BACKGROUND

In 2015, we hypothesized the possible impact of the delivery mode on gastrochisis (GS) anatomy, based on clinical data consisting of 100 newborns with this malformation, born naturally or by cesarean section (CS) between 1987 to 2015 years. Over the past 5 years, our experience has increased by 35 children with GS born by CS, which gave the opportunity to refuse or confirm the results of our previous studies.

In addition, the entire clinical data of 135 newborns with GS were adapted to the anatomical and physiological classification of GS developed by prof. O.K. Sliepov in 2019 (Table 1) [1], which provided new opportunities for research.

Research objective: to determine the impact of the delivery mode on the features of GS anatomy in newborns.

MATERIAL AND METHODS

A retrospective analysis of medical data of 135 pregnant women and their newborns with GS (n = 135), born naturally (n = 55) or by CS (n = 80), between 1987 and 2020 was performed. Newborns with GS are divided into 3 clinical groups, depending on the method and place of birth, prenatal diagnosis, transportation, location and duration of surgical treatment of the defect. Group I included 83 newborns with GS, who were born in the SI "O.M. Lukyanova Institute of Pediatrics, Obstetrics and Gynecology of the NAMS of Ukraine" (in utero transfer group), for the period from 2006 to 2020. In 100% of cases GS was diagnosed prenatally.

The vast majority of children (96.4%, n = 80) were born by CS. Maternal age ranged from 16 to 36 years (23.07 ± 4.2). Scheduled premature CS was performed in 45% (n = 36) of women at term of 36–38 (36.7 ± 0.54) weeks of gestation; planned term CS in 20% (n = 16) of women at 38–39 (38.2 ± 0.36) weeks of gestation; unplanned (emergency) CS was conducted in 35% (n = 28) of women at 32–38 (35.8 ± 1.34) weeks of gestation. Most children (66.2%, n = 53) were firstborn.

Table 1. Classification of GS (O.K. Sliepov, 2019)

<table>
<thead>
<tr>
<th>I. Isolated GS (simple GS)</th>
<th>Associated GS (GS with other congenital malformations or intrauterine pathology):</th>
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<td>a) simple</td>
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<td>b) complex</td>
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II. By localization of the anterior abdominal wall defect (AWD):

a) typical                   |

b) atypical

III. By the presence of a communication between the amniotic and abdominal cavities:

a) open GS                       |

b) closed GS (closing GS with vanishing midgut syndrome)

IV. By the volume of eventrated organs:

a) midgut                         |

b) midgut + gaster

c) midgut + gaster (or without) + other organs (liver, gallbladder, pancreas, duodenum, bladder, uterus and/or its appendages (in girls), testicles (in boys))

d) atypical eventration (appendix)

V. By bowel damage:

a) non-inflamed (intact)          |

b) with bowel inflammation:
   • moderate (bowel matting)
   • severe (peels formation)

VI. By the presence of intrauterine growth restriction (IUGR):

a) without IUGR                 |

b) with IUGR (grade I, II, III)  

VII. By degree of visceral abdominal disproportion (VAD):

a) GS without VAD               |

b) GS with VAD:
   • moderate
   • high

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The course of pregnancy was complicated in 57.5% (n = 46) of women: threatened miscarriage in 32.6% (n = 15), maternal extragenital diseases in 21.7% (n = 10), infection in 32.6% (n = 15), fetoplacental insufficiency in 19.6% (n = 9), anemia in 10.9% (n = 5) of women. In total, 41 (51.3%) girls and 39 (48.7%) boys were born after the CS. Premature babies predominated (78.7%, n = 63). The body weight of newborns ranged from 1760 to 4020 g, on average 2524 ± 460.5 g. Apgar score was 4.21 ± 1.52 for 1 min, and 4.62 ± 1.27 for 5 min. IUOR of various degrees (I–III) was detected in 36.2% (n = 29) of cases. Isolated GS was in 55% (n = 44) of cases and prevailed over associated GS (45%, n = 36). Associated GS was complicated in 17.5% (n = 14) of cases. VAD was found in 82.5% (n = 66) of infants: moderate degree in 56.2% (n = 45) and severe degree in 26.2% (n = 21). In all newborns of this group surgical management of GS was performed in the first minutes of life ("surgery of the first minutes").

Group II consisted of 27 newborns with GS, treated at the SI "O.M. Lukyanova Institute of Pediatrics, Obstetrics and Gynecology of the NAMS of Ukraine" between 1987 and 2005. Some children of this group (51.9%, n = 14) were born in our institute (in utero transfer), and other (48.1%, n = 13) children were transported from another hospitals. GS was diagnosed prenatally only in 1/3 of cases (29.6%, n = 8). Most women (92.6%, n = 25) had vaginal delivery at 34–40 weeks of gestation, averaging 37 ± 0.2 weeks. Maternal age ranged from 15 to 30 years, with an average of 19.7 ± 0.5 years. 77.8% (n = 21) women were first childbirth. The pregnancy course was complicated in 63% (n = 17) of women: threatened miscarriage in 6 (22.2%), infection in 4 (14.8%), anemia in 4 (14.8%), maternal extragenital diseases in 3 (11.1%), fetoplacental insufficiency in 2 (7.4%). There were 15 (60%) girls and 10 (40%) boys. There were 44.0% of premature infants (n = 11). Body weight ranged from 1480 to 3400 g (2568.5 ± 91.2 g). IUOR was diagnosed in 6 (24%) children. Isolated GS (88%, n = 22) prevailed over associated (12%, n = 3). Associated complicated GS was diagnosed in 2 (8%) children. VAD was found in 21 (84%) children: moderate in 7 (28%), severe in 14 (56%). All newborns of this group underwent delayed surgical correction of the defect in 1.5 to 48 h (13.9 ± 2.1 h) after birth.

Group III included 30 newborns with GS, who were treated in the Mykolaiv Regional Children's Hospital between 1987 and 2005. All children were transported to a surgical clinic from Maternity Hospitals of Mykolaiv city and Mykolaiv region. All children were born naturally at 32–40 weeks of gestation (36.6 ± 0.3 weeks). GS was diagnosed prenatally only in 3 (10%) cases. Maternal age ranged from 16 to 27 years (20.7 ± 0.5 years). The vast majority of children (70%, n = 21) were firstborn. The pregnancy course was complicated in 23 (76.7%) mothers: infections in 8 (26.7%), fetoplacental insufficiency in 5 (16, 7%), threatened miscarriage in 3 (10.0%), anemia in 3 (10.0%). There were 13 (43.3%) girls and 17 (56.7%) boys. Body weight ranged from 1700 to 3400 g (2434.3 ± 77.9 g). IUOR was detected in 36.7% (n = 11) of cases. Premature babies were predominated (73.3%, n = 22). GS was isolated in most cases (66.7%, n = 20). Associated GS was complicated in 23.3% (n = 7) of cases. VAD was detected in all cases: moderate in 14 (46.7%), severe in 16 (53.3%). All newborns of this group underwent delayed surgical management of the defect in 1 to 64 h (9.7 ± 2.5 h) after birth.

The study included children with GS from each group born exclusively by vaginal delivery (group II (n = 25) and group III (n = 30)) or by CS (group I (n = 80)). In the studied children the following anatomical features of the defect were investigated: localization and size of the AWD, connection with the abdominal cavity, nature and frequency of eventrated organs. Prenatal and postnatal ultrasonography, laboratory and radiological findings, data of intraoperative revision and morphological examination (at autopsy) were studied.

Statistical significance was assessed by Mann – Whitney U-test and Chi-squared test. P values < 0.05 were considered statistically significant.

The study was conducted in accordance with the principles of the Declaration of Helsinki. The research protocol was approved by the local Ethics Committee of the institution. The informed consent of the child’s parents was obtained for the research. The level of evidence of this study is III.

RESULTS

The results of a long-term study presented in Table 2 and show the anatomical features of GS in newborns depending on the delivery mode.

It was found that the AWD localization was typical in all groups, regardless of the delivery method. The frequency of open GS was also high and almost the same in all groups. Closed GS was detected in 3.7% of cases in group I.

The AWD size was significantly smaller in children born by CS (group I) than in those born by vaginal delivery (groups II and III). In newborns of group I it was 3.02 ± 0.58 cm, while in groups II and III they were 4.17 ± 0.3 cm (p < 0.01) and 4.7 ± 0.29 cm (p < 0.01), respectively. Thus, we confirmed in the literature for the first time our hypothesis about the impact of the delivery mode on the size of the AWD defect in patients with GS.

In addition, it was found that the delivery mode affected the frequency of eventration of the duodenum and pancreas. Frequency of the duodenum (52%) and pancreas (63.3%) eventration after vaginal delivery in groups II and III was significantly higher than in patients of group I (20.0%) born by CS (p < 0.01).

There was no significant difference in the frequency of eventration of other abdominal organs, both after CS and after vaginal delivery.

DISCUSSION

Until the beginning of the XXI century, and even until now, there is a controversy in the literature about the best way of childbirth in women who are prenatally diagnosed with fetal GS. Some clinicians promote natural vaginal birth as the safest and physiological for women [2, 3]. Others argue that vaginal birth is dangerous for a newborn with GS, due to infection and, most importantly, injury of eventrated organs during uterine contractions and their passage through the birth canal [3, 4]. Some researchers emphasize that in natural childbirth, as a result of uterine contractions, blood plasma is released from the capillaries of the exposed intestine which leads to peels formation [4, 5]. However, numerous studies by other authors
report that inflammatory damage of the eventrated bowel develop in utero before the onset of labor and are well diagnosed during fetal ultrasonography at 32–34 weeks of gestation [5–7].

In fetuses and newborns with GS, typically, the AWD is perforating, located to the right of the umbilical cord and is accompanied by splitting of the umbilical ring [1–6]. Rare forms include “closed” GS and GS with atypical localization of the defect [1]. “Closed” GS (vanishing GS) is a specific form of this malformation in which strangulation of the eventrated midgut in a stenotic AWD develops due to its strong narrowing, without splitting of the umbilical ring and connection between the amniotic and abdominal cavities [8]. According to the results of our study location of the defect was typical (right-sided) in all newborns, and “closed” GS was found in only 3.7% of infants born by CS, with no significant difference between the compared groups. This is due to the fact that the formation of a AWD occurs during fetal development, i.e. does not depend on the delivery mode, which is reflected in the results of our study. Moreover, inflammatory injuries of the eventrated organs occur only in those parts of them that are located extra-abdominal in the amniotic fluid. Intra-abdominal organs have a normal appearance of the serous membrane, soft and elastic. This indicates that inflammatory bowel damage develop only as a result of prolonged intrauterine interaction with amniotic fluid [7, 11].

Evretation of the duodenum and pancreas was significantly more common in patients born by vaginal delivery (Table 2). This is due to increased intra-abdominal pressure of the fetus, during uterine contractions and the passage of the fetus through the birth canal of a woman [11–14]. According to our observations, the duodenum and pancreas have no inflammatory lesions, indicating the absence of prolonged contact with amniotic fluid during fetal development. This means that their evretation occurs during natural childbirth.

According to data of our study, due to natural childbirth and intranatal evretation of an additional number of abdominal organs through the AWD, a significant increase in the size of the defect was found (Table 2). This is confirmed by the fact that the size of the defect is significantly smaller in babies born by CS, compared with those born naturally. Such data indicate that the natural birth of babies with GS leads to additional trauma to the abdominal organs [15–20]. In turn, this bowel damage lead to a significant increase in the duration of intestinal paresis, the duration of total parenteral nutrition, achieving of complete enteral autonomy, increasing the incidence of sepsis and central line associated complications [11, 21–25].

**CONCLUSIONS**

Thus, on a much larger amount of data, compared with previous studies, it can be reliably stated that the delivery mode affects the GS anatomy, namely changes the size of the abdominal wall defect, as well as frequency of the abdominal organs evretation.

**Conflict of interest**

The authors declare no conflict of interest.
REFERENCES/ЛИТЕРАТУРА

Висновки. Спосіб розродження впливає на розмір дефекту передньої черевної стінки та характер і частоту виявлення евентрованих органів черевної порожнини. Ефективність кесарево сечения в ряді випадків може бути обмеженою завдяки своєрідному анатомічному розташуванню дефекту.

Ключові слова: гастрошизис, естественны роды, кесарево сечение, анатомия гастрошизиса.