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Gastroschisis: Ward Reduction Compared With Traditional Reduction Under General Anesthesia

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Abstract

Background/Purpose

In gastroschisis it is proposed that gut reduction may be achieved without intubation or general anesthesia (GA) through ward reduction. The authors aimed to determine if ward reduction decreased morbidity and duration of treatment.

Methods

Infants born from January 1, 1995, to December 31, 2001, with gastroschisis were managed with either reduction under GA in the operating theatre (OT group)—up to September 1999, or ward reduction (when eligible) in the neonatal unit without GA/ventilation (ward reduction [WR] group)—from September 1999.

Results

Of the 37 infants, 31 were eligible for ward reduction—15 from the OT group, 16 from the WR group. All infants in the OT group had at least 1 episode of ventilation and 1 GA: 62% of infants in the WR group avoided ventilation (P = .0002) and 81% avoided GA (P < .0001). Infants who had ward reduction had significantly shorter durations of ventilation and oxygen therapy. Septicemia occurred in 31% of the WR group and 7% of the OT group (P = .17). Infants who had ward reduction left intensive care 16 days earlier (P = .02) and tended to reach full enteral feeds 8 days sooner (P = .06) and be discharged from hospital 15 days earlier (P = .05).

Conclusions

Infants who had ward reduction do better in terms of avoiding GA/ventilation, establishing feeds, and going home earlier. A randomized, controlled trial comparing the 2 approaches is feasible, safe, and worthwhile.

Index words: cohort studies; gastroschisis; operative surgical procedures

Gastroschisis is a congenital anterior abdominal wall defect with the uncovered abdominal contents (usually small and large bowel) protruding through the defect. Reduction of the abdominal contents is required within hours after birth as the infant is at risk for water and heat loss from the exposed bowel, compromised gut circulation, and infection. The traditional approach to management has been attempted reduction of the gut under general anesthesia (GA) in the operating theater.

To avoid the problems associated with GA and mechanical ventilation it has been proposed that the reduction of abdominal contents can be achieved in the neonatal unit without endotracheal intubation or GA. Bianchi and Dickson [1] were the first to report a series of patients to undergo this form of ward reduction in which the infants with gastroschisis had their gut reduced in the neonatal unit without GA, sedation, or analgesia. Concern has been voiced regarding the lack of analgesia [2]. Further caution was urged after a report of 4 patients where only 1 had an uncomplicated course after ward reduction [3].

Kimble et al [4] have reported the largest, most recent case series. Ward reduction in the neonatal unit without GA, ventilation, or surgical incision was attempted in 29 of 35 infants and was successful in 25.

Whether outcomes are improved after ward reduction compared with the traditional surgical approach is unknown. Only separate case series have been described for each approach [1], [2], [5], [6] and [7] and comparisons between these do no allow us to determine which is better. Case series describing the traditional approach usually report outcomes on all cases of gastroschisis, whereas those reporting ward reduction are selective and the outcomes are usually better.

It may well be beneficial to avoid GA and mechanical ventilation; however, it is not known whether this benefit would be accompanied by any disadvantages. Potentially, outcomes such as mortality, amount of gut loss, incidence of septicemia, duration of total parenteral nutrition (TPN), and duration of intensive care nursery (ICN) and hospital stay may be increased or decreased with ward reduction. A recent Cochrane systematic review found no evidence from randomized, controlled trials (RCTs) to either support or refute the practice of ward reduction [8]. To provide data comparing outcomes between the 2 approaches, and to enable sample size calculations for a proposed RCT, we examined a retrospective cohort of infants with gastroschisis. We hypothesized that a policy of ward reduction would decrease the need for, and duration of, mechanical ventilation, decrease the duration of TPN and hospital stay, and possibly decrease other complications. Our aim was to determine whether a policy of ward reduction leads to decreased morbidity in infants with gastroschisis.

1. Materials and methods

In this retrospective cohort study, all infants born from January 1, 1995, to December 31, 2001, with gastroschisis were identified from the neonatal database at the Royal Women's Hospital, Brisbane. The database contains data, on all infants admitted to our neonatal unit, collected contemporaneously with the infant's admission. Details are complete to the time of the infant's discharge home (including data from hospitals that the infant is transferred to before going home). Data retrieved from the database included birth weight; gestational age; sex; method of gastroschisis reduction; whether the infant had a general anesthetic or not; whether subsequent procedures were required after the initial attempt at reduction; mortality; septicemia (blood culture–positive); need for a silo before final reduction; and duration of mechanical ventilation, oxygen therapy, and ICN and hospital stay. Hospital chart notes were examined and the age at commencing enteral feeds, reaching feed volumes of 60 mL/kg per day, and reaching full enteral feeds were noted. Full enteral feeds were defined as either 150 mL/kg per day if less than 3 months old or 120 mL/kg per day if more 3 months old.

1.1. Surgical management

During the study period overall management of infants with gastroschisis was similar in both groups. All had their eviscerated bowel covered with polyethylene “kitchen-wrap” soon after birth and were then admitted to the neonatal ICN. A nasogastric tube was inserted, left on free drainage, and aspirated every 15 minutes. Intravenous antibiotics (metronidazole, gentamicin, penicillin) and maintenance fluids were started.

Up to September 1999, infants were then managed in the traditional manner with attempted reduction of the gut under GA in the operating theater (the OT group). After stabilization the infant was transferred to the operating theater where they had a general anesthetic and the eviscerated bowel was manually returned to the abdomen with or without first extending the abdominal wall defect. After full reduction, the abdominal wall was then closed in 2 layers with sutures. Postoperatively the infant was transferred back to the ICN while still intubated and ventilated. Mechanical ventilation was weaned over the next few days and the infant was extubated when breathing adequately.

From September 1999, infants were managed as per a ward reduction protocol (the WR group). Once stable, the infant was given paracetamol (acetaminophen, 20 mg/kg) rectally. The fully conscious neonate was then placed supine, the abdomen draped with sterile towels, and the bowel gently washed with warm saline. The bowel was carefully inspected and any minor adhesions divided. An assistant would "tent" the abdomen by firm upward traction on the umbilical cord that had been kept deliberately long. Reduction of the gut was then accomplished slowly over 10 to 30 minutes by manually returning the bowel, loop by loop, until the entire bowel was within the abdomen. Monitoring the heart rate and pulse oximetry assessed the effects on the infant. The abdominal wall defect was then closed by apposing the skin with adhesive strips with the cord placed over the residual defect and held down with a semiocclusive dressing. Infants experiencing significant respiratory embarrassment before, during, or after the reduction were intubated and ventilated. Ventilation and extubation were then managed as for the OT group.

In both groups, if it was felt that the intraabdominal pressure was too high during the initial reduction, then an artificial pouch (silo) was placed around the gut and attached to the edge of the defect so that it contained the eviscerated abdominal contents. (From September 1999, spring-loaded silos [Bentec, Sacramento, Calif] were used.) The gut would then be reduced by decreasing the size of the silo over the next few days. Once the gut was reduced the defect was closed under GA in the theater. All procedures were performed by, or under the supervision of, a pediatric surgeon from the Royal Children's Hospital, Brisbane (on the same campus as the Royal Women's Hospital), with the informed consent of 1 of the infant's parents.

Regardless of the method of reduction, enteral feeds were commenced once there were minimal nasogastric aspirate volumes. Until adequate feed volumes were tolerated enterally, nutrition was supported with parenteral nutrition via a percutaneously inserted central venous catheter usually inserted on day 2 or 3 of life.

1.2. Statistics

Statistical analyses of continuous data comparing the WR group with the OT group were performed using Student's *t* test or Mann-Whitney *U* test as appropriate. Comparisons for categorical data were analyzed using the 2-tailed Fisher's Exact test. Initial comparisons were made between all infants presenting with gastroschisis by mode of reduction (OT vs WR). These comparisons would tend to favor the WR group given that complex cases would be excluded from having a ward reduction. To minimize this selection bias we attempted to make the 2 comparison groups as similar as possible. Therefore, a comparison was made after removing those infants who were considered not to have been eligible for ward reduction (infants with gut perforation, necrosis, or atresia). Eligibility was assessed by 1 of the authors (RMK), blinded to outcomes, by examining the findings, at initial examination or in theater, recorded in the infant's case notes.

2. Results

2.1. All infants with gastroschisis

Thirty-seven infants with gastroschisis were admitted to our nursery from 1995 to 2001 inclusive. Reduction occurred under GA in 21 infants and ward reduction was carried out in 16. Overall mortality was 14%—higher in the OT group (19%) than the WR group (6%)—not a statistically significant difference. There were 4 deaths in the OT group: 3 infants had lost most or their entire small bowel because of agenesis, atresia, or vascular compromise; 1 had significant loss of small bowel accompanied by extrahepatic biliary atresia and died of presumed (blood culture–negative) septicemia. All deaths in the operative group were in patients who were not eligible for ward reduction. One infant in the WR group died of renal failure after developing abdominal compartment syndrome (despite decompression of abdominal contents into a silo). The incidence of acquired blood culture–positive septicemia

was higher in the WR group (31%) compared with the OT group (5%)—not a statistically significant difference. One infant in the OT group had acquired a blood culture–positive septicemia in the postoperative period (*Acinetobacter calcoaceticus* on day 32 of life), as did 5 in the WR group (*Klebsiella oxytoca*, *Staphylococcus epidermidis*, *Morganella morganii*, *Enterobacter cloacae*, *Escherichia coli* from day 9 to 71 of life).

Table 1. Infants not eligible for ward reduction

ID	Reason not eligible for ward reduction
Infant A	A multiple small bowel atresias, ischemic small bowel
Infant B	Infarcted small bowel
Infant C	Agenesis of small bowel and colon
Infant D	Agenesis distal small bowel, hypoplastic colon
Infant L	Mesenteric vessel torn at delivery
Infant M	Atresia of the ascending colon

2.2. Infants with gastroschisis eligible for ward reduction

Overall, 31 infants would have been eligible for a ward reduction (details of those infants not eligible for ward reduction are shown in Table 1). There were 15 in the OT group and 16 in the WR group. Data from these infants are shown in Table 2. Infants in the WR group, as expected, avoided ventilation in 62% of cases and avoided GA in 81% of cases. They therefore had significantly shorter duration of ventilation and oxygen therapy. Infants who had ward reduction started feeds earlier and on average (difference in medians) there was a trend to reaching full enteral feeds approximately 8 days sooner ($P = .06$) than those in the OT group. Infants in the WR group were discharged earlier from the ICN (16 days earlier, $P = .02$) and there was a trend toward earlier discharge from hospital (15 days earlier, $P = .05$). There were no differences between groups in the need for a silo and no differences in the need for further surgery before discharge home.

3. Discussion

Outcomes for the traditional approach to gastroschisis have been summarized in several case series [5], [6], [7], [9] and [10]. Hospital mortality ranges from 7% to 10%, often related to septicemia. Intubation, GA, and reduction of abdominal contents may lead to respiratory compromise and need for ongoing respiratory support. Driver et al [6] report a median duration of ventilation of 4.5 days. Failure of initial reduction and the need for a silo are common—in up to 30% of cases. Survivors may require more than 1 surgical procedure and compromised segments of bowel may need excision, possibly resulting in short bowel syndrome. Gut hypomotility and delay in establishing feeds are usual, with median durations of establishing full enteral feeds of around 3 to 4 weeks—TPN is required for most of this time. There is normally a prolonged hospital admission with a median duration of around 6 weeks in most series. Other possible complications of gastroschisis include hemodynamic

Table 2. Outcomes for infants with gastroschisis from January 1, 1995, to December 31, 2001, who would have been eligible for ward reduction of their gastroschisis

	OT reduction	**Ward reduction**	***P***
All infants eligible for ward reduction			
Number	15	16	
Male	10 (67)	10 (63)	1.0[a]
Birth weight (g)[b]	2198 (623)	2263 (432)	.74[c]
Gestational age (wk)[b]	36.1 (2.93)	36.4 (l.59)	.66[c]
Had at least 1 episode of ventilation	15 (100)	6 (38)	.0002[a]
Had at least 1 general anesthetic	15 (100)	3 (19)	<.0001[a]
Needed a silo before full reduction	4 (27)	2 (13)	.39[a]
Had at least 1 operation after first procedure	4 (27)	3 (19)	.69[a]
Septicemia (positive blood culture)	1 (7)	5 (31)	.17[a]
Mortality (to discharge home)	0 (0)	1 (6)	1.0[a]
Survivors to discharge among infants eligible for ward reduction			
Number	15	15	
Age at final extubation (d)[d]	6.4 (4.5-17.4)	0.0 (0.0-1.6)	.0021[e]
Total duration IPPV (h)[d]	129.2 (87.0-405.3)	0.0 (0.0-19.7)	.0001[e]
Total time oxygen therapy (h)[d]	42.0 (16.0-397.0)	2.0 (0.0-49.0)	.019[e]
Age at first enteral feed (d)[d]	16.0 (10.0-22.0)	7.0 (6.0-14.0)	.036[e]
Age at feeds 60 mL/kg per day (d)[d]	23.0 (22.0-33.0)	14.0 (12.0-24.0)	.023[e]
Age at full feeds (d)[b]	28.0 (26.0-36.0)	20.0 (15.0-33.0)	.062[e]
Duration CVL use (d)[d]	28.0 (24.0-33.0)	19.0 (14.0-30.0)	.12[e]
Age at final discharge from ICN (d)[d]	29 (18.0-37.0)	13 (7.0-24.0)	.02[e]
Age at final discharge from hospital (d)[d]	41 (28.0-50.0)	26 (20.0-39.0)	.054[e]

Data are given as n (%) unless stated otherwise.

IPPV indicates intermittent positive pressure ventilation; CVL, central venous line.

[a] Fisher's Exact test.

[b] Mean (SD).

[c] Student's *t* test.

[d] Median (interquartile range).

[e] Mann-Whitney *U* test.

compromise of the lower abdomen, kidneys and legs with abdominal compartment syndrome; gut perforation; infection (septicemia and/or wound infection); abdominal scars; a cosmetically abnormal umbilicus; late surgery for gut adhesions or scar cosmesis; compromised nutrition; and adverse neurologic outcome [9], [10] and [11].

Bianchi and Dickson [1] reported 14 cases treated with reduction in the neonatal unit—there were 12 survivors: 9 uncomplicated, 2 with mild periumbilical inflammation, and 1 requiring an intestinal lengthening procedure for ileal atresia. The 2 infants who died were immediately unwell after the initial reduction: one with a midgut volvulus and necrotic bowel who died at 22 months as a consequence of short bowel syndrome, the other had perforation proximal to a membranous ileal atresia and died at 7 months of septicemia.

Kimble et al [4] reported the largest series of infants managed with ward reduction. Eight of the infants in that series are included in the present study. Infants from 2 other hospitals were included in the earlier study [4] and are not included in our analysis. Ward reduction was contemplated in infants who met well-defined selection criteria, which excluded infants who were unstable or had gut perforation, necrosis, or atresia. Analgesia with rectal paracetamol was used. There were 35 infants with gastroschisis: manual reduction was attempted in 29 and was successful in 25. A silo was used in all 4 infants who had a failed ward reduction. All 4 later underwent successful delayed closure in the operating theater under GA. The mean age at reduction was 2 hours, the mean duration of TPN was 17 days, and the mean time to discharge was 20.5 days. Two infants in the WR group exhibited moderate respiratory distress before reduction and required endotracheal intubation and ventilation for a short period before and after reduction. Four infants who had successful ward reductions developed septicemia. There were no deaths.

This is the first study to compare directly the outcomes for the 2 approaches to the immediate management of infants with gastroschisis. We are in a unique position to compare the effects of the 2 approaches in a retrospective cohort of infants with a historical control group: the neonatal database contains reliable data on all outcomes of interest; this study was done in a single neonatal unit, over a relatively short period; established procedures and care protocols were in place enabling consistency of care. As far as we can be, we are assured that both groups of infants received the same degree of care except for the method of reduction. We believe that this allows the best possible comparison short of a RCT. However, caution in interpreting the results is warranted given the well-described problems with historical cohort studies [12]. Any unidentified differences in the patient population, changes in ICN practices, or modifications to the practice of individual clinicians may have influenced outcomes unrelated to the method of reduction.

We have demonstrated that infants who have their gastroschisis managed with ward reduction are better off in terms of avoiding GA and having a shortened duration of mechanical ventilation. They also tend to establish feeds and go home sooner. The only worrying aspect was an increased incidence (not statistically significant) of septicemia seen in infants who had a ward reduction. We speculate that this may be because these infants had enteral feeds started on average (difference in medians) 9 days earlier. The eviscerated bowel is often edematous with possible subclinical vascular compromise that takes time to return to normal. Perhaps the gut-blood barrier may not be as robust in the bowel in the first couple of weeks after reduction. This may predispose to infection and be exacerbated by early enteral feeds.

Other aspects of ward reduction that could not be investigated systematically in this retrospective study are worthy of discussion. Concerns have been raised with regard to adequate analgesia [2]. Unlike the first case series where no analgesia was used and the defect was closed with sutures [1], we used a dose of paracetamol (acetaminophen) before reduction and our technique did not require any incision or suturing. There were no significant changes in heart rate or pulse oximetry during ward reduction in any of the patients. Furthermore, the neonatal nursing staff involved in the ward reduction has not had any concerns with the

provision of analgesia in these infants. We also believe that the psychological impact on the parents of the diagnosis of gastroschisis can be lessened if we can counsel the parents that in most cases, general anesthesia and mechanical ventilation can be avoided.

Although the results of this study are encouraging, there have been problems encountered in other case series with ward reduction. It is time for a prospective RCT comparing the 2 approaches. This study not only provides valuable data to enable the calculation of an appropriate sample size for a proposed RCT, but also provides data on outcomes that demonstrate that a RCT is feasible, safe, and worthwhile.

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