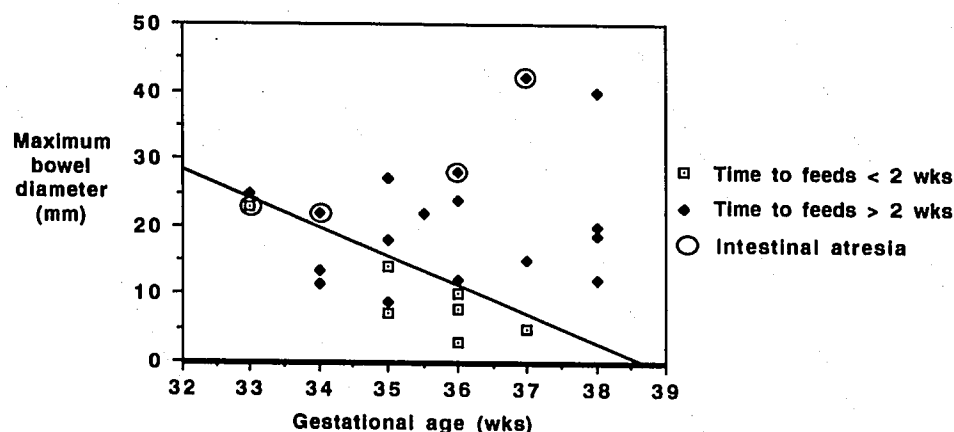
It has been postulated that gestational age may influence the degree of bowel dilatation,[18] and we and others[5,11,13,20] have suggested that gestational age at delivery may affect outcome. To assess this factor, we analyzed the combined effect of bowel diameter and gestational age on time to oral feeding (Figure 3). The graph generated by these data suggested a "threshold" line, above which all 14 infants had prolonged hypoperistalsis and below which only three of ten had hypoperistalsis ($P < .001$).

Other outcome measures that reflected intestinal damage were bowel resection and the need for a staged closure. Resection was required in four of ten infants (40%) with bowel wall thickness of 4 mm or more, compared with two of 14 (14%) with bowel wall thickness of 3 mm or less ($P = .07$). Resection was required in five of 12 patients (42%) with a maximal bowel diameter of at least 18 mm, compared with one of 12 (8%) in those with a diameter of at most 17 mm ($P = .03$). Four of the infants required resection because of intestinal atresia, one had volvulus, and one required resection at 6 weeks of age for chronic progressive ileal stenosis of uncertain etiology. Staged closure was required in two of ten infants (20%) with bowel wall thickness of at least 4 mm, compared with five of 14 (36%) with bowel wall thickness no greater than 3 mm (not significant). Staged closure was required in three of 12 patients (25%) with a maximal bowel diameter of 18 mm or greater, versus four of 12 (33%) with a diameter of 17 mm or less (not significant).

Two infants were born at 33 weeks' gestation. Both experienced problems that may have been related to prematurity: ependymal hemorrhage and developmental delay in one case and developmental delay in the other. Only one such complication was seen among the 22 infants born after 33 weeks (bilateral intraventricular hemorrhage in a 35-week infant).

Discussion

It is clear from both clinical and experimental data that intestinal damage in fetuses with gastroschisis occurs before delivery, most likely during the last few weeks of gestation.[14,15] Since Bond et al[16] first suggested that sonographic evidence of dilatation and thickening could predict outcome, other authors[17,18] have subjectively assessed these characteristics in small series of patients without success. None of these published series defined objective criteria that could be used prospectively in individual cases.

In our combined retrospective and prospective series of 24 cases, we attempted to define sonographic characteristics that might be used to identify ongoing bowel damage and to guide timing of delivery in individual pregnancies. Although there was a significant increase in time to oral feeding in infants who had a bowel diameter of more than 17 mm, the variability of this index made it difficult to use in individual cases. This variability also explains the disappointing results in previous small series.

The combined effect of gestational age and bowel diameter was interesting, generating a threshold line above which 100% of infants had prolonged hypoperistalsis. The graph produced by plotting gestational age against bowel diameter may be useful in individual cases, although definitive recommendations must await prospective evaluation in a large group.

The need for bowel resection in gastroschisis may result from intestinal atresia, necrosis, or both. Many cases with early dilatation result from atresia, a condition that is not necessarily associated with a poor outcome.[21] This may explain in part the direction of the threshold line, which permits a larger bowel diameter at early gestational ages and implies that late onset of dilatation may be more concerning than early onset.

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Preterm delivery may be advantageous for preventing ongoing bowel damage, but it does add the multiple risks of prematurity. In our series, the two infants born before 34 weeks both had complications that may have been related to premature delivery. Although these numbers are too small to draw firm conclusions, it is clear that the risks of prematurity must be weighed against the potential advantages of preterm delivery for infants with gastroschisis.

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