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Primary direct closure of gastroschisis after skin undermining and sheath expansion using electrocautery: a retrospective case series of 21 patients

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Gastroschisis is a congenital defect of the abdominal wall that needs immediate surgical correction. An alternative option is primary direct closure after skin undermining and sheath expansion using electrocautery, without the use of a temporary container (silo).

Aim – to assess the feasibility and short-term results of primary direct closure of gastroschisis after skin undermining and sheath expansion with electrocautery in newborns.

Materials and methods. A retrospective analysis of 21 newborns with gastroschisis who had primary direct closure performed from January to December 2024. The study followed STROBE guidelines for observational studies. The outcomes measured were the rate of primary closure, the duration of nasogastric (NG) tube, feeding milestones, and complications.

Results. Twenty-one patients were included, with a mean birth weight of 2.77 kg. Primary closure was successful in 18 patients (85.7%). Three (14.3%) patients were deemed to be unsuccessful. No patient required mechanical ventilation. Mean NG tube duration was 3.9 days. Six (28.6%) patients were able to tolerate full enteral feeding at a mean of 4.8 days after surgery. Five (23.8%) patients had complications; there was one (4.8%) fatal outcome. The unsuccessful Closure group (66.7%) had more complications compared to the successful group (16.7%).

Conclusion. Primary direct closure of gastroschisis following undermining of the skin and sheath expansion with electrocautery is a viable technique in selected patients with an 85.7% success rate. The technique provides hemostasis and accurate tissue separation. Failure of primary closure was seen in 14.3% on daily follow-up documentation.

The study was conducted in accordance with the principles of the Declaration of Helsinki. Informed consent was obtained from the parents or guardians of the children for the conduct of the study.

The author declares that there is no conflict of interest.

Keywords: gastroschisis, primary closure, electrocautery, sheath expansion, case series, neonatal surgery.

Первинне пряме закриття дефекту при гастрошизисі після відшарування шкіри та розширення апоневротичного кільця методом електрокоагуляції: ретроспективна серія випадків (21 пацієнт)

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Гастрошизис – це вроджена вада розвитку черевної стінки, що потребує негайної хірургічної корекції. Альтернативним методом є первинне пряме закриття дефекту після відшарування шкіри та розширення апоневротичного кільця за допомогою електрокоагуляції, без використання тимчасового контейнера (сило).

Мета – оцінити доцільність та короткострокові результати первинного прямого закриття гастрошизису після відшарування шкіри та розширення апоневротичного кільця методом електрокоагуляції у новонароджених.

Матеріали та методи. Проведено ретроспективний аналіз даних 21 новонародженого з гастрошизисом, яким у період із січня по грудень 2024 року було виконано первинне пряме закриття дефекту. Дослідження проводилося відповідно до рекомендацій STROBE

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для обсерваційних досліджень. Оцінювали такі показники: частота первинного закриття, тривалість використання назогастрального зонда, етапи налагодження харчування та ускладнення.

Результати. Дослідження охопило 21 пацієнта; середня маса тіла під час народження становила 2,77 кг. Первинне закриття було успішним у 18 пацієнтів (85,7%). У 3 (14,3%) пацієнтів спроба закриття виявилася невдалою. Жоден пацієнт не потребував штучної вентиляції легень. Середня тривалість використання назогастрального зонда становила 3,9 доби. Шість (28,6%) пацієнтів змогли перейти на повне ентеральне харчування в середньому через 4,8 доби після операції. У 5 (23,8%) пацієнтів виникли ускладнення; в одному (4,8%) випадку настав летальний кінець. У групі з невдалим закриттям дефекту частка ускладнень була вищою (66,7%) порівняно з групою успішного закриття (16,7%).

Висновок. Первинне пряме закриття дефекту при гастрошизисі після відшарування шкіри та розширення країв дефекту за допомогою електрокоагуляції є прийнятним методом для окремих пацієнтів; частота успішних результатів становить 85,7%. Ця методика забезпечує гемостаз і точне розділення тканин. Невдачу при спробі первинного закриття було зафіксовано у 14,3% випадків за результатами щоденного моніторингу.

Дослідження проводилося відповідно до принципів Гельсінської декларації. Отримано інформовану згоду батьків або опікунів дітей на проведення дослідження.

Автор заявляє про відсутність конфлікту інтересів.

Ключові слова: гастрошизис, первинне закриття, електрокоагуляція, розширення країв дефекту, серія клінічних випадків, хірургія новонароджених.

Introduction

Gastroschisis is a birth defect in which the intestines (and sometimes other organs) come down through the abdomen (full-thickness defect) to the right side of the body, typically near the umbilical cord. They are not encapsulated and are irritated and swollen due to amniotic

fluid and must be modified surgically soon after birth [4].

Gastroschisis has been rising in prevalence globally, and is estimated to occur in 1 in 2,000 – 1 in 5,000 live births [3]. Factors that increase risk are smoking during pregnancy, low socioeconomic status, and early motherhood [2].

There are a number of surgical procedures available to help treat this anomaly. The most common method used is to encase the organs in a silo and compress them into the abdominal cavity [4]. However, the placement of a silo is sometimes performed by a number of procedures, a long ventilation period, and a long hospital stay [10].

Primary direct closure has been recommended as an alternative in some patients because it involves a single-stage closure, earlier enteral feeding, and a shorter hospital stay [12].

Rationale for electrocautery in sheath expansion

Why electrocautery? Compared to sharp dissection, electrocautery offers:

- **hemostasis:** reduced intraoperative bleeding;
- **precision:** controlled tissue division;
- **efficiency:** shorter operative time.

The technique of combined **transverse and longitudinal sheath expansion exceeding 5 cm** using electrocautery has not been previously described in detail for gastroschisis closure. This study describes our experience with this technique.

The **aim** of this study was to assess the feasibility and early results of primary direct closure of gastroschisis after skin undermining and subsequent electrocautery to expand the sheaths both transversely and longitudinally in neonates.

The focus of the study was the successful primary closure rate, duration of nasogastric (NG) tube use, feeding milestones, mechanical ventilation use, and postoperative complications.

Table 1
STROBE checklist

STROBE item	Location in manuscript
Title and Abstract	Title and Abstract
Background/rationale	Introduction
Objectives	Aim of the Study
Study design	Materials and Methods – Study Design
Setting	Materials and Methods – Study Design
Participants	Inclusion and Exclusion Criteria
Variables	Data Collection and Definitions
Data sources/measurement	Data Collection
Bias	Study Limitations
Study size	Patient Characteristics
Quantitative variables	Data Analysis
Statistical methods	Data Analysis
Participants	Results
Descriptive data	Patient Characteristics and Table 1
Outcome data	Results
Main results	Results – Primary Closure Outcome
Other analyses	Results – Complications
Key results	Discussion
Limitations	Study Limitations
Interpretation	Discussion
Generalizability	Discussion
Funding	Declarations

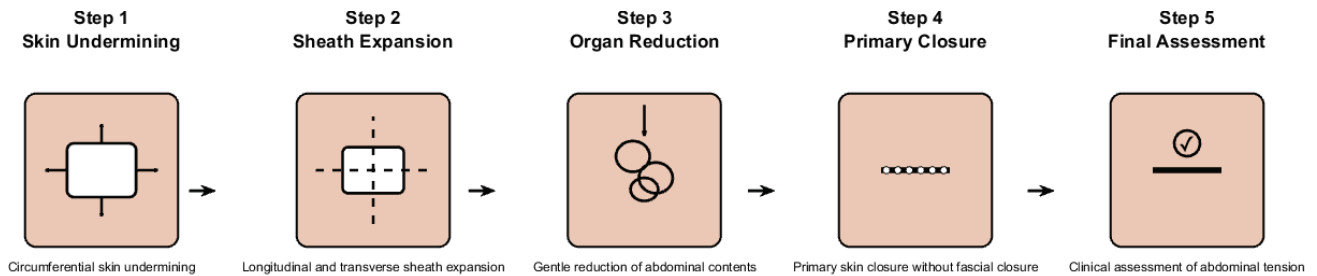


Fig. 1. Schematic diagram of the surgical technique

Materials and methods of the study

Study design. It was a retrospective case series of neonates who were diagnosed as having gastroschisis and who underwent primary direct closure at Bint Al-Huda Hospital from January 2024 to December 2024. The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for observational studies. The completed STROBE checklist for the present retrospective observational study is provided in Table 1 [11].

Inclusion and exclusion criteria. All newborns diagnosed with gastroschisis who underwent primary direct closure during the study period were included in the study. Patients were excluded if their medical records were incomplete or did not contain sufficient information to assess the study outcomes. Birth weight, gestational age, and abdominal wall defect size were not consistently documented in all medical records and therefore could not be used as mandatory inclusion criteria or systematically analyzed.

Surgical technique (detailed) (Figure 1)

Step 1: Skin undermining

- A circumferential incision was made around the defect margin.
- Skin was undermined from the underlying sheath for **1-2 cm** in all directions.

Step 2: Sheath expansion using electrocautery

- The anterior rectus sheath was opened using **electrocautery** (cutting mode, low power).
- **A midline longitudinal incision** was made first.
- **Transverse relaxing incisions** were added at the superior and inferior aspects.
- Total sheath opening dimension exceeded **approximately 5 cm**.

Step 3: Organ reduction

- Abdominal organs were gently reduced into the peritoneal cavity.
- No forceful reduction was attempted.

Step 4: Primary skin closure

- Skin was closed primarily **without fascial closure**.
- Interrupted or continuous sutures were used.

Step 5: Prevention of abdominal compartment syndrome

- Intra-abdominal pressure was assessed clinically by palpating bladder tension.
- If tension was excessive, the abdomen was left open (no case required this).

Postoperative care

- NG tube left open or on continuous suction.
- Mechanical ventilation with supplemental oxygen as needed.
- Triple antibiotic therapy (Ampicillin + Gentamicin + Metronidazole).
- Daily dressing change and wound care.
- Gradual initiation of feeding after return of bowel function.

Data collection

Data were extracted from daily follow-up medical records and included:

- birth weight (kg);
- success of primary closure (as documented);
- days on mechanical ventilation;
- days with NG tube (calculated from daily records);
- postoperative day of feeding initiation;
- postoperative day of full enteral feeding;
- complications (as recorded).

Definitions. If there was no documentation of failure in the daily follow-up records, closure was deemed successful. Primary closure was considered a failure if the patient had a record stating failure or death in the daily follow-up chart or if the patient died. Full enteral feeding was defined as the ability to receive full oral/enteral feeding without parenteral nutrition.

Data analysis and statistical analysis. All the data were analysed with the help of Microsoft Excel 16.0. The success rate was calculated using the Wilson score method and presented as descriptive statistics: mean, standard deviation (SD), range, and 95% confidence interval (CI). Categorical variables were displayed as frequencies and percentages.

Ethical considerations. This is a retrospective chart review and was considered to be ethical based on the guidelines of Bint Al-Huda Hospital. The nature of the study was retrospective, and informed consent was

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Table 2

Raw data extracted from daily follow-up records (n=21)

Patient	Birth Wt (kg)	NG days	Feed start day	Full feed day	Complication	Primary closure success
1	2.7	4	0	0	None	Yes
2	2.7	4	0	0	None	Yes
3	2.6	4	0	0	None	Yes
4	2.6	4	0	0	None	Yes
5	2.6	4	4	5	None	Yes
6	2.7	4	0	0	None	Yes
7	2.6	4	0	0	None	Yes
8	2.5	4	0	0	Yes	Yes
9	3.0	3	0	0	None	Yes
10	2.7	4	0	0	None	Yes
11	3.2	3	0	0	None	Yes
12	2.9	4	0	0	None	Yes
13	2.8	4	0	0	Death	No
14	2.9	4	5	5	None	Yes
15	3.0	4	5	5	None	Yes
16	2.8	5	0	0	None	Yes
17	2.5	3	0	0	Yes	No
18	2.8	4	5	5	None	Yes
19	3.0	4	5	5	None	Yes
20	2.7	3	0	0	Yes	No
21	2.6	4	0	0	None	Yes

Note: «0» indicates that the event (feeding start, full feed) did not occur during the documented follow-up period.

Table 3

Primary closure outcomes

Outcome	Number of patients	Percentage	95% CI
Successful primary closure	18	85.7	63.7–96.0
Unsuccessful primary closure:	3	14.3	4.0–36.3
- postoperative death	1	4.8	-
- documented failure without death	2	9.5	-

waived. Patient confidentiality has been ensured by the use of codes rather than names.

Results of the study

Patient characteristics (Table 2). A total of 21 newborns with gastroschisis underwent primary direct closure during the study period. Mean birth weight was 2.77 kg (range 2.5–3.2 kg, SD±0.21).

The data in Table 3 show that primary direct closure was successfully achieved in most patients. The duration of NG tube use was between 3 and 5 days, and feeding milestones were different for individual patients. The postoperative follow-up records indicated that there were three patients who had unsuccessful primary closure.

The primary closure was successful in 18 (85.7%) of 21 patients (95% CI: 63.7–96.0%). Three (14.3%) patients were classified as having unsuccessful primary

closure. Among these three patients, one (4.8%) postoperative death was documented, and two (9.5%) had documented closure failure without death.

Postoperative course (Table 4). No patient had documented mechanical ventilation. The mean duration of NG tube use was 3.9 days (SD±0.7; range 3–5 days). Six (28.6%) patients achieved full enteral feeding. The mean day of feeding initiation was 4.7 (SD±0.5), and the mean day of full feeding was 4.8 (SD±0.4).

The distribution of days of NG tube use is presented in Table 5. Most patients (16 (76.2%) of 21) had NG tube use for 4 days, while 4 (19.0%) patients had tube use for 3 days and 1 (4.8%) patient had tube use for 5 days. These data are consistent with the reported mean duration of 3.9 days (Figure 2).

Complications by outcome. Complications were documented in 3 (16.7%) of 18 patients with successful pri-

mary closure and in 2 (66.7%) of 3 patients with unsuccessful closure (Table 6). Thus, complications were more frequently documented among patients classified as having unsuccessful closure. Because of the small number of patients in the unsuccessful Closure group, this finding should be interpreted as a descriptive observation rather than evidence of a statistical association.

Overall, complications were documented in 5 (23.8%) of the 21 patients, while 16 (76.2%) patients had no documented complications. One (4.8%) postoperative death was recorded, and four (19.0%) patients had other complications whose specific types were not consistently documented in the available medical records (Table 7). Therefore, the reported complication data should be interpreted with consideration of the incomplete documentation of specific complication types.

Study flow diagram. Figure 2 shows the study flow diagram of 21 patients with gastroschisis who underwent primary direct closure after skin undermining and sheath expansion using electrocautery. All 21 patients attempted primary direct closure. Of these, 18 (85.7%) patients had successful primary closure (95% CI: 63.7–96.0%), while 3 (14.3%) patients were unsuccessful (95% CI: 4.0–36.3%). Among the unsuccessful group, one (4.8%) patient died postoperatively, and two (9.5%) patients had documented failure without death. Among the successful group, three patients (16.7%) developed complications.

Discussion

Summary of findings. None of the patients needed mechanical ventilation, and the mean duration of NG tube placement was 3.9 days.

The definition of unsuccessful primary closure was based on documentation in daily follow-up records and may not fully reflect operative decision-making.

Comparison with published literature (Table 7)

Why is NG duration shorter in our series? Potential explanations include:

1. No patient required mechanical ventilation, allowing earlier extubation and feeding.
2. The sheath expansion technique (transverse + longitudinal >5 cm) may reduce intra-abdominal pressure.
3. Selection bias: our cohort may represent less severe cases.

Why was mechanical ventilation zero? This may reflect:

- Strict patient selection (only those expected to tolerate primary closure).
- The effectiveness of the sheath expansion technique in preventing abdominal compartment syndrome.

Table 4

Postoperative outcomes (n=21)

Variable	Result
Mechanical ventilation	
Patients with documented ventilation	0 (0%)
NG tube duration	
Mean days (SD)	3.9 (±0.7)
Range (days)	3-5
Feeding milestones	
Patients achieving full enteral feeding	6 (28.6%)
Mean day of feeding initiation (SD)	4.7 (±0.5)
Mean day of full feeding (SD)	4.8 (±0.4)

Table 5

Distribution of NG tube days

NG days	Number of patients	Percentage
3	4	19.0%
4	16	76.2%
5	1	4.8%

Table 6

Complications stratified by closure outcome

Outcome	Number	Patients with complications	Percentage
Successful closure	18	3	16.7
Unsuccessful closure	3	2	66.7

Table 7

Types of complications (n=21)

Complication	Number of patients	Percentage
No complications	16	76.2
Complications recorded:	5	23.8
- death	1	4.8
- other complications (type unspecified in records)	4	19.0

Note: the specific type of complications (wound infection, dehiscence, hernia, etc.) was not consistently specified in the original medical records.

- Variations in institutional practice (some centers routinely extubate in the operating room).

Technical advantages of electrocautery sheath expansion. Compared to sharp dissection, electrocautery offers:

- **hemostasis:** minimal bleeding during sheath opening;
- **precision:** controlled incision length and depth;
- **efficiency:** reduced operative time.

The combined **transverse and longitudinal** approach creates a tension-free closure without the need for fascial repair, potentially reducing intra-abdominal pressure.

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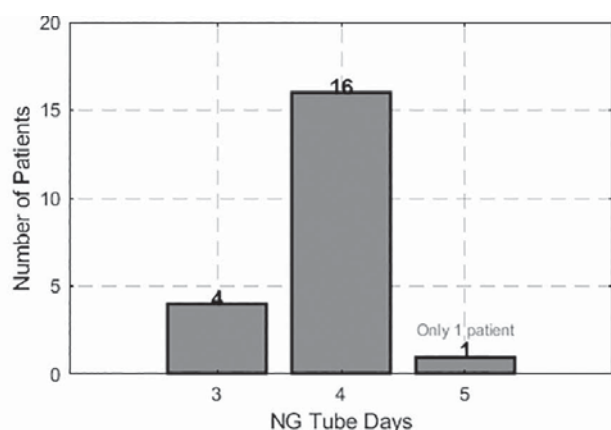


Fig. 2. Bar chart showing distribution of NG tube days among 21 patients

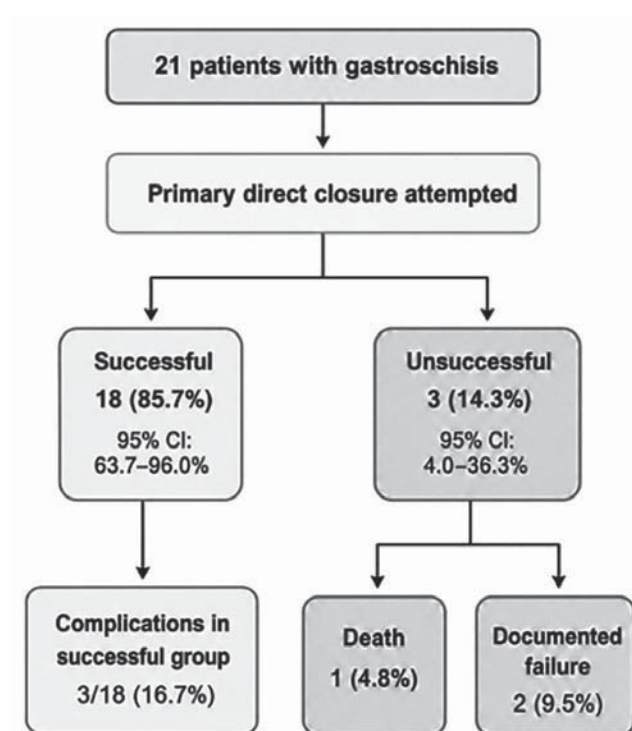


Fig. 3. Study flow diagram

Table 7

Comparison with published series

Study	Technique	N	Success rate	Mean NG days	Mortality	Notes
Present study	Primary closure + electro-cautery sheath expansion	21	85.7% (95% CI: 63.7–96.0)	3.9	4.8%	No ventilation
S.N. Kunz et al. (2013) [4]	Primary fascial closure	48	85%	5–7	2–6%	Comparable success
R.B. Hawkins et al. (2020) [3]	Silo	62	90%	7–10	3–8%	Longer NG duration
J.D. Fraser et al. (2020) [2]	Primary closure	35	88%	6	2–5%	Slightly higher success

Prevention of abdominal compartment syndrome. No patient in this series developed clinically evident abdominal compartment syndrome. This was achieved by:

1. Limiting sheath expansion to >5 cm.
2. Avoiding forced organ reduction.
3. Clinical assessment of bladder tension before closure.

Complications. The mortality rate of 4.8% is consistent with published gastroschisis mortality rates (2-10%) [8,9].

Feeding milestones. Six (28.6%) patients achieved full enteral feeding during the documented follow-up period, with a mean of 4.8 days postoperatively. In some patients, feeding initiation and full feeding were recorded on the same postoperative day (day 5), which may reflect rapid feeding advancement or documentation variation inherent to retrospective data collection.

The relatively low percentage of patients achieving full feeding may be due to limited duration of documented follow-up in medical records.

Study limitations. This study has several important limitations:

- Retrospective design. Data were collected from existing records with potential for incomplete or inconsistent documentation.
- Single center. Results may not be generalizable to other settings.
- No control groups. Comparison with silo or other techniques was not performed.
- Incomplete variables. Gestational age, defect size, and sheath opening dimensions were not consistently documented.
- Short follow-up. Long-term outcomes (incisional hernia, bowel obstruction) were not assessed.
- Complication specification. Type of non-fatal complications not specified in original records.
- Selection bias. Only patients who underwent primary closure were included.

- Failure definition. The definition of unsuccessful closure was based on documentation in daily follow-up records and may not fully reflect operative decision-making.

- No hospital stay data. Duration of hospitalization was not consistently recorded across all files.

Clinical implications and future directions. The clinical implications and future directions are outlined below. Clinical implications and future directions are detailed below.

Primary direct closure with sheath expansion with electrocautery seems to be a suitable approach in newborns with gastroschisis. Families should be preoperatively informed, however, of the 14.3% unsuccessful closure (death) rate.

Future studies should:

1. Include a Control group (silo patients) for direct comparison
2. Document hospital stay duration systematically
3. In the course of the operation, take some pictures or draw some diagrams.
4. Monitor patients for long-term follow-up of incisional hernia and bowel obstruction
5. Apply a prospective design using a standardized data collection method.

Conclusion

Primary direct closure of gastroschisis after skin undermining and transverse/longitudinal sheath expansion using electrocautery is a feasible technique with an 85.7% success rate (95% CI: 63.7–96.0%) in this single-center retrospective case series of 21 patients. Three (14.3%) patients were considered unsuccessful based on daily follow-up records: one died postoperatively, and two had documented failure. No patient required mechanical ventilation, and the mean NG tube duration was 3.9 days.

Complications were more frequent in the unsuccessful Closure group (66.7%) than in the successful group (16.7%). The technique offers advantages, including hemostasis and precise tissue division.

Limitations include retrospective design, absence of a Control group, incomplete documentation of certain variables, and a definition of unsuccessful closure based on daily records that may not fully reflect operative decision-making.

Prospective comparative studies with control groups, long-term follow-up, and standardized data collection are needed to determine the optimal surgical approach for gastroschisis.

The author declares that there is no conflict of interest.

Level of Evidence: Level IV (Case Series).

References/Literatura

1. Fischer JD, Chun K, Moores DC, Andrews MM. (1995). Gastroschisis: A simple technique for staged silo closure. *J. Pediatr. Surg.* 30(8): 1169-1171, doi: 10.1016/0022-3468(95)90014-4.
2. Fraser JD, Deans KJ, Fallat ME, Helmrath MA, Kabre R, Leys CM et al. (2020). Sutureless vs sutured abdominal wall closure for gastroschisis: Operative characteristics and early outcomes from the Midwest Pediatric Surgery Consortium. *J. Pediatr. Surg.* 55(11): 2284-2288, doi: 10.1016/j.jpedsurg.2020.02.017.
3. Hawkins RB, Raymond SL, St Peter SD, Downard CD, Qureshi FG, Renaud E et al. (2020, Jul). Immediate versus silo closure for gastroschisis: Results of a large multicenter study. *J. Pediatr. Surg.* 55(7): 1280-1285. Epub 2019 Aug 22. doi: 10.1016/j.jpedsurg.2019.08.002. PMID: 31472924; PMCID: PMC7731615.
4. Kunz SN, Tieder JS, Whitlock K, Jackson JC, Avansino JR. (2013). Primary fascial closure versus staged closure with silo in patients with gastroschisis: A meta-analysis. *J. Pediatr. Surg.* 48(4): 845-857. doi: 10.1016/j.jpedsurg.2013.01.020.
5. Lobo JD, Kim AC, Davis RP, Segura BJ, Alpert H et al. (2010). No free ride? The hidden costs of delayed operative management using a spring-loaded silo for gastroschisis. *J. Pediatr. Surg.* 45(7): 1426-1432. doi: 10.1016/j.jpedsurg.2010.02.047.
6. Lin S, Stephens C, Cunningham A, Hamilton N. (2021). Failure of primary closure predicts prolonged length of stay in gastroschisis patients. *Pediatr. Surg. Int.* 37(1): 77-83. doi: 10.1007/s00383-020-04772-3.
7. Pastor AC, Phillips JD, Fenton SJ, Meyers RL, Lamm AW, Ravall MV et al. (2008). Routine use of a SILASTIC spring-loaded silo for infants with gastroschisis: A multicenter randomized controlled trial. *J. Pediatr. Surg.* 43(10): 1807-1812. doi: 10.1016/j.jpedsurg.2008.04.003.
8. Sandler A, Lawrence J, Meehan J, Phearman L, Soper R. (2004, May). A "plastic" sutureless abdominal wall closure in gastroschisis. *J. Pediatr. Surg.* 39(5): 738-741. doi: 10.1016/j.jpedsurg.2004.01.040. PMID: 15137009.
9. Schlatter M, Norris K, Uitvlugt N, DeCou J, Connors R. (2003, Mar). Improved outcomes in the treatment of gastroschisis using a preformed silo and delayed repair approach. *J. Pediatr. Surg.* 38(3): 459-464; discussion 459-64. doi: 10.1053/jpsu.2003.50079. PMID: 12632367.
10. Sharma P, Gera P, Rao S. (2025). Early versus delayed silo closure in gastroschisis: A retrospective study. *Pediatr. Surg. Int.*, 41(1): 138. doi: 10.1007/s00383-025-06042-6.
11. Von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP et al. (2007). The Strengthening of Reporting of Observational Studies in Epidemiology (STROBE) Statement: Guidelines for Reporting Observational Studies. *PLoS Medicine*. 4(10): e296. doi: 10.1371/journal.pmed.0040296.
12. Wu Y, Vogel AM, Liu DC. (2003). Primary insertion of a Silastic spring-loaded silo for gastroschisis. *Am. Surg.* 69(12): 1083-1086. doi: 10.1177/000313480306901212.

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