

Changes in Intestinal Waste Products during the Antenatal Management of Gastroschisis by Serial Amniotic Fluid Exchange and Infusion

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Key Words

Gastroschisis · Amniotic fluid exchange · Amniotic fluid infusion · Intestinal damage · Amniotic fluid inflammation

Abstract

Despite the good survival rate of fetuses with gastroschisis, the length and cost of hospitalization for surgically repaired gastroschisis are high. In gastroschisis, prolonged exposure of the intestine to amniotic fluid (AF) containing intestinal waste products results in intestinal damage, including intestinal wall thickening and fibrous peel formation. The deleterious effects of AF on gastroschisis can be prevented by lowering the concentration of intestinal waste products. We describe the treatment of a case of fetal gastroschisis by repeated AF exchange and infusion. Following repeated, successful transabdominal AF exchange and infusion, the concentrations of various intestinal waste products were decreased. AF exchange and infusion may prevent intestinal damage and improve postnatal outcome in gastroschisis by diluting the AF, probably by lowering the concentrations of intestinal waste products.

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Introduction

Gastroschisis is a birth defect in which the fetal intestine extrudes into the amniotic cavity through a para-umbilical abdominal wall defect, probably due to the early interruption of the fetal omphalomesenteric arterial blood supply. The fetal intestine is not covered by a membrane and is exposed to amniotic fluid (AF) during the entire fetal period. Gastroschisis requires immediate postnatal surgery. The survival rate is over 90%, and is mainly influenced by the degree of intestinal inflammation [1]. Although the mechanisms are not yet clearly understood, damage to the exposed intestine is characterized by intestinal wall thickening and covering with a fibrous peel. AF exchange in gastroschisis, however, has been shown to prevent further intestinal damage by enhancing the clearance of inflammatory products present in AF [2, 3].

The purpose of this report is to demonstrate the usefulness of repeated AF exchange and infusion in a case of gastroschisis.

Case Report

A 27-year-old primigravida was referred at 15 weeks' gestation due to a fetal abdominal wall defect. Initial ultrasonography demonstrated that the fetus had appropriate growth for its gestational age, but had gastroschisis with extruded small bowel contents.

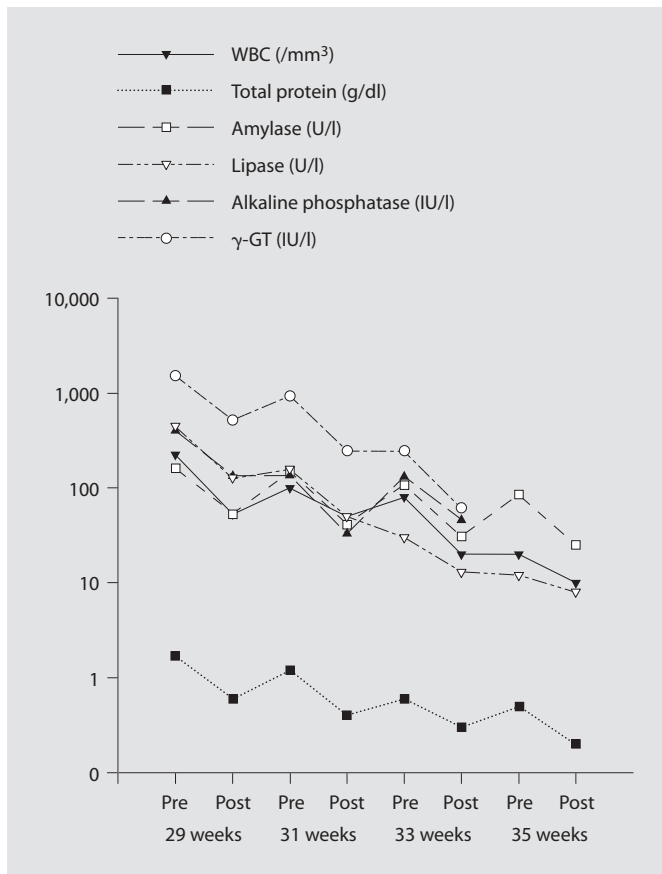


Fig. 1. WBC counts and concentrations of total protein, amylase, lipase, alkaline phosphatase and γ -GT in AF over time following repeated AF exchanges and infusions.

Amniocentesis performed at 19 weeks' gestation revealed a female fetus with normal karyotype, but its maternal α -fetoprotein level was elevated to 142 ng/ml. Serial ultrasonography was performed every 2–3 weeks; at 29 weeks' gestation, oligohydramnios had developed at 5.5 cm in the amniotic fluid index, but bowel dilatation was not observed. The patient was hospitalized and AF exchange and infusion was started at 29 weeks. The parents were counseled about all possible outcomes, and informed consent was obtained.

Under ultrasound guidance, a 20-gauge spinal needle was inserted transabdominally into the amniotic cavity, and an extension tube leading to a three-way stopcock was attached to the needle. A 50-ml injection syringe was attached, and AF exchange was performed with preheated normal saline solution, with 50 ml AF aspirated and replaced by 50 ml saline, until 300 ml had been exchanged, followed by AF infusion for oligohydramnios. AF exchanges and infusions were repeated every 2 weeks, for a total of four times. AF infusion volume was determined empirically to reach 10–13 cm of the amniotic fluid index after each procedure. To compare the laboratory findings and evaluate the effects of the procedure, AF samples collected before and at the end of the procedure were assayed for white blood cell (WBC) count, total protein, and amylase, lipase, and γ -glutamyl transferase (γ -GT) activity (table 1). We observed gradual, decreasing patterns in all of these parameters over time (fig. 1).

Fetal intestinal dilatations were detected by ultrasonography at 36 weeks' gestation. The diameter of the largest intestinal loop measured 14 mm, with a maximum wall thickness of 1.2 mm. The patient was admitted and delivery was induced at 38 weeks' gestation. A 1,989-gram female infant was delivered with Apgar scores of 5 and 6 at 1 and 5 min, respectively. She had a small bowel protrusion and there was slight meconium staining, but no fibrous peeling or severe bowel edema. Small bowel reduction and primary closure were performed immediately. Oral feedings were started at 9 days of age, stopped at 11 days of age due to bilious vomiting, and restarted at 13 days of age. The infant was discharged at 30 days of age. She is now 22 months old, has not required further treatment and is doing well.

Table 1. Changes in intestinal waste products following serial AF exchange and infusion

	Week 29		Week 31		Week 33		Week 35	
	pre	post	pre	post	pre	post	pre	post
WBC/mm ³	224	53	100	50	80	20	20	10
Total protein, g/dl	1.7	0.6	1.2	0.4	0.6	0.3	0.5	0.2
Amylase, U/l	161	53	147	41	107	31	85	25
Lipase, U/l	450	127	158	50	30	13	12	8
Alkaline phosphatase, IU/l	400	134	136	33	131	46	– ¹	– ¹
γ -GT, IU/l	1,510	513	928	246	244	62	– ¹	– ¹
Amniotic fluid index, cm	5.5	10.0	8.0	11.0	7.5	13.0	5.0	13.0
Exchange volume, ml		300		300		300		300
Total infusion volume, ml		110		160		300		300

¹ Not available.

Discussion

Due to its sporadic occurrence and low recurrence rate, as well as its non-association with gastrointestinal anomalies and chromosomal abnormalities, gastroschisis probably does not have a genetic cause [4]. Although the incidence of gastroschisis is relatively low, about 2–4 per 10,000 live births [5], the average length of hospital stay for newborns with surgically repaired gastroschisis was longer (41 days) than that required by newborns with other birth defects requiring hospitalization, such as omphalocele or diaphragmatic hernia. In addition, gastroschisis is expensive, with an average neonatal hospital charge in excess of USD 150,000 in the USA [6]. Following prenatal AF exchange and infusion, however, the infant described here was able to start oral feeding at 9 days of age and she had a relatively short hospital stay.

The etiology of intestinal damage in gastroschisis is unclear [7]. Recent experimental and clinical studies have shown that inflammatory reactions due to changes in AF content and prolonged exposure of the intestine to AF are responsible for the intestinal damage in gastroschisis [3, 7, 8]. AF contains various intestinal and urinary waste products. Removal of intestinal waste products from the AF by AF exchange and infusion prevented intestinal damage in gastroschisis, suggesting that intestinal rather than urinary waste products were responsible for the intestinal damage [8]. We did not measure changes in the concentrations of urinary waste products, but we confirmed that concentrations of intestinal waste products decreased gradually in AF as AF exchange and infusion was repeated.

Intestinal damage from prolonged exposure to the AF can lead to thickening of the bowel by fibrous peel. It is not always possible to repair the primary abdominal wall defect, and postoperative morbidity and hospitalization may be increased by hypoperistalsis, intestinal atresia, malrotation and even necrotizing enterocolitis. Despite recent developments in fetal surgery, high complication rates in fetuses with gastroschisis make this unfeasible. In addition, earlier preterm delivery of the fetus with gastroschisis to ameliorate the intestinal damage did not show significant benefits [9], and a recent report showed that prognosis in gastroschisis was better in newborns with high gestational age or high birth weight than in those with low gestational age or low birth weight [10].

Instead of preterm delivery, the deleterious effects of AF on gastroschisis can be prevented by lowering the concentration of the intestinal waste products. In fetuses with oligohydramnios, AF infusion can be performed by

introducing into the amniotic cavity a volume of physiologic saline proportional to the severity of the oligohydramnios. In fetuses with a normal AF volume, AF exchange can be performed by removing some of the AF and replacing it with physiologic saline [7, 11].

Many molecular components of the AF may be involved in inflammatory damage to the intestine, including interleukins, matrix metalloproteinases, ferritin, total protein, and digestive compounds (e.g. γ -GT, lipase, and amylase) [1, 3, 12]. In the case described here, WBC counts and concentrations of total protein, alkaline phosphatase, amylase, lipase and γ -GT in the AF were initially higher than reference values [3], but decreased gradually after AF exchange and infusion. We also found that the concentrations of these markers in AF prior to repeat procedures were not as high as the initial concentrations.

We have presented here a case report of a fetus with gastroschisis treated by repeated AF exchange and infusion. Our results suggest that repeated AF exchange and infusion may ameliorate intestinal damage by reducing inflammatory reactions and exposure to intestinal waste products. This case furthers our understanding of the mechanism of intestinal damage in gastroschisis. Considering the risk of the procedure, further investigations of exchange solutions, inflammatory markers for intestinal damage, timing and interval of procedure and the thresholds of inflammatory markers are warranted.

References

- 1 Fasching G, Haeusler M, Mayr J, Schimpl G, Haas J, Puerstner P: Can levels of interleukins and matrix metalloproteinases in the amniotic fluid predict postnatal bowel function in fetuses with gastroschisis? *J Pediatr Surg* 2005;40:1887–1891.
- 2 Aktug T, Demir N, Akgur FM, Olguner M: Pretreatment of gastroschisis with transabdominal amniotic fluid exchange. *Obstet Gynecol* 1998;91:821–823.
- 3 Burc L, Volumenie JL, de Lagausie P, Guibourdenche J, Oury JF, Vuillard E, Sibony O, Blot P, Saizou C, Luton D: Amniotic fluid inflammatory proteins and digestive compounds profile in fetuses with gastroschisis undergoing amnioexchange. *BJOG* 2004; 111:292–297.
- 4 Heinrich JK, Machado IN, Vivas L, Bianchi MO, Cursino Andrade K, Sbragia L, Barini R: Prenatal genomic profiling of abdominal wall defects through comparative genomic hybridization: perspectives for a new diagnostic tool. *Fetal Diagn Ther* 2007;22:361–364.

- 5 Canfield MA, Honein MA, Yuskiv N, Xing J, Mai CT, Collins JS, Devine O, Petrini J, Ramadhani TA, Hobbs CA, Kirby RS: National estimates and race/ethnic-specific variation of selected birth defects in the United States, 1999–2001. *Birth Defects Res A Clin Mol Teratol* 2006;76:747–756.
- 6 Hospital stays, hospital charges, and in-hospital deaths among infants with selected birth defects – United States, 2003. *MMWR Morb Mortal Wkly Rep* 2007;56:25–29.
- 7 Aktug T, Ucan B, Olguner M, Akgur FM, Ozer E: Amnio-allantoic fluid exchange for prevention of intestinal damage in gastroschisis. II. Effects of exchange performed by using two different solutions. *Eur J Pediatr Surg* 1998;8:308–311.
- 8 Aktug T, Ucan B, Olguner M, Akgur FM, Ozer E, Caliskan S, Onvural B: Amnio-allantoic fluid exchange for the prevention of intestinal damage in gastroschisis. III. Determination of the waste products removed by exchange. *Eur J Pediatr Surg* 1998;8:326–328.
- 9 Logghe HL, Mason GC, Thornton JG, Stringer MD: A randomized controlled trial of elective preterm delivery of fetuses with gastroschisis. *J Pediatr Surg* 2005;40:1726–1731.
- 10 Charlesworth P, Njere I, Allotey J, Dimitrou G, Ade-Ajayi N, Devane S, Davenport M: Postnatal outcome in gastroschisis: effect of birth weight and gestational age. *J Pediatr Surg* 2007;42:815–818.
- 11 Aktug T, Erdag G, Kargi A, Akgur FM, Tibboel D: Amnio-allantoic fluid exchange for the prevention of intestinal damage in gastroschisis: an experimental study on chick embryos. *J Pediatr Surg* 1995;30:384–387.
- 12 Luton D, de Lagausie P, Guibourdenche J, Oury J, Sibony O, Vuillard E, Boissinot C, Aigrain Y, Beaufils F, Navarro J, Blot P: Effect of amnioinfusion on the outcome of prenatally diagnosed gastroschisis. *Fetal Diagn Ther* 1999;14:152–155.