

Outcomes of simple gastroschisis surgical treatment in a highly specialized hospital

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ABSTRACT

Objective. To assess the outcomes of three surgical techniques in the management of simple gastroschisis.

Materials and methods. An observational, descriptive, retrospective, longitudinal study was carried out. Medical records of patients diagnosed with simple gastroschisis and treated with different surgical techniques –Simil-Exit, primary closure, and deferred closure– were reviewed.

Results. 38 gastroschisis patients undergoing either the Simil-Exit (n= 10), the primary closure (n= 11), or the deferred closure (n= 17) techniques were analyzed. The Simil-Exit technique involved a shorter operating time than primary closure and deferred closure. Both Simil-Exit and primary closure patients required a shorter mechanical ventilation time, fewer days of parenteral nutrition, shorter time to oral feeding initiation, and a shorter hospital stay than deferred closure patients. The deferred closure technique had more frequent complications, such as sepsis.

Conclusions. The Simil-Exit and the primary closure techniques demonstrated favorable outcomes in patients with simple gastroschisis. In addition, the former involved shorter operating times, it required less exposure of the small bowel loops to the environment, it was easily reproducible, and it provided a better cosmetic result.

KEY WORDS: Gastroschisis; Surgical procedures, operative; Neonatology.

Material y métodos. Se realizó un estudio observacional, descriptivo, retrospectivo y longitudinal. Fueron revisados los expedientes clínicos de pacientes con diagnóstico de gastrosquisis simple tratados con diferentes técnicas quirúrgicas, Símil-Exit, cierre de pared primario y cierre de pared diferido.

Resultados. Se analizaron los datos de 38 pacientes con gastrosquisis que fueron intervenidos quirúrgicamente con técnica Símil-Exit (n= 10), con cierre de pared primario (n= 11) y con cierre de pared diferido (n= 17). La técnica Símil-Exit mostró menor tiempo quirúrgico que el cierre de pared primario y que el cierre de pared diferido; tanto los pacientes intervenidos con Símil Exit como los de cierre de pared primario, con respecto a los de cierre de pared diferido, requirieron menor tiempo de ventilación mecánica, menor número de días de apoyo con nutrición parenteral, menor intervalo de tiempo para el inicio de alimentación oral y menor tiempo de estancia hospitalaria. La técnica de cierre diferido de pared presentó con mayor frecuencia complicaciones como sepsis.

Conclusiones. La técnica Símil-Exit y el cierre de pared primario mostraron resultados favorables en pacientes con gastrosquisis simple; la primera, además, requirió de menor tiempo quirúrgico, menor exposición de asas intestinales al medio ambiente, fácilmente reproducible y mejor resultado estético.

PALABRAS CLAVE: Gastrosquisis; Técnica quirúrgica; Neonatología.

RESULTADOS DEL TRATAMIENTO QUIRÚRGICO DE LA GASTROQUISIS SIMPLE EN UN HOSPITAL DE ALTA ESPECIALIDAD

RESUMEN

Objetivos. Evaluar los resultados de tres técnicas quirúrgicas para la resolución de gastrosquisis simple.

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INTRODUCTION

Gastroschisis is the most common congenital abdominal malformation. It occurs as an organ herniation through the abdominal wall, typically on the right side, with an intact umbilical cord and no membrane covering it. Gastroschisis incidence and prevalence have experienced a growing trend⁽¹⁻⁴⁾.

Various embryological theories regarding etiology –such as failed embryonic mesenchyme differentiation and abdominal wall folding, vascular disorders, or amnion rupture, among others– have been proposed. However, there is no general consensus^(2,5).

Among the primary elements associated with the presence of gastroschisis, maternal age < 20 years –which has been correlated with the exposure of this age group to predisposing factors such as drug, tobacco, and alcohol abuse– stands out^(6,7).

Embryologically speaking, the physiological herniation of the middle intestine is present before gestational week (GW) 11, which means prenatal ultrasonography between GWs 11 and 12 is the primary study in terms of diagnosis⁽⁸⁾.

Today, delivery timing and approach remain controversial in those cases where gastroschisis is prenatally detected. A good cost-effectiveness relationship has been reported in births scheduled at GW 38^(8,9). However, there is consensus when it comes to advancing birth in patients with a high risk of intestinal injury, thus limiting contact with the amniotic fluid⁽¹⁰⁾.

Gastroschisis has been described to predispose patients to a higher risk of sepsis, necrotizing enterocolitis, growth impairment, malnutrition, late enteral feeding initiation, need for multiple surgeries, use of mechanical ventilation, and long hospital stay^(11,12).

These complications may be less severe if an adequate surgical treatment is implemented. Indeed, surgical treatments have significantly progressed, increasing survival and reducing morbidity. The surgical techniques reported include primary closure –reduction of small bowel loops within the abdominal cavity with definitive wall closure on the first day of life–, deferred closure or “Silo” technique –progressive introduction of the extra-abdominal content within the cavity using a preformed Silastic silo for various days, followed by elective closure⁽¹³⁾–, and the Simil-Exit technique –reduction of the herniated organs while maintaining the support of the fetoplacental circulation to prevent air swallowing when crying and avoid greater difficulty in loop reduction, a technique that has been applied in various Latin-American countries since 2005⁽¹⁴⁾. This study aims to assess the outcomes of the three surgical techniques used for the management of simple gastroschisis.

MATERIALS AND METHODS

An observational, descriptive, retrospective, longitudinal study was carried out. Medical records of patients from the Pediatric Surgery and Neonatology Department were reviewed. Newborns diagnosed with simple gastroschisis undergoing surgery using the Simil-Exit, the primary closure, or the deferred closure techniques in a highly specialized medical unit were included. Patients with complicated gastroschisis –intestinal perforation, intestinal atresia, or intestinal necrosis– were excluded.

Demographic and perinatal variables –gestational age at birth, sex, weight at birth, and Apgar score– were recorded.

The surgical techniques assessed in this study were the Simil-Exit, the primary closure, and the deferred closure techniques.

Simil-Exit technique

The Simil-Exit technique (*ex-utero intrapartum treatment*) involved a total intrapartum reduction of the herniated organs while maintaining the support of the fetoplacental circulation. The loop reduction maneuvers were gently performed to achieve a total organ reduction and organ repositioning with immediate support of the fetoplacental circulation. It started with the reduction of the small bowel within the abdominal cavity on the right side. Only in those cases where the stomach curvature was herniated, gastric reduction was carried out before intestinal reduction.

Umbilical cord ligation for placental circulation interruption was conducted once pulse had ceased or after organ reduction had been completed. Following cord ligation, neonate care was pursued by the neonatologist, with placement of an orogastric probe in all newborns.

Given that gastroschisis had been prenatally detected in all cases, a strict follow-up was established for each patient. Ultrasound criteria for pregnancy completion included intestinal dilatation > 18 mm after GW 30, and presence of parietal inflammation or thickening as this could be a sign of intestinal impairment. In those cases where intestinal dilatation was > 18 mm before GW 34 and there was another indication to perform the Cesarean section scheduled, close fetal monitoring was maintained, and Cesarean section was scheduled at GW 34. Based on prenatal ultrasonography, Svetliza reducibility index (SRI) –calculated according to the largest small bowel loop diameter–, loop wall thickness, and abdominal wall defect size were recorded. If SRI was ≤ 1.5, the Simil-Exit correction was regarded as likely and applicable, and birth was scheduled between GWs 36 and 37; if SRI was > 1.5 and < 2.5, the Simil-Exit correction was regarded as possible and applicable; and if SRI was 2.5, the Simil-Exit correction was regarded as unlikely. If the index was progressively increasing, and before the 2.5 threshold was surpassed, the patient was scheduled for surgery at GW 34 or at the gestational age where it was detected. In those cases where pre-term pregnancy interruption was required, pulmonary maturation completion was prioritized. In the context of this surgical technique, both ultrasound findings and the immediate availability of a surgical team were considered.

Once the mother was in hospital for Cesarean section purposes, a cross-disciplinary team consisting of an obstetrician gynecologist, an adult anesthesiologist, a pediatric anesthesiologist, a neonatologist, and a surgical nursing team was gathered. In all cases, the operating room was prepared with all the human and material resources required for maternal and fetal care. The Simil-Exit technique was attempted in all cases on the maternal surgical

Table 1. General characteristics of the study population.

Variable	All n= 38	Simil-Exit n= 10	Primary closure n= 11	Deferred closure n= 17
Gestational age (weeks) ^a	36 (35-37)	36 (35-36)	37 (35-38)	36 (35-38.5)
Weight at birth (grams) ^a	2,430 (2,310-2,640)	2,592.5 (2,311-2,860)	2,500 (2,269-2,800)	2,400 (2,025-2,662)
APGAR at minute 5 ≥ 8 ^b	36 (94.7)	10 (100)	11 (100)	15 (88.2)
GSex (male) ^b	19 (50)	4 (40)	5 (45.4)	10 (58.8)

^aValues expressed as median and interquartile range. ^bValues expressed as number and percentage.

field to maintain feto-placental circulation, and once loops had been reduced, anesthetic infiltration of the abdominal wall was conducted for abdominal wall closure and plasty⁽¹⁴⁻¹⁶⁾.

Primary closure

Small bowel loop reduction within the abdominal cavity with definitive wall closure on the first day of life.

Deferred closure

Progressive introduction of the extra-abdominal content using a preformed Silastic silo for various days, followed by elective closure.

In all cases, the newborns were delivered by Cesarean section. In all study patients, the first option was the Simil-Exit technique. Only if total loop reduction at birth using this technique was not feasible or if the loops showed signs of serositis, the patient was referred to the operating room to try primary closure.

Once the patient was under general anesthesia and endotracheal intubation, primary closure was attempted according to the peak inspiratory pressure (PIP) of the mechanical ventilator. If PIP was < 20 cm H₂O, once the loops had been reduced and introduced within the abdominal cavity, wall closure was performed. If PIP was ≥ 20 cm H₂O, given the risk of compartment syndrome, decision was made to place the silo and schedule the patient for subsequent deferred closure.

Perioperative (time from birth to wall closure, operating time for abdominal wall closure, mechanical ventilation time) and postoperative (time with total parenteral nutrition support, time from birth to oral feeding initiation, hospital stay) variables, as well as complications following surgery, were recorded.

The outcomes of the various surgical techniques used were assessed by measuring the operating time required for abdominal wall closure, mechanical ventilation time, total parenteral nutrition time, time to oral feeding initiation, total hospital stay, and presence of complications. Outcomes were regarded as favorable when surgery involved

shorter resolution times regarding the variables analyzed and fewer complications.

As for the statistical analysis performed, qualitative variables were expressed as number and percentages, whereas the normality distribution of quantitative variables was determined using the Shapiro test. Data demonstrated to have a free distribution and was therefore reported as median and interquartile range. The NCSS Statistical Software 2024[®] package was used.

Given that medical records were analyzed without any interaction with the patients, the study was regarded as a riskless research, according to article 17 of the Mexican Health Research Regulation. Confidentiality and privacy of patient data were ensured. The research was approved by the Health Research Ethics Committee and the medical unit's Local Health Research Committee.

RESULTS

41 patients diagnosed with simple gastroschisis were analyzed. 3 cases –1 case with intestinal perforation, 1 case with intestinal atresia, and 1 case with intestinal necrosis– were excluded. Of the total of patients included in the study, the Simil-Exit technique was applied in 10 (26.3%) patients, primary closure was used in 11 (29%) patients, and deferred closure was employed in 17 (44.7%) patients. Patient clinical characteristics were similar among the study groups (Table 1). Similar to Svetliza et al.⁽¹⁴⁾, no predominance in terms of sex was observed.

The outcomes of the three surgical techniques were assessed. The Simil-Exit technique involved shorter operating times than primary closure and deferred closure. Regarding other variables analyzed, both the Simil-Exit and the primary closure techniques required fewer days of mechanical ventilation, shorter time with parenteral nutrition support, shorter time from birth to oral feeding initiation, and shorter hospital stay than the deferred closure technique (Table 2).

Complications occurred in 19 (50%) patients in total. Sepsis was more frequent in the deferred closure technique.

Table 2. Outcomes of the surgical techniques used for the management of simple gastroschisis.

Variables	All n= 38	Simil-Exit n= 10	Primary closure n= 11	Deferred closure n= 17
Operating time (minutes)	6 (5-7)	4 (4-5.25)	7 (5-8)	6 (5-7)
Mechanical ventilation (days)	2.5 (0-5)	0 (0-2)	2 (0-4)	4 (2.5-6.5)
Total parenteral nutrition (days)	15.5 (14.2-17.7)	15 (12.75-15.25)	15 (11-17)	17 (15-19)
Oral feeding initiation (days)	13 (12-15)	12.5 (11-13)	13 (10.5-14)	15 (12.5-16)
Hospital stay (days)	26 (22.2-31)	20.5 (18.75-23.25)	25 (21-26)	31 (27-33)

Values expressed as median and interquartile range.

Table 3. Complications associated with the surgical technique used in the management of simple gastroschisis.

Surgical technique	Simil-Exit n= 10	Primary closure n= 11	Deferred closure n= 17
Sepsis, n (%)	3 (30)	2 (18.2)	13 (76.8)
Compartment syndrome, n (%)	0 (0)	1 (9)	0 (0)

Values expressed as number and percentage.

Only 1 case of complications –compartment syndrome– was noted in the primary closure technique (Table 3).

DISCUSSION

Gastroschisis predisposes patients to complications and higher mortality rates as a result of organ exposure to the extra-abdominal environment. The development of sepsis is directly related to the exposure time of small bowel loops to the amniotic fluid. Indeed, sepsis was the most frequent complication in the study patients, predominantly in deferred closure cases^(17,18).

Patient prognosis is correlated with the degree of “*in utero*” intestinal injury, which means prenatal diagnosis, adequate surgical treatment, and postoperative care can have a favorable impact on prognosis, progression, morbidity, and mortality in patients with this complex pathology^(19,20).

Similar to Baeza et al., median gestational age was 36 weeks and median weight at birth was 2,430 g in our study⁽²¹⁾.

Over the years, since it was first documented, various techniques have been proposed for the management of this pathology⁽¹⁷⁾. There are few studies assessing the results achieved in gastroschisis repair using the Simil-Exit technique. Most have been carried out in Latin America since this technique was first described by Svetzila et al., but some of them have a small sample size^(14,22). To our knowledge, there are few studies assessing the outcomes of the three techniques discussed in this paper.

Regarding the time required for organ reduction, median time was similar to that reported by Svetliza et al.⁽¹⁴⁾ with the Simil-Exit technique, with lesser need for mechanical ventilation. In Oliveira et al.’s study⁽¹⁵⁾, patients undergoing the Simil-Exit technique had shorter ventilation times and shorter parenteral nutrition support times than patients undergoing deferred closure, consistent with our results. Rodríguez et al.⁽²³⁾ reported results similar to ours, with a shorter hospital stay and a shorter time to oral feeding initiation when comparing the same surgical techniques as in this paper.

The results achieved with the Simil-Exit and the primary closure techniques prove advantageous for simple gastroschisis patients in terms of the variables analyzed in this study. Even though the results regarding the variables assessed were similar between the Simil-Exit and the primary closure techniques –except for the operating time required for wall closure–, a tendency towards shorter times with the former can be observed. This results in a shorter exposure of small bowel loops to the environment, easier reproduction, and better cosmetic outcomes. Overall, the results were more favorable with the Simil-Exit and the primary closure techniques. Therefore, in our view, gastroschisis should be managed using either of these techniques in order to prevent the inflammation of the small bowel loops exposed to the amniotic fluid, thus facilitating reduction within the abdominal cavity while fetoplacental circulation is maintained, without the need for general anesthesia or mechanical ventilation, as it is the case with the Simil-Exit technique.

It is worth noting that sepsis is not regarded as a direct complication of the surgical technique. However, its presence within these procedures in relation with the risk of pathogen exposure can be evidenced. Our study showed a shorter resolution time and a lower frequency of sepsis with the Simil-Exit and the primary closure techniques, but the former significantly reduces small bowel loop exposure to the environment. This lowers the risk of injury as a result both of exposure and of reduced distension and potential injuries in subsequent procedures. It should be highlighted that the defect requires no enlarging with the Simil-Exit technique, which means the cosmetic outcomes are potentially more favorable than with the other two techniques. Therefore, we believe this aspect should be approached in future papers.

It should be noted that the availability of a cross-disciplinary team allows for better results in the management of this pathology. Given that there are few studies assessing the outcomes of the Simil-Exit technique, comparing the aforementioned results is uneasy.

Regarding our study limitations, patient follow-up was conducted during postoperative hospital stay only, and therefore, this should be considered in future papers. A longer follow-up period would be required to assess other types of complications or potential benefits over time with the use of the Simil-Exit or the primary closure techniques to provide these patients with a better treatment option.

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REFERENCES

1. Stallings EB, Isenburg JL, Short TD, Heinke D, Kirby RS, Romitti PA, et al. Population-based birth defects data in the United States, 2012–2016: A focus on abdominal wall defects. *Birth Defects Res.* 2019; 111(18): 1436-47.
2. Khan FA, Raymond SL, Hashmi A, Islam S. Anatomy and embryology of abdominal wall defects. *Semin Pediatr Surg.* 2022; 31(6): 151230.
3. Clark RH, Sousa J, Laughon MM, Tolia VN. Gastroschisis prevalence substantially decreased from 2009 through 2018 after a 3-fold increase from 1997 to 2008. *J Pediatr Surg.* 2020; 55(12): 2640-1.
4. Li N, Chen YL, Li J, Li LL, Jiang CZ, Zhou C, et al. Decreasing prevalence and time trend of gastroschisis in 14 cities of Liaoning Province: 2006-2015. *Sci Rep.* 2016; 6: 33333.
5. Chuairé Noack L. Nuevas pistas para comprender la gastrosquisis. *Embriología, patogénesis y epidemiología.* *Colomb Med.* 2021; 52(3): e4004227.
6. Baldacci S, Santoro M, Coi A, Mezzasalma L, Bianchi F, Pierini A. Lifestyle and sociodemographic risk factors for gastroschisis: A systematic review and meta-analysis. *Arch Dis Child.* 2020; 105(8): 756-64.
7. Raitio A, Tauriainen A, Leinonen MK, Syvänen J, Kempainen T, Löyttyniemi E, et al. Maternal risk factors for gastroschisis: A population-based case-control study. *Birth Defects Res.* 2020; 112(13): 989-95.
8. Kirolos DW, Abdel-Latif ME. Mode of delivery and outcomes of infants with gastroschisis: A meta-analysis of observational studies. *Arch Dis Child Fetal Neonatal Ed.* 2018; 103(4): F355-63.
9. Harper LM, Goetzinger KR, Biggio JR, Macones GA. Timing of elective delivery in gastroschisis: A decision and cost-effectiveness analysis. *Ultrasound Obstet Gynecol.* 2015; 46(2): 227-32.
10. Vila-Carbó JJ, Hernández E, Ayuso L, Ibáñez V. Impacto en nuestro medio de un protocolo de manejo terapéutico de la gastrosquisis. *Cir Pediatr.* 2008; 21(4): 203-8.
11. Lap CCMM, Brizot ML, Pistorius LR, Kramer WLM, Teeuwen IB, Eijkemans MJ, et al. Outcome of isolated gastroschisis; an international study, systematic review and meta-analysis. *Early Hum Dev.* 2016; 103: 209-18.
12. Fullerton BS, Velazco CS, Sparks EA, Morrow KA, Edwards EM, Soll RF, et al. Contemporary outcomes of infants with gastroschisis in North America: A multicenter cohort study. *J Pediatr.* 2017; 188: 192-7.
13. Allin BSR, Opondo C, Kurinczuk JJ, Baird R, Puligandla P, Skarsgard E, et al. Management of gastroschisis: Results from the NETS2GStudy, a joint British, Irish, and Canadian prospective cohort study of 1268 infants. *Ann Surg.* 2021; 273(6): 1207-14.
14. Svetliza J, Palermo M, Espinosa AM, Gallo M, Calahorra M, Guzmán E. Procedimiento Símil-Exit para el manejo de la gastrosquisis. *Rev Iberoamericana de Medicina Fetal y Perinatal.* 2007; 1(1): 7-12.
15. Oliveira GH de, Svetliza J, Vaz-Oliani DCM, Liedtke Junior H, Oliani AH, Pedreira DAL. Novel multidisciplinary approach to monitor and treat fetuses with gastroschisis using the Svetliza Reducibility Index and the EXIT-like procedure. *Einstein.* 2017; 15(4): 395-402.
16. Svetliza J, Espinosa AM, Gallo M, Vélez MA. New perinatal management by the procedure Simil-EXIT. *Rev Colomb Salud Libre.* 2011; 10: 11-22.
17. Villela Rodríguez J, Salinas López MP, Navas MAR. Evolución médico-quirúrgica de neonatos con gastrosquisis acorde al tiempo, método de cierre abdominal y compromiso intestinal: seis años de experiencia. *Cir Pediatr.* 2009; 22: 217-22.
18. Al Maawali A, Skarsgard ED. The medical and surgical management of gastroschisis. *Early Hum Dev.* 2021; 162: 105459.
19. Cohen-Overbeek TE, Hatzmann TR, Steegers EAP, Hop WCJ, Wladimiroff JW, Tibboel D. The outcome of gastroschisis after a prenatal diagnosis or a diagnosis only at birth. Recommendations for prenatal surveillance. *Eur J Obstet Gynecol Reprod Biol.* 2008; 139(1): 21-7.
20. Robertson JA, Kimble RM, Stockton K, Sekar R. Antenatal ultrasound features in fetuses with gastroschisis and its prediction in neonatal outcome *Aust N Z J Obstet Gynaecol.* 2017; 57(1): 52-6.
21. Baeza-Herrera C, Cortés-García R, María del Carmen Cano-Salas D, Manuel García-Cabello L, Martínez-Leo B. Gastros-

- quisis. Su tratamiento en un estudio comparativo. *Acta Pediatr Mex* 2011; 32(5): 266-72.
22. Durmaz LO, Brunner SE, Meinzer A, Krebs TF, Bergholz R. Fetal Surgery for gastroschisis-A review with emphasis on minimally invasive procedures. *Children* 2022; 9(3): 416.
23. Rodríguez Y, Álvarez L, Pérez R, Barbera M. Gastrosquisis: Experiencia en el manejo quirúrgico. Servicio de Cirugía Pediátrica. Hospital Universitario "Dr. Alfredo Van Griken". Período Enero 2009 – Octubre 2018. *Revista Arbitrada Interdisciplinaria de Ciencias de la Salud Salud y Vida*. 2019; 3(6): 20.