Chirurgia (2015) 110: 151-156
No. 2, March - April

Birth Weight, Compromised Bowel and Sepsis are the Main Variables Significantly Influencing Outcome in Gastroschisis

E. Țarcă, I. Ciongradi, S.G. Aprodu

"Gr. T Popa" University of Medicine and Pharmacy Iassy, Faculty of Medicine, Mother and Child Department, Discipline Pediatric Surgery and Orthopedics, Iassy, Romania
"Sf. Maria" Emergency Children Hospital, Clinic of Peditric Surgery and Orthopedics, Iassy, Romania

Rezumat

Greutatea la naștere, prezența anselor intestinale compromise și sepsisul sunt principalii factori care influențează prognosticul laparoschizisului

Introducere: Deşi rata supraviețuirii pacienților cu laparoschizis s-a îmbunătățit la peste 90% în țările dezvoltate, o rată ridicată a mortalității şi morbidității, respectiv cu perioade prelungite de spitalizare şi costuri aferente ridicate sunt încă regula în România.
Metode: Studiu analitic retrospectiv al tuturor pacienților cu laparoschizis tratați în clinica noastră între 1990 şi 2012. Au fost analizate: datele demografice, diagnosticul antenatal, rata prematurității, tipul naşterii, greutatea la naştere, anomaliile asociate, momentul intervenției chirurgicale, afectarea anselor intestinale, tipul intervenției chirurgicale, complicațiile post-operatorii, alimentația enterală, perioada de spitalizare, mortalitatea.
Rezultate: 115 nou-născuți cu laparoschizis au fost tratați în intervalul celor 23 de ani. Diagnosticul antenatal a fost efectuat doar în 13 cazuri, la o vârstă gestațională de 25 săptămâni în medie. Naşterea a fost naturală în 80,8% din cazuri. Malformații asociate au fost prezente la 47 pacienți, iar 24 nou-născuți aveau laparoschizis complex. S-a efectuat închidere primară în 90 cazuri (79%), la restul de 24 pacienți s-a aplicat metoda Schuster. Rata supraviețuirii a fost de doar 29,8%, cauza principală a decesului fiind sepsisul sever cu insuficiență multiplă de organ (61,4%) şi bronhopneumonia (52,6%). Rata complicațiilor postoperatorii, necesitând reintervenție a fost de 19,3%.
Concluzii: Analiza factorilor de risc prin regresie logistică demonstrează faptul că greutatea mică la naştere creşte riscul complicațiilor postoperatorii de 17,4 ori, sepsisul creşte acest risc de 12,2 ori şi prezența anselor intestinale compromise (laparoschizis complex) de 5,5 ori.

Cuvinte cheie: laparoschizis complex, morbiditate, mortalitate, nou-născut, factori de risc, sepsis

Abstract

Background: The survival rate for gastroschisis has improved to more than 90% in the developed countries, but increased mortality, morbidity, consequent long hospitalisation and high costs are the rule in Romania.
Methods: Analytic retrospective study of all patients with gastroschisis treated at our department between 1990 and 2012. The study protocol included: demographic data, antenatal diagnosis, prematurity, mode of delivery, birth weight, associated anomalies, time to surgery, presence of compromised bowel, type of repair, post-operative complications, time to full enteral feeding, length of hospitalisation, mortality.
Results: 115 newborns with gastroschisis were treated during 23 years. Antenatal diagnosis was made only in 13 cases at a mean gestational age of 25 weeks. Delivery was vaginal in 80.8%. Associated malformations were present in 47 patients. Twenty-four patients had complex gastroschisis.

Corresponding author: Assistant Professor Elena Țarcă, MD
"Gr. T. Popa" University of Medicine and Pharmacy Iassy
"Sf. Maria" Emergency Children Hospital
Clinic of Pediatric Surgery and Orthopedics
Iassy, Vasile Lupu Street, no 62
E-mail: elatarca@gmail.com

Primary repair was done in 90 cases (79%) and in 24 patients a silo was used. Overall survival was only 29.8%, the main cause of death being severe sepsis with multiple organ failure (61.4%) and bronchopneumonia (52.6%). The rate of complications associated with closure, needing reintervention was 19.3%.
Conclusions: Analysis of risk factors by logistic regression showed that low birth weight increased the risk of post-operative complications 17.4 times, sepsis increased the risk of complicated postoperative course 12.2 times, and the presence of compromised intestinal loops (complex gastroschisis) 5.5 times.

Key words: complex gastroschisis, morbidity, mortality, neonate, risk factors, sepsis

Introduction

The survival rate in gastroschisis in the developed countries has improved to more than 90%, and still a very high morbidity and mortality is common in our country, probably because of the late closure of the abdominal wall, sepsis, abdominal compartment syndrome and gastrointestinal complications, which are frequently present, with consequent morbidity or long period of hospitalisation (1-3). The presence of prematurity, low birth weight or complex gastroschisis have been recognized as factors associated with bad outcome, but it seems that there are still other factors associated with adverse prognosis and high mortality (4,5). This study aimed at finding the causes and further reducing the high rate of perinatal morbidity and mortality associated with gastroschisis, and also at performing an adequate risk stratification of patients, with utility in counseling young families, predicting hospital stay and identifying those group of patients who would benefit from further strategies to improve bad outcomes.

Materials and Methods

We conducted a retrospective study of the neonates with gastroschisis treated at the Pediatric Surgery Department of „Saint Mary" Children Hospital between 1990 and 2012. Patient data extracted from case report forms were processed statistically, and the antenatal diagnosis, demographic data, prematurity, mode of delivery, birth weight (BW), associated anomalies, time to surgery, presence of compromised bowel, type of repair, post-operative complications (PC), time to full enteral feeding (TFE), length of hospitalisation (LH) and mortality were analyzed. Statistical analysis was performed using SPSS for windows and Microsoft Excel. Data were analyzed with the use of Chisquare, Fisher's exact and Mann–Whitney U tests for categorical variables and with the independent sample t test for continuous variables. We performed logistic regression analysis to identify independent predictors for adverse outcome and to establish relative risk factors. The used level of statistical significance was $p \leq 0.05$. Patients came from seven counties, being referred immediately after birth for specialized treatment in our clinic. After birth the herniated organs are washed with saline solution and protected with sterile moistened gauze to minimize heat and fluid loss, and when the baby is hemodynamically stable is sent for surgical intervention. Primary closure was attempted as a rule, based on the ease of reduction of abdominal contents as judged by the pediatric surgeon and arterial oxygen saturation and the need for increased ventilatory pressures, objectively assessed by the anesthetist. If excess abdominal tension with compromised ventilation or disproportional abdominal cavity were noted, the Gross method, the use of umbilical cord as a patch, or a delayed closure with placement of a silo were performed. PC included the need for re-intervention (abdominal compartment syndrome, ulceronecrotic enterocolitis, wound dehiscence, evisceration), short bowel syndrome, intestinal obstruction or perforation. Compromised bowel means the presence of perforation, necrosis, volvulus, intestinal atresia or a combination of these – complex gastroschisis (4).

This study was ethically approved by our Institutional Ethics Committee.

Results

One hundred and fifteen newborns with gastroschisis were admitted during the 23 years; 114 were eligible for the study, one patients with lethal chromosomal anomaly (trisomie 18) being excluded from analysis. The male/female ratio was 1.37. The mean maternal age was 20.6 years, 40% were unmarried, and 15% of the parents consumed alcohol and tobacco before and during the pregnancy. Gastroschisis was antenatally diagnosed in only 11.4% of cases, and the antenatal diagnosis rate was two-fold in urban as compared to rural children. Antenatal diagnosis of a fetus with gastroschisis significantly correlated with term delivery (p=0,038). Delivery was vaginal in 80.8% of the cases. Mean gestational age (GA) at birth was 36.5 weeks, and mean BW 2329,2 grams. Associated anomalies (except intestinal ones) were found in 47 patients including three patients with chromosomal anomalies; 24 patients (21%) had complex gastroschisis (*Table 1*). Mean time to intervention was 7.18 h, but there was a significantly two hour difference in favor of survivors compared with deceased (5.88 versus 7.82 hours, p=0.012). Primary repair (Gross method and the use of umbilical cord as a patch -15,78%, included) was successful in 90 patients (79%), and in 24 patients (21%) a silo was applied. As to the LH and survival rates, the differences were not statistically significant for primary closure versus Schuster method (p=0.758, and 0.279 respectively); but with a higher rate (15% more) of PC in the patients treated by the Schuster method (p=0.037). The median LH for all the survivors was 26.5 days; mean LH of survivors was 27.07 days for simple gastroschisis and 42.87 days for complex gastroschisis (mean 30.79 days in total). The mean LH of antenatally diagnosed infants was 35.15 days compared to 19.49 days (p=0.042), due to the significantly higher survival rate in the first group (61.5% versus 25.7%, p=0.008).

Table 1. *Patient characteristics*

Gender - 66 M/48 F
Urban area – (31.5%), n=36
Prenatal diagnosis - (11.4%), n=13
Mean maternal age (years) – 20.6 (13–31); (41.2% < 20 years, n = 47)
Primigravida – 65.7%, n = 75
Normal birth - (80.8%), n=92
Preterm baby (<259 days) – 42.1%
Mean gestational age (weeks) – 36.5 (29–41.5)
Mean birth weight (g) – 2329.2 (1500–3700); LBW (<2500 g) – 64.9%
Associated anomalies - (41.2%), n= 47
Trisomie 18 – n=1 (excluded)
Scheletal anomalies – n=13
Cardiac defects - n=12
Congenital megacolon or intestinal neurodisplasia – n=5
Undescended testis – n=4
Renal anomalies – n=3
Hydrocephalus – n=2
Complex gastroschisis- (21%), n= 24; (including intestinal atresia – n=15)
Mean time to intervention (h) – 7.18
Schuster method- (21%), n=24
Mean TFE (days) – 22.6
Median LH (days) – 26.5
Survival rate – 29.8%, n=34

Table 2. *Post-operative and medical complications - n (%)*

Post-operative complications - 87 (76.3%)
Closure-related complications – 31: reintervention – 22 (19.3%)
Intestinal occlusion needing reintervention - 14
Abdominal compartment syndrome - 10
Evisceration - 10
Anastomotic disruption requiring surgical reintervention - 6
Short bowel syndrome - 6
Mortality - 80 (70.2%)
Bronchopneumonia with severe respiratory failure - 60
Severe sepsis and multiple organ failure - 70
Ulceronecrotic enterocolitis - 21
Ventricular hemorrhage, septic meningitis - 16
Abdominal compartment syndrome - 9
Bowel resection incompatible with life - 5

The post-operative course was uncomplicated in 27 patients (23.7%) and complicated in 87 patients (76.3%) (*Table 2*). Complications associated with closure occurred in 31 patients (necrosis and/or perforation of the bowel post-operatively, evisceration or anastomotic leakage), 10 patients developed an abdominal compartment syndrome, of whom nine died. In 20 of the 24 patients with complex gastroschisis primary resections and anastomoses or stomies were performed, the mortality rate being 66.7%. In six of the patients with complex gastroschisis the short bowel syndrome occurred following surgery, and only one of these survived. Overall survival was only 29.8%, the main cause of death being severe sepsis with multiple organ failure (61.4%) and bronchopneumonia (52.6%). The rate of PC was higher in case of vaginal delivery - p=0.034, and low birth weight (LBW) newborns showed 30% more complications compared to those with normal BW (p=0.0001). Although all patients received upon admission an association of at least two broad-spectrum antibiotics, 41.1% of the survivors and 70% of the deceased infants developed severe nosocomial sepsis (61.4% of total). Forty-two patients (36,8%) had positive cultures, the most common isolated germs being Candida spp, Klebsiella pneumoniae, Escherichia coli, Pseudomonas aeruginosa.

We analised the influence of some factors on the outcome parameters: PC, TFE, LH (*Table 3*). Natural birth, preterm labour, LBW and type of closure were not significantly different for TFE or LH. The group of patients with complex gastroschisis, as those with intestinal atresia only had a longer TFE than those with simple gastroschisis. Sepsis developed in 61.4% of the patients, being primarily related to delivery in other hospitals, inadequate transportation of the newborn, delayed surgery, and central line infections. The group with sepsis had a more complicated postoperative course (p=0.001, Fisher's exact test) and a longer LH (p=0.016), with a delayed TFE (p=0.012). To detect those factors which significantly influence the postoperative course we applied a regression model (logistic regression analyses). The independent variables were: type of birth, GA, BW, surgical approach, presence of intestinal atresia and compromised loops, occurrence of sepsis. Interpretation consists in the use of exponentiated values of the coefficients (representing relative risk ratios). Results: if BW is below normal then there is a 17.4 times higher risk of postoperative complications. The occurrence of sepsis increases the risk of a complicated postoperative course by 12.2 times, and the presence of compromised intestinal loops increases this risk by 5.5 times (*Table 4*).

Table 3. *Comparison of risk factors by post-operative complications (PC), time to full enteral feeding (TFE) and length of hospitalisation (LH)*

	PC (n, patients)		TFE (median, days) – for survivors		LH (median, days) – for survivors	
Independent variable	**Yes/No**	**P value**	**Yes/No**	**P value**	**Yes/No**	**P value**
Preterm delivery	40/47	0.133	25/22	0.566	29/26	0.782
Natural birth	74/13	0.034	23/21	0.695	27/26	0.368
LBW	65/22	0.000	20/23	0.622	23/29	0.435
Primary closure	38/49	0.037	22/29	0.716	26/29	0.758
Compromised bowel	21/66	0.147	30/19	0.013	35/25	0.201
Intestinal atresia	13/74	-	33/21	0.027	38/26	0.236
Sepsis	61/26	0.001	29/18	0.012	34/22	0.016

Table 4. *Variabiles significantly influencing the postoperative course*

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
Birth weight	2.861	.708	16.315	1	.000	17.483	4.362	70.077
Compromised bowel	1.705	.883	3.731	1	.053	5.500	.975	31.011
Sepsis	2.508	.692	13.152	1	.000	12.281	3.166	47.631
Constant	-1.905	.690	7.619	1	.006	.149		

Discussion

Most demographic and clinical features of our study patients with gastroschisis are perfectly consistent with the literature data. Studies worldwide have reported an increasing incidence and prevalence of anterior abdominal wall defects, especially gastroschisis (6, 7). The male predominance has been demonstrated, with a maximum of 1.68 found by Torfs (8); in our study the male/female ratio was 1.37/1. The mean maternal age was 20.6 years, similar to that reported by Suita, 20.6 ± 4.9 years (9). Most authors state that maternal age below 20 years is associated with a high risk for gastroschisis (10), in our study 41.2% of the mothers being younger than 20 years, 65.7% primigravida, 40% unmarried, and parental tobacco and alcohol use was 15% (10). Primiparity is a risk factor for gastroschisis, in a study by Axt 89% of the mothers being primiparous (11). The risk for gastroschisis is higher in socioeconomically disadvantaged women, probably accounted for by low maternal age, frequent drug and tobacco use, lack of family planning in this population, lower living standards and unmarried status (8, 12-14); 68.5% of our children with gastroschisis came from rural areas, and prenatal detection rate was twofold greater in urban than in rural infants. Likely, all these socioeconomic factors have negatively influenced the rate of going to a doctor by mothers, with negative impact on the subsequent evolution of cases.

We demonstrated a statistically positive correlation between the prenatal diagnosis of gastroschisis and the close to term birth by caesarean section; also the rate of PC was higher in case of vaginal delivery. While other authors failed describing lower proportions of damaged bowel in caesarean sections (15-17), the results described in this manuscript could be related to the fact that those newborns had not prenatal diagnosis and vaginal delivery was elected. In a series reported by Tan, a significant intrauterine growth retardation was found in 31.9% of fetuses with gastroschisis, this being later reinforced by the fact that one-third of children will be born prematurely (18). These figures are significantly higher in our series, the likely explanations being the lower socioeconomic status in our country, absence of ultrasound pregnancy monitoring, and probably the higher rate of therapeutic abortion in developing countries, the latter fetuses nor being considered. However, a mean 36.5 weeks GA at birth versus 37 weeks, average weight of 2329.2 grams versus 2490 grams, frequency of associated malformations, 80.8% vaginal delivery rate versus 74%, and even our treatment approaches are similar to a Dutch study, the only difference being in prenatal diagnosis rate (68% versus 11.4%) (19). Mortality rate for congenital anomalies of the anterior abdominal wall decreased to 6-7% for gastroschisis, but these good results are recorded in developed countries where the prenatal diagnosis rate exceeds 60% (69% for omphalocele and 88% for gastroschisis in Germany), allowing birth planning and optimal medical and surgical management (20). In most developing countries the mortality rate is still high, reaching 20% for omphalocele and 80% for gastroschisis (21).

In 5-25% of cases gastroschisis is associated with intestinal atresia and stenosis (13.2% in our study), which may be simple or multiple atresias. Morbidity and mortality are higher for complex gastroschisis, due to intra-abdominal infections and sepsis, gastrointestinal bleeding, abdominal compartment syndrome, respiratory distress (4). The presence of multiple intestinal atresias predispose the patient to the further development of short bowel syndrome and malabsorption. Numerous authors recommend first-line resection and primary anastomosis not to be attempted, but delayed as a second surgical step a few weeks after primary closure. Although in our study group 20 of the 24 patients with complex gastroschisis underwent primary resection and anastomosis or stomies, the rate of reintervention for complication (37.5%) was similar to that in the literature, the same not being true for mortality rate. A quarter of patients with complex gastroschisis developed short bowel syndrome following surgery, and only one survived, intestinal transplantation not being available in our country. The frequency of abdominal compartment syndrome following primary abdominal wall closure was high in the study group, and nine of the 10 patients died. Primary closure complications can be minimized by objective measurement of perioperative intra-abdominal pressure. According to Olesevich, intra-operative measurement of bladder pressure improves safety of primary closure, prevents bowel loops ischemia and shortens the time to TFE and LH (22). Although intraoperative measure of bladder pressure is an easy and inexpensive way to improve safety of primary closure, unfortunately not all our surgeons perform this routinely. Obviously, the LH depends on gastroschisis type: between 10 and 50 days for simple gastroschisis and about 162 days for complex gastroschisis, with an overal average of about 42 days (2). A study in the UK reported an average LH of 36 days for simple gastroschisis and 84 days for complex gastroschisis (23); in our study the LH for the survivors with simple gastroschisis was of 27.07 days while for those with complex gastroschisis 42.87 days. The type of abdominal wall closure also used to be a predictor of the LH for gastroschisis (24), but in recent years

the gap is getting smaller due to changes in the management strategies. Thus, in a recent study the average LH was 34 days for patients with primary closure and 38 days for silo method (23). In our study the difference was not statistically significant either in terms of LH or survival rates, but the rate of PC was higher in patients treated by the Schuster method (p=0.037), accounted for by the greater complexity of the cases included in this group (possibly bias selection). Usually surgical decision is based only on the degree of visceroabdominal disproportion and association of intestinal abnormalities. When intra-abdominal pressure measurement is not possible, very good results can be obtained by covering the abdominal wall defect with an umbilical cord patch, readily available autologous material to the patient and surgeon, allowing an increase in the volume of peritoneal cavity (25, 26). This way the umbilical scar will be circumferential and esthetically the result will be excellent with a scar-free abdomen and belly button in the correct position (27). In 15.78% of our study patients the abdominal wall defect was covered with umbilical cord patch, the postoperative results being similar to those obtained in patients treated with other surgical methods, including primary closure.

The most common complications in the management of gastroschisis are the infectious ones, being correlated with the initial status of the patient or therapeutic method adopted. Although demographics, surgical management and PC rate in our study are similar to other studies (19, 28), the mortality rate was very high (70.2%), the patients dying of severe sepsis and multiple organ failure or bronchopneumonia, due to nosocomial infections favored by newborn ambulance transport, sometimes for long distances in improper conditions, prolonging the time to surgery (we demonstrate a significantly two hour difference in favor of survivors compared with deceased). In a recent study was demonstrated the importance of early abdominal wall closure on the rate of infectious complications: 21.2% infection rate for delayed surgical intervention versus 8.2% in patients in whom the abdominal wall was closed within the first six hours of life (29). Many of these infections can be avoided by strictly observing the rules of perioperative asepsia and antisepsia, by reinforcing central lines care or contact precautions and by systematic antibiotic therapy under antifungal protection when antibiotics are administered for a long time.

Several other factors have been found to be associated with adverse outcome, including marked prematurity, mode of delivery and method of closure (4, 5). In this study we aimed at investigating the influence of certain personal factors, surgical approach or occurrence of sepsis on the postoperative course of gastroschisis patients, obtaining the following results: postoperative course was significantly better and with a lower mortality or surgical reintervention rate in children born by cesarean section, of normal BW, in which complete reintegration and primary abdominal wall closure were successful and who did not develop postoperative sepsis. Using a regression model we showed that: LBW generates a 17.4 times higher risk of developing PC, the occurrence of sepsis increases 12.2 times the risk of a complicated postoperative course, and the presence of compromised intestinal loops increases the risk 5.5 times.

Conclusion: regression analysis of some possible risk factors demonstrated that the presence of compromised bowel, sepsis, and especially LBW were associated with a complicated postoperative course. Risk stratification of patients with gastroschisis in our country appears possible, based on the presence of these factors. We must also emphasize the importance of antenatal diagnosis and early abdominal closure in terms of survival and infection. Further studies on congenital malformations in general, on the modalities of diagnosing and treating them, and on the causes of such a high morbidity and mortality are needed given the fact that these malformations are an important factor of neonatal mortality.

The work was performed at "Sf. Maria" Emergency Children Hospital, Clinic of Pediatric Surgery and Orthopedics, Iassy. This study was ethically approved by our Institutional Ethics Committee. There is no financial support used for the study. There is no conflict of interest.

References

1. Snyder CL. Outcome analysis for gastroschisis. J Pediatr Surg 1999; 34(8):1253-6.
2. Driver CP, Bruce J, Bianchi A, et al. The contemporary outcome of gastroschisis. J Pediatr Surg 2000; 35(12):1719-23.
3. Mungnirandr A, Khorana J, Ruangtrakool R. Correlation between duration of postoperative parenteral nutrition and incidence of postoperative complication in gastroschisis patients. J Med Assoc Thai 2010; 93(4):443-8.
4. Molik KA, Gingalewski CA, West KW, et al. Gastroschisis: a plea for risk categorisation. J Pediatr Surg 2001; 36(1):51-5.
5. Singh SJ, Fraser A, Leditschke JF, et al. Gastroschisis: determinants of neonatal outcome. Pediatr Surg Int 2003; 19(4):260-5.
6. Goldkrand JW, Causey TN, Hull EE. The changing face of gastroschisis and omphalocele in southeast Georgia. J Matern Fetal Neonatal Med 2004; 15(5):331-5.
7. Tan KBL, Tan KH, Chew SK, et al. Gastroschisis and omphalocele in Singapore: a ten-year series from 1993 to 2002. Singapore Med J 2008; 49(1):31-6.
8. Torfs CP, Velie EM, Oechsli FW, et al. A population-based study of gastroschisis: demographic, pregnancy and life-style risk factors. Teratology 1994; 50:44-53.
9. Suita S, Okamatsu T, Yamamoto T, et al. Changing profile of abdominal wall defects in Japan: results of a national survey. J Pediatr Surg 2000; 35(1):66-71.
10. Forrester MB, Merz RD. Epidemiology of abdominal wall defects, Hawaii, 1986-1997. Teratology 1999; 60:117-23.
11. Axt R, Quijano F, Boos R, Hendrik HJ, et al. Omphalocele and gastroschisis: prenatal diagnosis and peripartal management. A case analysis of the years 1989-1997 at the Department of Obstetrics and Gynecology, University of Homburg/Saar. Eur J Obstet Gynecol Reprod Biol 1999; 87(1):47-54.
12. Di Tanna GL, Rosano A, Mastroiacovo P. Prevalence of gastroschisis at birth: retrospective study. BMJ 2002; 325(14):1389-90.
13. Draper ES, Rankin J, Tonks AM, et al. Recreational drug use: a major risk factor for gastroschisis? Am J Epidemiol 2008; 167(4):485-91.
14. Lam PK, Torfs CP: Interaction between maternal smoking and malnutrition in infant risk of gastroschisis. Birth Defects Res

A Clin Mol Teratol 2006; 76(3):182-6.
15. How HY, Harris BJ, Pietrantoni M, Evans JC, Dutton S, Khoury J, Siddiqi TA. Is vaginal delivery preferable to elective cesarean delivery in fetuses with a known ventral wall defect? Am J Obstet Gynecol 2000; 182(6):1527-34.
16. Salihu HM, Emusu D, Aliyu ZY, Pierre-Louis BJ, Druschel CM, Kirby RS. Mode of delivery and neonatal survival of infants with isolated gastroschisis. Obstet Gynecol 2004; 104(4):678-83.
17. Snyder CW, Biggio JR, Brinson P, Barnes LA, Bartle DT, Georgeson KE, Muensterer OJ. Effects of multidisciplinary prenatal care and delivery mode on gastroschisis outcomes. J Pediatr Surg 2011; 46(1):86-9.
18. Tan KH, Kilby MD, Whittle MJ, et al. Congenital anterior abdominal wall defects in England and Wales 1987-93: retrospective analysis of OPCS data. BMJ 1996; 313(7062):903-6.
19. Jager LC, Heij HA. Factors determining outcome in gastroschisis: clinical experience over 18 years. Pediatr Surg Int 2007; 23(8):731-6.
20. Henrich K, Huemmer HP, Reingruber B, et al. Gastroschisis and omphalocele: treatments and long-term outcomes. Pediatr Surg Int 2008; 24(2):167-73.
21. Askarpour S, Ostadian N, Javaherizadeh H, et al. Omphalocele, gastroschisis: epidemiology, survival, and mortality in Imam Khomeini hospital, Ahvaz-Iran. Pol Przegl Chir 2012; 84:82-5.
22. Olesevich M, Alexander F, Khan M, et al. Gastroschisis revisited: role of intraoperative measurement of abdominal pressure. J Pediatr Surg 2005; 40:789–92.
23. Bradnock TJ, Marven S, Owen A, et al; BAPS-CASS. Gastroschisis: one year outcomes from national cohort study. BMJ 2011; 15;343:d6749. doi: 10.1136/bmj.d6749.
24. Di Lorenzo M, Yazbeck S, Ducharme JC. Gastroschisis: a 15-year experience. J Pediatr Surg 1987; 22(8):710-2.
25. Werbeck R, Koltai J. Umbilical cord as temporary coverage in gastroschisis. Eur J Pediatr Surg 2011; 21(5):292-5.
26. Ionescu S, Andrei B, Tirlea S, Bunea B, Licsandru E, Cirstoveanu C, et al. Considerations on gastroschisis repair. Chirurgia (Bucur). 2013 Jul-Aug;108(4):509-15.
27. Sandler A, Lawrence J, Meehan J, et al. A "plastic" sutureless abdominal wall closure in gastroschisis. J Pediatr Surg 2004; 39(5):738-41.
28. Stoll C, Alembik Y, Dott B, et al. Omphalocele and gastroschisis and associated malformations. Am J Med Genet A 2008; 146A(10):1280-5.
29. Baird R, Puligandla P, Skarsgard E, et al; Canadian Pediatric Surgical Network. Infectious complications in the management of gastroschisis. Pediatr Surg Int 2012; 28(4):399-404.