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Gastroschisis in the neonatal period: A prospective case-series in a Brazilian referral center

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ABSTRACT

Background/Purpose: Gastroschisis is increasing in incidence and has low mortality and high morbidity. We describe the clinical and surgical characteristics of gastroschisis patients in a Brazilian referral center.
Methods: Single-center prospective case series of gastroschisis patients. The following two groups were formed depending on the intestinal characteristics: simple and complex patients.
Results: In total, 79 patients were enrolled, 89% of whom were classified as simple and 11% as complex. The baseline characteristics were similar between the groups, with the exception of the illness severity score. The complex group had a significantly smaller defect size, more reoperations and worse clinical outcomes than the simple group, with the initiation of feeding taking 1.5 times longer, the duration of total parenteral nutrition taking twice as long, and the length of hospitalization being 2.5 times longer; the complex group also included all the deaths that occurred. Overall, the survival rate was 96%. Patients who underwent the sutureless technique had significantly fewer wound infections and a decreased duration of mechanical ventilation than sutured patients.
Conclusions: This study provides a comprehensive picture of gastroschisis during the neonatal period in a Brazilian referral center, emphasizing the significantly higher risk for morbidity and mortality among complex patients than among simple patients and the few advantages of the sutureless technique over the sutured technique in terms of closing the defect.
Type of study: Prognostic.
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Gastroschisis (GS) is a congenital malformation characterized by visceral herniation usually through a right-sided anterior abdominal wall defect alongside an intact umbilical cord that is not covered by a membrane. The exact etiology is controversial. The incidence has been increasing over the last few decades worldwide, and according to the International Clearinghouse Report for Birth Defects, there are 5.1 gastroschisis cases/10,000 live births in the USA. The incidence is estimated to be 10.7/10.000 in South America, including Brazil [1].

Several international reports have shown survival rates as high as 90% to 97%, but morbidity is still considerable [2,3]. GS patients usually have a high incidence of prematurity, a low birth weight, general anesthesia exposure, impaired intestinal function, a high risk for infection and prolonged hospitalization [4–8].

Although many studies in the field are retrospective [8–12], this was a prospective case series of GS patients admitted to a referral center in Rio de Janeiro, Brazil, and followed in a specific outpatient clinic. Our aim was to describe and determine the clinical outcomes and surgical characteristics of GS infants during hospitalization, from birth to discharge. Secondary objectives were to compare the outcomes of simple and complex patients and, finally, to compare our results with those in the literature.

1. Methods

All patients admitted with GS between May 2016 and February 2019 at Instituto Fernandes Figueira, a tertiary children's referral public hospital in Rio de Janeiro, a large city in the southeastern region of Brazil, were eligible for the study. The exclusion criteria were genetic syndromes and/or confirmed congenital infectious diseases. This study is part of a cohort study of gastroschisis patients titled “Evaluation of growth and neurodevelopment of gastroschisis patients during the first two years of life: a cohort study”, where the main outcomes were growth and neurodevelopment during the first two years of life. The study was approved by the Ethics Committee of the Institution under IRB number 54015316.8.0000.5269 and was registered by REBEC

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(www.ensaiosclinicos.gov.br) under the number U1111.1236.2214. Participation was voluntary, and informed written consent was obtained after a live birth. Patient data were prospectively collected by a pediatrician from the patients' charts and study forms, from birth to the end of the second year of life. EpiData 3.1 software (Odense Denmark, EpiData association) was used for the database.

In-born patients were defined as those who were delivered within our center; out-born patients were defined as those delivered elsewhere who were subsequently transferred to our hospital for care.

The outcomes of infants with gastroschisis are primarily determined by the amount of intestinal damage that occurs during fetal life. Gastroschisis results in impaired motility and mucosal absorptive function, which, in turn, lead to a prolonged need for total parenteral nutrition (TPN) and, in some cases, severe intestinal failure. Patients were labeled as having complex gastroschisis if one or more of the following conditions were diagnosed at birth: intestinal atresia, perforation or necrosis [13]. Patients were also considered complex if they developed short gut syndrome (SGS) and became dependent on TPN for more than 60 days.

The baseline patient characteristics and surgical and clinical characteristics were measured in all gastroschisis patients, and the patients were separated into simple and complex groups according to Molik's definition [13]. The results of the two groups were compared.

The baseline characteristics included birthplace (in-born or out-born), the presence of meconium amniotic fluid, the need for resuscitation at birth (face mask ventilation or endotracheal ventilation), APGAR scores at 1 and 5 min of life, gestational age (completed weeks, by first trimester ultrasound or date of last menstrual age, in this order), birth weight (in grams), small for gestational age (SGA) (birth weight equal to or less than the 10th percentile, using the Fenton neonatal growth chart), sex (female or male), illness severity score, SNAPPE-II (Score for Neonatal Acute Physiology with Perinatal Extension II) in the first 12 h of NICU admission and associated anomalies (other than intestinal). The maternal data included age (in years), parity, multiple pregnancies, prenatal diagnosis of the malformation, tobacco use and mode of delivery (vaginal or cesarean section).

The surgery-related characteristics included the following: the size of the defect (in cm, measured with a ruler by the surgeon at the time of surgery), patient age at the first surgery, need for a silo, number of days with a silo, method of abdominal defect closure (sutureless, simple suture or retention suture) and need for reoperation.

In our institution, the pediatric surgery team comprises 5 experienced surgeons, and it is routine that all patients receive general anesthesia, usually followed by neuraxial anesthesia (caudal epidural block) in the operating room for closure of the abdominal defect. Ideally, surgery to correct the defect is undertaken within six hours after delivery [14]. Primary operative reduction is the procedure of choice if eviscerated contents can be safely placed into the abdominal cavity without causing excessive intraabdominal pressure and clinical instability. Intragastric or intravesical pressure, which can reflect abdominal pressure, is not always measured. If the viscera cannot be reduced primarily, a silo bag is sutured, allowing for a staged reduction of the abdominal contents over the next few days. The method of abdominal closure changed over the period of the study. During the first year, there were two options: simple suture (of the fascia and skin) or retention suture (heavily reinforced suture deep within the muscle and fascia). Afterwards, the sutureless technique also became an alternative and then became the first option for surgeons. With the sutureless technique, the viscera are reduced, and the umbilical cord is flapped over the defect, which is then covered with a watertight dressing. The technique allows for spontaneous closure through cicatrizing the umbilical port, and the procedure minimizes increases in intraabdominal pressure [15]. According to our protocol, after five days, the occlusive dressing was removed and replaced with another dressing for five more days. When intestinal atresia was present at birth, the defect was closed, and a second operative exploration was performed within a few weeks to establish bowel continuity. This period of time allows for a decrease in bowel inflammation.

The clinical characteristics included the time to initiate feeding (in days), duration of TPN (in days), cholestasis (direct bilirubin [DB] levels greater than 2 mg/dl), time to reach full enteral feeds (in days), duration of mechanical ventilation (in days), wound infection (classified based on wound erythema, purulent discharge or pus and treatment with antibiotics), proven sepsis (defined as a positive blood culture), use of second-line antibiotics for clinically suspected sepsis, abdominal compartment syndrome, necrotizing enterocolitis (NEC) (defined as Bell's stage 2 or more) [16], length of hospital stay (in days) and survival until hospital discharge.

In our hospital, patients receive respiratory support based on clinical indications as determined by the attending neonatologist and/or surgeon. Antibiotics are initiated for all patients when they are born (since visceral exposure increases the chance for infection) and are discontinued after 3 or 5 days if there are no further infection concerns. However, antibiotics are continued if a silo is in place until it is removed. Since a period of adynamic ileus is expected after surgery owing to the characteristics of the malformation, the infants need to be totally supported by parenteral nutrition. We usually start TPN on day one of life, beginning with SMOF (soybean oil, medium-chain triglycerides, olive oil, and fish oil) as a lipid emulsion for hepatic protection as soon as possible. In our nutrition protocols, feeds are held until gastric drainage becomes clear, starting with maternal breast milk, since we have a human milk bank available at the institution. Patients who become chronically dependent on TPN must remain hospitalized since it is not possible for them to have home TPN.

The statistical analysis was performed using Epi-Info 7.1 software. Categorical variables were presented as numbers and proportions (%), and continuous variables were presented as the mean and standard error of the mean (SEM) or median and interquartile range (IQR). Simple and complex GS patients were compared using the Chi-square test or Fisher's exact test (if the expected count was <5) for categorical data and the Mann–Whitney test for continuous data. A p value of <0.05 was considered statistically significant. To verify the importance of different variables in the outcomes, we performed a logistic regression analysis.

2. Results

During the 34-month period analyzed, 90 patients with gastroschisis were admitted to our hospital. There were 12 deaths among them: 2 stillbirths, 5 neonatal deaths, and 5 post neonatal deaths (never left the hospital). Two patients had meconium aspiration syndrome with severe pulmonary hypertension, one patient had abdominal compartment syndrome with pulmonary hypertension and disseminated intravascular coagulation (DIC), and two patients did not have therapeutic options owing to extensive intestinal necrosis at birth or a disproportion between the abdomen contents and exposed viscera. Three patients were not included in the study because the parents refused to give consent, five patients were not included because they died before informed consent was obtained from the parents, and 2 patients were not included because they were stillbirths, leaving 79 patients in the study cohort (Fig. 1).

Of 79 subjects, 70 fulfilled the criteria for simple gastroschisis, and 9 fulfilled the criteria for complex gastroschisis. Of the patients with complex gastroschisis, 2 had intestinal atresia and necrosis, 2 had intestinal atresia and perforation, 2 had intestinal atresia only, 1 had intestinal necrosis only, and 1 had intestinal necrosis and perforation at birth. One patient was classified as simple at birth but developed intestinal failure, was dependent on TPN for more than 60 days, and was then reclassified as complex. At four months of age, after a laparoscopic procedure for a clinical manifestation of intestinal obstruction, it was seen that he only had 40 cm of small intestine, reassuring us that in fact he

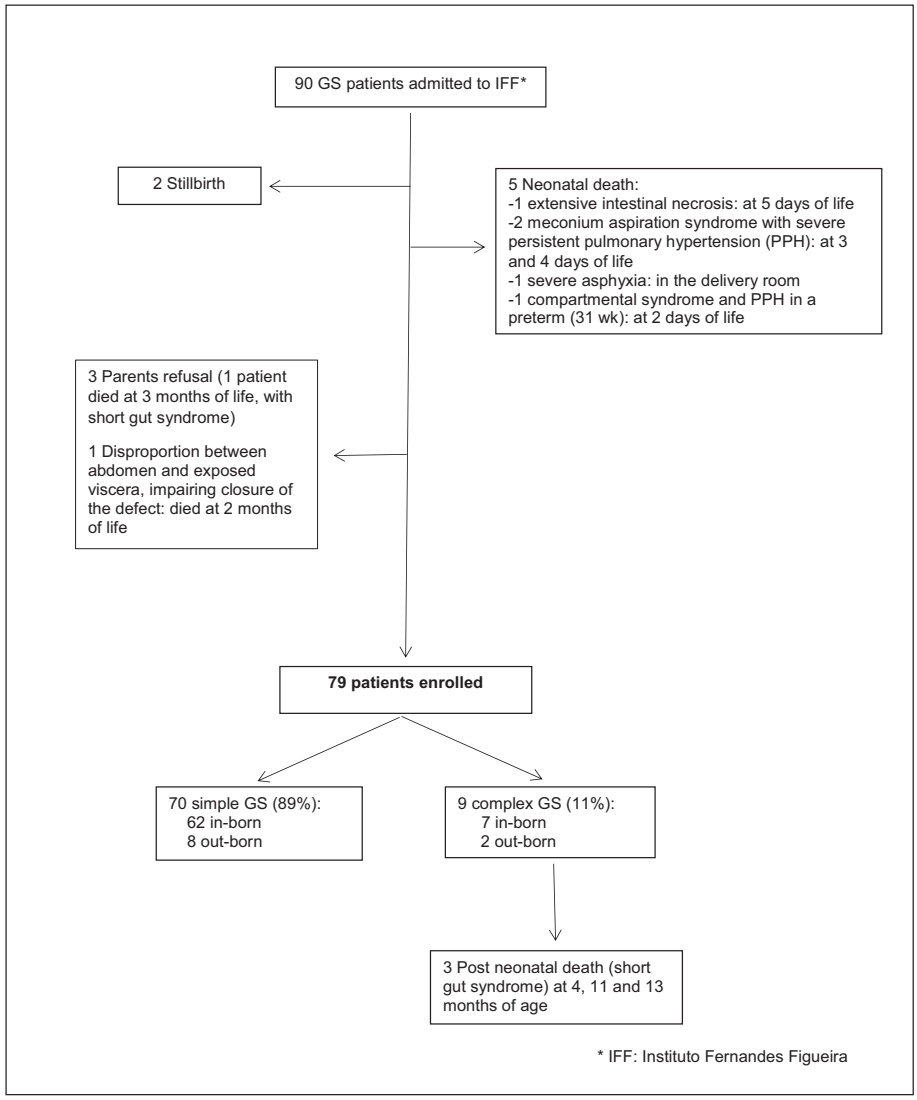

Fig. 1. Flowchart of gastroschisis (GS) patients.

was a complex case. Five patients from the complex group developed short gut syndrome (6%). Table 1 reports the perinatal and demographic characteristics of the studied population and the comparison between simple and complex patients. The majority of mothers were young, with 53% being less than 21 years old and a quarter having used tobacco.

There were no significant differences between the groups in terms of the patients' baseline characteristics. The majority of the cohort was in-born and delivered by cesarean section: 43% were elective operation patients, and 29% were preterm labor patients. A total of 35% of patients required resuscitation in the delivery room, with 16% needing face mask positive pressure ventilation and 19% needing tracheal intubation and ventilation. The mean gestational age was 36 weeks, and more than half of the patients were preterm, with 47% being late preterm newborns. The mean birth weight was 2339 g, and 14% were classified as SGA. Minor congenital anomalies in addition to gastroschisis occurred in 27% of patients, and isolated atrial septal defects (ASD) (38%) and cryptorchidism (14%) were the two most frequent congenital anomalies. One patient also had associated mild hydrocephalus, cleft palate and arthrogryposis. Among the 8 ASD cases, none required surgery.

SNAPPE-II, a predictor of illness severity and neonatal death [17], although it does not specifically evaluate the severity of bowel injury in GS, was significantly higher in the complex group than in the simple group.

Table 1
Perinatal and demographics data.

	GS ($n = 79$)	Simple GS $n = 70$ (89%)	Complex GS $n = 9$ (11%)	p value
Maternal age (years)	21 ± 5.1	21 ± 1.5	23 ± 6.8	0.27
Tobacco use	18 (23%)	17 (26%)	1 (11%)	0.67
Prenatal diagnosis	76 (96%)	68 (97%)	8 (89%)	0.30
Inborn	69 (87%)	62 (89%)	7 (78%)	0.32
C-section	53 (67%)	46 (66%)	7 (89%)	0.71
1 min APGAR	8 (6.5–8.0)	8 (6.5–8.5)	9 (8.0–9.0)	0.96
5 min APGAR	9 (8.5–9.0)	8 (6.5–8.5)	9 (8.0–9.5)	0.62
Gestational age (weeks)	36 ± 1.7	36 ± 1.5	36 ± 2.5	0.15
Prematurity	40 (51%)	34 (51%)	6 (67%)	0.48
Birth weight (g)	2339 ± 492	2341 ± 482	2327 ± 595	0.94
SGA	11 (14%)	9 (13%)	2 (22%)	0.60
Male	37(47%)	33 (47%)	4 (44%)	1.00
Associated malformation	21 (27%)	18 (26%)	3 (33%)	0.69
SNAPPE II	15 (9–26)	15 (8–20)	23.5 (14–45)	0.02*

GS = gastroschisis; SGA = small for gestational age considered as ≤10th in Fenton Growth Chart; SNAPPE = Score of Neonatal Acute Physiology Perinatal Extension. Results are expressed by mean (SD), median (IQR) or n (%). *$p < 0.05$.

Table 2 shows the surgery-related characteristics. The median time to the first surgery was not different between the groups, but the size of the defect was significantly smaller in the complex group than in the simple group. Staged abdominal closure with a sutured silo seemed to be more common in the complex group than in the single group, but the difference did not reach significance (p value = 0.05). The duration of the silo was similar in both groups, with a median time of 5 days. There were 2 patients with evisceration, 1 patient with abdominal compartment syndrome and 1 patient with silo dislodgment, all in the simple group. However, reoperation occurred 12 times more frequently in the complex group than in the simple group. Causes for reoperation varied from a second look to intestinal atresia to pneumoperitoneum and adhesive bowel obstruction. There were 6 cases of suspected intestinal atresia at birth, and in all of them, intestinal atresia was confirmed at reoperation.

Table 3 summarizes the nutritional clinical characteristics and the comparison between simple and complex GS patients. The median time to initiate feeding and to reach full enteral feeding was significantly different between the groups, being longer in the complex group than in the simple group. Two patients in the complex group died without reaching full enteral feeding. The median time on TPN was twice as long, and the development of cholestasis associated with TPN was 5 times more frequent in the complex group than in the simple group. The median peak direct bilirubin level was 3.7 mg/dl. Only one patient developed hepatic insufficiency, and the patient was in the complex group. NEC occurred in 6% of all GS patients, and one patient from each group required surgery. Of these patients, one developed short gut syndrome. The majority of the patients discharged were breastfed, either exclusively or complemented with formula.

The use of mechanical ventilation (MV) was similar between the groups, but the duration was significantly longer in the complex group than in the simple group, with the difference being more than double (2.5 × 6.0 days). The number of infectious complications was high in both groups, and there was no significant difference between the groups. One-third of the patients in the simple group and half of the patients in the complex group had proven sepsis. Centrally inserted lines were present in 27/79 (34%) patients, and peripherally inserted lines (PICCs) were present in 73/79 (92%) patients. The median duration of hospitalization was 2.5 times longer in the complex group than in the simple group (31.5 × 78 days). There were three deaths in the complex group and all occurred after the neonatal period, in patients who developed short gut syndrome, with a median number of days to death of 359 (IQR 99–455).

Almost all of the clinical outcomes were significantly worse in the complex group than in the simple group in the univariate analysis, but when we performed the logistic regression analysis, only length of hospitalization was statistically significant (median of 31.5 × 78 days in the simple and complex groups, p < 0.01).

There was no difference between the simple and complex groups with regard to the defect closure method. However, when we divided the patients into groups according to the method of closure of the defect (sutureless vs. any type of suture) and compared the two, the need and duration for mechanical ventilation and the rate of wound infection were significantly lower in the sutureless group, with a tendency toward a lower length of hospital stay. After excluding the complex patients from the analysis, the same results for wound infection and mechanical ventilation persisted. However, the length of hospital stay was no longer significantly different between the groups. These results can be seen in Table 4.

Comparing the two periods, before and after using the sutureless technique, there was no significant difference in the rates of wound infection or in the need or duration of mechanical ventilation, even when we analyzed the two groups (simple and complex GS) separately.

After splitting the patients into two groups according to the reduction method (primary vs. staged, using a silo), the primary reduction group was associated with a significantly shorter time to initiate and reach full feeding, in addition to a significantly decreased wound infection rate and the need and duration of mechanical ventilation (Table 4).

We also analyzed patients according to their gestational age (preterm/n = 40 vs. term/n = 39), and when we compared the two groups, the median time to initiate feeding (19 vs. 15 days, respectively) was the only outcome that was significantly different, being longer in the first group (p = 0.02).

Finally, when we compared patients who were in-born and out-born, a prenatal diagnosis of GS was significantly more common in the in-born group than in the out-born group (100% vs. 70%, respectively). The median age at first surgery (5.0 vs. 19.5 h), rate of cholestasis (12% vs. 40%) and rate of death (1.5% vs. 20%) were also different between the groups, with significantly lower rates in the in-born group than in the out-born group.

Table 2
Surgical-related characteristics.

	GS n = 79	Simple GS n = 70 (89%)	Complex GS n = 9 (11%)	p value
Age at first surgery (h)	5.5 (3.0–15.5)	5.5 (3.5–15.5)	7.0 (2.5–15.5)	0.80
Defect size (cm)	3.0 (2.5–3.75)	3.0 (2.75–3.75)	2.2 (1.75–3.5)	0.04*
Silo	19 (24%)	14 (20%)	5 (55%)	0.05
Duration of silo (days)	5.0 (4.0–6.5)	5.0 (4.0–6.0)	5.0 (4.0–6.0)	0.56
Surgical technique[a]				
- sutureless	34 (43%)	32 (46%)	2 (22%)	0.32
- simple suture	21 (27%)	17 (24%)	4 (45%)	
- retention suture	24 (30%)	21 (30%)	3 (33%)	
Reoperation	13 (16%)	5 (7%)	8 (89%)	< 0.01*

GS = gastroschisis.
Results are expressed by median (IQR) or n (%). *p < 0.05.
[a] There was 1 case of vacuum assisted to help closure of abdominal wall.

Table 3
Nutritional characteristics.

	GS n = 79	Simple GS n = 70 (89%)	Complex GS n = 9 (11%)	p value
Time to initiate feeds (days)	16 (13.5–23.5)	15.5 (12–21)	26 (17.30)	< 0.01*
Full enteral feeds (days)	24 (20.5–31)	24 (20.5–30)	39 [a] (36–192)	< 0.01*
Duration of TPN (days)	23 (16–27.5)	21 (16–26.5)	48 (32.5–365)	< 0.01*
Cholestasis	12 (15%)	7 (10%)	5 (56%)	< 0.01*
NEC	5 (6%)	2 (3%)	3 (33%)	< 0.01*
Feeding at discharge:				< 0.01*
EBM	44 (56%)	43 (61%)	1 (12.5%)	
BM and Formula	24 (31%)	23 (33%)	1 (12.5%)	
Formula	10 (13%)	4 (6%)	6 (75%)	

GS = gastroschisis; TPN = total parenteral nutrition; NEC = necrotizing enterocolitis; EBM = exclusive breast milk; BM = breast milk.
Results are expressed by median (IQR) or n (%). *p < 0.05.
[a] For the ones who reached full enteral feeding (n = 5).

3. Discussion

This study is, to our knowledge, the first prospective case series of gastroschisis patients in Brazil, and it showed similar results to those seen in the international literature in high-income settings [2,3].

The mothers were usually young, with a history of tobacco use and prenatal diagnosis made in almost all cases. The available data do not support a policy of cesarean delivery for infants with gastroschisis, and it should be reserved for the usual obstetrical indications [18], but 67% of our patients had a cesarean section. A planned delivery during daytime hours, with all professionals available, is more readily achieved by cesarean section than by vaginal delivery.

Table 4
Surgical procedures x clinical outcomes.

	Primary closure ($n = 58$)	Silo ($n = 21$)	*P* value	Sutureless (n-34)	Suture (n-45)	*P* value
Time to initiate feeds (days)	14.5 (12.5–20.5)	23 (17.5–30.5)	0.01*	14 (25.5–37)	17 (28–44)	0.08
Full enteral feeds[a] (days)	22 (20–30)	30 (25–43)	< 0.01*	21 (19–29)	25.5 (21–37)	0.08
Duration of TPN (days)	20 (16–25)	28.5 (23.5–35)	0.26	20 (16.5–25)	24.5 (16–30)	0.09
Mechanical Ventilation	40 (70%)	21(100%)	< 0.01*	12 (36%)	38 (71%)	0.01 *
Days on MV	2 (1.5–3)	9 (6.5–14)	< 0.01*	1.5 (0–4.5)	5.0 (2.5–8)	< 0.01 *
Wound infection	4 (7%)	11 (52%)	< 0.01*	2 (6%)	15 (29%)	0.01 *
Sepsis	19 (33%)	8 (36%)	1.00	13 (38%)	18 (33%)	0.81
Length of Hospitalization (days)	31 (25.5–41.5)	41 (28–64)	0.14	30 (25.5–37)	35 (28–44)	0.05
Death [b]	2 (3.5%)	1 (5%)	1.00	0	3 (6%)	0.25

TPN = total parenteral nutrition; MV = mechanical ventilation.
Results are expressed by median (IQR) or *n* (%). * $p < 0.05$.
[a] For the ones who reached full feeding.
[b] All deaths after the neonatal period.

Previous studies have examined whether birthplace affects outcomes, and a few studies have shown that in-born patients have better outcomes than out-born patients [19,20]. The number of out-born patients in our population was small ($n = 10$), but the risk of death was significantly higher with out-born than with in-born ($p = 0.04$) deliveries. Notably, out-born patients were referred to our hospital because they could not be operated upon where they were born since no pediatric surgery was available.

Consistent with previous reports, most registered patients with GS in our population were late preterm (47%) [4] and categorized in the simple group of patients (89%), showing better outcomes than complex patients (11%) [13,21–24]. The study by Arnold et al. combined 2 large national databases of hospital discharge records in the USA and validated the risk stratification system, dividing infants with GS into simple and complex subgroups [21]. The presence of intestinal atresia, necrosis or perforation at birth has been consistently shown to predict poorer outcomes of GS, including ventilator duration, time to initiate enteral feeding, duration of TPN, hospital stay and mortality [13,21–24].

Dysmotility is a type of intestinal dysfunction related to gastroschisis that frequently impairs the beginning and advancement of enteral feeds [25]. Human milk has been shown to decrease the time to achieve full enteral feeds and length of hospital stay [26,27]. Human milk has nutritive and nonnutritive factors that promote survival and healthy development [28]. Based on the benefits of human milk over formula, we developed a nutrition and feeding protocol in our institution prioritizing human milk at the beginning and during advances of feeds. The related outcome rates, such as the median times to initiate feeding, to reach full feeding or to discontinue TPN, in our patients were comparable to those of previous studies [2,3,7,8,10]. We even observed a smaller prevalence (15%) of TPN-associated cholestasis compared to what has been reported previously (up to 28%) [7,10,29].

Constriction of the bowel at the base of the extruded loop in GS has been related to the degree of intestinal damage at birth and the development of dysmotility, but clinical findings do not confirm this hypothesis [30]. However, smaller defects were significantly present in our complex patients, suggesting a role for the defect size in the degree of bowel damage.

GS patients have been reported to be at risk for nosocomial infections [5,31], which are usually associated with a significant proportion of deaths and a prolonged length of hospital stay. Our results showed a high incidence of wound infection and proven sepsis, usually central line-associated bloodstream infections, when compared with results in the international literature [6,31]; however, our results are similar to those of other Brazilian studies [8,32]. We speculate that our high levels of infections were because of the manipulation and poor quality of the central venous line catheter. A focus on developing and implementing guidelines for catheter manipulation has been implemented. Despite our higher infection rates, the length of hospital stay was comparable to that seen by other authors [2,3,7,9,10,12,33].

The current evidence on the best reduction method lacks quality, and the choice of primary or staged reduction is influenced by local practice [34]. In our institution, operative primary reduction is the first option, and staged reduction using a sutured silo is less frequent. In the complex patients, this method was more commonly used owing to the severity of the malformation. The significantly higher degree of wound infection when a silo was in place probably occurred owing to increased manipulation, and the significant increase in the time to initiate and reach full feeding with a silo in place may reflect the higher amount of intestinal inflammation present.

The method of abdominal defect closure changed over the period of our study, with the introduction of the minimally invasive sutureless technique in 2017, and although it was not our goal initially, we were able to compare patients who had undergone both types of techniques. Overall, the results were in favor of the sutureless group, which was associated with significantly fewer episodes of wound infection and a need for and greater duration of mechanical ventilation compared to the sutured group. However, when we analyzed patients separated according to the type of reduction (primary closure vs. silo), as was done elsewhere [35], there was no difference between the sutureless and sutured groups.

Bruzoni et al., at Stanford University, conducted a randomized controlled clinical trial comparing sutureless ($n = 19$) and sutured ($n = 20$) closure among simple GS patients and found lower rates of wound infection (21% vs. 55% $p = 0.048$). However, a significant increase in the time to full feeding and time to discharge among the sutureless group was also observed [36]. In our study, when we analyzed only simple GS patients, there was a significant decrease in the rate of wound infection and duration of ventilation among sutureless patients compared to sutured patients, but there were no differences in the time to full feeding and time to discharge between the groups.

Evidence of the benefits of sutureless closure over sutured closure is suboptimal, but our results favored the modern technique [37–39]. A systematic review and meta-analysis aimed at determining the safety and usefulness of plastic closure (or the sutureless method) in infants with gastroschisis was recently published and suggested that plastic closure may be beneficial for infants with gastroschisis requiring silo formation. However, further studies are needed [35].

The survival rates of GS are reported to be greater than 90% in high-income settings and up to 97% recently [2,3,7,9,10,12,33]. Our results were slightly lower (10/88 = 89%) than that, after excluding the stillbirth patients. However, two deaths were considered inevitable (one patient with extensive intestinal necrosis at birth and another one with disproportion between the abdomen contents and exposed viscera) and among the eight evitable deaths, four occurred in patients who died from complications of short gut syndrome. When we analyzed only the cohort patients there were three deaths among them, resulting in a better survival rate (3/79 = 96%).

Notably, we achieved similar results to high-income settings in almost all outcomes analyzed, despite the difficulties of a low/medium income setting. The survival rate was higher in inborn patients than in out-born patients, which may reflect the difficulty in the care of gastroschisis patients before arrival at a referral hospital such as ours.

The strengths of this study included the prospective nature of the data collection on consecutive patients for almost 3 years at the same institution, the careful collection of the data, the use of a consistent approach for surgical closure and consistent clinical management, including a feeding protocol. However, the limitation of this study was that it was an observational study; therefore, it is possible that uncontrolled confounding factors, such as factors involved in surgical decision-making, could account for some of the differences observed. It was also a single-center study, which limited its generalizability, and the sample size, despite a significant number for a single center, was small.

In this report, only short-term outcomes were assessed, but we are continuing to follow these infants up to two years of age to obtain more data, particularly regarding growth and development. We intend to present these long-term outcome findings soon.

4. Conclusion

This prospective case-series study provided a comprehensive picture of gastroschisis in a Brazilian referral center from birth to discharge, emphasizing the significantly higher risk of morbidity and mortality among complex patients than among simple patients. The study also showed a few advantages of the sutureless technique over the sutured technique for closing the abdominal defect, encouraging its use.

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