

Surgical Management of Gastroschisis With the Use of Primary and Staged Closure on the Basis of the Department's 20-Year Experience

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Abstract

BACKGROUND: Gastroschisis belongs to common developmental anomalies. The aim of surgical management is to restore the integrity of the abdominal wall and to insert the bowel into the abdominal cavity with the use of the primary or staged closure technique.

The objective of this paper is to analyze our 20-year experience with surgical treatment of gastroschisis with primary and staged closure, to compare the postoperative course for the said techniques as well as to identify factors influencing the course and early results of treatment.

METHODS: The research materials comprise of a retrospective analysis of medical history of patients treated at the Surgery Clinic in Poznan in the years 2000-2019. 59 patients were operated on: 30 girls and 29 boys.

Surgical treatment was performed with the use of primary closure in 33% of the cases, whereas the staged silo closure was performed in 67% of the cases.

RESULTS: Postoperative analgesia was used for 6 days on average after primary closures, and for 13 days on average after staged closures. Incidence frequency of generalized bacterial infection was 21% for primary closures and 37% for staged closures. Infants treated with staged closure began enteral feeding considerably later (day 22) than those treated with primary closure (day 12).

CONCLUSIONS: It is not possible to indicate clearly which surgical technique is superior to the other on the basis of the results obtained. When choosing the treatment method, the patient's clinical condition, associated anomalies and the medical team's experience must be taken into consideration.

Background

Congenital abdominal wall defects belong to common conditions requiring surgical intervention at newborn age. Over the course of decades, the survival rate of infants with gastroschisis has grown considerably in developed countries, particularly thanks to improved perinatal care and prenatal diagnosis [1, 2, 3].

However, this condition still constitutes a significant issue due to the continuous growth of its incidence, although a specific cause has not been identified. Ongoing research indicates a correlation with low maternal age, low BMI, genitourinary system infections, cocaine and amphetamine use, use of antidepressants, tobacco smoking and gestational diabetes [4].

The anomaly is treated surgically. The aim of the surgery is to restore the integrity of the abdominal wall and to insert the bowel into the abdominal cavity. This is possible with the use of the primary closure or staged closure technique. The decision on surgical technique depends on the patient's clinical condition [5].

The objective of this paper is to analyze our 20-year experience with surgical treatment of gastroschisis with primary and staged closure, to compare the postoperative course for the said techniques as well as to identify factors influencing the course and early results of treatment.

Methods

The research materials comprise of a retrospective analysis of medical history of patients treated at the Clinic of Surgery, Traumatology and Pediatric Urology in Poznan in the course of 20 years.

In the years 2000–2019, 59 patients were operated on: 30 girls and 29 boys. They were operated on with the use of the primary closure technique with simultaneous insertion of the bowel into the abdominal cavity, and the staged closure technique with temporary use of a silo bag. The surgical technique had been decided on by the operating surgeon and had depended on the patient's clinical condition. One of the treated infants passed away. This death occurred in a neonate of trisomy 18 with complex cardiac deformity.

This paper analyzes the following parameters: week of birth, delivery method, birthweight and its centiles on the day of birth and on the day of discharge, APGAR score at 1 and 5 minutes after birth, frequency of blood transfusion during the surgery, postoperative analgesia duration, feeding method and periods of its implementation, time of natural bowel movement, incidence of a generalized bacterial infection, and length of hospital stay.

According to the Poznan Bioethics Committee's guidelines, it was not necessary to obtain an individual consent for the performed research analyses due to the retrospective nature of this paper.

STATISTICAL ANALYSIS

The results were summarized in a Microsoft Excel spreadsheet and grouped according to the obtained values.

A statistical analysis was performed with the use of the Statistica software (StatSoft Inc., Tulsa, USA). The Mann-Whitney U test, the chi-squared test and the Student t-test were employed. The level of statistical significance was determined to be $p < 0.05$.

Results

The summarized results demonstrated that 94% of the operated infants were born prematurely. The earliest delivery occurred at week 31 of pregnancy, the latest one at week 39. 97% of births were Cesarean deliveries.

Average birthweight of infants with gastroschisis was 2,384 g. The lowest birthweight noted was 910 g and the highest one was 4,100 g.

The primary closure technique was applied in 19 cases, the stage closure technique in 40 cases.

No statistically significant difference in the body mass of the operated infants either on the day of birth or on the day of discharge was proven. In the case of primary closure, the average was 2,312 g on the day of birth and 3,002 g on the day of discharge. In the case of staged closure, the values were 2,476 g and 2,932 g respectively.

Average daily weight gain was 12.7 g after primary closure surgery and 10.3 g after staged closure surgery. No statistically significant difference in the values provided above was proven.

APGAR score of infants treated with primary closure was 7 points at 1 minute and 9 points at 5 minutes after birth (median). In infants treated with staged closure, the score was 8 and 10 points respectively. No correlation was proven in the obtained result.

An analysis of the infants' eventrated organs was carried out. Intestines eventrated in all the cases. Other organs such as the stomach, the liver, the spleen or the Fallopian tubes eventrated in 63% of the infants treated with primary closure and in 53% of those treated with staged closure (Table 1).

Table 1

Numbers of patients with gastroschisis of intestines and other organs, treated with primary and staged closure.

Number of patients n = 59	Patients treated with primary closure n = 19 (32%)	Patients treated with staged closure n = 40 (68%)
Patients with gastroschisis of intestines	19 (100%)	40 (100%)
Patients with gastroschisis of other organs n = 33 (56%)	12 (63%)	21 (53%)
Stomach	8 (67%)	4 (19%)
Liver	2 (17%)	12 (57%)
Spleen	0	5 (24%)
Fallopian tubes	2 (16%)	0

Table 1 Numbers of patients with gastroschisis of intestines and other organs, treated with primary and staged closure.

Statistical analysis proved no correlation between eventrated organs and the choice of surgical technique. The decision on the surgical technique was made based on the patient's clinical condition and the volume of eventrated organs in proportion to the volume of the abdominal cavity established during physical examination.

Figure 1A patient with gastroschisis who qualified for surgical treatment with the use of the primary closure technique.

Figure 2A patient with gastroschisis who qualified for surgical treatment with the use of the staged silo closure technique.

It was examined whether there is a relationship between other eventrated organs (i.e. apart from intestines which eventrated in every case) and APGAR scores along with birthweight centiles.

In patients operated on with the use of primary closure, the median of APGAR scores at 1 minute after birth was 7 points when only the intestines eventrated, and 8 when other organs eventrated as well. In the case of staged closure, the values were 8 g and 10 g respectively.

Birthweight centiles on the day of birth in infants treated with primary closure were even and their value was 50, irrespective of eventrated organs. In infants treated with staged closure, the values were 50 when only the intestines eventrated and 10 when other organs eventrated as well.

The value of birthweight centiles on the day of discharge in infants treated with primary closure was 10, irrespective of eventrated organs. In the case of staged closure, the values were 10 centiles when only intestines eventrated, and 3 centiles when intestines as well as other organs eventrated.

Blood transfusion was performed during both surgery types. In the case of primary closure it was performed in 7% of surgeries, whereas in the case of staged closure it was performed in 18% of surgeries. The chi-squared test did not prove a correlation between surgery type and frequency of blood transfusion.

An evident correlation was, however, proven in the duration of analgosedation after the surgery at neonatal intensive care unit.

In the case of infants treated with primary closure, analgosedation was used for 6 days on average; the shortest ventilation time was 2 days and the longest ventilation time was 12 days. In the case of infants treated with staged closure, analgosedation was used for 13 days on average; the shortest ventilation time was 6 days and the longest ventilation time was 32 days. The Mann-Whitney U test demonstrated a statistically significant relationship within the examined parameters.

Generalized bacterial infection developed in 21% of the infants treated with primary closure and in 37% of the infants treated with staged closure. The chi-squared test did not demonstrate a statistically significant relationship.

Time of enteral feeding implementation was analyzed as well. In the case of primary closure, enteral feeding was implemented on day 12 after surgery on average. Enteral feeding was implemented on day 5 at the earliest and on day 51 after surgery at the latest. In the case of staged closure, enteral feeding was implemented on day 22 after surgery on average (on day 8 at the earliest and on day 36 at the latest). An analysis with the use of the Mann-Whitney U test proved a correlation between the time of enteral feeding implementation and the surgical technique used.

The time of the first natural normal bowel movement in the infants (without the use of cleansing infusions) was day 13 on average in the case of primary closure (bowel movement occurred on day 6 at the earliest and on day 25 at the latest) and day 21 after staged surgery (bowel movement occurred on day 8 at the earliest and on day 39 at the latest). The Student t-test showed a statistically significant difference in the times of the first natural normal bowel movement depending on the surgical technique used.

The average length of hospital stay after primary closure was 32 days; here an infant was hospitalized for 15 days at the shortest and for 86 at the longest, whereas after staged closure, the average length of hospital stay was 44 days (minimum and maximum length were 19 and 79 days respectively). The Mann-Whitney U test demonstrated a correlation between the length of hospital stay and the chosen surgical technique.

Discussion

Current survival rates for infants operated on due to gastroschisis are very good and exceed 90% [6]. Despite the excellent treatment results, research of the described condition needs to be maintained continuously, so that the outcomes and full recovery process after surgical treatment could be gradually improved. In order to achieve this, a lot of time and support by a multi-specialty medical team are necessary, of course. Full recovery of an infant depends not only on the extent of the opening in the abdominal wall and of the gastroschisis, but also on the patient's clinical condition as well as other associated congenital anomalies. Associated congenital anomalies occur with various frequency from 8–32% depending on publication [7, 8]. Therefore, research based on long-term analysis is particularly important.

The research carried out by the Poznan-based department involved a 20-year analysis of the therapeutic process in patients operated on due to gastroschisis with the use of primary and staged silo closure. The observations covered the period from the infant's birth and surgical treatment up to their discharge.

If gastroschisis is diagnosed prenatally, it is advisable to choose mother and child care in the highest-level health center with a neonatal intensive care unit and pediatric surgery department. It was shown that deliveries carried out in other than tertiary care centers are connected with higher frequency of complications [4].

The right time of delivery is still debatable. On one hand, it is believed that earlier delivery exposes intestines to amniotic fluid less, which minimises their atresia, necrosis and enterocolitis. On the other hand, premature delivery is connected with the risk of respiratory disorders which in turn may have repercussions during surgery and anesthesia.

Mesas Burgos et al. argue that the most appropriate stage for delivery is week 35-36.9, and for Cesarean delivery it is week 35 [9]. Baud et al. suggest week 37 [10]. Youssef et al. found that every week of

intestines in utero is beneficial for the intestines and decreases the risk of complications in the form of severe bowel matting by 3.6% [11].

Nasr et al. oppose this view and argue that it is delivery after week 38 that causes increased bowel matting [12]. At our department, 94% of infants operated on were prematurely born, i.e. between weeks 31 and 39. Cesarean delivery was performed in 97% of the deliveries.

Rachel et al. carried out an analysis of birthweight of infants with gastroschisis in their publication. Based on the statistics, a significant difference was found between the birthweight of prematurely born infants with gastroschisis and full-term infants with gastroschisis [13]. Low birthweight means birthweight below 2,500 g [14]. In the material collected by our department, average birthweight of infants with gastroschisis was 2,384 g.

According to Lawrence, normal weight gain closest to WHO charts is 26–31 g daily in the period of 0–3 months (based on long-term observation) [15]. In patients treated at our department due to gastroschisis, weight gain was around 1/3 – 1/2 of the normal value. This can be easily explained by the recovery period of intestines after their insertion into the abdominal cavity, and by the necessity of gradual, moderate diet expansion.

A statistically significant correlation between APGAR scores in infants qualified for primary or staged closure was not found. These were values of 9 and 10 points respectively.

A correlation was found between the infants' birthweight centiles and the extent of gastroschisis. Infants with a considerable extent of gastroschisis with associated eventration of other organs than intestines, treated with the staged closure technique, presented birthweight of average value of 10th centile as opposed to the 50th centile in infants treated with primary or staged closure when only intestines were eventrated.

Body mass values at discharge from the hospital were referred to centile charts as well. They confirmed a similar relationship as birthweight centile values. Infants treated with primary and staged closure, but with eventration of intestines only, would achieve the 10th centile of normal body mass. Infants in which staged closure was necessary and other organs were eventrated as well would achieve the 3th body mass centile.

Similar data have not been found in available literature. The demonstrated data would constitute an evidence of a relationship between low birthweight, low body mass at discharge (difficulties in gaining weight) and the clinical condition of a patient with a highly extensive anomaly.

The performance of the analyses may be justified by the fact that birthweight centiles and body mass at discharge are identical for the specific groups.

The average postoperative analgo-sedation time for primary and staged silo closure was 6 and 12 days respectively, which resulted from the very specifics of surgical treatment. There are 3 categories of

surgical management of gastroschisis: operative primary fascial closure, silo placement with staged reduction and delayed closure, and sutureless umbilical closure [4]. Two techniques are used at our department: operative primary fascial closure and silo placement with staged reduction and delayed closure. Silo placement with staged reduction and delayed closure consists in placing the eventrated organs into a sterile bag and attaching it to the abdominal wall. The bag volume is decreased gradually until the closure of the abdominal wall is possible [16].

Fischer et al. summed up ventilation time in their publication. For infants treated with primary closure, the ventilation time was 3–15 days, and for those treated with staged silo closure it was 5–17 days [17].

Landisch et al. determined that the frequency of generalized bacterial infection among the infants operated on is 31.6%. According to research carried out at our department, the higher incidence of infection of 37% was in patients treated with staged closure, whereas the incidence in infants treated with primary closure was 21% [13.]

According to the publication by Fischer et al., enteral feeding was implemented in the period of days 7–22 in the case of primary closure, and in the period of days 9–23 in the case of staged silo closure [17]. With reference to the presented results, the time of feeding implementation at our department was 12 days on average (5–51 days) for primary closure and 22 days on average (8–35 days) for staged closure. Nutrition for an infant with gastroschisis is a complex topic and there is not a lot of uniformity in the literature to formulate evidence-based care [18].

On the basis of our department's analyses, the time of the first natural normal bowel movement was 13 days on average for primary closure and 21 days for staged closure. Unfortunately, no reference to the provided results by other departments was found in available literature. In our research we did not take into account bowel movements encouraged by a suppository or a colocolyter, only the patient's first natural bowel movement. Bowel movement that occurred evidently earlier in an infant treated with primary closure may be related to shorter recovery time of intestines after surgery, lower exposure to intestinal inflammation during staged insertion of intestines into the abdominal cavity, and lower probability of sepsis and concretion during healing. It was proven that numerous cases of intestinal concretion are related to the organism's generalized inflammatory reaction (with incidence frequency of 37% in patients treated with staged closure) and peritoneal dehiscence which was not observed as a complication in our patients [5].

Pratheppanyapat et al. recognise the following as normal intestinal function: presence of normal bowel sound, passage of the stool, reduction of the nasogastric content and the disappearance of the bilious content aspiration from nasogastric tube. The patients who had continuous feeding without an episode of feeding intolerance until full feeding within 21 days of life were described as successful feeding. In the mentioned publication, none of the silo-closure group had successful early enteral feeding [19].

The average hospital stay of a patient at our department was 32 days long (15 days at the shortest, 86 days at the longest) for treatment with primary closure, and 44 days (19–76 days) for treatment with

staged closure. In comparison with outcomes noted by Fischer et al., it was 11–38 and 14–35 days respectively [17]. On this basis, a tendency for greater caution and prolonged hospital stays at health centers in Poland can be observed.

Conclusions

It is not possible to indicate clearly which surgical technique is superior to the other on the basis of the results obtained. The choice of treatment method depends on the patient's clinical condition, associated anomalies and the medical team's experience. The course of the surgery, postoperative period and postoperative complications are related to the extent of the anomaly. In infants treated with staged closure, a more frequent necessity of blood transfusion, a more frequent occurrence of generalized bacterial infection, longer time of the first natural bowel movement after the surgery and slower weight gain were noted in comparison with infants treated with primary closure.

Declarations

Ethics approval and consent to participate

This was a retrospective analysis and the consent of the bioethics committee was not required. These rules are compliant with the guidelines of the Bioethical Commission of Poznan University of Medical Science.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

This was a retrospective, anonymous analysis and the consent to participate was not required. (These rules are compliant with the guidelines of the Bioethical Commission of Poznan University of Medical Science.)

Consent for publication

This was a retrospective, anonymous analysis and the consent for publication was not required. (These rules are compliant with the guidelines of the Bioethical Commission of Poznan University of Medical Science.)

Availability of data and materials

Data available on request.

Competing interests

The authors have no conflict of interest.

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Authors' contributions

Conceptualization: P.S.-S., D.S, P. M; Methodology: P.S.-S., D.S, P. M; Validation: P.S.-S., D.S, P. M; Formal Analysis: P.S.-S., D.S, P. M; Investigation: P.S.-S.; Resources: P.S.-S.; Data Curation: P.S.-S., D.S, P. M; Writing – Original Draft Preparation: P.S.-S., D.S, P. M; Writing – review and editing: P.S.-S., D.S, P. M; Visualization: P.S.-S.; Supervision and final approval: P.S.-S., D.S, P. M; Project Administration: P.S.-S., D.S, P. M

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Figures



Figure 1

A patient with gastroschisis who qualified for surgical treatment with the use of the primary closure technique.



Figure 2

A patient with gastroschisis who qualified for surgical treatment with the use of the staged silo closure technique.