



Preterm delivery promotes a high primary reduction in simple gastroschisis and the exit-like technique may improve the outcomes

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Abstract

Purpose The aim of this study was to analyze the rate of primary closure and to compare the post-operative results of the classic technique with the exit-like technique in preterm newborns with simple gastroschisis.

Methods Observational, analytical, retrospective cohort study including patients diagnosed with simple gastroschisis that were divided into: Group I: preterm newborns undergoing primary closure and Group II: preterm newborns undergoing an exit-like surgical treatment.

Main results A total of 58 patients were included. 55/58 (95%) had a primary closure. The median days on mechanical ventilation was three days for group I and one day for group II ($p < 0.001$). The duration of parenteral nutrition was 19.7 ± 9.9 days and 18.4 ± 7.2 days for groups I and II respectively ($p = \text{ns}$). The time to full enteral feeding was 23 ± 9.9 days and 18.9 ± 5.8 days for groups I and II respectively ($p = 0.02$). The length of hospital stay was 28 ± 11 days in group I and 24 ± 8 days in group II ($p = \text{ns}$). The complication rate was similar in both groups.

Conclusions Preterm delivery resulted in a high rate of primary closure. The exit-like technique avoids endotracheal intubation, general anesthesia, mechanical ventilation and shortens the time to full enteral feeding in simple gastroschisis.

Keywords Gastroschisis · Exit-like · Minimally invasive surgery · Preterm delivery · Outcome · Primary closure

Introduction

Gastroschisis is a congenital defect characterized by the herniation of intestinal contents outside of the abdominal cavity through a defect in the abdominal wall usually to the right of the umbilical cord. The incidence has been increasing with an estimate of 1:2,000–3,000 live births in different countries. Newborns with gastroschisis require surgical

correction shortly after birth in order to reintroduce the viscera into the abdominal cavity to minimize abdominal fluid loss, prevent infection, and avoid damage of the exposed organs [1].

Primary closure is achieved in 50–83% of patients with gastroschisis according to different authors. If primary closure is not possible due to the presence of dilated and thickened intestinal wall, a staged closure with a Silo is mandatory [2].

Prolonged exposure of the intestine to amniotic fluid in utero and vascular compromise of the herniated intestine due to a constricting effect on the umbilical defect generates progressive dilation of the intestine and thickening of the bowel wall, inflammatory peel, and can even cause necrosis or atresia [3]. These findings led to considerate approximately fifteen years ago, that premature delivery of fetuses with gastroschisis could minimize intestinal damage, promote a primary reduction of the viscera and improve prognosis [4].

Sveltiza et al. in 2005 described a minimally invasive technique for the treatment of gastroschisis that included

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a preterm delivery and reintroduction of the exteriorized bowel loops immediately after birth before cutting the umbilical cord, maintaining the fetoplacental blood support, similar to the EXIT (Extrauterine Intrapartum Treatment) technique, and therefore he named it exit-like technique [5]. This technique does not require a general anesthesia and the introduction of the viscera into the abdominal cavity is performed before the newborn swallows. Therefore, this technique avoids the distension of the intestinal content that occurs when the newborn begins to breathe, facilitating the introduction of the bowel into the abdomen and yielding a higher primary closure rate [6].

The aim of this study was to analyze the proportion of patients achieving primary closure and to compare the postoperative results of the exit-like technique with the classic technique in preterm newborn patients with gastroschisis.

Methods

A retrospective cohort study included data from medical records of patients diagnosed with gastroschisis born at Hospital Gustavo Fricke and Hospital Carlos Van Buren,

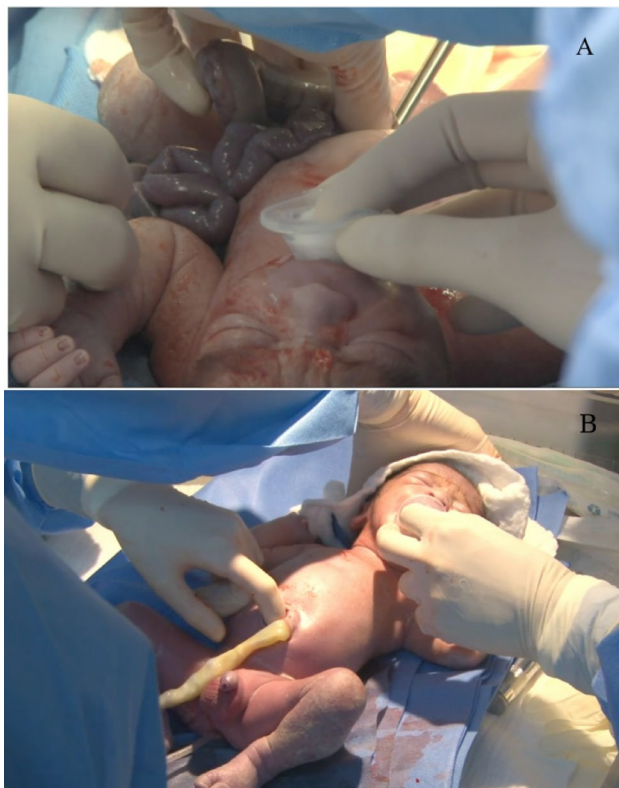


Fig. 1 Exit-like technique for simple gastroschisis. **A** Immediately after birth the surgeon introduces the exteriorized bowel loops into the abdominal cavity before cutting the umbilical cord and without general anesthesia. **B** Once the viscera are reduced, the abdominal defect is closed with absorbable suture under local anesthesia

both general hospitals associated to the School of Medicine of the Universidad de Valparaíso, Chile, between 2008 and 2020. This research was approved by the Bioethics Committee of the Faculty of Medicine of the Universidad de Valparaíso (n° 14/2021).

At Hospital Gustavo Fricke, the pregnancy is interrupted by elective caesarean section at 34 weeks of gestation. Once the newborn is stabilized a few hours after birth, he is transferred to the operating room and under general anesthesia the viscera are reduced into the abdominal cavity and primary closure is performed using stitches. If primary closure is not possible, a Silo is installed extending the defect. The postoperative analgesia was initially fentanyl and after that paracetamol.

At Hospital Carlos Van Buren the exit-like technique was introduced in 2008 for the treatment of gastroschisis. According to this technique, a systematic ultrasound monitoring is performed on pregnant women with fetuses with gastroschisis and an elective caesarean section is programmed at 34 weeks of gestation. The technique is performed immediately after exteriorizing the newborn, under the fetoplacental blood supply, thus before cutting the umbilical cord, with the newborn positioned in between his mother's thighs. Two pediatric surgeons carefully reintroduce the prolapsed bowel loops into the abdominal cavity using their fingers and a non-traumatic forceps. Once the abdominal viscera are reduced, the umbilical cord is sectioned and after that the paraumbilical defect is closed with an absorbable suture under local anesthesia. This technique does not require endotracheal intubation or general anesthesia and allows the correction to be carried out before the newborn breathes or swallows, avoiding the distension of the intestinal loops that occurs when the newborn begins to breathe, facilitating the introduction of the intestine. (Fig. 1). During bowel manipulation the newborn is still under the effects of fentanyl used for the mother's anesthesia. The postoperative analgesia consists in fentanyl and after that paracetamol.

The selection criteria for the study were: women undergoing a single pregnancy affected by a simple gastroschisis (Gastroschisis Prognostic Score 0 or 1); newborns with antenatal diagnosis of gastroschisis diagnosed by ultrasound prior to 34 weeks of gestation; evidence of intestinal viability and newborn without other associated diseases. Exclusion criteria included newborns with multiple associated malformations; newborns with complex gastroschisis, defined by the presence of atresia, stenosis, necrosis, perforation, or intestinal volvulus; and newborns presenting acute fetal distress.

The patients were divided into two groups: Group I: preterm newborns that underwent classic surgical treatment and Group II: preterm newborns that underwent an exit-like surgical treatment. The outcomes of the study were: (1)

Table 1 Demographics of the cohort

	Total (n=58)	Group I (n=24)	Group II (n=34)	p value
Maternal age (years)	22.67±5.24	22.29±4.92	22.94±5.50	0.32
Female sex	36/58 (62.1%)	15/24 (62.5%)	21/34 (61.8%)	0.59
Birth weight (gr)	2171.69±356.14	2240.83±406.98	2122.88±312.58	0.11
Pregnancy termination (week)	33.86±0.60	33.79±0.41	33.91±0.71	0.23
Lung maturation	54 (93.1%)	20 (83.3%)	34 (100%)	0.382
Primary closure	55/58 (94.8%)	22/24 (91.7%)	33/34 (97.1%)	0.370

Table 2 Outcomes of patients undergoing primary closure

	Group I (n=22)	Group II (n=33)	p value
Time on mechanical ventilation (median days)	Median 3 days (RIC: 2–5)	Median 1 day (RIC: 1–1)	<0.001
Duration of parenteral nutrition (days)	19.7 ±9.9	18.4 ± 7.2	0.68
Time to full enteral feeding (days)	23.4 ± 9.9	18.9 ± 5.8	0.02
Length of hospital stay (days)	28 ± 11	24 ± 8	0.19

Table 3 Postoperative complications

Complication	Group I (n=22)	Group II (n=33)	p value
Sepsis	2/24	3/33	0.461
Surgical wound infection	3/24	4/33	0.484
Intestinal obstruction	0/24	1/33	0.644
Compartment syndrome	1/24	0/33	0.356
Intestinal perforation	0/24	0/33	–
Patient deaths	0/24	1/33	0.654
Unplanned reoperation	0/24	1/33	0.644

Table 4 Complications associated with prematurity

Complication	Group I (n=22)	Group II (n=33)	p value
Respiratory distress	0	0	–
Hyaline membrane	2	0	0.121
Retinopathy of prematurity	0	0	–
Necrotizing enterocolitis	0	0	–

Number of patients achieving primary closure; (2) Days on mechanical ventilation; (3) Duration of parenteral nutrition; (4) Time to full enteral feeding; (5) Length of hospital stay; (6) Number and type of surgical complications: sepsis, intestinal obstruction, intestinal perforation, abdominal compartment syndrome, surgical wound infection and unplanned return to the operating room and (7) Complications associated with prematurity such as: respiratory distress, hyaline membrane disease, retinopathy of prematurity, necrotizing enterocolitis.

The clinical records of these patients born between 2008 and 2020 were reviewed. Data was collected in an Excel database and was analyzed using the statistical program STATA 16.0.

Qualitative variables were compared with Fisher Exact Test for the comparison of the variances of both groups. For quantitative variables T test or its non-parametric similar were applied, if the data didn't have a normal distribution, for the comparison between the two groups. The results

obtained were considered statistically significant with a p value <0.05.

Results

There were 108 newborns with gastroschisis during the study period. 58 out of 108 patients were preterm simple gastroschisis that were included in the study; 33 out of 108 patients were term newborns that underwent classic surgical treatment because they were diagnosed later during pregnancy and 17 out of the 108 patients were complex gastroschisis. From the 58 preterm simple gastroschisis, Group I included 24 patients and Group II included 34 patients. Table 1 shows the demographics of the full cohort.

Out of the 58 patients, 55 (95%) achieved primary closure. In Group I, 22 out of 24 (91%) patients underwent primary closure and a Silo was performed in 2 patients. In Group II, 33 out of 34 patients (97%) achieved primary closure and only 1 patient required a silo.

Table 2 shows the results of patient outcomes for both groups when a primary closure was achieved. There was a significant difference in outcomes related to days on mechanical ventilation and time to full enteral feeding. In Group II, only 6 patients require mechanical ventilation whereas the other 27 out of 34 patients did not require any. However, there is no evidence supporting a reduction in days of parenteral nutrition, time and length of hospital stay.

Table 3 shows the number of patients who experienced postoperative complications in each of the studied groups. One patient in Group I experienced respiratory sepsis as a complication of mechanical ventilation.

The complications associated with prematurity were studied (Table 4): two patients from Group I developed hyaline membrane. There were no patients developing retinopathy of prematurity or necrotizing enterocolitis in any patient.

Discussion

Historically there has been a high rate of delayed closing and significant morbidity in the postoperative period in gastroschisis. The rate of primary closure for Gastroschisis has been reported between 50 and 83% [2], and a more recent systematic review reports a 69% of primary closure [7]. In our study, a 95% primary closure rate was achieved, superior to the results reported in the literature.

Approximately twenty years ago some authors suggested an early ending of pregnancy in gastroschisis based on the fact that the greatest damage to the intestinal loops occurs in the last weeks of pregnancy [8]. It was reported that evident ultrasound signs of fetal compromise were observed after the 30th week of gestation and that the decision to perform an elective cesarean section based on these criteria was associated with an improved postnatal surgical outcome without significantly increasing morbidity due to prematurity [8]. At that time, our group established the preterm delivery in simple gastroschisis in both hospitals and has been keeping doing so. The results of our study show that thanks to preterm delivery, we are able to achieve primary closure in nearly all newborns. Contrarily, other authors have reported 69% of primary closure in babies with gastroschisis [7]. Nowadays, the preterm delivery for gastroschisis is debated. Delivery after 37 weeks post-conceptual age is considered optimal [9]. Published studies have reported worse results in preterm interruption, such as longer time to full enteral feed and more hospitalization days [10]. Our results show less days to full enteral feeding and less length of hospital stay in preterm newborns compared to literature.

Short-term complications in preterm delivery include infections, respiratory complications, breastfeeding difficulties, risk of intracranial hemorrhage and higher mortality. Complications associated with prematurity have been reported in preterm delivery in newborns with gastroschisis [11]. A recent systematic review from the European Reference Network for rare Inherited Congenital Anomalies (ERNICA) recommends vaginal birth between 37 and 39 weeks of gestation. However, they did not consider the rate of primary closure as one of the questions asked in the systematic review. Considering that our study shows that almost all the patients were able to undergo a primary closure, and that we had few complications associated with prematurity, we believe that elective preterm delivery plays a key role in enhancing the primary closure rate in gastroschisis.

In 2008 both hospitals in our study implemented the preterm delivery in gastroschisis: one hospital kept performing the classical primary closure under general anesthesia whereas the other hospital started performing the exit-like technique, in which no general anesthesia is given to the newborn and the reduction of the viscera is performed

before the section of the umbilical cord. There was no statistically significant difference in the rate of primary closure when comparing both groups.

The main advantage of the exit-like technique is that there is no need for general anesthesia avoiding the possible long-term impact of it in the newborn including behavioral problems and neurodevelopmental disorders [12]. Moreover, this technique avoids mechanical ventilation after the procedure in most of the patients, eluding possible complications like lung injury, hemodynamics impact or ventilator-associated pneumonia, that is the most prevalent healthcare-associated infection in neonatal intensive care units [13, 14]. In a meta-analysis comprising a total of 1652 patients, the average days in mechanical ventilation for simple gastroschisis was 5.5 ± 2.0 days [15]. Our study shows fewer days in mechanical ventilation for both groups.

The exit-like is an innovative technique that has shown positive postoperative results; however, the published studies include a small number of patients [5, 6, 16]. Cisneros-Gasca compared the classic technique with a few cases of exit-like technique and found significant statistical differences in ventilation days required, duration of parenteral nutrition and duration of enteral feed [17]. In our study we had similar results, there were significant differences favorable for the exit-like technique group in presenting fewer days on mechanical ventilation compared to the classic technique and a lower time to full enteral feeding.

When comparing preterm newborns with full-term newborns a study reported no difference in time to enteral feed between those born at $34-36 + 6$ weeks (mean 28 days) compared with ≥ 37 weeks (mean 27 days) [11]. In our study, the time to full enteral feed was achieved in less days in both groups despite being premature. Our study also showed less time to achieve full enteral feeding in the exit-like group compared to the classical technique. Regarding the length of parenteral nutrition, in a metaanalysis comprising a total of 1652 patients, the duration of parenteral nutrition was 35.3 ± 4.4 days [14]. Other authors, in a study with 570 cases found a mean duration of parenteral nutrition of 44 ± 56 days [18]. Our study shows a shorter duration of parenteral nutrition in both groups.

The mean length of stay for simple gastroschisis is an average of 28 days which is comparable to what we found in both our groups [4]. Recent studies show no significant difference in length of stay between preterm and control cohorts [19].

Common post-surgery complications described by literature include sepsis, surgical wound infection, intestinal obstruction, among others [20]. Sepsis has been documented from 7% up to 44% of the positive blood culture [20, 21]. In our study the two most frequent complications were surgical wound infection and sepsis.

In 1998, Bianchi et al. argued that primary closure in gastroschisis without endotracheal intubation and general anesthesia was feasible in the neonatal intensive care unit, associated with less antibiotic use, surgical infections, and decreased ventilator time [22]. A recent systematic review and meta-analysis on the avoidance of routine endotracheal intubation and general anesthesia for primary closure of gastroschisis including 248 patients showed a primary closure success rate that was statistically equivalent between the groups with and without general anesthesia that ranged between 25 and 93%. However, the authors included a wide range of gestational ages, from preterm to fully term newborns. With respect to time to enteral feeds and length of hospital stay, outcomes were either equivalent between the two groups or favored the group that underwent primary closure without intubation and general anesthesia [23]. The advantages of exit-like technique as opposed to the Bianchi technique is that the preterm delivery and the reduction of the intestine immediately after birth and before the newborn moves and swallows air, allows an easy and painless reduction of the viscera, enhancing the rate of primary closure.

Gastroschisis is a congenital malformation that requires a multidisciplinary approach for its management in expert pediatric surgery centers and neonatal units to improve perinatal outcomes. The involvement of the surgeon from prenatal control is vital for success. Patients with diagnosis of gastroschisis should be relocated as soon as possible to deliver at a facility capable of performing postnatal surgical repair. Programming the moment of interruption using C-section allows a precise coordination between obstetrician, pediatric surgeon and neonatologist. As studies show access to quality neonatal surgical care, is an important prognostic factor [24].

Limitations of this study: it is a retrospective study that took place in a wide time range and patients belong to different hospitals where neonatal unit management might be slightly different. The long-term complications of preterm delivery were not studied.

Conclusions

Preterm delivery resulted in a very high rate of primary reduction and closure. The Exit-like technique is a minimally invasive novel technique that shows similar surgical results to the classic technique in simple gastroschisis while avoiding endotracheal intubation, general anesthesia and mechanical ventilation in the newborn.

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Alejandra Elton (AE), Carmen Gloria Ibáñez (CGI), Valentina López (VL), Sandra Montedónico (SM) RA, AM, AE and SM conceived of the presented idea and designed the study. RA, CGI and VL reviewed the patients charts and structured the information. RA analyzed the results. All authors discussed the results. RA wrote the manuscript with support from SM. All authors discussed the results and commented on the manuscript.

Data availability Data extracted from the patients charts is available upon request.

Declarations

Conflict of interest The authors declare no competing interests.

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