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Gastroschisis in Newborns: Surgical Techniques, Postoperative Care, and Prognostic Factors

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ABSTRACT

Gastroschisis is a congenital paraumbilical abdominal wall defect characterized by evisceration of abdominal viscera without a protective sac. Although survival now exceeds 90% in well-resourced neonatal surgical systems, morbidity remains substantial and is driven primarily by the condition of the bowel, the presence of complex gastroschisis, and the pace of postoperative intestinal recovery. This narrative review synthesizes contemporary evidence on surgical closure, postoperative management, and prognostic factors in newborns with gastroschisis. Current guidelines support individualized closure based on bowel condition, abdominal domain, and physiologic tolerance. Primary fascial closure is appropriate when reduction can be achieved without clinically important respiratory or hemodynamic compromise, whereas staged silo reduction remains valuable when immediate reduction would create excessive intra-abdominal pressure. Sutureless closure has emerged as an effective alternative in selected infants and is associated with less general anesthesia exposure, shorter ventilation, and fewer surgical-site infections, but a higher risk of umbilical hernia and later hernia repair. Postoperative care is dominated by intestinal dysmotility, the need for parenteral nutrition, cautious transition to enteral feeding, prevention of central-line infection, and surveillance for cholestasis and other complications of prolonged intestinal failure. Protocolized feeding and avoidance of unnecessarily delayed enteral nutrition are supported predominantly by low- or very-low-certainty evidence, so recommendations should be applied with attention to clinical context. Prognosis is strongly influenced by the distinction between simple and complex gastroschisis; intestinal atresia, perforation, necrosis, or volvulus are associated with longer parenteral nutrition, delayed feeding autonomy, longer hospitalization, and increased risk of intestinal failure and bowel obstruction. Long-term survival is excellent for many patients, but gastrointestinal symptoms, reoperations, and possible neurodevelopmental vulnerabilities justify structured follow-up. The available literature remains heterogeneous, and high-quality multicenter prospective studies are needed to define optimal closure, nutritional strategies, and long-term surveillance..

Keywords: Gastroschisis; Neonatal Surgery; Abdominal Wall Defects; Enteral Nutrition; Parenteral Nutrition; Prognosis.

INTRODUCTION

Gastroschisis is a congenital full-thickness defect of the anterior abdominal wall, usually located immediately to the right of a normally inserted umbilical cord, through which bowel and occasionally other abdominal organs herniate directly into the amniotic cavity. Unlike omphalocele, the exteriorized viscera are not covered by a sac. Contemporary care has transformed gastroschisis from a frequently fatal anomaly into a condition with high survival in specialist neonatal surgical centers, yet the burden of morbidity remains considerable. The most important determinants of the

clinical course are not simply the size of the abdominal wall defect, but the degree of intestinal injury, the relationship between eviscerated viscera and available Abdominal Domain, Associated Intestinal Complications, And Postoperative Recovery Of Bowel Function [1,2,3].

The clinical spectrum is commonly divided into simple and complex gastroschisis. Simple gastroschisis lacks major intestinal complications at birth, whereas complex gastroschisis is generally defined by intestinal atresia, perforation, necrosis, or volvulus. This distinction has strong prognostic value and should be considered early in counseling, surgical planning, and interpretation of outcomes. Landmark risk-stratification studies and subsequent meta-analyses consistently demonstrate that complex disease is associated with greater morbidity, longer dependence on parenteral nutrition, delayed attainment of full enteral feeding, longer hospitalization, and a higher risk of intestinal failure and bowel obstruction [4,5,6]. Management is inherently multidisciplinary. Prenatal diagnosis permits planned delivery in a center with neonatal intensive care and pediatric surgical capability; after birth, successful treatment requires prompt thermoregulation, protection of exposed bowel, gastric decompression, fluid and electrolyte management, antimicrobial prophylaxis, and an individualized strategy for bowel reduction and abdominal wall closure.

The operative episode is only one component of care. Many infants subsequently require prolonged parenteral nutrition while intestinal motility recovers, followed by cautious advancement of enteral feeds and careful surveillance for catheter-related infection, cholestasis, feeding intolerance, necrotizing enterocolitis, bowel obstruction, and complications related to complex intestinal disease [1,2]. The purpose of this narrative review is to synthesize current evidence on three interdependent domains that determine outcomes in neonatal gastroschisis: surgical closure strategies, postoperative care, and prognostic factors. Particular emphasis is placed on evidence published in the last decade, including the 2024 European Reference Network for rare Inherited and Congenital Anomalies (ERNICA) guideline, the 2024 American Pediatric Surgical Association (APSA) evidence review, recent meta-analyses of closure and nutrition, and contemporary cohort studies of simple and complex gastroschisis [1,2].

2. METHODS

A targeted literature search was conducted and updated through October 4, 2026. PubMed/MEDLINE, major guideline repositories, and reference lists of high-quality systematic reviews and consensus documents were searched using combinations of the terms "gastroschisis," "newborn," "neonate," "primary closure," "silo," "sutureless closure," "complex gastroschisis," "intestinal atresia," "enteral feeding," "parenteral nutrition," "cholestasis," "prognosis," "long-term outcome," and "neurodevelopment." Priority was given to evidence-based guidelines, systematic reviews, meta-analyses, randomized or prospective comparative studies, multicenter cohorts, national registry studies, and recent large observational series. Older studies were retained when they established widely used concepts such as simple-versus-complex risk stratification or addressed questions for which modern high-level evidence remains limited.

Bibliographic details of the most recent studies were cross-checked against indexed records. This was not designed as a formal systematic review or meta-analysis; therefore, no pooled re-analysis of published data was performed. Because several areas of gastroschisis management are supported predominantly by retrospective studies, conclusions were framed according to the strength and consistency of the available evidence. Where contemporary guidelines differed in emphasis, recommendations were interpreted in the context of patient selection, institutional expertise, abdominal domain, bowel condition, and the risk of confounding by indication [1,2].

3. EPIDEMIOLOGY, ETIOLOGY, AND PATHOPHYSIOLOGY

Gastroschisis occurs in approximately 2 to 6 per 10,000 live births in many contemporary series, although prevalence varies geographically and over time. More than 90% of cases are now detected prenatally in settings with routine obstetric ultrasonography. A striking epidemiologic feature is the strong association with young maternal age. Non-genetic exposures have also been investigated. A systematic review and meta-analysis found associations between gastroschisis and maternal smoking, alcohol exposure, and illicit drug use, but these observations should not be interpreted as proof of causality because residual confounding and correlated social or environmental exposures remain possible [1,3,7]. No single embryologic mechanism fully explains gastroschisis. Proposed theories include abnormal ventral body-wall folding, failure of incorporation of yolk-sac-related structures, vascular disruption, and rupture or abnormal development near the umbilical ring.

The epidemiologic pattern and relatively low frequency of major chromosomal abnormalities compared with omphalocele suggest that gastroschisis is biologically distinct from midline abdominal wall defects [3]. The condition of the bowel at birth is central to both management and prognosis. Exteriorized intestine is exposed to amniotic fluid and may develop edema, serosal inflammation, matting, and impaired motility. In addition, constriction at the abdominal wall defect can compromise mesenteric perfusion and may contribute to ischemia and progressive bowel loss in severe closing or closed forms of gastroschisis. Intestinal atresia, perforation, necrosis, and volvulus define the broader complex phenotype and may arise through more than one mechanism. The resulting dysmotility can persist after apparently successful abdominal wall closure and explains why feeding recovery may be prolonged even when no mechanical obstruction is present [3,4].

The simple-versus-complex classification provides a clinically useful summary of this intestinal injury. Molik and colleagues

originally highlighted major differences in postoperative course between uncomplicated and complicated disease, and later analysis of more than 4,000 infants confirmed substantially longer hospitalization and higher inpatient mortality in complex cases. A subsequent systematic review similarly demonstrated higher risks of sepsis, short bowel syndrome, necrotizing enterocolitis, prolonged parenteral nutrition, and delayed feeding in complex gastroschisis [4,5,6].

4. PRENATAL DIAGNOSIS, SURVEILLANCE, AND DELIVERY

Prenatal ultrasound usually demonstrates free-floating bowel loops outside the fetal abdomen adjacent to an intact umbilical cord insertion. Once the diagnosis is established, serial assessment commonly includes fetal growth, amniotic fluid volume, bowel appearance, intra-abdominal and extra-abdominal bowel diameter, gastric dilation, and other signs that may indicate progressive intestinal compromise. The goal of surveillance is not only to confirm the diagnosis but also to identify fetuses at increased risk of complex disease and to support coordinated delivery planning [1,8,9]. However, the predictive accuracy of individual ultrasound markers remains limited. The ERNICA guideline considers intra-abdominal bowel dilatation and extra-abdominal bowel dilatation useful predictors of complex gastroschisis, while emphasizing that interpretation should integrate multiple parameters rather than rely on a single threshold.

A 2021 systematic review and meta-analysis found significant associations between complex gastroschisis and intra-abdominal bowel dilatation, extra-abdominal bowel dilatation, and polyhydramnios. More recent single-center data also suggest that intra-abdominal bowel dilatation and qualitative abnormalities such as non-free-floating bowel loops may improve prediction, particularly later in gestation. Nevertheless, the positive predictive value of individual markers remains insufficient to determine neonatal management in isolation [1,8,9]. Routine elective preterm delivery has not been shown to improve neonatal outcomes and exposes the infant to complications of prematurity. The 2024 ERNICA guideline suggests vaginal birth between 37+0 and 39+0 weeks for uncomplicated gastroschisis, while APSA's evidence review similarly concludes that delivery after 37 weeks is generally optimal.

Cesarean delivery should be reserved for standard obstetric indications rather than performed solely because gastroschisis is present [1,2]. Delivery planning should prioritize location. Delivery at, or rapid transfer to, a center with neonatal intensive care, pediatric anesthesia, and pediatric surgical expertise reduces avoidable delays in stabilization and definitive management. Prenatal counseling should be realistic: most infants with simple disease survive and ultimately achieve enteral autonomy, but prolonged hospitalization is common, and prenatal findings cannot reliably exclude complex intestinal pathology [1,2].

5. IMMEDIATE POSTNATAL STABILIZATION

Initial care should proceed simultaneously with surgical assessment. The exposed bowel should be protected promptly from evaporative heat and fluid loss and from direct trauma. A sterile transparent bowel bag or appropriate moist sterile covering allows visualization while limiting contamination and heat loss. The bowel should be positioned to avoid torsion or kinking of the mesentery. Gastric decompression with an orogastric or nasogastric tube reduces swallowed air and gastrointestinal distension. Temperature, perfusion, urine output, acid-base status, glucose, and electrolytes require close monitoring because these newborns may have substantial third-space and evaporative losses [2,3]. Vascular access should be obtained early, but resuscitation should be guided by clinical perfusion and laboratory assessment rather than by automatic administration of large fluid volumes.

Both under-resuscitation and excessive fluid loading may be harmful: inadequate intravascular volume can worsen organ perfusion, whereas fluid overload may increase bowel edema, compromise abdominal domain, prolong ventilation, and make closure more difficult. The need for respiratory support should be individualized. Some stable infants can undergo bedside reduction or staged treatment without routine intubation, whereas infants requiring general anesthesia, substantial opioid sedation, or a tight abdominal closure may need mechanical ventilation [1,2]. Antimicrobial prophylaxis is recommended before definitive closure. The APSA evidence review supports prophylaxis directed at skin flora until closure in uncomplicated cases. A 2026 single-center retrospective study of 53 silo-managed neonates found that stopping prophylaxis within 24 hours after closure was not associated with greater infection odds than longer prophylaxis; the small retrospective design means this should be interpreted as supportive rather than definitive evidence.

Bowel ischemia, perforation, sepsis, or another independent indication for antimicrobial treatment should override a prophylaxis-only schedule [2,10]. The initial surgical examination should document bowel viability and identify atresia, perforation, necrosis, volvulus, severe matting, or a constricting abdominal ring. It should also estimate whether the viscera can be reduced without creating excessive intra-abdominal pressure. These findings determine the immediate pathway: primary reduction and closure, primary reduction with sutureless coverage, or staged reduction with a silo [1,2,3].

6. SURGICAL MANAGEMENT

The objectives of surgery are to protect the bowel, restore the viscera to the abdominal cavity without compromising perfusion or cardiorespiratory function, and close or cover the abdominal wall defect with the lowest overall physiologic burden. No single technique is appropriate for every newborn. Contemporary guidance emphasizes individualized selection

based on abdominal domain, bowel edema and viability, physiologic stability, associated intestinal pathology, local expertise, and whether reduction can be achieved without clinically important tension [1,2].

6.1 Primary reduction and fascial closure

Primary closure may be performed when the bowel can be reduced safely and the abdominal cavity can accommodate the viscera without excessive pressure. Potential advantages include immediate restoration of abdominal wall continuity and avoidance of a prolonged staged reduction. However, forcing reduction in an infant with marked bowel edema or limited abdominal domain can impair venous return, renal perfusion, intestinal blood flow, and ventilation. The decision therefore should be physiologic rather than cosmetic or purely technical. Changes in airway pressure, oxygenation, perfusion, abdominal tension, and urine output can provide clinically useful warning signs during and after reduction [1,2,3]. APSA's 2024 evidence synthesis supports primary fascial repair without a staged silo when abdominal domain and hemodynamics permit. ERNICA similarly recognizes primary reduction under anesthesia as an appropriate strategy and notes that bedside approaches such as Bianchi reduction can be considered in selected newborns with simple gastroschisis and favorable bowel conditions.

The evidence comparing these approaches is predominantly observational and of low certainty [1,2].

6.2 Staged reduction with a silo

When immediate reduction is not tolerated or would place excessive pressure on the viscera and thoracoabdominal compartment, staged reduction with a silo is an established alternative. A preformed spring-loaded silo can often be placed at the bedside, with gradual reduction of bowel over subsequent days followed by definitive closure. This approach allows time for edema to decrease and abdominal capacity to adapt and may avoid the physiologic consequences of a tight primary closure. Bowel perfusion, silo position, and the defect margin should be reassessed repeatedly; the silo ring itself must not create clinically important constriction [1,2,3]. A large multicenter retrospective study of 566 neonates found broadly similar mortality, sepsis, readmission, and time-to-full-feeding outcomes between immediate closure and silo treatment when definitive closure after silo placement occurred within five days.

Longer time to closure was associated with longer hospitalization, ventilation, time to full feeds, and parenteral nutrition. These findings are clinically useful but should not be interpreted as proof that delayed closure itself causes poor outcomes because infants requiring prolonged silo treatment are often those with more severe edema, lower abdominal capacity, or greater physiologic instability [11]. For stable infants, staged reduction does not always require routine ventilation or general anesthesia. ERNICA suggests that treatment without ventilation and general anesthesia may be considered when a silo strategy is chosen for simple gastroschisis, provided pain and comfort are carefully monitored [1].

6.3 Sutured versus sutureless closure

Sutureless closure has become an important option for selected infants. After bowel reduction, the umbilical cord or a non-sutured dressing construct is used to cover the defect, allowing gradual epithelialization and spontaneous fascial contraction. The approach can reduce or avoid general anesthesia and may lessen ventilatory requirements [1,2]. A small randomized trial published in 2017 found that sutureless repair was safe but, in that single-center protocol, was associated with longer time to full feeds and discharge. Subsequent observational studies and pooled analyses have produced a more favorable overall picture. A 2026 meta-analysis of 23 studies including 2,646 infants found no significant increase in mortality (RR 1.11, 95% CI 0.61-2.03) and no significant overall delay in time to full feeds (mean difference -1.62 days, 95% CI -4.61 to 1.38).

Sutureless closure was associated with less use of general anesthesia (RR 0.23, 95% CI 0.15-0.36), a shorter duration of mechanical ventilation (mean difference -1.96 days, 95% CI -2.66 to -1.26), and fewer surgical-site infections (RR 0.60, 95% CI 0.43-0.83). The trade-off was a higher incidence of umbilical hernia (RR 2.50, 95% CI 1.57-3.98) and later hernia repair (RR 2.66, 95% CI 1.65-4.27) [12,13]. Because most contributing studies were observational, these pooled estimates remain vulnerable to case-mix and center-level confounding. A technique that avoids general anesthesia may be particularly attractive in a stable infant who can be reduced at the bedside. Conversely, when the infant already requires general anesthesia and formal primary closure is feasible, ERNICA suggests sutured closure to reduce the later hernia burden. Families should be counseled about this balance between short-term perioperative advantages and the greater probability of an umbilical defect requiring observation or later repair [1,13].

6.4 Avoiding abdominal compartment physiology

The major technical hazard across all closure strategies is excessive intra-abdominal pressure. Clinical deterioration after reduction may include rising ventilatory pressures, impaired oxygenation, hypotension, reduced urine output, tense abdominal wall, lower-extremity venous congestion, or worsening metabolic acidosis. These findings should prompt immediate reassessment of the reduction.

A staged approach is preferable to a technically successful but physiologically harmful closure [1,2,3].

6.5 Management of complex gastroschisis

Complex gastroschisis requires individualized intestinal decision-making in addition to abdominal wall management. Atresia may be treated with primary anastomosis when bowel condition and infant stability are favorable, or with delayed reconstruction when edema, inflammation, ischemia, or size discrepancy make immediate repair unsafe. Perforation and necrosis require control of contamination and preservation of viable bowel. Volvulus demands urgent assessment of perfusion and correction of torsion. In all scenarios, bowel preservation is a priority because extensive resection increases the risk of short bowel syndrome and intestinal failure [1,6]. ERNICA suggests that primary intestinal repair can be attempted in complex gastroschisis with atresia when the infant's condition and bowel permit, while emphasizing that the strategy should be tailored to the individual case.

Large multicenter data confirm that gastroschisis with intestinal atresia is associated with longer hospitalization, later initiation and completion of enteral feeding, higher rates of necrotizing enterocolitis and perforation, and greater likelihood of feeding-tube dependence at discharge [1,14].

6.6 Closing and closed gastroschisis

Closing or closed gastroschisis is a rare, severe subset of complex disease in which the abdominal wall defect progressively constricts or closes around the eviscerated intestine. Constriction can impair mesenteric perfusion and produce entry or exit stricture, atresia, ischemia, necrosis, or resorption of bowel; the most extreme phenotype is often termed vanishing gastroschisis or vanishing midgut and may result in profound short bowel syndrome [3]. Prenatal clues can include reduction or disappearance of the extra-abdominal bowel accompanied by increasing intra-abdominal bowel dilatation, but prenatal prediction is imperfect [3,8,9]. After birth, a narrow constricting ring with threatened bowel perfusion requires urgent surgical assessment; the immediate priority is preservation of viable bowel rather than forced reduction through a restrictive defect. Prognosis depends largely on the amount and function of the remaining intestine, and infants with major bowel loss require early intestinal failure expertise, meticulous nutrition, and long-term multidisciplinary follow-up [3].

7. POSTOPERATIVE CARE

Successful closure does not immediately restore normal intestinal function. Postoperative management is therefore directed toward supporting cardiorespiratory stability, maintaining nutrition while dysmotility resolves, preventing line-related and wound complications, and recognizing evolving intestinal pathology. The duration of postoperative recovery varies widely and is strongly influenced by whether gastroschisis is simple or complex [1,6].

7.1 Respiratory and hemodynamic management

The need for postoperative ventilation reflects several factors: prematurity, anesthetic exposure, opioid requirements, abdominal pressure after reduction, and baseline pulmonary status. Infants treated by bedside reduction and sutureless closure may avoid intubation altogether, whereas tight fascial closure or substantial sedation may necessitate short-term ventilation. The key principle is to avoid maintaining ventilation solely because of the diagnosis while also recognizing that rising ventilatory pressures after closure can signal excessive intra-abdominal pressure [1,2,13]. Analgesia and comfort should be assessed systematically throughout bedside or staged reduction. ERNICA specifically recommends objective pain and comfort monitoring when staged closure is performed in spontaneously breathing infants, because avoidance of routine intubation should not come at the expense of undertreated procedural pain [1].

Fluid therapy should be reassessed frequently after closure. Early losses may be substantial, but ongoing liberal fluid administration after bowel coverage can worsen edema and respiratory mechanics. Urine output, capillary refill, blood pressure, weight change, serum electrolytes, lactate or acid-base status when clinically indicated, and overall fluid balance are more informative than fixed-volume protocols [3].

7.2 Gastric decompression and intestinal dysmotility

A prolonged functional ileus is expected in many infants because the exposed bowel has varying degrees of inflammation and dysmotility. Gastric decompression is usually continued until drainage decreases and clinical evidence of bowel function appears. Bilious output is common early in the course and should be interpreted in context. Persistent high output, abdominal distension, failure of progression, or new clinical deterioration should raise concern for mechanical obstruction, atresia, volvulus, ischemia, or other complications rather than being attributed automatically to postoperative ileus [1,3].

7.3 Parenteral nutrition

Parenteral nutrition is necessary for most infants while bowel function recovers. Adequate protein, energy, essential fatty acids, electrolytes, vitamins, and trace elements are required to support growth during a period in which enteral intake may be minimal. The objective is not simply to provide calories but to bridge the infant safely to enteral autonomy while minimizing complications associated with prolonged central venous access and parenteral nutrition [3]. Duration of parenteral nutrition is one of the most clinically meaningful markers of disease burden. In simple gastroschisis, prolonged ventilation, delayed closure, prenatal bowel dilation, necrotizing enterocolitis, and central-line-associated bloodstream infection have been associated with longer parenteral nutrition and hospitalization; in a large prospective Canadian registry, central-line-associated infection was the strongest predictor of prolonged resource use among several modifiable and non-

modifiable factors [15].

7.4 Initiation and advancement of enteral feeding

Feeding practice varies among centers because no universally validated regimen defines the ideal day of initiation, starting volume, advancement rate, or response to gastric aspirates. Contemporary evidence supports avoiding unnecessary delay once the infant is clinically stable and gastrointestinal decompression is improving. ERNICA suggests starting enteral feeds within 14 days after repair in simple gastroschisis and states that feeding before day 7 can be considered when the clinical condition is favorable and aspirates are low. Importantly, the guideline also notes that the evidence is very weak and does not establish superiority of starting before day 7 over starting on days 8-14. A standardized feeding protocol is suggested to reduce unwarranted practice variation [1]. A 2017 systematic review of 42 observational studies found that each day of delay in commencing enteral feeds was associated with longer time to full enteral feeding, longer parenteral nutrition, and longer hospitalization, although causation cannot be established because sicker infants predictably start feeding later.

A 2021 systematic review and meta-analysis found that protocolized pathways were associated with earlier initiation of enteral feeding by approximately three days, while effects on time to full feeds and parenteral nutrition duration were less certain [16,17]. The safest interpretation is pragmatic: feeds should not be advanced against

clear evidence of intolerance, but routine prolonged fasting after uncomplicated closure is difficult to justify. Persistent high bilious output, progressive abdominal distension, recurrent bilious emesis, systemic deterioration, or concern for obstruction or ischemia should prompt reassessment rather than automatic feed advancement [1,3]. Human milk is biologically attractive because of its immunologic and trophic properties. A 2024 Canadian national cohort found similar adjusted in-hospital outcomes between exclusive human milk and supplemental or exclusive formula among infants with uncomplicated gastroschisis, although early human milk exposure strongly predicted breastfeeding at discharge.

A 2026 systematic review and meta-analysis of seven observational studies including 3,661 infants found very-low-certainty evidence suggesting lower mortality with exclusive human milk but no definitive reduction in necrotizing enterocolitis, cholestasis, or sepsis. These data support prioritizing maternal milk when available while avoiding causal claims of proven superiority for most clinical endpoints [18,19].

7.5 Central venous access and infection prevention

Because parenteral nutrition may continue for weeks, reliable central venous access is often required. Catheter-related bloodstream infection can prolong intestinal rehabilitation and hospitalization and can contribute to cholestasis and systemic instability. Meticulous insertion and maintenance practices, prompt evaluation of suspected infection, and removal of unnecessary central access once enteral autonomy is achieved are therefore central components of postoperative care. The strong association between central-line-associated bloodstream infection and prolonged outcomes in simple gastroschisis underscores that prevention of line infection is not merely a general NICU quality metric but a disease-specific determinant of recovery [15]. When a peripherally inserted central catheter is required, ERNICA suggests the upper extremity as the first-choice insertion site. If a lower-extremity PICC is used, particularly while a silo is in place, careful surveillance for catheter-related complications is warranted [1].

7.6 Cholestasis and intestinal failure-associated liver disease

Infants with gastroschisis are vulnerable to cholestasis because they frequently require prolonged parenteral nutrition, experience delayed enteral stimulation, and may develop recurrent infection. In a recent single-center cohort of 176 infants, 23.3% developed cholestasis; prematurity and low birth weight were among associated factors, and lipid composition also appeared relevant. These findings reinforce the multifactorial nature of intestinal failure-associated liver disease [20]. Prevention should focus on minimizing avoidable parenteral nutrition exposure, advancing enteral nutrition when clinically appropriate, preventing sepsis, and using contemporary neonatal nutrition practices for lipid and nutrient delivery. Direct bilirubin and liver biochemical tests should be monitored in infants requiring prolonged parenteral nutrition. Progressive cholestasis should trigger review of infection, nutrient prescription, line necessity, enteral strategy, and the possibility of prolonged intestinal failure [20].

7.7 Necrotizing enterocolitis, obstruction, and other complications

Necrotizing enterocolitis is not the dominant complication of simple gastroschisis but occurs more frequently in complex disease. In the 2025 multicenter review comparing simple and complex gastroschisis, necrotizing enterocolitis and intestinal dysmotility were markedly more frequent in complex cases. Intestinal atresia similarly identifies a subgroup with greater feeding morbidity [14,21]. Mechanical obstruction may occur during the neonatal admission or after discharge as a consequence of atresia, stricture, adhesions, volvulus, or recurrent intestinal pathology. A sudden change from expected dysmotility to worsening distension, bilious emesis, systemic instability, or abnormal imaging should prompt renewed surgical evaluation. Wound infection, dehiscence, incisional or umbilical hernia, catheter thrombosis, and reoperation should also be considered in structured follow-up [13,22].

8. PROGNOSTIC FACTORS

Prognosis in gastroschisis is best understood as the interaction of prenatal, anatomical, physiologic, surgical, and

postoperative variables rather than as the consequence of a single closure technique. This distinction is important because treatment choices are strongly confounded by disease severity: infants with the most edematous bowel, smallest abdominal domain, or greatest instability are also the infants most likely to receive prolonged silo treatment or delayed reconstruction [1,2].

8.1 Simple versus complex gastroschisis

The presence of complex gastroschisis remains the most clinically useful categorical prognostic factor. Historic studies established the concept, and contemporary data continue to validate it. In a 2025 multicenter analysis of 331 neonates, complex gastroschisis was associated with a median hospital stay of 75 days compared with 33 days in simple disease, as well as higher rates of necrotizing enterocolitis and dysmotility. Survival to discharge did not differ significantly in that cohort, illustrating that modern intensive care can achieve high survival even when morbidity is substantial [4,5,6,21]. Long-term data strengthen the prognostic importance of this distinction. A Swedish national register-based cohort of 315 children found that complex gastroschisis was associated with an approximately 12-fold higher hazard of intestinal failure and more than fourfold higher hazard of bowel obstruction. Most adverse gastrointestinal events occurred during the first two years of life, a period in which clinical follow-up should therefore be particularly attentive [22].

8.2 Prenatal markers

Intra-abdominal and extra-abdominal bowel dilatation are the best-supported prenatal markers of complex disease, but neither is sufficiently accurate to determine outcome alone. Meta-analytic evidence supports an association between intraabdominal bowel dilation and complex gastroschisis, while extra-abdominal dilation and polyhydramnios also carry prognostic information. Recent data suggest that combinations of quantitative and qualitative sonographic abnormalities may improve prediction. However, thresholds vary across studies, gestational age affects measurements, and positive predictive values remain modest. Prenatal imaging should therefore be used for risk stratification and counseling rather than for deterministic predictions [1,8,9].

8.3 Gestational age, birth weight, and physiologic condition

Prematurity and low birth weight may compound the morbidity of gastroschisis by increasing vulnerability to respiratory disease, infection, impaired growth, and parenteral nutrition complications. These factors are difficult to separate from the biology that leads to spontaneous preterm delivery or fetal growth restriction. Elective prematurity should not be used as a strategy to prevent bowel injury in uncomplicated disease because current evidence does not show a consistent neonatal benefit [1,2].

8.4 Surgical and postoperative factors

The ability to achieve closure without prolonged physiologic compromise is more informative than the label of a specific technique. Prolonged time to closure may identify infants with more severe bowel edema or limited abdominal capacity and has been associated with longer hospitalization and nutritional support. Conversely, sutureless closure appears to reduce anesthesia exposure and ventilation without worsening mortality or feeding outcomes, but increases the later hernia burden [11,13]. Postoperative events can substantially modify the expected course. Central-line-associated infection, necrotizing enterocolitis, persistent dysmotility, reoperation, and prolonged inability to establish enteral feeding are associated with longer parenteral nutrition and hospitalization. These variables are clinically important because some are potentially preventable or modifiable even when prenatal anatomy is not [14,15].

8.5 Prognostic counseling

Families should receive estimates framed as ranges rather than precise predictions. A newborn with uncomplicated gastroschisis, stable physiology, and successful early reduction usually has an excellent chance of survival and eventual enteral autonomy, but still may remain hospitalized for several weeks. The presence of atresia, perforation, necrosis, volvulus, major bowel loss, persistent sepsis, or prolonged intestinal failure shifts the expected course substantially. Counseling should be updated as new information becomes available after direct bowel inspection and during nutritional recovery [1,6,22].

9. LONG-TERM OUTCOMES

Short-term survival is no longer an adequate endpoint for gastroschisis care. Children may experience later bowel obstruction, recurrent abdominal pain, constipation, gastroesophageal reflux symptoms, feeding difficulties, scar concerns, and additional abdominal operations. The burden is greatest in complex disease, but even children with simple gastroschisis may require targeted gastrointestinal follow-up [22,23]. A 2026 Norwegian national follow-up study reported that 20% of respondents had undergone at least one unplanned laparotomy, most often for mechanical obstruction. Nearly one third reported significant gas and bloating, diarrhea, or constipation, and a minority reported impaired school functioning or dissatisfaction with follow-up. Only 82 of 172 eligible patients responded (48%), so symptom frequencies should be interpreted with the potential for response bias in mind.

Nevertheless, these findings indicate that clinically relevant morbidity may persist well beyond neonatal discharge [23]. Growth is often impaired during the neonatal period because of prematurity, inflammatory stress, prolonged parenteral

nutrition, and feeding delay. Many children demonstrate catch-up growth during early childhood, particularly after simple gastroschisis, but growth should be monitored in patients with intestinal failure, repeated surgery, or persistent feeding symptoms [3,22]. Neurodevelopmental outcomes are less well defined. A 2025 review identified substantial heterogeneity among available studies and suggested possible neurodevelopmental vulnerability but could not reliably isolate the independent effect of gastroschisis from prematurity, critical illness, intestinal failure, sepsis, and repeated procedures. This uncertainty supports a risk-based approach to developmental surveillance, especially in children with complex disease or prolonged neonatal intensive care exposure [24].

Long-term care should therefore be individualized. Infants with simple disease and uncomplicated recovery may require routine growth and gastrointestinal surveillance, while children with complex gastroschisis, intestinal failure, major resection, recurrent obstruction, or developmental concerns may benefit from coordinated pediatric surgery, gastroenterology, nutrition, primary care, and developmental follow-up [22,23,24].

10. CURRENT CONTROVERSIES AND EVIDENCE GAPS

Despite major advances in survival, many everyday decisions in gastroschisis remain supported by low-certainty evidence. The first uncertainty is closure strategy. Modern data support both primary and staged approaches, and the 2026 sutureless meta-analysis clarifies important trade-offs, yet most contributing studies are observational and subject to institutional selection bias. A definitive trial would need to stratify infants by bowel condition and abdominal domain rather than randomize obviously dissimilar clinical phenotypes [1,2,13]. The second uncertainty is nutritional timing. Observational evidence supports avoidance of very delayed feeding and favors protocolized advancement, but the exact optimal start day and advancement rate remain unclear. Feeding tolerance is affected by bowel injury, closure timing, opioid exposure, sepsis, and complex intestinal pathology, which makes a universal schedule unlikely to fit every patient.

Multicenter prospective studies using standardized definitions of feeding intolerance and enteral autonomy would be valuable [1,16,17]. Third, prenatal prediction remains incomplete. Sonographic bowel dilation and related markers are useful for risk stratification but cannot yet distinguish simple from complex gastroschisis with sufficient certainty to dictate delivery or surgical strategy. Better predictive models should combine serial imaging, gestational age, qualitative bowel characteristics, fetal growth, and potentially novel biomarkers [1,8,9]. Fourth, long-term outcomes are underreported. Mortality, length of stay, and days of parenteral nutrition remain essential
endpoints, but they do not capture later bowel obstruction, chronic gastrointestinal symptoms, growth,
neurodevelopment, cosmetic outcomes, family burden, or quality of life.

Standardized core outcome sets and prospective registries can improve comparability across centers and permit evaluation of whether early management choices affect later health. A published gastroschisis core outcome set identifies eight stakeholder-prioritized outcomes: mortality, sepsis, growth, number of operations, severe gastrointestinal complications, time on parenteral nutrition, liver disease, and child quality of life [1,22,23,24,25]. Finally, evidence from resource-limited settings remains insufficient. Gastroschisis outcomes are highly dependent on timely neonatal stabilization, safe transport, infection prevention, parenteral nutrition, central venous access, and pediatric surgical expertise. Interventions that are equivalent in a highly resourced NICU may not have the same feasibility or risk profile where access to these supports is inconsistent.

Future guidelines should distinguish biologic efficacy from system-level feasibility and include implementation research across diverse care environments.

11. DISCUSSION

The contemporary management of gastroschisis is best understood as a continuum from prenatal risk assessment to long-term follow-up rather than as a choice between competing closure techniques. The most consistent message across current guidelines and recent outcome studies is that the condition of the bowel and the physiology of the newborn should drive treatment. In uncomplicated disease, primary closure, staged reduction, and sutureless closure can all produce excellent survival when appropriately selected. The practical objective is to achieve safe visceral reduction without sacrificing perfusion or respiratory stability [1,2]. The growing evidence for sutureless closure illustrates how outcomes can shift when perioperative burden is considered alongside traditional surgical endpoints. The 2026 meta-analysis suggests meaningful reductions in general anesthesia, ventilation, and surgical-site infection, with no overall penalty in mortality, hospital stay, or feeding milestones, but at the cost of more umbilical hernias and hernia repairs.

This is not a simple superiority signal. It is a trade-off that may favor sutureless treatment in a stable infant who can avoid anesthesia, while a sutured closure may be reasonable when the infant is already anesthetized and fascial approximation is physiologically acceptable [13]. Postoperative recovery is largely an intestinal rehabilitation problem. Parenteral nutrition is often unavoidable, but its complications become increasingly important as exposure lengthens. Earlier recognition of feeding readiness, protocolized advancement, protection of central access, and prevention of sepsis may have as much influence on length of stay as the closure itself. The strongest evidence does not support aggressive feeding regardless of clinical signs; rather, it argues against prolonged fasting without a specific physiologic reason [1,15,16,17]. The distinction between simple

and complex gastroschisis remains indispensable.

It predicts short-term resource use and long-term intestinal morbidity more reliably than many technical details of closure. Recent multicenter and national cohort data confirm that complex disease continues to carry markedly longer hospitalization and higher risks of dysmotility, necrotizing enterocolitis, intestinal failure, and bowel obstruction even when survival is high. This has implications for prenatal counseling, neonatal resource planning, and follow-up intensity [21,22]. Several limitations should temper interpretation of the literature. Most studies are retrospective, definitions of complex disease and feeding outcomes are not perfectly uniform, and treatment is center-dependent. Confounding by indication is particularly problematic: the sickest infants are more likely to receive prolonged silo treatment, delayed reconstruction, longer ventilation, and slower feeding.

Apparent associations between a treatment and an adverse outcome may therefore reflect underlying severity rather than harm from the treatment itself. The ERNICA guideline explicitly grades much of the evidence as low or very low certainty, and APSA similarly emphasizes the need for higher-quality comparative studies [1,2]. A high-quality gastroschisis program should consequently focus on processes that remain valid despite uncertainty in individual techniques: prenatal coordination, delivery at an appropriate center, rapid protection and stabilization of

the exposed bowel, physiologically safe reduction, standardized nutritional and line-care pathways, early identification of complex intestinal disease, and structured long-term follow-up for high-risk survivors. These principles are more robust than any single institutional preference for primary closure, silo, or sutureless repair.

12. CONCLUSIONS

Gastroschisis is a highly survivable neonatal surgical condition in well-resourced systems, but morbidity remains substantial and is driven primarily by intestinal injury and postoperative recovery. Closure should be individualized according to bowel condition, abdominal domain, and physiologic tolerance. Primary fascial closure is appropriate when it can be achieved safely; staged silo reduction remains essential when immediate reduction would create excessive pressure; and sutureless closure can reduce anesthesia exposure, ventilation, and surgical-site infection in selected infants, with a recognized increase in umbilical hernia risk [1,2,13]. Postoperative management should prioritize careful fluid and respiratory support, parenteral nutrition while dysmotility resolves, timely and protocolized transition to enteral feeding, rigorous central-line care, and surveillance for cholestasis, necrotizing enterocolitis, obstruction, and recurrent surgical disease.

Complex gastroschisis - particularly disease complicated by atresia, perforation, necrosis, or volvulus - remains the strongest clinical marker of prolonged hospitalization and later intestinal morbidity [1,14,21,22]. Future progress will depend less on discovering a universally superior closure method than on generating multicenter prospective evidence, standardizing outcome definitions, improving prenatal risk prediction, optimizing intestinal rehabilitation, and extending follow-up beyond discharge to capture gastrointestinal, nutritional, neurodevelopmental, and quality-of-life outcomes.

Table 1. Comparison of principal abdominal wall closure strategies

Feature	Primary sutured closure	Staged silo reduction	Sutureless closure
Best suited for	Infant with adequate abdominal domain and stable physiology	Infant in whom immediate reduction would create excessive tension or physiologic compromise	Selected stable infants after reduction, particularly when general anesthesia can be avoided
Major advantages	Immediate definitive fascial repair	Gradual accommodation of bowel and abdominal cavity; avoids forced tight closure	Less general anesthesia; shorter ventilation; fewer surgical-site infections in pooled contemporary data
Major limitations	Risk of elevated intra-abdominal pressure if performed under tension	Requires staged management and later closure; prolonged time to closure may reflect greater disease severity	Higher frequency of umbilical hernia and later hernia repair

Key evidence point	Supported when abdominal domain and hemodynamics permit [2]	Outcomes comparable to immediate closure when closure occurs promptly in appropriately selected infants [11]	2026 meta-analysis: anesthesia RR 0.23; ventilation MD -1.96 days; SSI RR 0.60; umbilical hernia RR 2.50; hernia repair RR 2.66 [13]

Table 2. Clinically relevant prognostic factors in neonatal gastroschisis

Domain	Examples	Clinical interpretation
Prenatal	Intra-abdominal bowel dilatation, extra-abdominal bowel dilatation, polyhydramnios, abnormal qualitative bowel findings	Useful for risk stratification but insufficiently accurate for deterministic prediction; interpret serially and in combination [1,8,9]
Anatomical	Atresia, perforation, necrosis, volvulus, closing/closed gastroschisis, major bowel loss	Defines or signals complex disease and strongly predicts prolonged nutritional and gastrointestinal morbidity [3,6,14,21,22]
Physiologic	Prematurity, low birth weight, instability, poor perfusion	May increase respiratory, infectious, nutritional, and growth-related vulnerability
Treatment course	Prolonged time to closure, prolonged ventilation, reoperation	Often marks greater underlying severity; associations are vulnerable to confounding by indication [11,15]
Postoperative	CLABSI, NEC, persistent dysmotility, prolonged PN, cholestasis	Potentially modifiable drivers of longer hospitalization and delayed enteral autonomy [14,15,20]

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