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Original Article

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Surgical Complications of Simple and Complex Gastroschisis in Newborn

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ABSTRACT

Objective: *To determine early or late post surgical complications secondary to simple and complex gastroschisis.* ***Methods:*** *The association between early (acid-base disorders, electrolyte disturbances and presence of hypoalbuminemia), and late postnatal complications (respiratory, gastrointestinal, infectious) was investigated in newborn.* ***Results:*** *42 children, 54.8% male, 73.8% premature, average gestational age of 35.6±2.5 gestational weeks of age (GWA), weight 2147±537gr, they have a NICU stay of 192±14 days, PNT of 19.2±20 days, mortality of 26.2%. The frequent immediate postoperative complications were base-acid imbalance; the metabolic acidosis was associated to simple gastroschisis (p=0.049). The complex gastroschisis was associated to necrotizing enterocolitis (p=0.025), surgical closure type (p=0.003), reinterventions (p=0.025).* ***Conclusion:*** *Acid-Base alterations (76.1%), hypoalbuminemia (59.5%) as early complications and Late sepsis (40.4%), cholestasis (26.1%) as late complications are the most common in patients with Gasthoschisis.*

Key words: *Simple, complex, gastroschisis, postsurgical complications*

Yenidoğanlarda Basit ve Kompleks Gastrozisin Cerrahi Sonrası Komplikasyonları

ÖZET

Amaç: *Basit ve kompleks gastrozise sekonder erken ve geç cerrahi komplikasyonları saptamaktır.* ***Yöntem:*** *Erken (asit-baz bozukluğu, elektrolit dengesizliği ve hipoalbuminemi) ve geç postnatal komplikasyonları (solunum, gastrointestinal ve infeksiyöz) arasındaki ikişki yenidoğanlarda araştırılmıştır.* ***Bulgular:*** *42 çocuk, %54.8 erkek, %73.8 prematüre, ortalama doğum yaşı 35.6±2.5, ağırlık 2147±537gr, yenidoğan yoğun bakım kalış süresi 192±14 gün, PNT 19.2±20gün ve mortalite %26.2 idi. En sık acil postop komplikasyon basit gastrosizis ile ilşikili metabolik asidoz idi (p=0.049). Kompleks gastrozisis ile ilişkili komplikasyon nekrotizan enterokolit (p=0.025), cerrahi kapatma şwkli (p=0.025) ve tekrarlayan işlemler (p=0.025) idi.* ***Sonuç:*** *Gastrozisisli hastalarda en yaygın olarak asit baz değişkiliği (%76.1), erken komplikasyon olarak hipoalbuminemi (%59.5) ve geç komplikasyon olarak sepsis(%40.4) ve kolestaz (%26.1) idi.*

Anahtar kelimeler: *Basit, kompleks, gastrozisis, cerrahi sonrası komplikasyonlar*

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INTRODUCTION

Gastroschisis is characterized by eviscerated bowel herniated through a congenital abdominal wall defect invariably to the right of the umbilicus, visceral damage exists secondary to the amniotic liquid exposition (1-2), The evisceration of the stomach, small and large intestine is common, it exact etiology and the moment of the event still remain controversial (3-6).

In recent decades, gastroschisis incidence has increased all over the world, it is reported in 0.4-11.7 cases per 10,000 newborns (2,7-10), predominantly in young women and first pregnancy (11). In women younger than 20 years old the incidence is 0.26 per 10000 newborns, which indicates a strong association with maternal age (12-13). In spite of the increasing frequency on young mothers, it is not universal across all the studies published (14-17). The Mexican prevalence is reported in 5.1 per 10,000 newborns, 50-60% is associated to prematurity or some degree of intrauterine growth restriction, 18% to necrotizing enterocolitis (NEC), intestinal atresia and short bowel syndrome, which significantly increases morbidity (2). Prenatal diagnosis and premature labor secondary to elective caesarean, reduces the complications of gastroschisis and is associated to a better quality in surgical outcome (2).

Gastroschisis is classified into simple, which describes intact bowel that is not compromised or breached. In contrast complex gastroschisis is defined by the presence of one of five criteria: intestinal atresia, necrosis, perforation, stenosis or volvulus. Fortunately, most reports refer to a proportion of 90% for simple and only 10% for complex cases of gastroschisis (18).

The advances in care, closure techniques and PNT contribute to a survival above 90%, even in complex gastroschisis (17-19). The post surgical morbidity is associated to long periods of hospitalization, with mortality from 10 to 25% (18-19).

The surgical treatment to gastroschisis includes visceral reduction into the abdominal cavity and closure of the abdominal wall in one or two stages, immediately after birth or as soon as possible within the first 24 hours from birth, reporting shorter ventilation time, oxygen, intensive cares, and achieving faster enteral feeding and discharge, besides to decrease water loss, and heath of the exposed intestine. However, this is not always possible secondary to the intestinal inflammation grade, the defect size and the general conditions of the newborn (prematurity or low weight), sometimes the primary closure of the abdominal wall is accomplished only in the 53-67%, the rest secondary to other surgical techniques such as closure assisted by plastic me sh or silo. Gastroschisis may occur as an isolated defect or associated to gastrointestinal anomalies in the 10 to 45% (malrotation, intestinal atresia, volvulus or infarct), few times is associated with multiple congenital anomalies, longer PNT and ventilation time, which consequently leads to late complications such as infectious and respiratory (20). Patients with complex gastroschisis have a bigger morbidity, mortality and higher cost of hospitalization compared to patients with simple gastroschisis (2).

The objective of this study is to determine the complications in newborns after surgical treatment of simple and complex gastroschisis in the neonatal intensive care unite.

MATERIAL AND METHODS

From june of 2008 to January of 2013, a transversal, ambilective, study, was performed. Previous authorization by the local committees of investigation was obtained with registration number R-2011-2102-3. A total of 42 patients were treated for gastroschisis and were admitted to the NICU. Maternal variables were analyzed from the clinical file such as: maternal age, number of pregnancy and delivery type. The newborn variables were: sex, gestational age, weight, APGAR at the first and fifth minute, days in the NICU, hospitalization days, days of mechanical ventilation, day of oral take onset, days of parenteral nutrition, defect size, congenital anomalies presence (intestinal associated anomalies and no intestinal), mortality.

The association between simple and complex gastroschisis with early (acid-base disorders, electrolyte disturbances and presence of hypoalbuminemia) and late (respiratory, gastrointestinal, infectious) complications were analyzed, as well as the surgical technique used and reoperations. The exclusion criteria were those newborns that died immediately after birth. Elimination criteria: incomplete information from the clinical file.

We defined as early complication that presented at the first 72 hours and late after 72 hours. The statistical analysis was carried out with the SPSS program version 18.

Table 1. *General characteristics in patients with simple and complex gatroschisis*

n=42	Average	Frequence %
Sex Male		54.8
Gestational average age (weeks±SD)	35.6±2.5	
Premature		73.8
Average weight birth (gr±SD)	2147±537g	
Low weight		66.7
Apgar first minute	6.8±1.7	
Apgar fifth minute	7.9±1.5	
Days in the NICU	19.2±14	
Days of hospital stay	32.5±25	
Mechanical ventilation assited days	10.0±12	
Days of start of oral intake	16.1±17	
Days of total parenteral nutrition	19.2±20	
Size of the deffect	5.1±2.8 cm	
Complex gastroschisis		30.9
Surgical technique: Primary closure wall		42.8
SILO		33.3
SIMIL EXIT		14.2
Plastic mesh		9.5
Reoperation		35.7
Death		26.2

Table 2. *Early complications, simple and complex*

	n=42	Frequence of patients (%)
Acid-base alterations		
Metabolic acidosis	32	76.1
Hypoalbuminemia	25	59.5
Electrolyte disturbances		
Hyponatremia	12	28.5
Hyperkalemia	12	28.5
Hypocalcemia	11	26.1
Metabolic disturbances		
Hyperglucemias	7	16.6
Others		
Hypertriglyceridemia	9	22
Early sepsis	8	19.5
Late complications		
Late sepsis	17	40.4
Cholestasis	11	26.1
Surgical wound infection	7	16.6
Nosocomial Pneumonia	7	16.6
Renal failure	5	11.9
Adherences	7	16.6
Peritonitis	4	9.5
Intestinal Obstruction	6	14.2
Intestinal Perforation	5	11.9
Ileus	6	14.2
Necrotizing Enterocolitis	3	7.1
Dehiscence of the wound	4	9.5

RESULTS

Forty two newborns with gastroschisis, average maternal age of 21.8±4 (16 to 35 years) and 55.3% with their first pregnancy. The caesarean section was performed in 40 cases (95.2%). The 54.1% were male patients, 73.8% prematures with an average gestational age at the time of diagnostic of 34.6±2 weeks, average weight 2147±537g, 28 (66.7%) with low weight. The APGAR at the first minute of 6.8±1.7 and at the fifth minute of 7.9±1.5 (table 1). The 69% of the patients presented simple gastroschisis, the average size deffect was 5.1±2.8 cm. The primary closure of the abdominal wall was posible in 42.9%. 14.3% was realized with the SIMIL EXIT technique, SILO technique in 33.3% and mesh used in 9.5%. The global mortality was 26.2%.

The early postoperative complications were presented in the 92.7% (Table 2), the acid-base disorders, predominantly metabolic acidosis was the main complication, followed by hypoalbuminemia and electrolyte disturbances (hyponatremia was the main electrolyte disturbance). The late complications during hospitalization were infectious and late sepsis the main cause. The gastrointestinal postoperative complications were the presence of adherences, intestinal obstruction, ileus, peritonitis, etc. leading to new surgical procedures in many cases, which delay the enteral feeding. The most common gastroin-

***Table 3**. Abnormalities coexisting in simple and complex gastroschisis*

	Frequency
Intestinal malrotation	*4*
Intestinal atresia	*3*
Stenosed colon	*1*
Meckel's diverticulum	*2*
Not related to gastrointestinal abnormalities	
Arthrogryposis	*2*
Congenital hydrocefalia	*2*
Cardiac abnormalities (DA, VSD, FO, EP)	*5*
Congenital abnormalities	*4*

testinal anomalies associated were the intestinal malrotation and intestinal atresia. Other anomalies were the cardiac problems.

In early complications the metabolic acidosis (simple 25 vs 6 complex), was more associated with simple gastroschisis (x2 ,p=0.049). The complex gastroschisis had greater association with necrotizing enterocolitis (simple 0 vs 3 complex), Fisher (p=0.005). The surgical closure was possible in simple gastroschisis, (x2 ,p=0.003). In complex gastroschisis more reoperations were required, (Fisher, p=0.005). (Table 4,5). Association or correlation? between complex and simple gastroschisis with the NICU stay, hospitalization days, mechanical ventilation days, oral intake start, parenteral nutrition days, were not found. The early and late postoperative complications were not associated with a higher mortality or the gastroschisis type.

DISCUSSION

After surgical correction great losses of water, sodium and proteins exists in the third space and the inflamed thickened intestinal walls. The low serum albumin leads to lower colloid osmotic pressure in plasma, with liquid loss from the extravascular areas, decrease of intravascular volume, rise of intra abdominal pressure contributing to decreased renal perfusion. The presence of hyponatremia is correlated with more days of mechanical ventilation; the albumin administration may improve this situation. Post surgical ileum is also frequent, as well as the intestinal circulation with ischemia and infarct (3,16).

Table 4.Surgical closure type *

	Gastroschisis		
	Simple	Complex	Total
Primary closure	13	5	18
Mesh	0	4	4
Silo	13	1	14
SIMIL EXIT	3	3	6
Total	29	13	42

x^2(p=0.003)

Steady deterioration exists and generally requires prolonged parenteral alimentation, with harmful effects on the intestinal development and growth. Delay on intestinal maturation, enzymatic activity, impaired in the renewal of mucosa, also exists (8,12,22).

The introduction of enteral diet may be difficult secondary to repeated vomits, abdominal distension, intestinal malabsorption and episodes of enterocolitis. Even the minimal enteral nutrition may decrease associated morbidity to parenteral nutrition, may improve intestinal functions, weight gain and tolerance, reduce sepsis episodes, duration of PNT and shortens hospital stay (23,24).

Newborns with gastroschisis remain at considerable risk for cholestasis development. A retrospective review of 59 children with gastroschisis, 16 (28%) developed cholestasis, which predispose these newborns to a deficient postnatal growth. Jensen AR et al, reported that continuous parenteral nutrition induces 2.86 times cholestasis more than those patients administered cyclically, without statistical differences (p = .088). We found similar results in our study, representing a 26.1% of the late complications (25,26) . Peyro JL et al, have commented about the benefits of forward the birth to avoid inflammation of the

***Table 5**. Reoperations**

		Gatroschisis		
		simple	*complex*	*Total*
Reoperation	*no*	*23*	*4*	*27*
	yes	*6*	*9*	*15*
	Total	*29*	*13*	*42*

Fisher (p=0.005)

intestines and neonatal consequences. They suggest that the surgical procedure is performed with less abdominal tension, besides of lesser mechanical ventilation, with average of start of oral intake at the sixth day and an average of PNT of 19.1 days (12). Gastrointestinal complications (intestinal atresia, perforation or resection), presence of no gastrointestinal anomalies, not elective silo (little abdominal cavity which does not allow primary closure), influence on the short-term response (3,12,15, 7). Previous studies have reported treatment with silo associated to less complications and mortality, compared to traditional techniques (12,17,25).

Pastor AC et al. (10) did not find differences between patients treated with silo vs primary closure in association with age, sex, weight, APGAR, PNT time, days of hospitalization, sepsis incidence and necrotizing enterocolitis. In the silo group the mechanical ventilation days were fewer, without statistical significance, allowing abdominal wall closure (10).

There is no evidence about variation of the infectious processes according to the abdominal closure method (early closure vs delayed, closure in the operative room vs closure in NICU) or to the ventilation type or the anesthesia during the abdominal closure.Sepsis has been documented from 7% to 58% and u p to 44% of the positive blood culture. A recent review describes to continue antibiotics until the abdominal defect is closed, even though the current practical patterns are not known (23-25). Prematurity is a factor which influence on the children with gastroschisis response, gestational age, type of delivery and weight at birth. The stay duration in the NICU or the PNT time was not influenced.

Gómez-Alcalá AV et al. reported adynamic ileus in 100% as main postoperative complication, with a average of 14 days ±4.5, all of them required parenteral support, survival of 81.2%. However, we report this complication only in a 14.2% of our patients (26, 2). This is probably due to advances in medical science treatment that can be done preoperatively to the mother. In our hospital we have observed an increase in the incidence of gastroschisis like those reported in the world literature. Maternal age is similar than the reported by Davis RP et al. (8).

The vast majority of the study population was premature, higher than reported by Sekabira (25), a great proportion presented intrauterine growth restriction, which often accompanies the gastroschisis. The complex gastroschisis presented in a low proportion. The primary closure of the abdominal wall was possible in 70.3%, similar to those reported by Sekabira et al. (27), (74%). The SIMIL EXIT technique was performed in 6 patients, which is a manual reduction of the abdominal organs into the abdominal cavity immediately after an elective cesarean, with the fetal-placental circulation support, avoiding the delay between the birth and the surgical resolution, its benefits are described to shorten oral intake onset and discharged. However, bigger studies are necessary (27). A lower mortality was found in our study contrary to those reported by Sekabira et al. (27), with sepsis (43%) as the main cause for mortality. The stay in the NICU, regular hospitalization and parenteral support were prolonged, which delays the onset of oral intake.

The more frequent early complications were metabolic acidosis, which is susceptible to immediate treatment and may contribute to decrease in morbidity. The late complications in general were higher than those reported by Aguinaga et al, the infectious cause were higher than in other series. In this study the enteral feeding was late, factor that influenced the prolonged duration of parenteral nutrition and the higher cholestasis frequency (27).

The complex gastroschisis had greater association with necrotizing enterocolitis in our study than simple gastroschisis. In the literature the etiologies of NEC after gastroschisis repair may be multifactorial, the important related factors are those present in complex gastroschisis such as gastrointestinal anomalies, especially intestinal atresia, presented in 3 patients with complex gastroschisis (28-29). A higher proportion of reoperations were needed in the patients with gastrointestinal complications, unlike those reported in other series.

The surgical technique in simple and complex gastroschisis, is not associated with an improvement with mechanical ventilation days or hospitalization days. However, some series exists which report a strong tendency to lower mechanical ventilation days. Limitations of the study are sample size, lack of long-term follow up in these children.

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