APS
Advances in Pediatric Surgery

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pISSN 2635-8778
eISSN 2635-8786

Vol. 32 · No. 1 · June 2026

https://aps-journal.org

Vol. 32 · No. 1 · June 2026

https://aps-journal.org

Korean Association of Pediatric Surgeons

https://aps-journal.org

pISSN 2635-8778
eISSN 2635-8786

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Aims and scope

Advances in Pediatric Surgery (APS) is the official journal of the Korean Association of Pediatric Surgeons. We aim to provide broad and in-depth development of pediatric surgery by publishing high quality research and case reports from around the world. The abbreviated title is Adv Pediatr Surg. This journal is published two times a year, on June 30th and December 31st. The categories of manuscripts are original articles, case reports, reviews and letters to the editor. The Editorial Board consists of editors and reviewers who are experts in the specific field of pediatric surgery.

APS publishes special articles on clinical and basic studies about surgically correctable diseases in neonates and children. The journal is distributed to members of the Korean Association of Pediatric Surgeons, medical schools, libraries and related institutes to pursue the academic advancement in pediatric surgery and to promote an active communication between the members and international societies of pediatric surgery. Eventually, the journal aims to contribute to cure of pediatric surgical diseases and improvement of public health.

Journal Infomation

APS was originally launched in 1995 as Journal of Korean Association of Pediatric Surgeons. It has since been relaunched under the new title, Advances in Pediatric Surgery in 2018. pISSN 2635-8778, eISSN 2635-8786 were assigned in 2018 (previously pISSN 2383-5036, eISSN 2383-5508 since 2014 and pISSN 1225-9047 since 1995). This journal is an open access journal, and the person using this journal website (https://aps-journal.org/) may use, reproduce, disseminate, or display the open access version of contents for non-commercial purposes. All or part of the articles in this journal is abstracted/indexed in KoreaMed, KoreaMed Synapse, KoMCI, DOI/Crossref, and Google Scholar.

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Publisher Korean Association of Pediatric Surgeons
Editor-in-Chief So-Hyun Nam

Published on June 30, 2026

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Advances in Pediatric Surgery

APS
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pISSN 2635-8778
eISSN 2635-8786

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pISSN 2635-8778 · eISSN 2635-8786
https://doi.org/10.13029/aps.2026.00045

APS Advances in Pediatric Surgery

Management of ingested foreign bodies in children: a narrative review with an emphasis on surgery

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This review summarizes the epidemiology, diagnosis, and management of pediatric foreign body (FB) ingestion, with particular emphasis on circumstances that may require surgical involvement. Initial evaluation includes history taking, assessment of symptoms, and radiographic imaging to determine the type and location of the ingested object. Plain radiography remains the primary diagnostic modality for detecting radiopaque objects and localizing them within the gastrointestinal tract; however, additional imaging may be needed for radiolucent objects or when complications are suspected. Management depends on the anatomical location and characteristics of the FB. Esophageal FBs generally require urgent endoscopic removal, especially when button batteries, magnets, or sharp objects are involved. After an object has passed into the stomach, many cases can be managed conservatively; however, high-risk objects, including button batteries, multiple magnets, and long or sharp items, may require early removal. FBs beyond the pylorus usually pass spontaneously but require monitoring for complications. Surgical intervention may be necessary when endoscopic removal is not feasible or when complications such as obstruction, perforation, or fistula formation occur. This review outlines location- and object-specific management strategies and identifies situations in which early surgical involvement may improve outcomes in children with FB ingestion.

Keywords: Foreign bodies; Child; Gastrointestinal tract; Magnets; Surgery

INTRODUCTION

Foreign body (FB) ingestion is a common clinical problem in children. Mouthing and tasting environmental objects are normal developmental behaviors in early childhood, but they also increase the risk of accidental ingestion [1]. Most ingested FBs pass spontaneously through the gastrointestinal (GI) tract without complications. However, impaction can cause mucosal injury, bleeding, obstruction, or perforation and may necessitate endoscopic or surgical intervention. The risk of complications and the choice of treatment depend on FB size, type, and location; the interval since ingestion; and the presence of symptoms.

This review summarizes the epidemiology of pediatric FB ingestion and outlines management strategies according to anatomical location and object characteristics, with particular emphasis on surgical indications. Widely adopted international guidelines and key studies are discussed in relation to surgical practice. This manuscript was prepared as a narrative review focused on the practical management of pediatric GI FB ingestion, particularly in situations requiring pediatric surgical consultation or intervention. Relevant publications from 2005

Received: March 18, 2026; **Revised:** May 13, 2026; **Accepted:** May 20, 2026
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to 2025 were identified through PubMed, KoreaMed, and Google Scholar using combinations of the terms "foreign body," "foreign body ingestion," "children," "pediatric," "gastrointestinal," "magnet," "button battery," and "surgery." Publications in English and Korean were reviewed, and the reference lists of selected articles were screened to identify additional relevant studies. Priority was given to international clinical guidelines, review articles, multicenter studies, pediatric surgical case series, and representative Korean studies. The final selection was based on clinical relevance to practical management and pediatric surgical decision-making.

Written informed consent for publication of the photographs and radiographic images was obtained from the patient or the patient's legal guardian.

GENERAL CHARACTERISTICS OF INGESTED FOREIGN BODIES IN CHILDREN

FB ingestion is common in children, particularly during early childhood. The peak incidence is reported between 6 months and 3 years of age, when children explore their environment by mouthing and tasting objects [1-3]. According to data from the American Association of Poison Control Centers, 94,051 FB ingestions were recorded in 2019 across all age groups, including 67,186 cases in children younger than 5 years [3]. National safety surveillance data from Korea also indicate a high burden of FB ingestion and aspiration among young children. In a recent 5-year analysis by the Korea Consumer Agency, the annual number of FB ingestion and aspiration incidents increased each year except in 2021. Among these cases, 5,411 (55.4%) occurred in children aged 1 to 3 years and 2,634 (26.8%) occurred in those aged 4 to 6 years [4].

The risk of FB ingestion is influenced by environmental and host factors. Lack of supervision, inadequate childproofing, developmental exploration, and behavioral or developmental disorders have been identified as important risk factors [5]. Pediatric cases are usually accidental, whereas FB ingestion in older children (>5 years) or adults is more often associated with suicidal intent, psychiatric illness, intellectual disability, or secondary gain [3,5].

Most pediatric FB ingestions occur unintentionally in the home during routine daily activities [2,3,6]. The types and sizes of ingested objects vary widely and are influenced by regional, cultural, and socioeconomic factors [2,6]. Common objects include coins, toy parts, button batteries, magnets, safety pins, fishbones, and other small household items, such as screws or jewelry [2,3,6,7]. In some Asian and Mediterranean countries with high fish consumption, fishbones are particularly common ingested FBs [2,8]. In a Korean tertiary-center cohort of 273 pediatric FB ingestions, coins were the most common objects, followed by button batteries and sharp items; only 3.3% of cases required surgery [9].

The clinical course of ingested FBs is benign in most cases. Approximately 80% to 90% of FBs that reach the GI tract pass spontaneously without complications, 10% to 20% require endoscopic removal, and about 1% require surgery because of obstruction, perforation, or other complications [2,3,7]. Certain anatomical sites are more prone to FB impaction because of physiological narrowing or angulation, including the upper esophageal sphincter, aortic arch level, lower esophageal sphincter, pylorus, duodenal sweep, ileocecal valve, Meckel diverticulum, and anus [2,7]. Recognition of these common impaction sites helps clinicians predict the likely location of an FB, select appropriate imaging studies, and determine whether endoscopic or surgical intervention is required.

INITIAL APPROACH FOR DIAGNOSIS OF FOREIGN BODY INGESTION

Guidelines from the European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) and the European Society of Gastrointestinal Endoscopy recommend prompt emergency department evaluation for all children with suspected FB ingestion [10]. During the initial assessment, the physician should obtain a detailed history from the child, caregivers, or witnesses. Essential information includes the type of FB, the estimated number of objects, and the time of ingestion. In many cases, especially in children younger than 5 years, a history of possible ingestion may be the only specific finding. If respiratory distress, wheezing, or cyanosis is present, airway aspiration should be suspected rather than passage into the GI tract, and urgent airway evaluation is required [2,3].

Even when the FB is presumed to have entered the GI tract, associated symptoms should be assessed carefully. Fever, irritability, vomiting, abdominal pain, or poor oral intake may influence the need for urgent endoscopy or surgical consultation [3,7]. Underlying conditions should also be reviewed, particularly congenital or acquired GI diseases and any history of abdominal or esophageal surgery that could affect FB passage.

Regardless of the suspected FB type, plain radiography is generally recommended as the initial imaging study. Current international guidelines recommend biplane radiographs of

https://doi.org/10.13029/aps.2026.00045

the neck, chest, and abdomen to evaluate the esophagus and GI tract [7,10]. Plain radiographs help determine the shape, size, and location of radiopaque objects, such as coins, metallic fragments, and button batteries. They may also show indirect evidence of radiolucent FBs, including bowel gas patterns suggestive of ileus and free intraperitoneal air suggestive of perforation [2,3].

If a radiolucent FB is suspected but cannot be identified on plain radiographs, computed tomography (CT) can help detect the object and identify complications, including perforation, abscess, or obstruction [2,3]. Magnetic resonance imaging is not useful for localizing ingested metallic FBs and is contraindicated when button battery or magnet ingestion is suspected because of safety concerns. Ultrasound and handheld metal detectors have been investigated as adjunctive tools, but current evidence is insufficient to support their routine use [2,6]. Contrast esophagography or fluoroscopic studies may be considered when FB ingestion is strongly suspected but not confirmed, or when stricture is a consideration [7,10]. However, these examinations are often unavailable as emergency procedures in many institutions. Importantly, additional diagnostic tests should not delay necessary therapeutic interventions. When a high-risk FB is identified or serious complications are suspected, endoscopic or surgical removal should not be postponed solely to obtain further imaging [3,7,10].

INITIAL MANAGEMENT ACCORDING TO FOREIGN BODY LOCATION

The anatomical location of an ingested FB remains a key determinant of urgency and therapeutic approach. In general, objects lodged in the esophagus require prompt intervention because of the risks of obstruction, mucosal injury, perforation, and aspiration. In contrast, many objects that have passed into the stomach or beyond can be managed expectantly, depending on object type, symptoms, and interval progression.

Esophagus

Esophageal FBs warrant urgent assessment because prolonged impaction increases the risk of local injury and airway compromise. Food bolus impaction is another common indication for urgent pediatric endoscopy, particularly in children with underlying esophageal disorders such as stricture or eosinophilic esophagitis. Symptomatic children with drooling, dysphagia, chest discomfort, vomiting, or respiratory symptoms require prompt removal [2,7]. Even in asymptomatic patients, removal within 24 hours is generally recommended for most retained esophageal objects [6,7]. Certain high-risk objects, particularly button batteries, sharp objects, and multiple magnets, require emergent intervention.

Stomach

After an FB has reached the stomach, many blunt and small objects pass spontaneously. Management depends primarily on object type, size, and symptoms [2,7]. Coins and other low-risk blunt objects may be observed in asymptomatic children, whereas button batteries, magnets, long or large objects, and sharp objects often require early endoscopic retrieval [2,3,7]. Persistent gastric retention or the development of symptoms should prompt reassessment.

Small bowel and beyond

Most FBs that progress beyond the pylorus pass spontaneously without complications [2,3]. Observation with caregiver education and selective follow-up imaging is appropriate in asymptomatic children when progression is expected. However, abdominal pain, vomiting, fever, GI bleeding, signs of obstruction or peritonitis, or failure to progress on serial imaging should prompt urgent reevaluation and surgical consultation [3,7]. A practical summary of management strategies according to anatomical location is presented in Table 1.

APPROACH ACCORDING TO THE TYPE AND SHAPE OF FOREIGN BODY

Magnets

Among ingested FBs, magnets are particularly important from a surgical perspective because they carry a high risk of serious complications. Although safety regulations for magnetic toys have improved in some regions, small, powerful magnets remain widely available in products such as imported toys, therapeutic "magnet patches," and magnetic jewelry. Many of these products contain exposed neodymium rare-earth magnets that are small enough to be swallowed but can generate very strong attractive forces. They are also often sold without adequate warning labels or child-safety precautions [2,6,9].

A survey of members of the North American Society for Pediatric Gastroenterology, Hepatology and Nutrition (NASPGHAN) reported 424 pediatric cases of magnet ingestion over a 10-year period, with a marked increase in the most recent year [7]. In preliminary data, 52% of patients were managed with endoscopic intervention alone, 20% required both en-

Table 1. Location-based practical summary of recommended management strategies for pediatric foreign body ingestion

Location	Emergent removal (within 2 hr)	Urgent removal (within 24 hr)	Observation acceptable	When to involve pediatric surgery
Esophagus	• Button battery (<2 hr) • Sharp or pointed object • Airway compromise/ secretion intolerance	• Blunt object (e.g., coin) if asymptomatic • Magnets	• Rare	• Failed endoscopic removal • Evidence of perforation • Suspected vascular injury
Stomach	-	• Symptomatic button battery • ≥20 mm battery in children <5 yr (if retained 24–48 hr) • Multiple magnets • Sharp or pointed object • Long or large object	• Small blunt object (e.g., coin) if asymptomatic • Asymptomatic single magnet with close follow-up	• Failed endoscopic removal • Signs of obstruction or peritonitis
Small bowel (distal to pylorus)	-	• High-risk object with symptoms	• Most blunt objects • Asymptomatic single magnet with serial radiographs	• Lack of progression on serial imaging (e.g., 24–48 hr for magnets) • Persistent non-progression over several days (sharp objects) • Small bowel obstruction or peritoneal signs
Colon	-	-	• Most objects	• Rare, symptomatic cases only

Recommendations summarize widely adopted principles from North American Society for Pediatric Gastroenterology, Hepatology and Nutrition (NASPGHAN) (2015) [7] and European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) (2017) [10] guidelines. Observation requires reliable caregivers and appropriate clinical and radiographic follow-up. Additional imaging should not delay necessary therapeutic intervention.

doscopy and surgery, 8% required surgery alone, and only 15% were managed with observation. Among patients who underwent surgery, 41% required repair of perforations or fistulas and 22% required bowel resection [7].

Several Korean series have highlighted the severity of magnet-related injuries. In a single-center cohort of 273 pediatric GI FB ingestions, magnets accounted for only 4.8% of objects, but 46.2% of magnet cases developed gastric, small-bowel, or colonic perforation or deep ulceration. Most of these children required emergency surgery [9]. Reviews of domestic surgically treated cases have reported multiple small-bowel perforations, jejuno-jejunal or jejuno-ileal fistulas, and combined gastroduodenal or gastrocolic injuries caused by chains of small rare-earth magnets [11-14]. Similar findings have been observed in contemporary multicenter and national series from Asia and Europe, in which approximately 20% to 40% of children with multiple-magnet ingestion ultimately required surgical intervention and a substantial subset required bowel resection or temporary stoma formation for perforation, fistula, or peritonitis [15-17].

Ingestion of two or more magnets, or a magnet together with a metallic object, can be dangerous regardless of object size. Magnets located in different intestinal segments can attract across adjacent bowel loops and compress the intervening bowel wall, resulting in pressure necrosis, perforation, obstruction, fistula formation, and bleeding (Figs. 1, 2) [2,3,6]. Deaths associated with magnet ingestion have also been reported, underscoring the importance of prevention and early recognition [14,16].

Clinically, many children with magnet ingestion present with nonspecific symptoms, including abdominal pain, vomiting, and irritability, and the exact time of ingestion is often unknown. Plain radiographs are essential for identifying the number and location of ingested magnets. However, distinguishing a single magnet from multiple closely attached magnets can be difficult [2,7]. Ultrasound may help identify clustered magnets or fistulous tracts in selected cases [11,14], whereas CT may be limited by metallic artifacts [2,3].

Current international recommendations suggest that multiple magnets, or a magnet combined with another metallic object, should be removed endoscopically as soon as possible when located in the esophagus or stomach, even in asymp-

https://doi.org/10.13029/aps.2026.00045

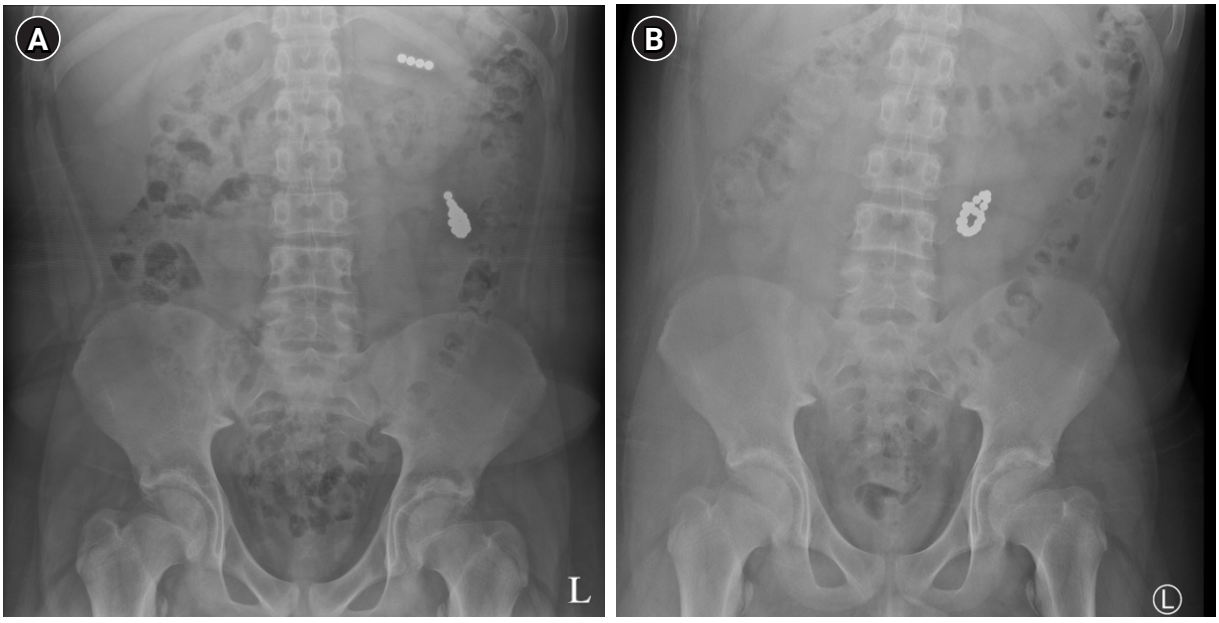

Fig. 1. Plain radiographs of a 16-year-old boy who swallowed multiple magnets. (A) On the day of admission, magnets were located in two different areas. (B) Two days later, the magnets had become attached. Because no interval movement was observed on subsequent radiographs, emergency surgery was performed.

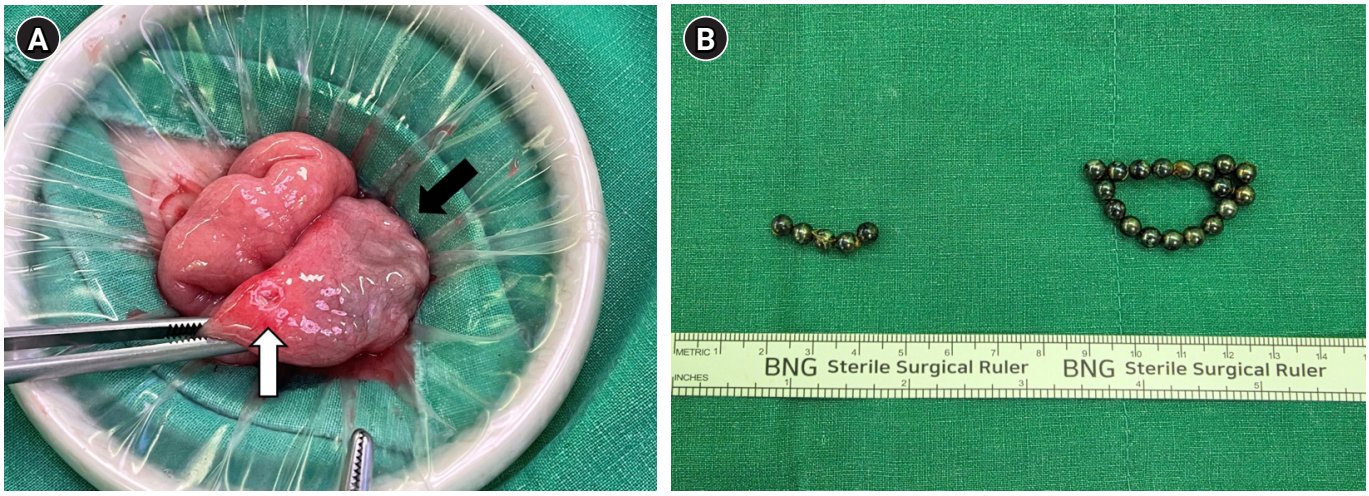

Fig. 2. Intraoperative findings in a 16-year-old boy with multiple-magnet ingestion. (A) After mini-laparotomy, the adherent jejunum and ileum were exteriorized. Magnets were found in the ileum (black arrow), with ulceration also visible (white arrow). (B) The magnets were removed through the ulcer-induced perforation.

tomatic children [7,10]. A single magnet in the stomach may be observed with close clinical and radiographic follow-up if the child is asymptomatic. Lack of progression or the development of symptoms should prompt removal. When multiple magnets have passed into the small bowel, the threshold for surgical consultation should be low because endoscopic access is limited and the risk of perforation or fistula is substantial. Serial radiographs should be used to monitor progression. Lack of movement over 24 to 48 hours or the development of severe abdominal pain, vomiting, fever, or peritoneal signs should prompt urgent operative management [3,6,7,16].

Magnet ingestion therefore requires a more aggressive approach than most other FB ingestions, including early endoscopic removal from the upper GI tract and prompt surgical consultation when magnets have progressed distally or complications are suspected. Recent reviews and practice guide-

lines consistently emphasize early surgical involvement for suspected multiple-magnet ingestion, even when endoscopic removal is initially attempted [3,18].

Button batteries

Button batteries are increasingly used in household electronic devices, and pediatric ingestion remains associated with substantial morbidity, particularly in children younger than 5 years and after ingestion of larger lithium cells [6,19,20].

When impacted in the esophagus, button batteries can rapidly cause severe injury through local electrical current generation and alkaline tissue damage, resulting in liquefaction necrosis, perforation, fistula formation, and life-threatening hemorrhage within hours [2,6,7]. Plain radiographs are important for differentiating button batteries from coins. Characteristic findings include the double-ring or halo sign on frontal views and the step-off sign on lateral views (Fig. 3).

Esophageal button batteries require emergent endoscopic removal, ideally within 2 hours of diagnosis [7,10,19]. Although earlier NASPGHAN and ESPGHAN guidelines remain important foundations, more recent expert consensus places greater emphasis on immediate removal, selected pre-endoscopic mitigation strategies such as honey or sucralfate in appropriate cases, and post-removal surveillance for delayed vascular or fistulous complications [6,19,20]. Evidence supporting these adjunctive measures is based mainly on experimental studies and expert consensus rather than randomized clinical trials, and these measures should not delay urgent endoscopic intervention. Honey should not be administered to infants younger than 12 months because of the risk of infant botulism [6,18,19]. After removal, careful mucosal assessment is required. Additional imaging, such as CT angiography, may be considered when deep ulceration or vascular injury is suspected [19,20].

For gastric button batteries in asymptomatic children, management should be individualized. Observation may be appropriate when the battery is small and progressing distally, whereas endoscopic removal should be considered for larger batteries, children younger than 5 years, prolonged gastric retention, or the development of symptoms [7,10,19]. Batteries that have passed beyond the stomach may be followed clinically, but obstruction, perforation, GI bleeding, or failure to progress should prompt urgent surgical consultation.

Long or large objects

In children, long or large FBs are less common than coins, food boluses, button batteries, or magnets, but they pose distinct management challenges because they are less likely to pass spontaneously and can cause obstruction or perforation. Typical examples include toothbrushes, chopsticks, skewers, hairpins, and certain toys or tools [2,3,18].

Although definitions vary slightly across studies and guidelines, several practical size thresholds are commonly used

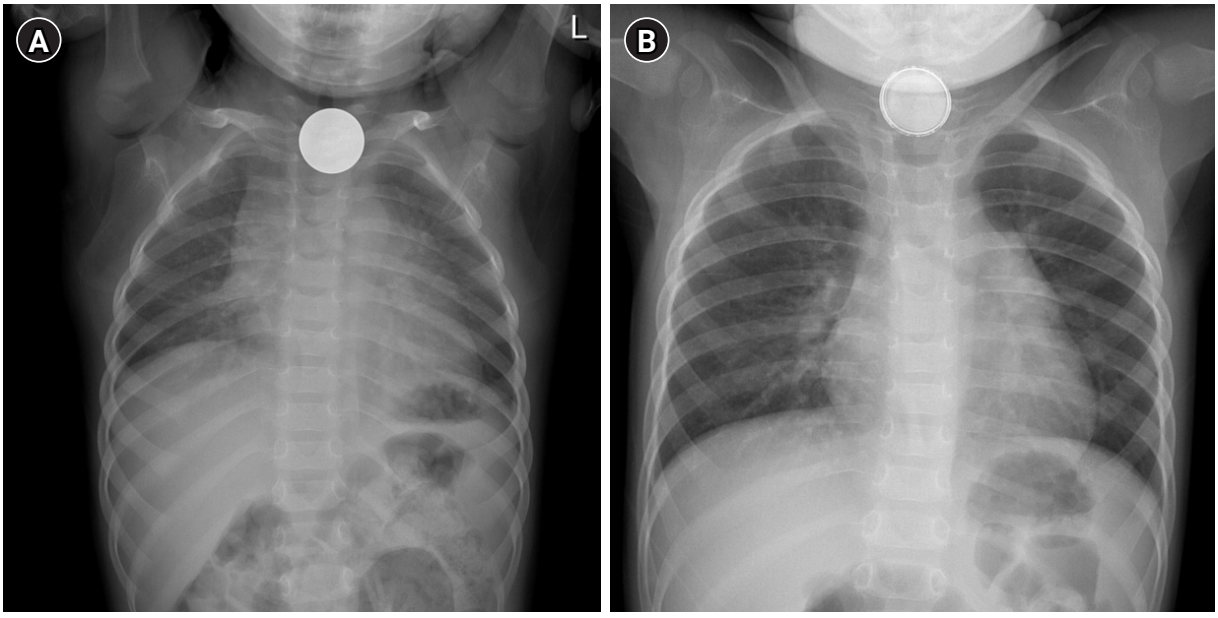

Fig. 3. Comparison of plain radiographs in children with coin and button battery ingestion. (A) Coin in the esophagus. (B) Button battery in the esophagus showing the "double-ring sign," which differentiates it from a coin.

https://doi.org/10.13029/aps.2026.00045

because they reflect the likelihood of passage through physiological narrowings of the GI tract. In children younger than 5 years, objects wider than approximately 2.0 to 2.5 cm are less likely to pass the pylorus, whereas objects longer than 5 to 6 cm may fail to negotiate the duodenal sweep or ileocecal valve. In children aged 5 years or older, slightly larger objects may pass spontaneously, but objects longer than 6 to 10 cm or wider than 2.5 cm remain concerning for retention [2,3,7].

Accordingly, international guidelines generally recommend endoscopic retrieval rather than expectant management for long or large FBs identified in the stomach or proximal duodenum, particularly in smaller children [7,10]. Retrospective series confirm that most such objects require endoscopic removal, although only a small proportion ultimately require surgery [18,21].

If a long or large FB has already entered the small bowel, but the child is asymptomatic and radiographs show steady distal movement, careful observation with serial imaging may be appropriate. However, if serial radiographs show no progression, or if vomiting, abdominal pain, or signs of obstruction develop, early surgical consultation is indicated. Persistent impaction in the small bowel or ileocecal region despite expectant management may ultimately require operative removal, often through limited enterotomy or segmental resection, depending on bowel viability.

Superabsorbent polymers (water beads)

Superabsorbent polymer balls, also known as water beads, are used for hydroponic plant cultivation, decorative purposes, fragrance products, and sensory play. In their dry state, water beads are small (often 2–3 mm in diameter) and visually resemble candy, making them attractive to young children. When exposed to water, they can expand to more than 30 to 60 times their original volume and become much larger and slippery [6,7,22]. Experimental data and recent reviews suggest that some products may expand to more than 100 to 150 times their dry size, particularly in low-osmolar solutions [3,6].

Because of their marked swelling capacity, ingested water beads may fail to pass spontaneously and can cause small bowel obstruction. Diagnosis is challenging because water beads are usually radiolucent and may not be visible on plain radiographs; even on CT, they can be difficult to distinguish from surrounding bowel contents in some cases [6,18,22]. Children often present with nonspecific symptoms, including vomiting, abdominal distension, and reduced oral intake, and the ingestion history may not be apparent. In some reports, water bead obstruction has been associated with electrolyte disturbances or neurological symptoms, such as acute hyponatremia with seizure, further complicating the clinical picture. The mechanism is uncertain and may involve severe electrolyte disturbance secondary to obstruction or possible direct acrylamide-related neurotoxicity in selected products [22,23].

When small bowel obstruction caused by water beads is suspected, surgical exploration is frequently required. At laparotomy or laparoscopy, the beads may be found impacted in the distal small bowel or ileocecal region. Management options include enterotomy with bead removal or manual fragmentation and milking of the beads toward the colon to facilitate passage. The choice depends on the degree of obstruction, bowel viability, and the surgeon's judgment [3,22]. Although some asymptomatic children who ingest very small beads can be managed conservatively, those with established obstruction almost always require operative intervention [3,18].

Given the diagnostic difficulty and potential for severe obstruction or death, prevention through caregiver education and regulation of high-risk products is essential. Recent regulatory efforts in North America and Europe have proposed limiting the expansion capacity and size of water beads marketed for children and, in some jurisdictions, restricting or banning their sale altogether [6,18].

Pointed or sharp objects

The types of sharp or pointed FBs ingested by children vary over time and by region. In earlier decades in Western countries, safety pins used for cloth diapers were common sharp FBs, but their frequency has declined with the widespread adoption of disposable diapers [7]. Common examples include needles, pins, nails, screws, fishbones, and fragments of glass or plastic [2,3,6]. In Asian and Mediterranean regions where fish consumption is high, fishbones are particularly frequent sharp FBs [2,8,21]. Many sharp objects are radiopaque and readily visible on plain radiographs; however, some plastic or wooden objects may be radiolucent and require additional imaging for detection.

Sharp objects pose a higher risk of mucosal injury, bleeding, and perforation than blunt objects. Historically, management has been influenced by Jackson's axiom that advancing points puncture whereas trailing points do not. Sharp objects with the pointed end leading are more likely to cause perforation [5,24]. Clinical studies and case series have documented complications such as esophageal or gastric perforation, small bowel obstruction, intra-abdominal abscess, and fistula formation af-

ter sharp-object ingestion [3,19,25]. In Korean pediatric series, fishbones and glass fragments were associated with a relatively high rate of endoscopic removal, whereas neglected sharp objects occasionally led to mediastinitis or intra-abdominal sepsis [8,9].

Guidelines recommend urgent endoscopic removal of sharp objects lodged in the esophagus or stomach, even in asymptomatic patients, because of the high risk of perforation and migration [7,10,19]. In the esophagus, sharp objects are usually removed emergently to prevent catastrophic complications. In the stomach and proximal duodenum, prompt endoscopic retrieval is also advised when feasible, particularly if the object is long or has multiple sharp edges [3,6,7].

Once a sharp object has passed beyond the ligament of Treitz, management remains a topic of debate. Some guidelines suggest that small, smooth, sharp objects may be observed with serial radiographs if the child is asymptomatic and the object is progressing distally [7,19]. However, signs of obstruction, localized peritonitis, or lack of progression on imaging should prompt early surgical consultation. Surgical options range from limited enterotomy for object removal to segmental bowel resection in cases of perforation, necrosis, or abscess formation [3,25].

Overall, sharp-object ingestion in children requires a lower threshold for endoscopic and surgical intervention than many other FB ingestions. Management should be individualized according to object characteristics, location, and the child's clinical status.

Coins

Coin ingestion is one of the most common causes of FB ingestion in children, particularly in countries where coins are widely used [2,7,21,26]. Large cohort studies and national surveillance data consistently show that coins account for a substantial proportion of pediatric FB ingestions presenting to emergency departments and endoscopy units, often among children younger than 5 years [9,21]. More than 80% of ingested coins in children pass spontaneously without significant complications, especially when the coin has already reached the stomach and the child is asymptomatic [2,3,18]. However, certain coin sizes and age groups are associated with a higher risk of esophageal impaction or failure to pass.

In children younger than 5 years, coins with a diameter ≥23 mm are more likely to become lodged in the esophagus or fail to progress, which can lead to esophageal ulceration or stricture if removal is delayed [2,7,19]. Current guidelines recommend urgent endoscopic removal of esophageal coins, particularly in symptomatic children, and removal within 24 hours even in asymptomatic cases [7,10]. Gastric coins in asymptomatic children may be observed with serial radiographs, and elective removal can be considered if the coin remains in the stomach or if symptoms develop [3,18].

In Korea, coins of four main denominations are in circulation, with approximate diameters of 18.0 mm (new 10-won), 21.6 mm (50-won), 24.0 mm (100-won), and 26.5 mm (500-won) [27]. From a practical standpoint, coins ≥23 mm in diameter, including old 10-won coins, 100-won coins, and 500-won coins, are unlikely to pass the esophagus spontaneously in children younger than 5 years. Therefore, endoscopic removal is generally recommended in this age group when such coins are impacted rather than relying on spontaneous passage [9]. Clinicians should also remain vigilant for radiographic misinterpretation of button batteries as coins and should carefully evaluate distinguishing signs before selecting a management strategy [3,19]. For ease of clinical application, a risk-oriented summary based on object characteristics is provided in Table 2.

SURGICAL MANAGEMENT FOR PEDIATRIC FOREIGN BODY INGESTION

Absolute indications for surgery in pediatric FB ingestion have not been clearly defined, and management decisions are often individualized according to FB type and location, clinical symptoms, and available endoscopic expertise. As summarized in Tables 1 and 2, surgical consultation should be considered when spontaneous passage is unlikely or has failed, when endoscopic removal is unsuccessful or infeasible because the FB is beyond the reach of the endoscope, or when evidence of bowel perforation or obstruction makes nonoperative management inappropriate [2,3,7]. Emergency operation is generally reserved for children with generalized peritonitis, complete mechanical obstruction, hemodynamic instability, or radiological and clinical evidence of bowel perforation or necrosis. In other situations, close inpatient observation with serial examinations and imaging may allow urgent but nonemergent operative planning. In centers where pediatric endoscopy is not readily available, early involvement of pediatric surgeons or transfer to an appropriate referral center should be considered.

No surgical procedure is specific to FB ingestion, and standard GI surgical principles are generally applied. In most cases, two basic approaches are used. The first is gastrotomy or

https://doi.org/10.13029/aps.2026.00045

Table 2. Object-based risk-oriented practical summary for surgical decision-making in pediatric foreign body ingestion

Object type	Key pathophysiologic risk	Core timing principle	When to involve pediatric surgery
Button battery	• Rapid alkaline necrosis, fistula formation, vascular erosion	• Esophagus → remove within 2 hr • Stomach → remove if symptomatic or ≥20 mm in children <5 yr	• Deep ulceration or necrosis after removal • Suspected tracheoesophageal or aorto-esophageal fistula • Distal battery with symptoms
Multiple magnets	• Pressure necrosis, entero-enteric fistula, perforation	• Early removal if reachable in upper gastrointestinal tract	• Beyond stomach with no progression on serial imaging (24–48 hr) • Abdominal pain, fever, obstruction
Single magnet	• Usually benign unless combined with metallic object	• Observation with serial radiographs if asymptomatic	• Combined with metallic object • Development of symptoms or lack of progression
Sharp or pointed object	• Increased risk of perforation	• Remove within 24 hr if reachable	• No progression on serial imaging • Clinical signs of perforation
Long or large object	• Pyloric or ileocecal impaction	• Remove if located in stomach	• Failure to progress • Obstruction or peritonitis
Coins (blunt object)	• Usually benign	• Remove from esophagus within 24 hr • Observe in stomach	• Rare, symptomatic cases
Superabsorbent polymers (water beads)	• Expansion → small bowel obstruction	• Remove if reachable in upper gastrointestinal tract	• Small bowel obstruction • Radiolucent obstruction requiring exploration

Serial radiographic monitoring is recommended when observation is chosen. Surgical management is indicated for failed endoscopic retrieval, perforation, obstruction, fistula formation, or clinical deterioration.

enterotomy at the site of impaction, FB removal, and primary closure of the enterotomy. The second is segmental resection of the affected bowel segment followed by primary anastomosis. The choice between these approaches depends on the location of the FB, the presence and extent of perforation or ischemia, and the patient's overall condition. Minimally invasive approaches, including laparoscopy or laparoscopy-assisted extracorporeal bowel repair through a small incision, are feasible in selected stable patients and may reduce wound burden, postoperative pain, and recovery time while allowing complete abdominal exploration. Open surgery remains appropriate in patients with diffuse peritonitis, marked bowel distension, hemodynamic instability, or anticipated complex reconstruction.

In cases of multiple-magnet ingestion, magnets may adhere across adjacent bowel loops and form entero-enteric fistulas, leading to perforation, obstruction, or necrosis [2,6,12,13]. In some situations, the magnets can be removed through the fistula tract itself without creating an additional enterotomy, after which the fistula can then be repaired, or the affected bowel segment can be resected, depending on bowel viability. Sharp objects may require localized repair or limited bowel resection when perforation is identified. Button batteries located beyond endoscopic reach may require operative removal when progression fails or when delayed perforation or fistula formation is suspected. Large bezoars or impacted intraluminal FBs may occasionally require gastrotomy or enterotomy when endoscopic treatment is unsuccessful. Anecdotal techniques, such as transappendiceal extraction of a small FB impacted near the ileocecal valve, have also been described in selected cases [12], but these are not established standard approaches and should be individualized according to intraoperative findings.

When perforation or obstruction has been present for a prolonged period, the affected bowel may be edematous or ischemic, and multiple perforations may be present. In such cases, segmental resection may be preferable to primary repair. The decision to perform primary anastomosis or temporary stoma formation should follow the same principles used in other emergency GI operations, taking into account hemodynamic stability, the degree of contamination, and the quality of the bowel ends.

Perioperative management generally follows standard protocols for emergency abdominal surgery in children, including appropriate fluid resuscitation, broad-spectrum antibiotics,

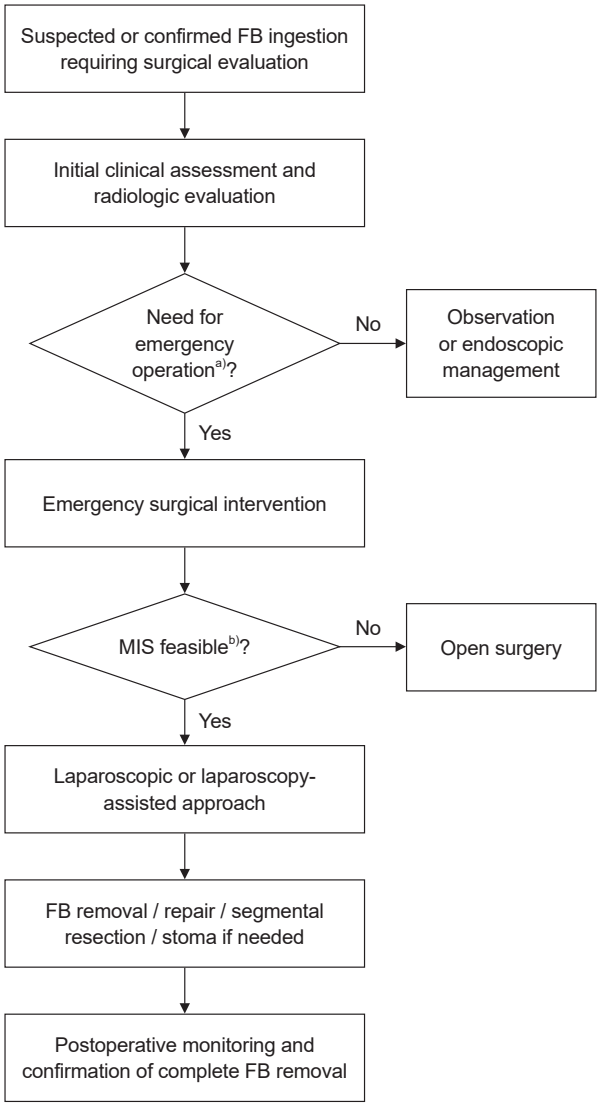

Fig. 4. Practical surgical decision-making algorithm for pediatric gastrointestinal FB ingestion. MIS, minimally invasive surgery; FB, foreign body. [a]Emergency indications: peritonitis, perforation, complete obstruction, hemodynamic instability, or suspected bowel necrosis. [b]Consider in stable patients with localized pathology and limited contamination.

and careful monitoring for signs of anastomotic failure or ongoing sepsis. Reported postoperative complications include wound infection, ileus, intra-abdominal abscess, anastomotic leak after bowel resection, and the need for reoperation in selected cases, particularly after delayed diagnosis or severe bowel injury [16,21]. At the end of the procedure, surgeons should verify that the number and type of removed FBs correspond to those identified on imaging and in the clinical history. Whenever possible, retrieved objects should be documented with photographs or operative notes to facilitate communication with caregivers and consulting services. This documentation may also be useful for medicolegal and preventive purposes. A practical framework for pediatric surgical involvement is summarized in Fig. 4.

CONCLUSION

Management of pediatric FB ingestion should be tailored to the object's location and type and to the child's clinical condition. Most ingested FBs pass spontaneously without complications. However, esophageal button batteries, multiple magnets, long or large objects, and other high-risk FBs require prompt, decisive intervention. FBs that remain in the GI tract for more than approximately 1 week should be followed with radiography to confirm progression or removal.

Although most cases resolve without serious consequences, FB ingestion can occasionally result in severe, life-threatening complications. Continued public education, careful supervision of young children, and improved regulation and design of high-risk consumer products remain important preventive measures. Timely recognition of children who require pediatric surgical consultation is essential to prevent major morbidity.

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Conflict of interest

None.

Funding

None.

Data availability

Not applicable.

https://doi.org/10.13029/aps.2026.00045

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Original Article

Adv Pediatr Surg. 2026 Jun;32(1):12-17
pISSN 2635-8778 · eISSN 2635-8786
https://doi.org/10.13029/aps.2026.00010

APS Advances in Pediatric Surgery

Clinical, anatomical, and pathological features of enteric duplication cysts in children: a 40-year single-center retrospective study

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Purpose: Enteric duplication cysts (EDCs) are rare congenital anomalies of the gastrointestinal tract. This study aimed to delineate the clinical, anatomical, and pathological spectrum of EDCs based on a 40-year single-center experience.
Methods: A retrospective review was conducted of 45 pediatric patients who underwent surgical treatment for EDCs at a single institution between 1985 and 2023. Clinical records, imaging studies, and pathological reports were analyzed.
Results: The study included 28 males and 17 females, with a median age at surgery of 4.7 months. Most patients (75.6%) underwent surgery before 2 years of age. The ileum was the most common location (57.8%), followed by the jejunum (11.1%) and ileocecal valve (11.1%). Vomiting (46.7%) was the most common presenting symptom. Emergency surgery was required in 28.9% of cases because of complications such as volvulus or intussusception. Preoperative imaging using ultrasonography (US) and/or computed tomography resulted in a correct diagnosis in 34 of 45 patients (75.6%), with EDCs correctly identified in 30 patients (66.7%), frequently based on the characteristic "double wall sign" observed on US. Histopathological examination identified heterotopic gastric mucosa in 61.4% of evaluable cases. Postoperative outcomes were generally favorable, with a median hospital stay of 7.5 days.
Conclusion: EDCs are rare congenital anomalies that are primarily diagnosed during early childhood. The ileum is the most frequent site of involvement, and clinical presentation is often related to acute complications. Prompt and complete surgical excision remains the definitive treatment and leads to favorable short-term postoperative outcomes, with no recurrence observed during the available follow-up period.

Keywords: Cysts; Gastrointestinal tract; Children; Gastric mucosa; Ultrasound

INTRODUCTION

Enteric duplication cysts (EDCs), also referred to as alimentary tract duplications, are rare congenital anomalies of the gastrointestinal (GI) tract. These lesions can occur anywhere from the tongue to the anus but are most commonly located in the small intestine [1,2]. The reported incidence of EDCs ranges from 1 in 4,500 to 1 in 18,000 live births, making them an important, although uncommon, condition in pediatric surgery [3,4]. The term "alimentary tract duplication" was formally established by Ladd [5] in 1937 to unify a variety of previously described malformations.

Received: January 8, 2026; **Revised:** February 11, 2026; **Accepted:** March 3, 2026
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Pathologically, enteric duplications must satisfy three essential criteria proposed by Gross et al. [6] in the 1950s: the presence of a well-developed smooth muscle coat, an epithelial lining representing a portion of GI mucosa, and a close anatomical association with the adjacent alimentary tract, often with a shared blood supply. EDCs most commonly present as noncommunicating spherical cystic lesions, although tubular forms that communicate with the adjacent bowel lumen have also been described [2].

EDCs predominantly affect infants and young children, with approximately 80% of cases diagnosed before 2 years of age [7]. Clinical presentation is highly variable and nonspecific and depends largely on lesion size, anatomical location, and the presence of ectopic tissue within the cyst [1]. Common manifestations include vomiting, abdominal distension, and a palpable abdominal mass, typically reflecting mass effect or partial bowel obstruction. However, many patients present acutely with surgical emergencies such as intestinal obstruction, intussusception, or volvulus [4,8].

Because of the rarity of EDCs, most published literature consists of case reports or small case series. Large, long-term single-center studies provide valuable information regarding the natural history, evolving diagnostic approaches, and contemporary surgical management of these lesions, including minimally invasive techniques [9].

In this study, we retrospectively analyzed 45 pediatric patients with EDCs treated at a single institution over a 40-year period. Through this large institutional experience, we sought to characterize the clinical, anatomical, and pathological spectrum of EDCs and provide comprehensive data to support the optimal management of this rare and challenging congenital anomaly.

METHODS

Ethics statement

This study was approved by the Institutional Review Board of Keimyung University Dongsan Hospital, and the requirement for informed consent was waived because of the retrospective study design (No. 2025-12-078).

Study design and patient population

This retrospective study reviewed pediatric patients diagnosed with EDCs who underwent surgical treatment between June 1985 and June 2023. Surgically treated enteric duplications arising along the GI tract were included in the analysis. Anal canal duplications were excluded because they are considered distinct perineal duplication anomalies rather than true alimentary tract duplications. A total of 45 patients met the inclusion criteria and were included in the study.

Data collection

Clinical records were reviewed for demographic characteristics, age at presentation and surgery, presenting symptoms, and prenatal detection history. Diagnostic evaluation included plain abdominal radiography, ultrasonography (US), and computed tomography (CT), and the corresponding preoperative radiological impressions were recorded. Operative notes were reviewed to identify intraoperative findings, including lesion location, lesion size, and operative time. Postoperative outcomes and complications were also assessed. Emergency surgery was defined as surgery performed for acute complications, including bowel obstruction, volvulus, intussusception, or perforation.

Imaging evaluation

Imaging studies were reviewed to evaluate the diagnostic work-up. US and CT were used selectively according to the clinical presentation; some patients underwent only US, others underwent only CT, and some received both examinations. Imaging findings and preoperative radiological impressions were compared with the intraoperative diagnosis.

Pathological analysis

All resected specimens were examined by experienced pathologists. The epithelial lining of each duplication cyst was evaluated, including the presence of heterotopic mucosa and other epithelial variants described in the pathology reports.

Outcomes

The primary outcomes were clinical presentation, anatomical distribution, operative indications, surgical management, and pathological characteristics of enteric duplications. Secondary outcomes included postoperative complications and short-term postoperative results. Long-term follow-up data were unavailable for most patients.

RESULTS

Demographics and clinical presentation

A total of 45 children underwent surgical treatment for EDCs, including 28 males and 17 females. The median age at surgery was 4.7 months (range, 2 days–127.2 months), and 34 patients

(75.6%) underwent surgery before 2 years of age (Table 1). Prenatal US identified duplication cysts in eight patients. Seven of these eight prenatally detected cases were treated after 2000. Of these, four underwent elective surgery before 1 year of age according to institutional protocols for complication prevention. Surgery was delayed until 1 year of age in one patient at the parents' request. Two patients were diagnosed incidentally during evaluations for enteritis, and subsequent history-taking revealed a previously reported prenatal diagnosis that had not been followed up. The remaining patient became symptomatic before the planned elective intervention. The surgical approach, including minimally invasive surgery, was determined primarily by surgeon preference. With advances in surgical techniques, laparoscopic approaches became more common after 2009 and were used in the majority of recent cases. The most common presenting symptom was vomiting (46.7%), followed by abdominal pain (26.7%) and abdominal distension; GI bleeding was rare.

Table 1. Demographic and clinical characteristics of patients with enteric duplication cysts (n=45)

Characteristic	Value
Sex	
Male	28 (62.2)
Female	17 (37.8)
Age at surgery	
Median (range) (mo)	4.7 (0.1–127.2)
<1 yr	27 (60.0)
1–2 yr	7 (15.6)
>2 yr	11 (24.4)
Anatomic location	
Ileum	26 (57.8)
Jejunum	5 (11.1)
Ileocecal valve	5 (11.1)
Stomach	3 (6.7)
Colon/cecum	3 (6.7)
Duodenum	2 (4.4)
Appendix	1 (2.2)
Pathological feature	
Morphology (cystic/tubular)	43/2
Luminal communication (noncommunicating/communicating)	41/4
Size, maximum dimension (cm)	3.5 (1.2–7.5)
Presence of ectopic gastric mucosa	27/44 (61.4)
Clinical presentation	
Emergency surgery	13 (28.9)
Elective surgery	32 (71.1)

Values are presented as number (%) or median (range).

Imaging evaluation

US was performed in 34 patients (75.6%), whereas CT was obtained in 15 patients; some patients underwent both studies. The most consistent finding was a cystic mass showing the double wall sign, which consists of an echogenic inner lining and a peripheral hypoechoic muscular rim (Fig. 1). Among the 34 patients who underwent US, 28 (82.4%) were correctly identified as having a duplication cyst on US alone. Of the 11 patients who did not undergo US, two were correctly diagnosed preoperatively based on CT findings. Overall, preoperative imaging with US and/or CT contributed to the correct surgical diagnosis in 34 of 45 patients (75.6%): EDCs were directly identified in 30 patients (66.7%), and intussusception with a visible lead point was diagnosed in four patients, in whom EDC was subsequently confirmed intraoperatively as the lead point. These imaging modalities yielded variable preoperative impressions, often suggesting obstructive or cystic abdominal lesions rather than definitively identifying duplication cysts. Nevertheless, imaging findings were useful for surgical planning.

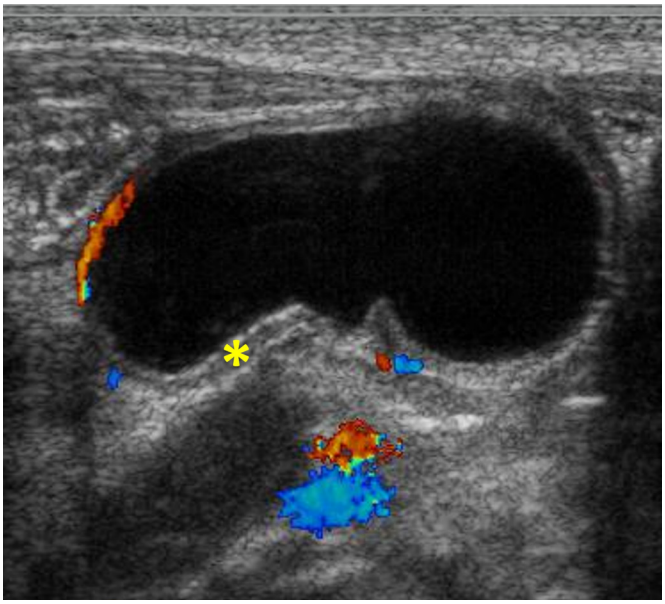

Fig. 1. Abdominal ultrasonography showing a well-defined cystic lesion. The image demonstrates the characteristic double wall sign, or muscular rim sign, indicated by the asterisk. This sign consists of an inner hyperechoic layer representing the mucosa and submucosa and an outer hypoechoic layer representing the smooth muscle propria. This characteristic finding is valuable for the preoperative diagnosis of enteric duplication cysts.

https://doi.org/10.13029/aps.2026.00010

Anatomical distribution and morphology

The ileum was the most common site of duplication, identified in 26 cases (57.8%). Jejunal and ileocecal duplications were each identified in five cases (11.1%). Less frequent locations included the stomach, colon, duodenum, and appendix. Most lesions showed cystic morphology (43 cases), whereas tubular duplications were identified in two cases. Communication with the adjacent bowel was identified in four cases. These communicating duplications were managed by segmental bowel resection that included the shared bowel segment.

Operative management

The most frequently performed procedures were small-bowel segmental resection with primary anastomosis (18 cases, some requiring adjunct procedures) and ileocecal or ileo-ascending colon resection (15 cases). Bowel-preserving procedures were performed in 12 cases, including enucleation or cyst excision in nine cases and wedge resection in three cases (Fig. 2). Emergency surgery was required in 13 patients (28.9%) because of acute complications, including volvulus in three patients, intussusception in three, bowel obstruction in five, and perforation in two. Among the perforation cases, a jejunal tubular duplication measuring 5.8 cm in maximum dimension perforated in a 6-day-old neonate, and a 2.5-cm colonic duplication perforated in a 40-month-old child.

Pathological findings

Histopathological examination was performed in 44 of 45 resected specimens; the epithelial subtype could not be determined in one case because archived slides were unavailable. Among the 44 evaluable cases, heterotopic gastric mucosa was identified in 27 cases (61.4%) (Fig. 3), intestinal-type epithelium in nine cases (20.5%), and respiratory-type epithelium in three cases (6.8%). Five lesions (11.4%) lacked an identifiable epithelial lining. Despite the high prevalence of gastric mucosa, only one patient presented with GI bleeding.

Postoperative outcomes

Postoperative complications included wound infection in two patients. The median postoperative hospital stay was 7.5 days (range, 2–23 days). No recurrence of duplication cysts was identified during the available follow-up period, although fol-

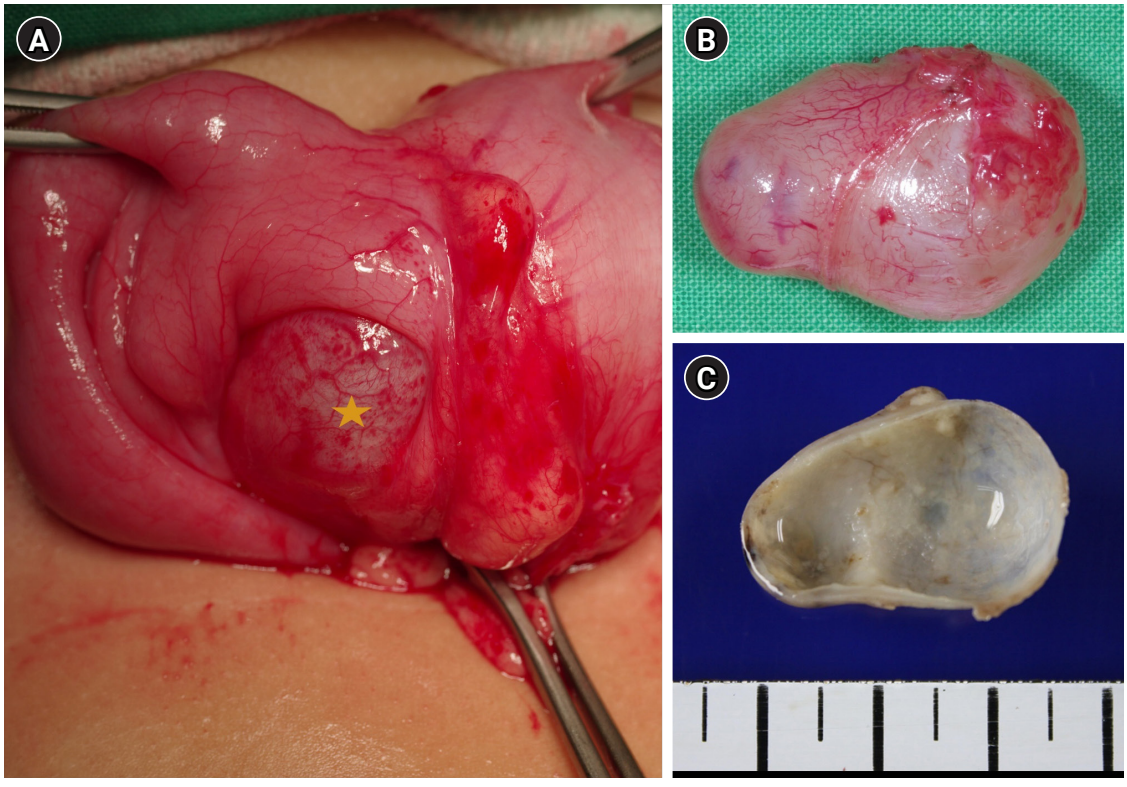

Fig. 2. Intraoperative and macroscopic findings of the duplication cyst. (A) An ileocecal duplication cyst, indicated by the star, is located on the mesenteric side of the ileocecal valve. (B) Surgical view after enucleation of the cyst. (C) Cross-sectional view of the resected specimen showing the internal structure of the cyst.

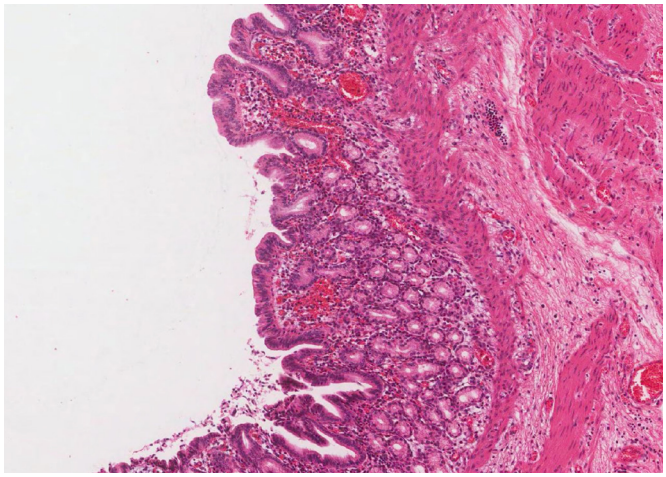

Fig. 3. Histopathological findings of the duplication cyst (H&E stain, ×100). Microscopic examination shows a cyst wall lined with gastric mucosa, characterized by foveolar epithelium and underlying gastric glands. Adjacent to the mucosa, a well-developed, distinct layer of smooth muscle, the muscularis propria, is observed, confirming the diagnosis of a true alimentary tract duplication cyst. Prominent vascular congestion and focal inflammatory cell infiltration are noted within the lamina propria.

low-up duration was limited in many patients.

DISCUSSION

This 40-year single-center experience provides valuable long-term data on the characteristics and management of EDCs in children. Consistent with international literature, EDCs in our cohort were predominantly diagnosed during infancy, with 75.6% of cases presenting before 2 years of age, emphasizing their congenital origin and potential for early symptoms [1,3,4,10]. The male predominance in this cohort (male-to-female ratio, 1.6:1) is also consistent with the slight male predominance reported in general series of alimentary tract duplications.

Our findings confirm that the ileum (57.8%) is the most frequent site of EDCs, followed by the jejunum (11.1%) and ileocecal valve (11.1%). This predilection for the distal small bowel suggests a specific, although unconfirmed, vulnerability during midgut development [2,11]. The most common presenting symptoms, including vomiting (46.7%) and abdominal pain (26.7%), illustrate the mechanical effects of these space-occupying lesions.

A key finding of this series was the high rate of complications requiring emergency surgery, which occurred in 28.9% of patients with EDCs. Bowel obstruction was the most common indication for emergency surgery (5 cases), followed by volvulus and intussusception (3 cases each) and perforation (2 cases). These findings underscore the need for a high index of clinical suspicion for EDCs in infants presenting with acute abdominal symptoms, because duplication cysts can serve as pathological lead points for intussusception or precipitate bowel volvulus [8]. The need for prompt surgical intervention in these emergency settings further highlights the importance of preoperative diagnosis.

The frequent use of US in this cohort (75.6%) reflects its non-invasive nature and effectiveness in identifying the characteristic double wall sign of cystic lesions in the pediatric abdomen [1,2,4]. Among the 34 patients who underwent US, 28 (82.4%) were correctly identified as having a duplication cyst, underscoring the high diagnostic accuracy of this modality when the double wall sign is recognized. The increasing rate of prenatal US diagnosis in recent decades, as suggested by our series in which 7 of 8 prenatally detected cases underwent surgery after 2000, mirrors global trends and facilitates planned delivery and timely postnatal management.

Pathologically, the strong predominance of cystic morphology in this series is consistent with previous reports. The presence of heterotopic gastric mucosa in 27 of 44 evaluable EDCs (61.4%) is clinically relevant. Ectopic gastric mucosa can cause peptic ulceration and potentially life-threatening hemorrhage or perforation because of acid secretion [12]. Notably, only one patient with gastric mucosa presented with GI bleeding in our series, suggesting that the clinical manifestations of ectopic mucosa may not always correlate directly with its presence or that acid production was insufficient in other cases. The low incidence of bleeding despite the frequent presence of gastric mucosa may reflect limited acid secretion, small mucosal volume, or early surgical removal before ulceration developed. Nonetheless, the potential for malignant transformation, although extremely rare, supports complete excision [10].

The surgical approach, including ileo-ascending colon resection and small-bowel resection, was determined by the lesion location and degree of involvement of the adjacent bowel. For most cystic duplications, complete excision with segmental bowel resection remains the standard of care because it fully removes the shared wall and any ectopic mucosa. However, when the cyst is well defined and easily separable from the bowel wall, bowel-preserving procedures such as enucleation or wedge resection are viable alternatives [9], as demonstrated in 12 cases (26.7%) in our series. Overall, postoperative outcomes were favorable, with low morbidity. These

https://doi.org/10.13029/aps.2026.00010

results demonstrate that, despite the complexity of these congenital anomalies, excellent outcomes can be achieved over a long period at a specialized pediatric surgical center.

This study has several limitations. Its retrospective, single-center design may have introduced selection bias. In addition, the 40-year study period spans substantial changes in diagnostic modalities and surgical techniques, which may have influenced management strategies and limited direct comparisons across eras. Information on prenatal detection was based partly on retrospective parental reports, limiting precise evaluation of its influence on surgical timing. However, the relatively large number of patients accrued over this extended period is a significant strength and provides valuable data on a rare condition.

In conclusion, this 40-year retrospective analysis of EDCs in children confirms that EDCs are rare congenital anomalies that primarily present within the first 2 years of life. The ileum is the most common site, and clinical presentation is often related to complications such as bowel obstruction, volvulus, and intussusception, which require emergency surgical intervention in a substantial proportion of patients. Cystic morphology predominates, and the presence of heterotopic gastric mucosa requires careful pathological evaluation. US is the key diagnostic modality. Prompt and complete surgical excision remains the definitive treatment and is associated with favorable short-term postoperative outcomes, with no recurrence observed during the available follow-up period in this specialized setting. This extensive single-center experience provides substantial evidence supporting proactive management strategies to prevent life-threatening complications associated with EDCs.

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Conflict of interest

None.

Funding

None.

Data availability

Data of this research is available from the corresponding author upon reasonable request.

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Original Article

Adv Pediatr Surg. 2026 Jun;32(1):18-26
pISSN 2635-8778 · eISSN 2635-8786
https://doi.org/10.13029/aps.2026.00031

APS Advances in Pediatric Surgery

Clinical characteristics and surgical outcomes of intestinal duplication in South Korean children: a nationwide multicenter retrospective case series

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Purpose: This study investigated the clinical characteristics, anatomical distribution, operative management, and postoperative outcomes of pediatric patients who underwent surgery for intestinal duplication and were registered through a nationwide multicenter survey conducted by the Korean Association of Pediatric Surgeons (KAPS).

Methods: KAPS conducted a nationwide multicenter retrospective survey across 18 institutions between 2020 and 2024 and collected data from 144 patients.

Results: Female patients accounted for 55.6% of surgically treated cases, corresponding to a male to female ratio of 1:1.25. Vomiting and abdominal pain were the most common presenting symptoms. Prenatal diagnosis was achieved in 43.7% of cases. The ileum was the most common site of intestinal duplication (41.0%). Cystic duplications predominated (82.6%), and communication with the native bowel was documented in 19.4% of cases. Elective surgery was performed in 83.3% of patients, with laparoscopic-assisted surgery being the most commonly used approach (52.8%). The most frequently performed surgical procedures were excision (49.3%) and bowel resection with anastomosis (47.2%). Recurrence occurred in three patients (2.1%), and mortality was reported in one patient (0.7%).

Conclusion: This study represents the largest multicenter dataset on intestinal duplication in South Korea and provides comprehensive information regarding its clinical characteristics and surgical outcomes. These findings may serve as a useful reference for understanding the clinical spectrum and operative management of pediatric intestinal duplication in South Korea and may support the development of future standardized prospective studies.

Keywords: Intestinal duplication; Child; Surveys and questionnaires; Laparoscopy

Received: February 3, 2026; **Revised:** February 23, 2026; **Accepted:** March 17, 2026
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INTRODUCTION

Intestinal duplications are rare congenital anomalies that can occur anywhere along the alimentary tract, most commonly in the small intestine [1-3]. They occur in approximately 1 in 4,500 live births and are most frequently diagnosed in neonates and children [4-6]. The clinical presentation of intestinal duplication varies according to morphological type, anatomical location, and patient age group. Presentations range from incidental prenatal detection to dysphagia, abdominal pain, abdominal mass, intussusception, inflammation, bleeding, and even peritonitis secondary to perforation. Because of the rarity of this condition and its nonspecific clinical manifestations, achieving an accurate preoperative diagnosis is often challenging. Definitive treatment generally requires complete surgical excision, as residual lesions after partial excision may predispose patients to recurrence, and even clinically silent duplications may subsequently result in complications [6]. Despite numerous single-center reports, nationwide multicenter data regarding surgically treated pediatric cases remain limited. Therefore, we report the findings of a nationwide multicenter Korean survey coordinated by the Korean Association of Pediatric Surgeons (KAPS), detailing demographic characteristics, prenatal diagnosis, clinical manifestations, associated anomalies, preoperative diagnostic methods, anatomical location and type of intestinal duplication, presence of communication and ectopic tissue, operative management, and postoperative outcomes in patients with intestinal duplication, with particular emphasis on how lesion characteristics inform surgical decision-making.

METHODS

We retrospectively reviewed the medical records of pediatric patients who underwent surgery for intestinal duplication at 18 KAPS institutions between January 2020 and December 2024. The KAPS committee developed a case registration form to collect data regarding patient sex, birth weight, gestational age, prenatal diagnosis, clinical manifestations, associated anomalies, preoperative diagnostic methods, anatomical location and type of intestinal duplication, presence of communication and ectopic tissue, operative management, and postoperative outcomes. The form was distributed by email to 18 pediatric surgical centers and completed by authorized KAPS members at the participating centers, yielding data from 144 patients. Patients were eligible if they were <18 years of age and underwent surgical treatment for intestinal duplication during the specified 5-year study period. Cases with insufficient data were excluded. Because the survey included cases reported by 18 participating KAPS-affiliated pediatric surgical centers, the dataset represents a multicenter surgical registry rather than a population-based national incidence database.

Ethics statement

The study protocol was approved by the Institutional Review Board of Kyungpook National University Hospital (No. 2025-06-005). Informed consent was waived due to the use of deidentified data and the retrospective nature of the study.

RESULTS

Registered case numbers

A total of 144 patients with intestinal duplication were registered in this nationwide survey. The annual case distribution was as follows: 39 cases in 2020, 28 in 2021, 25 in 2022, 27 in 2023, and 25 in 2024. The regional distribution was as follows: 114 cases (79.1%) from the Seoul/Gyeonggi region, 16 cases (11.1%) from the Busan/Ulsan/Gyeongnam region, six cases (4.2%) from Daegu, six cases (4.2%) from the Jeolla region, and two cases (1.4%) from the Chungcheong region. This distribution suggests a concentration of registered cases in the Seoul/Gyeonggi region, likely reflecting referral patterns and the geographic distribution of participating tertiary centers.

Patient demographics and perinatal characteristics

The cohort included 64 male patients (44.4%) and 80 female patients (55.6%), yielding a male to female ratio of approximately 1:1.25 and demonstrating a predominance of female patients in this surgical series. A total of 115 patients (79.9%) were born at a gestational age of ≥37 weeks, and 113 patients (78.5%) had a birth weight of ≥2,500 g. The median age at surgery was 8.5 months (range, 1 day–17 years). Prenatal diagnosis was confirmed in 63 patients (43.7%). Among the subset of patients for whom this information was available, the mean gestational age at prenatal diagnosis was 25.6 weeks. Maternal polyhydramnios was absent in 105 patients (72.9%). No family history of intestinal duplication was reported among any of the 144 patients (Table 1).

Clinical manifestations

Clinical manifestations at diagnosis included vomiting in 39 patients (27.1%), making it the most common presenting

Table 1. Patient demographics and perinatal characteristics

Characteristic	No. (%)
Sex	
Male	64 (44.4)
Female	80 (55.6)
Gestational age (wk)	
<37	15 (10.4)
≥37	115 (79.9)
Not available	14 (9.7)
Birth weight (g)	
<2,500	12 (8.3)
≥2,500	113 (78.5)
Not available	19 (13.2)
Prenatal diagnosis	
Yes	63 (43.7)
No	76 (52.8)
Not available	5 (3.5)
Polyhydramnios	
Yes	1 (0.7)
No	105 (72.9)
Not available	38 (26.4)

Table 2. Clinical manifestations

Clinical manifestation	No. (%)
Absence of symptoms	80 (55.6)
Vomiting	39 (27.1)
Abdominal pain	35 (24.3)
Abdominal mass	16 (11.1)
Abdominal distension	11 (7.6)
Hematochezia	10 (6.9)
Abnormal anal appearance or discharge	8 (5.6)
Fever	7 (4.9)
Melena	4 (2.8)
Constipation	2 (1.4)
Dysphagia	2 (1.4)

Multiple clinical manifestations could be recorded for each patient; therefore, percentages do not sum to 100%.

symptom, followed by abdominal pain in 35 patients (24.3%) and abdominal mass in 16 patients (11.1%). Abdominal distention was observed in 11 patients (7.6%), hematochezia in 10 patients (6.9%), abnormal anal appearance or discharge in eight patients (5.6%), and fever in seven patients (4.9%). However, 80 patients (55.6%) were asymptomatic at the time of diagnosis (Table 2).

Associated anomalies

Cardiovascular anomalies were the most frequently observed associated anomalies, occurring in 10 patients, followed by craniofacial and musculoskeletal anomalies in seven patients. Other associated anomalies included gastrointestinal anomalies in four patients, central nervous system anomalies in four, genitourinary anomalies in four, and chromosomal abnormalities in three.

Preoperative diagnostic methods

Multiple diagnostic modalities were used in some patients. The most frequently performed preoperative imaging studies were abdominal radiography in 122 patients (84.7%) and abdominal ultrasonography in 120 patients (83.3%). Other diagnostic modalities included abdominal computed tomography (CT) in 57 patients (39.6%), abdominal magnetic resonance imaging (MRI) in 21 (14.6%), upper gastrointestinal series or small bowel series in 13 (9.0%), colon studies in 13 (9.0%), Meckel scans in seven (4.9%), colonoscopy in five (3.5%), and endoscopy in three (2.1%). These findings indicate that conventional radiography and ultrasonography were strongly preferred for initial evaluation in clinical practice.

Location and type of intestinal duplication

The ileum was the most common site of intestinal duplication, occurring in 59 cases (41.0%). Other locations included the cecum in 19 cases (13.2%), stomach in 18 cases (12.5%), anus in 17 cases (11.8%), jejunum in 13 cases (9.0%), esophagus in six cases (4.1%), duodenum in five cases (3.5%), rectum in five cases (3.5%), and colon in two cases (1.4%) (Fig. 1). Multiple duplications were identified in two patients: one patient had two duplications in the ileum, and one had duplications in both the jejunum and ileum. For anatomical classification, the patient with two ileal duplications was counted as one ileal case, and the patient with one jejunal and one ileal duplication was also counted as one ileal case. Most intestinal duplications were cystic, accounting for 119 cases (82.6%), whereas tubular duplications were identified in 20 cases (13.9%). In five cases (3.5%), the type was unknown. This distribution indicates that cystic duplications predominated across nearly all locations except the anus, where tubular duplications were more frequent (Table 3).

Presence of communication with native bowel and ectopic tissue according to anatomical location

Communication between the duplication and the adjacent native intestinal lumen was identified in 28 patients (19.4%), whereas 107 patients (74.3%) had no communication. Com-

https://doi.org/10.13029/aps.2026.00031

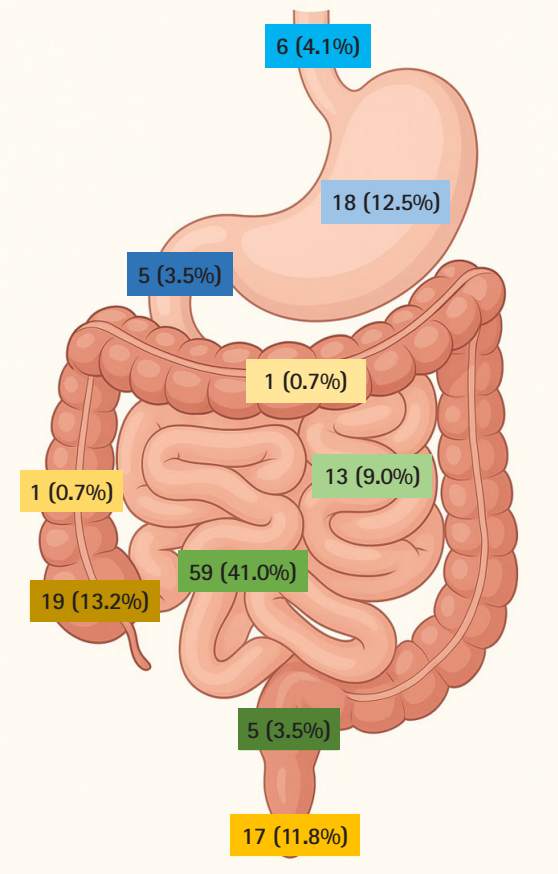

Fig. 1. Distribution of intestinal duplication according to anatomical location.

munication status was unknown in nine cases (6.3%). Table 4 summarizes communication between the intestinal duplication and the adjacent bowel according to anatomical location. These findings indicate that most intestinal duplications did not communicate with the native intestinal tract, although communication was relatively more frequent in duodenal and rectal duplications.

Ectopic tissue was identified in 21 of 144 patients (14.6%), whereas 123 patients (85.4%) had no ectopic tissue. Table 4 also shows the distribution of ectopic tissue in intestinal duplications according to anatomical location. These findings suggest that ectopic gastric or pancreatic tissue was most frequently identified in duplications located in the ileum and duodenum.

Change in the size of intestinal duplication

Among the patients, 112 had data allowing comparison of intestinal duplication size between initial diagnosis and surgery. Of these, 67 cases (59.8%) increased in size, 31 (27.7%) decreased in size, and 14 (12.5%) showed no change.

Table 3. Location and type of intestinal duplication

Location	Cystic type	Tubular type	Unknown type
Esophagus	6 (100)	0 (0)	0 (0)
Stomach	18 (100)	0 (0)	0 (0)
Duodenum	4 (80.0)	1 (20.0)	0 (0)
Jejunum	10 (76.9)	3 (23.1)	0 (0)
Ileum	57 (96.6)	1 (1.7)	1 (1.7)
Cecum	17 (89.5)	0 (0)	2 (10.5)
Colon	1 (50.0)	1 (50.0)	0 (0)
Rectum	4 (80.0)	1 (20.0)	0 (0)
Anus	2 (11.8)	13 (76.4)	2 (11.8)
Total	119 (82.6)	20 (13.9)	5 (3.5)

Values are presented as number (%).

Operative treatment of intestinal duplication

Among the 144 patients with intestinal duplication, elective surgery was performed in 120 (83.3%), whereas emergency surgery was required in 24 (16.7%). A breakdown by anatomical location is shown in Table 5. These findings indicate that most patients underwent planned elective surgery, although emergency intervention was more frequently required for duplications located in the jejunum, ileum, and cecum than for those in other locations.

The most commonly used surgical approach was laparoscopic-assisted surgery, performed in 76 patients (52.8%), followed by open surgery in 40 patients (27.8%), pure laparoscopic surgery in 26 patients (18.0%), and thoracoscopic surgery in two patients (1.4%). Table 6 summarizes operative modalities for intestinal duplication according to anatomical location. These findings highlight the increasing preference for minimally invasive techniques, particularly laparoscopic-assisted surgery, in the treatment of intestinal duplication, especially in the small intestine. However, open surgery remained predominant for anorectal or anal lesions.

The most commonly used operative methods were excision in 71 cases (49.3%) and bowel resection with anastomosis in 68 cases (47.2%). Less common procedures included partial excision in two cases (1.4%) and other methods in three cases (2.1%). A breakdown by anatomical location is shown in Table 7. These findings suggest that excision and bowel resection with anastomosis were the two main surgical strategies and were selected according to lesion location, communication with the native bowel, and involvement of surrounding structures.

Table 4. Presence of communication with native bowel and ectopic tissue according to anatomical location

Location	Communication			Ectopic tissue	
	+	–	Unknown	+	–
Esophagus	1 (16.7)	5 (83.3)	0 (0)	0 (0)	6 (100)
Stomach	4 (22.2)	14 (77.8)	0 (0)	1 (5.6)[a]	17 (94.4)
Duodenum	3 (60.0)	2 (40.0)	0 (0)	2 (40.0)[b]	3 (60.0)
Jejunum	1 (7.7)	10 (76.9)	2 (15.4)	2 (15.4)[c]	11 (84.6)
Ileum	8 (13.6)	46 (77.9)	5 (8.5)	14 (23.7)[d]	45 (76.3)
Cecum	7 (36.8)	11 (57.9)	1 (5.3)	2 (10.5)[e]	17 (89.5)
Colon	1 (50.0)	1 (50.0)	0 (0)	0 (0)	2 (100)
Rectum	3 (60.0)	1 (20.0)	1 (20.0)	0 (0)	5 (100)
Anus	0 (0)	17 (100)	0 (0)	0 (0)	17 (100)
Total	28 (19.4)	107 (74.3)	9 (6.3)	21 (14.6)	123 (85.4)

Values are presented as number (%).
[a]Pancreatic tissue; [b]one case of gastric tissue, one case of gastric and pancreatic tissue; [c]two cases of gastric tissue; [d]13 cases of gastric tissue, one case of pancreatic tissue; [e]two cases of gastric tissue.

Table 5. Elective versus emergency surgery according to location

Location	Elective	Emergency
Esophagus	6 (100)	0 (0)
Stomach	17 (94.4)	1 (5.6)
Duodenum	5 (100)	0 (0)
Jejunum	9 (69.2)	4 (30.8)
Ileum	47 (79.7)	12 (20.3)
Cecum	12 (63.2)	7 (36.8)
Colon	2 (100)	0 (0)
Rectum	5 (100)	0 (0)
Anus	17 (100)	0 (0)
Total	120 (83.3)	24 (16.7)

Values are presented as number (%).

Postoperative complications, recurrence, and mortality

Postoperative complications occurred in both the early and late postoperative periods. Early complications occurred in six patients and included wound infection in five cases (duodenal duplication, one; jejunal duplication, one; ileal duplication, three) and anastomotic leakage in one case involving duodenal duplication. A late postoperative complication was observed in one patient with duodenal duplication, who developed intestinal obstruction. Recurrence was observed in three of 144 patients (2.1%): one with esophageal duplication, one with duodenal duplication, and one with rectal duplication. One notable case involved a female patient who underwent reoperation for remnant rectal duplication cysts over several years after initial involvement of both the colon and rectum. One death occurred (0.7%), involving a patient with duodenal duplication. The cause of death was pulmonary hypertension during the healing phase after anastomotic leakage.

DISCUSSION

Intestinal duplication is a rare congenital anomaly characterized by a well-formed cystic or tubular structure that is attached to, or shares a common wall with, the alimentary tract; is lined by gastrointestinal mucosa; and has a well-developed smooth muscle layer [3,4,7].

The exact pathogenetic mechanism underlying intestinal duplication remains unclear. Several mechanisms have been proposed, including the split notochord theory, abnormal recanalization of the transiently solid gastrointestinal tract during embryogenesis, abortive twinning, persistence of embryological diverticula, and intrauterine vascular accidents. These hypotheses reflect the complex, multifactorial nature of this congenital anomaly [8].

Although intestinal duplication has traditionally been reported more frequently in male patients, Sujka et al. [9] observed a female predominance, with 62.0% of cases occurring in female patients. Similarly, intestinal duplication was more common in female patients in our series, accounting for 55.6% of cases.

The clinical manifestations of intestinal duplication vary widely depending on patient age, anatomical location, duplication cyst size, and presence of ectopic mucosa [4]. In our nationwide survey, vomiting (27.1%) and abdominal pain (24.3%) were the most common symptoms, whereas a substantial proportion of patients (55.6%) were incidentally diagnosed without symptoms. These findings are consistent with those of

https://doi.org/10.13029/aps.2026.00031

Table 6. Surgical approach

Location	Thoracoscopy	Laparoscopy	Laparoscopic-assisted	Open
Esophagus	2 (33.3)	4 (66.7)	0 (0)	0 (0)
Stomach	0 (0)	16 (88.8)	1 (5.6)	1 (5.6)
Duodenum	0 (0)	2 (40.0)	1 (20.0)	2 (40.0)
Jejunum	0 (0)	0 (0)	10 (76.9)	3 (23.1)
Ileum	0 (0)	0 (0)	50 (84.7)	9 (15.3)
Cecum	0 (0)	1 (5.3)	12 (63.1)	6 (31.6)
Colon	0 (0)	1 (50.0)	1 (50.0)	0 (0)
Rectum	0 (0)	2 (40.0)	1 (20.0)	2 (40.0)
Anus	0 (0)	0 (0)	0 (0)	17 (100)
Total	2 (1.4)	26 (18.0)	76 (52.8)	40 (27.8)

Values are presented as number (%).

Table 7. Operative methods according to location

Location	BRA	Excision	Partial excision	Others
Esophagus	0 (0)	5 (83.3)	0 (0)	1 (16.7)
Stomach	3 (16.7)	14 (77.8)	1 (5.5)	0 (0)
Duodenum	1 (20.0)	4 (80.0)	0 (0)	0 (0)
Jejunum	10 (76.9)	3 (23.1)	0 (0)	0 (0)
Ileum	38 (64.4)	20 (33.9)	1 (1.7)	0 (0)
Cecum	14 (73.7)	4 (21.0)	0 (0)	1 (5.3)
Colon	2 (100)	0 (0)	0 (0)	0 (0)
Rectum	0 (0)	5 (100)	0 (0)	0 (0)
Anus	0 (0)	16 (94.1)	0 (0)	1 (5.9)
Total	68 (47.2)	71 (49.3)	2 (1.4)	3 (2.1)

Values are presented as number (%).
BRA, bowel resection with anastomosis.

previous studies [4,10].

In our nationwide survey, the ileum was the most common location of intestinal duplication (41.0%), followed by the cecum (13.2%), stomach (12.5%), anus (11.8%), and jejunum (9.0%). This distribution was comparable to that reported in previous studies [1,3]. In our series, 82.6% of intestinal duplications were cystic, consistent with previous reports [4,9].

Most cases in our cohort (74.3%) showed no communication with the adjacent bowel, consistent with previously published data [4]. However, intestinal duplications involving the duodenum and rectum demonstrated relatively high rates of communication with the native bowel (60.0% in each location), which may substantially influence surgical decision-making and treatment strategy.

Compared with the study by Guerin et al. [7], which reported ectopic tissue in 41.0% of cases, our series demonstrated a lower prevalence of ectopic tissue (14.6%). Complete mucosal excision is particularly important in intestinal duplications with ectopic tissue, as retained mucosa may contribute to complications such as bleeding, ulceration, and recurrence.

With the increasing use of prenatal ultrasonography, the number of intestinal duplications diagnosed before birth has steadily increased. In our nationwide survey, 43.7% of patients were diagnosed at a mean gestational age of 25.6 weeks among those with available data, comparable to rates reported in previous studies [2,5]. This relatively high prenatal detection rate underscores the value of prenatal ultrasonography for prompting postnatal surveillance and timely consultation.

In our nationwide survey, plain abdominal radiography and ultrasonography were the most widely used preoperative studies, reflecting their accessibility and diagnostic utility. Abdominal ultrasonography typically reveals a cystic lesion adjacent to the intestine with a characteristic double-wall or muscular rim sign, reflecting an inner hyperechoic mucosal layer and an outer hypoechoic smooth muscle layer [1]. Cross-sectional imaging, including CT and MRI, as well as contrast studies, can assess lesion location, vascularity, and communication, thereby facilitating surgical planning. On abdominal CT, intes-

tinal duplication usually appears as a well-defined, low-attenuation, unilocular cystic mass that is most commonly round or spherical and often lacks apparent communication with the native bowel. In some cases, however, the duplication may appear as a tubular structure continuous with the intestinal lumen.

Complete surgical excision remains the mainstay of treatment for intestinal duplication [11-13]. Partial excision is associated with an increased risk of recurrence, and even asymptomatic lesions may lead to future complications [14]. In this survey, all three cases of recurrence were observed following cyst excision. These recurrences occurred not only after partial excision but also after complete excision, indicating that meticulous follow-up is warranted regardless of the extent of excision. According to Ma et al. [15], malignant transformation in intestinal duplication is rare but carries an unfavorable prognosis, supporting the need for definitive surgical treatment. Therefore, careful selection of the surgical strategy is essential, and the optimal approach should be determined according to the size and location of the cyst and its anatomical relationship with the adjacent intestine. The most commonly used surgical techniques in our series were simple excision (49.3%) and bowel resection with anastomosis (47.2%). Bowel resection with anastomosis was used more frequently for jejunoileal and cecal lesions, in which shared walls or vascularity often preclude safe enucleation. Conversely, simple excision or enucleation is particularly favored in locations where bowel resection with anastomosis should be avoided, such as the esophagus, stomach, and duodenum [16]. Selective mucosal excision has been described as an effective treatment strategy in rare cases of extensive tubular intestinal duplication [1]. Recently, minimally invasive laparoscopic surgery has been increasingly adopted for intestinal duplication [9,11,14,16]. In our series, laparoscopic and laparoscopic-assisted procedures were frequently used, particularly for small intestinal lesions; however, because complications were not analyzed according to operative approach, comparative safety cannot be inferred. With advances in imaging modalities, an increasing number of intestinal duplications are being detected during prenatal evaluation, leading to ongoing debate regarding the optimal timing of surgical intervention [17-20]. Laje et al. [18] suggested that early surgical treatment after birth is warranted because intestinal duplication can cause substantial complications. In a systematic review by Fahy and Pierro [19], almost half of prenatally diagnosed patients developed symptoms early in life and required surgical intervention, whereas close observation with delayed prophylactic resection during infancy was recommended for asymptomatic patients. Similarly, Wang et al. [20] reported that intestinal obstruction is the most common complication of intestinal duplication and occurs predominantly during the neonatal period. They concluded that symptomatic patients require early intervention, whereas asymptomatic patients can be managed with close observation and delayed resection. Early surgical resection can be considered for duplications with a diameter greater than 3 cm or those of the intraluminal type. Therefore, the timing of surgery should be individualized according to the size and location of the duplication cyst and its potential for complications.

This nationwide multicenter survey of 144 children treated for intestinal duplication across 18 KAPS institutions represents the largest Korean dataset to date and provides several practice-relevant insights. Nevertheless, this study has important limitations. Its retrospective design may have introduced selection and information bias. Substantial heterogeneity in anatomical location, clinical presentation, and disease extent, combined with the multicenter nature of the data, likely influenced surgical decision-making and perioperative management. Variations in institutional experience and operative preferences limit direct comparisons among surgical approaches and reflect differences in local practice patterns across institutions. However, these nationwide data provide an important foundation for identifying consensus-based strategies and may facilitate the future development of a standardized KAPS clinical pathway for the management of intestinal duplication. Future research should focus on prospective multicenter studies with standardized data collection and treatment protocols. Stratification according to anatomical location and clinical characteristics will help define optimal surgical strategies and long-term outcomes in patients with intestinal duplication.

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https://doi.org/10.13029/aps.2026.00031

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Conflict of interest

Jinyoung Park, Soo-Hong Kim, So Hyun Nam, Jung-Man Namgoong, Junbeom Park, Ji-Young Sul, Hee-Beom Yang, Sanghoon Lee, Ju Yeon Lee, Kyong Ihn, Yeon Jun Jeong, Jae Hee Chung, and Min Jeng Cho are editorial board members of this journal, but were not involved in the peer reviewer selection, evaluation, or decision process of this article. No other potential conflict of interest relevant to this article was reported.

Funding

None.

Data availability

All data generated or analyzed during this study are included in this published article. For other data, these may be requested through the corresponding author.

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https://doi.org/10.13029/aps.2026.00031

Original Article

Adv Pediatr Surg. 2026 Jun;32(1):27-33
pISSN 2635-8778 · eISSN 2635-8786
https://doi.org/10.13029/aps.2026.00038

APS Advances in Pediatric Surgery

Perioperative outcomes of laparoscopic-assisted diverticulectomy versus small bowel resection for Meckel diverticulum in South Korea: a retrospective cohort study

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Purpose: This study aimed to compare perioperative outcomes between laparoscopic-assisted diverticulectomy and laparoscopic-assisted small bowel resection for Meckel diverticulum.

Methods: This single-center retrospective comparative cohort study included 39 patients who underwent laparoscopic-assisted surgery for Meckel diverticulum at Samsung Medical Center, Korea, between June 2010 and December 2023. Patients were classified into the laparoscopic-assisted diverticulectomy group or the laparoscopic-assisted small bowel resection group. Baseline characteristics, preoperative presentation, operative time, time to first oral feeding, postoperative hospital stay, complications, reoperation, and follow-up outcomes were compared between groups.

Results: Of the 39 patients, 19 underwent laparoscopic-assisted diverticulectomy and 20 underwent laparoscopic-assisted small bowel resection. Baseline characteristics and preoperative presentation did not differ significantly between groups. Operative time was significantly shorter in the diverticulectomy group than in the small bowel resection group (median, 55.0 vs. 76.0 minutes; P=0.002). Time to first oral feeding did not differ significantly between groups (median, 2 days [2–2 days] vs. 2 days [1–3 days]; P=0.397). Postoperative hospital stays also did not differ significantly between groups (median, 4 days [3–4 days] vs. 4 days [4–5 days]; P=0.118), although hospitalization tended to be longer in the laparoscopic-assisted small bowel resection group. No statistically significant difference in complication rates was observed between groups; however, the number of events was low, limiting definitive comparison.

Conclusion: Laparoscopic-assisted diverticulectomy was associated with shorter operative time and a tendency toward shorter postoperative hospital stay than small bowel resection, without an observed increase in early complications. It may be a reasonable option for carefully selected patients with uncomplicated Meckel diverticulum.

Keywords: Cohort studies; Meckel diverticulum; Laparoscopy; Length of stay; Operative time

INTRODUCTION

Background

Meckel diverticulum arises from incomplete closure of the omphalomesenteric duct during early development. It is among the most common congenital intestinal anomalies, affecting 0.3% to 2.7% of the population [1,2]. The duct provides nutrition until placental formation and normally separates

Received: February 6, 2026; **Revised:** April 23, 2026; **Accepted:** May 13, 2026
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from the intestine by the seventh week of gestation. Failure of complete separation may result in cysts, fistulas, or fibrous bands that can cause obstruction. In the absence of additional attachments, Meckel diverticulum may form. Classically, Meckel diverticulum has been described by the "rule of twos": it affects approximately 2% of the population, measures approximately 5 cm (2 inches) in length, is located approximately 60 cm (2 feet) from the ileocecal valve in the ileum, is twice as common in males, and may contain two types of ectopic tissue, gastric or pancreatic. Ectopic gastric or pancreatic tissue can secrete acid and pepsin, leading to ulceration of the adjacent ileal mucosa and gastrointestinal bleeding. This bleeding is usually painless and may be brisk or massive, causing stool to appear bright red, brick red, or black. Intestinal obstruction is another common complication. It can occur through several mechanisms, including volvulus around a fibrous band, intussusception, Littre hernia, entrapment of the small bowel beneath the diverticular blood supply, stricture from chronic diverticulitis, or Meckel diverticulum lithiasis [3]. Surgeons treat Meckel diverticulum with either diverticulectomy or small bowel resection with anastomosis, depending on the diverticulum anatomy, base width, complications such as ischemia or perforation, and the presence of ectopic gastric tissue [3,4].

Traditionally, symptomatic Meckel diverticulum has been managed with excision through laparotomy, using either segmental small bowel resection or wedge resection with anastomosis. Minimally invasive techniques now enable laparoscopic-assisted excision, and the use of laparoscopic stapling devices for intracorporeal diverticulectomy is increasingly common [5]. The choice between diverticulectomy and small bowel resection is particularly relevant for diverticula with a wide base or those complicated by bleeding or inflammation, because ectopic tissue can extend into the adjacent ileum [6]. However, direct comparisons of perioperative outcomes between laparoscopic-assisted diverticulectomy (LA-D) and laparoscopic-assisted small bowel resection (LA-SBR) remain limited.

Objectives

Therefore, this study aimed to evaluate perioperative characteristics and postoperative outcomes according to the type of laparoscopic-assisted procedure performed for Meckel diverticulum.

METHODS

Ethics statement

This retrospective study was approved by the Institutional Review Board at Samsung Medical Center (No. 2026-01-058). Informed consent was waived due to the use of deidentified data and the retrospective nature of the study.

Study design

This was a single-center retrospective comparative cohort study. We included 39 patients with Meckel diverticulum who underwent surgery at Samsung Medical Center from June 2010 to December 2023.

Surgical procedures

The surgical procedure was selected intraoperatively on the basis of diverticular morphology and disease severity including diverticular base width, suspected extension of ectopic tissue, degree of inflammation, and bowel viability.

LA-D was preferred for narrow-based diverticula without evidence of inflammation, ischemia, or suspected extension of ectopic mucosa into the adjacent ileum. LA-SBR was selected for broad-based diverticula, suspected ectopic mucosal involvement of the adjacent ileum, or complicated pathology such as inflammation, perforation, or ischemia.

All procedures were performed using a laparoscopic-assisted approach. The diverticulum or involved bowel segment was exteriorized through the umbilical incision before extracorporeal resection. For diverticulectomy, the diverticulum was resected extracorporeally with a linear stapler, and the staple line was oriented transversely to reduce the risk of luminal narrowing. For small bowel resection, segmental bowel resection followed by primary anastomosis was performed extracorporeally.

Participants

The study included patients who required either LA-D or LA-SBR with anastomosis, regardless of symptom status or the presence of complications such as bleeding, obstruction, or inflammation.

Variables

The exposure variable was the type of surgical procedure: LA-D or LA-SBR. The primary outcomes were operative time and postoperative hospital stay. Secondary outcomes were time to first oral feeding, postoperative complications, reoper-

https://doi.org/10.13029/aps.2026.00038

ation, and late complications during follow-up.

Data sources/measurement

Data were extracted from electronic medical records, operative notes, anesthesia records, pathology reports, and outpatient follow-up records. Operative time was defined as the interval from skin incision to wound closure. Time to first oral feeding was defined as the number of postoperative days until oral intake was initiated. Postoperative hospital stay was defined as the number of days from operation to discharge. Complications were identified from inpatient records and follow-up visits.

Bias

Because the surgical procedure was selected intraoperatively according to diverticular morphology, suspected ectopic mucosal extension, inflammation, and bowel viability, confounding by indication was possible. To reduce selection bias, all eligible consecutive patients during the study period were included, and baseline clinical characteristics were compared between groups. However, residual confounding from unmeasured anatomical or disease-severity factors could not be excluded.

Study size

No a priori sample size calculation was performed because Meckel diverticulum requiring surgery is uncommon, and this was a retrospective study including all eligible patients treated during the study period. Therefore, the analyses should be interpreted as exploratory, particularly for infrequent outcomes such as complications and reoperation.

Statistical analysis

Statistical analyses were conducted using IBM SPSS ver. 25.0 (IBM Corp.). Continuous variables were summarized as median (interquartile range [IQR]), and categorical variables were summarized as number (%). Between-group comparisons for continuous outcomes were performed using the Mann-Whitney U test, and effect sizes were additionally reported as Hodges-Lehmann estimates of location shift with 95% confidence intervals (CIs) where applicable. Categorical variables were compared using Fisher exact test or the chi-square test, as appropriate. Operative time analyses were conducted as complete-case analyses because operative time data were missing in cases with concomitant procedures; the number of available observations is reported for each group. A two-sided P-value <0.05 was considered statistically significant.

RESULTS

Baseline characteristics and perioperative outcomes are summarized in Table 1 and Fig. 1. A total of 39 patients underwent

Table 1. Baseline characteristics and clinical outcomes

Characteristic	Total (n=39)	LA-D (n=19)	LA-SBR (n=20)	P-value
Male sex	33 (84.6)	17 (89.5)	16 (80.0)	0.661
Age at operation (yr)	7.8 (2.5–12.7)	10.0 (3.1–13.7)	5.8 (2.6–10.9)	0.550
Weight at surgery (kg)	28.3 (12.5–48.7)	42.0 (12.5–55.1)	22.1 (13.0–38.1)	0.351
Preoperative symptoms				
Bleeding	20 (51.3)	10 (52.6)	10 (50.0)	0.869
Obstruction	10 (25.6)	3 (15.8)	7 (35.0)	0.273
Severe inflammation (abscess)	3 (7.7)	1 (5.3)	2 (10.0)	0.999
Asymptomatic	6 (15.4)	5 (26.3)	1 (5.0)	0.091
Operative time (min)[a]	68.0 (55.5–83.5)	55.0 (44.5–69.0)	76.0 (66.0–99.5)	0.002
Time to first oral feeding (day)	2 (1.5–3.0)	2 (2.0–2.0)	2 (1.0–3.0)	0.397
Postoperative hospital stays (day)	4 (3.0–5.0)	4 (3.0–4.0)	4 (4.0–5.0)	0.118
Complication	3 (7.7)	1 (5.3)	2 (10.0)	0.999
Ileus (conservative management)	2 (5.1)	1 (5.3)	1 (5.0)	0.999
Reoperation (adhesive ileus)	1 (2.6)	0 (0)	1 (5.0)	0.999
Follow-up (mo)	1.0 (0.5–7.8)	0.6 (0.5–5.0)	1.3 (0.5–10.5)	0.985

Values are presented as number (%) or median (interquartile range).
LA-D, laparoscopic-assisted diverticulectomy; LA-SBR, laparoscopic-assisted small bowel resection.
[a]Operative time was available for 31 patients (LA-D, n=15; LA-SBR, n=16).

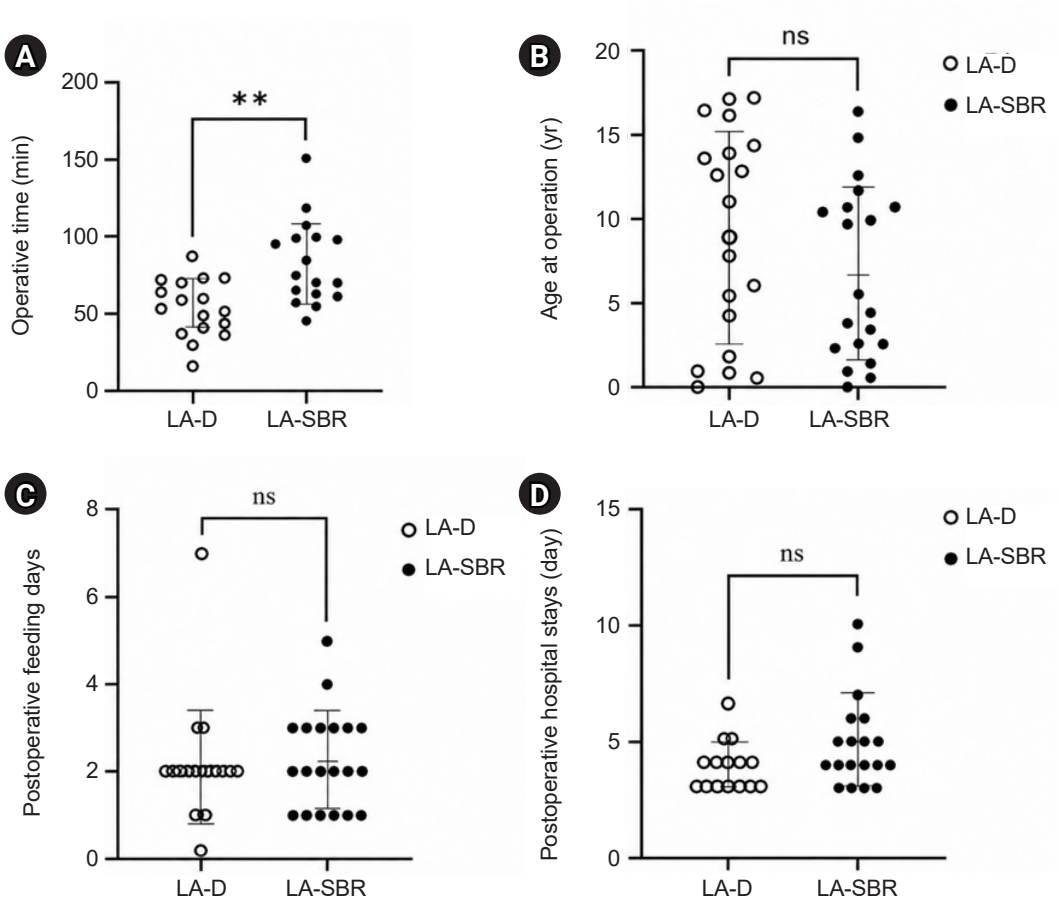

Fig. 1. Comparison of selected perioperative outcomes between LA-D and LA-SBR. (A) Operative time in minutes (P=0.002); (B) age at operation; (C) time to first oral feeding; and (D) postoperative hospital stay. LA-D, laparoscopic-assisted diverticulectomy; LA-SBR, laparoscopic-assisted small bowel resection; ns, not significant. **P<0.01.

laparoscopic-assisted surgery for Meckel diverticulum, including 19 patients in the LA-D group and 20 in the LA-SBR group.

Baseline demographic characteristics were comparable between the two groups. The proportion of male patients was 89.5% in the LA-D group and 80.0% in the LA-SBR group (P=0.661). The median age at surgery was 10.0 years (IQR, 3.1–13.7 years) in the LA-D group and 5.8 years (IQR, 2.6–10.9 years) in the LA-SBR group (P=0.550). Median body weight at surgery was 42.0 kg (IQR, 12.5–55.1 kg) and 22.1 kg (IQR, 13.0–38.1 kg), respectively (P=0.351).

Preoperative clinical presentations were similar between groups. Gastrointestinal bleeding was the most common presentation (52.6% vs. 50.0%, P=0.869), followed by intestinal obstruction (15.8% vs. 35.0%, P=0.273). Severe intra-abdominal inflammation, including abscess formation, was observed in a small number of patients (5.3% vs. 10.0%, P=0.999). Six patients (15.4%) were asymptomatic at diagnosis, with a higher proportion in the LA-D group than in the LA-SBR group (26.3% vs. 5.0%, P=0.091).

Operative outcomes showed a significantly shorter operative time in the LA-D group (n=15) than in the LA-SBR group (n=16) (median, 55.0 minutes vs. 76.0 minutes; P=0.002). Operative time data were available for 31 patients because data from eight cases were excluded (four in each group) owing to missing or nonseparable operative duration records, particularly in patients who underwent combined procedures with other surgical departments. The estimated difference in operative time between groups, assessed using the Hodges-Lehmann method, was 22.0 minutes (95% CI, 9.0–34.5 minutes) in the LA-SBR group.

Postoperative recovery outcomes were largely comparable. Time to first oral feeding did not differ significantly between groups (median, 2 days [2–2 days] vs. 2 days [1–3 days]; P=0.397). Postoperative hospital stay also did not differ significantly between the LA-D and LA-SBR groups (median, 4 days [3–4 days] vs. 4 days [4–5 days]; P=0.118), although the LA-SBR

https://doi.org/10.13029/aps.2026.00038

group showed a tendency toward longer hospitalization, with a Hodges-Lehmann location shift of 1.0 day (95% CI, 0–1.0 day).

Postoperative complications were infrequent in both groups (1 vs. 2 events), and no statistically significant difference was observed between groups (5.3% vs. 10.0%, P=0.999). However, because the number of events was very small, meaningful comparison between groups was limited. Two patients developed postoperative ileus requiring conservative management, and one patient in the LA-SBR group underwent reoperation for adhesive ileus.

Body weight was not significantly associated with operative time (Spearman ρ=0.21, P=0.24) or postoperative complications (P=0.550). Although body weight was numerically higher in the LA-D group than in the LA-SBR group, this difference was not statistically significant (P=0.351).

The median follow-up duration was 1.0 month (IQR, 0.5–7.8 months), with follow-up conducted through outpatient clinic visits. No late complications, including bowel stenosis or residual symptoms related to ectopic tissue, were observed during the follow-up period.

DISCUSSION

Key results

In this study, LA-D was associated with significantly shorter operative time and a tendency toward shorter postoperative hospital stay compared with LA-SBR, while early postoperative bowel recovery and complication rates were comparable between the two approaches.

Interpretation/comparison with previous studies

These findings are consistent with previous studies suggesting that diverticulectomy is associated with more favorable perioperative outcomes than segmental bowel resection [5,7].

These results are clinically relevant because they support a less extensive surgical strategy for appropriately selected patients with Meckel diverticulum. In the absence of high-risk features, diverticulectomy preserves the native bowel, avoids anastomosis, and reduces operative complexity, which may translate into faster recovery and shorter hospitalization. Previous literature has emphasized the advantages of minimally invasive approaches in reducing surgical trauma and improving postoperative recovery [1,4,8].

The longer operative time and hospital stay observed in the LA-SBR group are likely attributable to the additional technical steps required for mesenteric division and bowel anastomosis. Segmental resection inherently involves more extensive tissue handling and reconstruction, which has been associated with increased postoperative morbidity in prior studies [7,9]. In contrast, diverticulectomy minimizes disruption of bowel continuity and may therefore contribute to improved perioperative outcomes.

Importantly, time to first oral feeding did not differ significantly between the two groups. This finding is consistent with reports that early bowel recovery may be similar after minimally invasive procedures [1,5].

A key consideration in interpreting these results is the potential for selection bias. The choice of surgical procedure was determined intraoperatively based on diverticular morphology and disease severity. Patients undergoing LA-SBR may have had more complex disease, such as broad-based diverticula or associated inflammation. Previous studies have also highlighted that diverticular characteristics, including base width and the presence of ectopic mucosa, play an important role in determining the appropriate surgical approach [6,10].

Although body weight showed a trend toward association with surgical approach selection, it was not significantly associated with operative time or postoperative complications, suggesting that body weight alone may not be a determining factor in surgical outcomes.

Clinical implication

These results support intraoperative selection of the procedure according to diverticular anatomy and disease severity. LA-D may be considered the initial surgical approach in cases with a narrow-based diverticulum without evidence of inflammation, ischemia, or suspected ectopic mucosal extension. Conversely, small bowel resection should be reserved for cases with high-risk features, including a broad base, involvement of the adjacent ileum, or complicated pathology such as perforation or severe inflammation. This approach is supported by previous reports emphasizing individualized surgical decision-making based on intraoperative findings [3,11-13].

The absence of late complications, including bowel stenosis or residual symptoms related to ectopic tissue, further supports the safety of diverticulectomy in appropriately selected patients, although the short follow-up limits assessment of delayed adverse outcomes. Nevertheless, because incomplete resection of ectopic mucosa remains a concern, particularly in broad-based diverticula, careful intraoperative assessment is needed to reduce this risk [6,10].

Limitations

This study has several limitations. Its retrospective design introduces inherent risks of selection bias and unmeasured confounding. The relatively small sample size limits the feasibility of robust multivariable analysis or propensity score matching. Additionally, operative time data were missing in a subset of patients, and the follow-up duration may not be sufficient to capture all late complications. Nevertheless, this study provides useful comparative data reflecting real-world clinical practice in the era of minimally invasive surgery.

Generalizability

The findings of this study are most applicable to patients with Meckel diverticulum treated at tertiary centers with experience in laparoscopic-assisted pediatric or adolescent surgery. Because this was a single-center retrospective study with a small sample size, the results should be generalized cautiously to other institutions, adult populations, open surgical approaches, purely intracorporeal laparoscopic procedures, or patients with severely complicated disease.

Suggestions for further studies

Future multicenter prospective registry studies are needed to validate these findings in larger and more diverse patient populations. Such studies should collect standardized intraoperative variables, including diverticular base width, diverticulum length, presence and location of ectopic mucosa, degree of inflammation, bowel viability, and the specific reason for selecting diverticulectomy or small bowel resection. Larger datasets would allow multivariable adjustment or propensity-score methods to reduce confounding by indication and provide more precise estimates of postoperative complications, reoperation, and long-term outcomes.

Conclusions

In this single-center retrospective cohort study, LA-D was associated with shorter operative time and a trend toward shorter postoperative hospital stay than LA-SBR, with no observed difference in time to first oral feeding or early postoperative complications. Because the surgical procedure was selected according to intraoperative findings and follow-up was limited, these findings support LA-D as a reasonable option for carefully selected patients with narrow-based, uncomplicated Meckel diverticulum, while small bowel resection remains appropriate for broad-based diverticula, suspected ectopic mucosal extension, ischemia, perforation, or severe inflammation.

ARTICLE INFORMATION

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Conflict of interest

Sanghoon Lee is an editorial board member of this journal, but was not involved in the peer reviewer selection, evaluation, or decision process of this article. No other potential conflict of interest relevant to this article was reported.

Funding

This work was supported by the SMC-Ottogi Research Fund (No. SMO1190231).

Data availability

All data generated or analyzed during this study are included in this published article. Additional data may be requested from the corresponding author.

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https://doi.org/10.13029/aps.2026.00038

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Original Article

Adv Pediatr Surg. 2026 Jun;32(1):34-40
pISSN 2635-8778 · eISSN 2635-8786
https://doi.org/10.13029/aps.2026.00087

APS Advances in Pediatric Surgery

Natural orientation-based parallel anastomosis in laparoscopic duodenoduodenostomy: association with atresia location and perioperative outcomes in a retrospective cohort study

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Purpose: At our institution, congenital duodenal atresia is repaired laparoscopically using duodenoduodenostomy with a parallel anastomosis. During our use of this technique, we noted that after mobilization, the distal duodenal segment naturally rested in either a cranial or caudal orientation relative to the proximal segment and that this resting orientation appeared to vary with the anatomical level of atresia. This study primarily evaluated the association between atresia location and the natural orientation of the distal duodenal segment. It secondarily compared perioperative outcomes between the cranial and caudal orientation groups.

Methods: This retrospective cohort study was conducted at Samsung Medical Center (Seoul, South Korea) and included neonates who underwent laparoscopic duodenoduodenostomy with parallel anastomosis for congenital duodenal atresia from January 2008 to June 2021. After patients with annular pancreas or duodenal web were excluded, 22 neonates were analyzed and categorized into the cranial (n=16) or caudal (n=6) orientation group according to intraoperative findings. Perioperative outcomes were compared, and the relationship between atresia location and distal segment orientation was analyzed.

Results: Operative time, postoperative ventilator support, time to feeding initiation, time to full feeding, and length of hospitalization did not differ significantly between groups. No patient required conversion to open surgery, developed an anastomotic stricture, or died during hospitalization. One patient in the cranial group developed an anastomotic leak, which was treated by laparoscopic reanastomosis. First-portion duodenal atresia was significantly more frequent in the caudal group than in the cranial group (83.3% vs. 25.0%, P=0.023).

Conclusion: Laparoscopic duodenoduodenostomy with parallel anastomosis was feasible in both cranial and caudal orientations, with no conversions to open surgery. The natural orientation of the distal duodenal segment was significantly associated with the anatomical location of atresia, supporting an anatomical basis for orientation-guided parallel anastomosis.

Keywords: Duodenal atresia; Duodenoduodenostomy; Laparoscopy; Infant

Received: May 8, 2026; **Revised:** June 4, 2026; **Accepted:** June 9, 2026
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INTRODUCTION

Duodenal atresia is a congenital intestinal obstruction that occurs in approximately 1 in 5,000–10,000 live births and is often accompanied by trisomy 21, congenital heart defects, or other gastrointestinal malformations [1,2]. Duodenoduodenostomy is the definitive operative treatment, and current long-term survival rates exceed 90% [3,4]. Even with these favorable survival outcomes, technical aspects of reconstruction remain clinically relevant because they can contribute to postoperative complications such as anastomotic leak, stricture, and delayed enteral feeding [4,5].

Over the past two decades, laparoscopic duodenoduodenostomy has become an accepted minimally invasive approach in specialized pediatric surgical centers, where it can reduce surgical trauma, improve operative visualization, and support faster recovery [6-9]. The diamond-shaped anastomosis introduced by Kimura et al. [10] remains the most widely used configuration [11-13]. Our institution uses a parallel anastomosis technique in which the proximal and distal duodenal segments are approximated according to their natural alignment rather than rotated into a predetermined configuration [14]. As our experience with this approach increased, we observed that the distal duodenal segment rested in one of two reproducible orientations—cranial or caudal—relative to the proximal segment and that this orientation appeared to correspond to the anatomical location of the atresia [15,16].

Although laparoscopic repair of duodenal atresia has been increasingly reported, few studies have examined how the level of atresia relates to the intraoperative alignment of the duodenal segments or to the selected anastomotic configuration [8,17,18]. The primary aim of this study was therefore to characterize the association between duodenal atresia location and the natural orientation of the distal duodenal segment during laparoscopic parallel anastomosis. The secondary aim was to compare perioperative outcomes between the cranial and caudal orientation groups as an assessment of the feasibility of this anatomy-guided approach.

METHODS

Ethics statement

This single-center retrospective cohort study was approved by the Institutional Review Board of Samsung Medical Center (No. 2024-12-137). The requirement for informed consent was waived because the study used a retrospective design.

Study design and patient selection

We reviewed all neonates who underwent laparoscopic duodenoduodenostomy for congenital duodenal atresia between January 2008 and June 2021. Among 29 initially identified patients, seven were excluded after intraoperative findings showed annular pancreas or duodenal web. Patients with duodenal atresia accompanied by annular pancreas were excluded because an encircling pancreatic ring may independently change the spatial relationship between the proximal and distal duodenal segments, thereby confounding assessment of their natural orientation. Patients with duodenal web were excluded because this obstruction differs mechanistically from true atresia. The final study cohort comprised 22 neonates (Fig. 1).

Data sources and measurement

The operative technique followed our previously published protocol [14]. Two experienced pediatric surgeons performed all procedures. A four-trocar configuration was used, consisting of a 5-mm transumbilical camera port, two 3-mm working ports placed on either side of the umbilicus, and a 3-mm epigastric assistant port. After the duodenal C-loop had been mobilized, the distal duodenal segment was allowed to settle into its natural perpendicular relationship to the proximal segment without forced rotation. A transverse incision was made in the proximal duodenum, and a longitudinal incision was made in the distal duodenum to create parallel openings. The anastomosis was constructed posterior wall first with interrupted 5-0 glyconate monofilament absorbable sutures (Monosyn, B. Braun). An orogastric tube was routinely placed for gastric decompression in all patients.

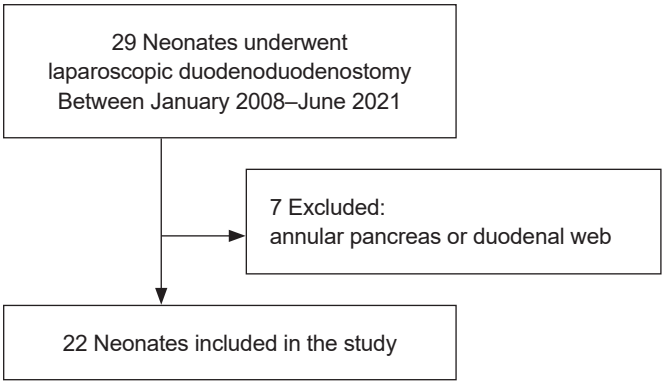

Fig. 1. Flowchart of patient selection.

Variables

The distal segment was classified as having a cranial orientation when it was directed toward the head and as having a caudal orientation when it was directed toward the feet, based on its resting position after mobilization (Fig. 2). Orientation was determined after Kocherization and mobilization of the duodenal C-loop and before stay sutures were placed. The classification relied on the unforced resting position of the distal segment relative to the proximal segment, with no traction applied. This orientation was documented in the operative notes at the time of surgery and later confirmed by review of the operative video recordings. In every case, the orientation could be classified clearly, and no intermediate or borderline orientation was encountered.

Atresia location was assigned according to intraoperative anatomical landmarks. First-portion atresia was defined as obstruction proximal to the expected ampullary region and was identified by the absence of bile staining in the proximal duodenal lumen together with the relationship between the atretic segment and the pancreatic head. Postampullary atresia was defined as obstruction at or distal to the expected ampullary level and was typically recognized by bile-stained fluid in the proximal segment.

Data collection

The collected variables included demographic characteristics, associated anomalies, atresia location, operative time, duration of postoperative ventilator support, time to feeding initiation, time to full feeding, length of hospitalization, and complications. Enteral feeding was started after nasogastric output had decreased to less than 5 mL/kg/day and radiographic passage of intestinal gas had been confirmed.

Statistical analysis

A formal sample-size calculation was not performed because the retrospective cohort included all eligible patients treated during the study period. No data were missing for the primary variables included in the analysis.

Continuous variables were summarized as median (range) and compared with the Mann-Whitney U test. Categorical variables were compared with the Fisher exact test. Statistical significance was defined as $P<0.05$. All analyses were performed using IBM SPSS ver. 25 (IBM Corp.).

RESULTS

In total, 22 neonates underwent laparoscopic duodenoduodenostomy with parallel anastomosis; 16 were assigned to the cranial orientation group and six to the caudal orientation group. No procedure required conversion to open surgery. The cohort included 11 male neonates (50.0%). Median gestational age was 37+1 weeks (range, 35+3 to 38+6 weeks), and median

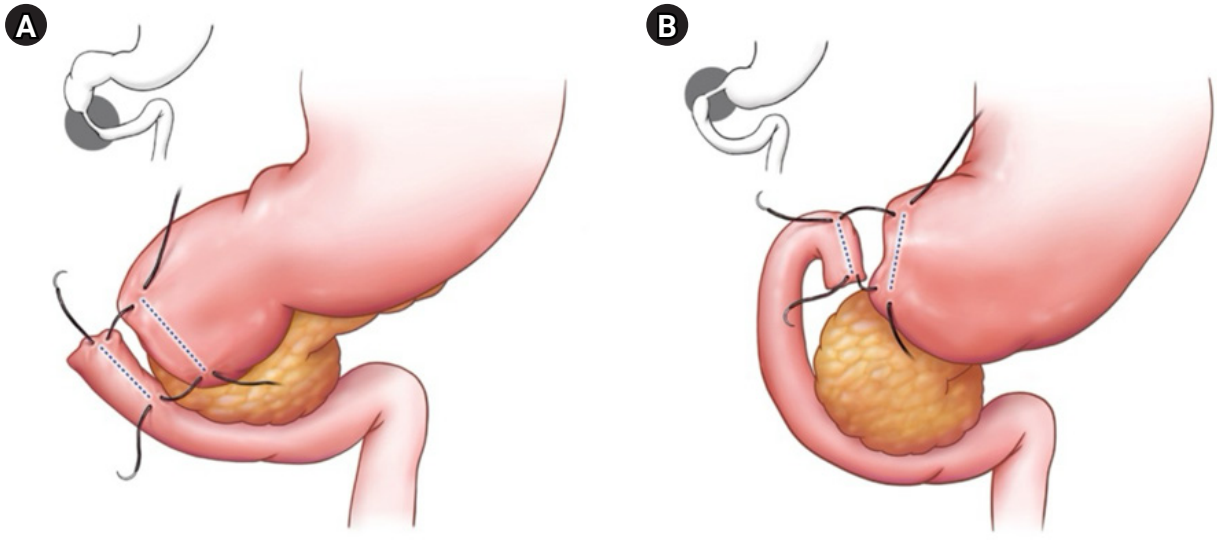

Fig. 2. Schematic illustration of parallel anastomosis according to the natural orientation of the distal duodenal segment during laparoscopic duodenoduodenostomy. (A) Cranial orientation of the distal duodenal segment. (B) Caudal orientation of the distal duodenal segment. Dotted lines indicate the planned enterotomy sites in the proximal and distal duodenal segments.

https://doi.org/10.13029/aps.2026.00087

birth weight was 2,575 g. The median age at surgery was 2.5 days, and median body weight at operation was 2,400 g. Associated anomalies were identified in seven patients (31.8%) and included Down syndrome (n=5), congenital heart defects (n=4), esophageal atresia (n=1), and limb anomalies (n=1). Gastrointestinal malrotation was found in one patient (4.5%) and was reported separately because it represented a distinct surgical finding that could influence intraoperative anatomy.

Table 1 summarizes the baseline characteristics according to orientation group. Gestational age, birth weight, and the presence of associated anomalies were not significantly different between groups. Male sex was more frequent in the caudal group than in the cranial group (83.3% vs. 37.5%), but this difference did not reach statistical significance (P=0.149).

Atresia location was significantly associated with the natural orientation of the distal duodenal segment. First-portion duodenal atresia occurred more often in the caudal group than in the cranial group (83.3% vs. 25.0%, P=0.023).

Table 2 presents perioperative outcomes. Body weight at operation (2,335 g vs. 2,695 g, P=0.073) and age at operation (3 days vs. 2 days, P=0.474) were not significantly different between groups. Median operative time was numerically shorter in the caudal group than in the cranial group (109 minutes [range, 95–147 minutes] vs. 134.5 minutes [range, 95–248 minutes]), but this difference was not statistically significant (P=0.186).

Short-term postoperative outcomes were similar between the cranial and caudal orientation groups. Duration of postoperative ventilator support (1 day [range, 0–13 days] vs. 1 day [range, 0–5 days], P=0.920), length of hospital stay (13.0 days [range, 9–107 days] vs. 12.5 days [range, 10–39 days], P=0.677), time to feeding initiation (5 days [range, 3–30] vs. 5 days [range, 3–9], P=0.755), and time to full feeding (10.0 days [range, 6–45 days] vs. 9.5 days [range, 7–15 days], P=0.679) did not differ significantly. Median follow-up duration also did not differ significantly between groups (6.6 months vs. 7.3 months, P=0.900).

Postoperative complications were recorded in one patient (6.3%) in the cranial group and in no patients in the caudal group (P>0.999). The affected patient developed an anastomotic leak that was successfully treated with laparoscopic reanastomosis. No anastomotic strictures were observed, and no

Table 1. Patients' demographic and baseline characteristics between the cranial and caudal orientation groups

Characteristic	Overall (n=22)	Cranial group (n=16)	Caudal group (n=6)	P-value
Male sex	11 (50.0)	6 (37.5)	5 (83.3)	0.149
Gestational age (wk+day)	37+1 (35+3 to 38+6)	37+1 (35+3 to 38+6)	37+6 (36+5 to 38+4)	0.079
Birth weight (g)	2,575 (1,470–3,200)	2,466 (1,470–3,200)	2,840 (2,180–3,040)	0.101
Associated anomalies	7 (31.8)	5 (31.3)	2 (33.3)	>0.999
Gastrointestinal malrotation	1 (4.5)	1 (6.3)	0 (0)	>0.999
First-portion duodenal atresia	9 (40.9)	4 (25.0)	5 (83.3)	0.023*

Values are presented as number (%) or median (range).
*Statistically significant (P<0.05).

Table 2. Perioperative characteristics and outcomes between the cranial and caudal orientation groups

Characteristic	Overall (n=22)	Cranial group (n=16)	Caudal group (n=6)	P-value
Body weight at operation (g)	2,400 (1,410–3,100)	2,335 (1,410–3,100)	2,695 (2,180–2,880)	0.073
Age at operation (day)	2.5 (1–16)	3.0 (1–16)	2.0 (1–12)	0.474
Operative time (min)	134.0 (95–248)	134.5 (95–248)	109.0 (95–147)	0.186
Postoperative ventilator day	1 (0–13)	1 (0–13)	1 (0–5)	0.920
Postoperative hospital day	13.0 (9-107)	13.0 (9-107)	12.5 (10-39)	0.677
Time to initiation of feeding (day)	5 (3-30)	5 (3-30)	5 (3-9)	0.755
Time to full feeding (day)	10.0 (6-45)	10.0 (6-45)	9.5 (7-15)	0.679
Follow-up (mo)	6.7 (0.8–71.7)	6.6 (0.8–71.7)	7.3 (0.9–59.0)	0.900
Postoperative complication	1 (4.5)	1 (6.3)[a]	0 (0)	>0.999
Mortality during hospitalization	0 (0)	0 (0)	0 (0)	NA

Values are presented as median (range) or number (%).
NA, not applicable.
[a]Anastomotic leak.

in-hospital deaths occurred in either group.

DISCUSSION

In this retrospective cohort, perioperative outcomes after laparoscopic duodenoduodenostomy with parallel anastomosis showed no statistically significant differences between the cranial and caudal orientation groups. During the available follow-up period, no anastomotic strictures were identified, no in-hospital deaths occurred, and the single anastomotic leak was successfully treated by laparoscopic reanastomosis. The main statistically significant finding was the association between atresia location and distal segment orientation: first-portion atresia was predominantly associated with caudal orientation, whereas postampullary atresia was associated with cranial orientation (P=0.023). This association is the principal observation of this study and suggests that the natural alignment encountered during parallel anastomosis may reflect, at least in part, the anatomical level of obstruction. Because the cohort was small and had limited statistical power, the lack of significant between-group differences in perioperative outcomes should not be interpreted as evidence of equivalence.

The anatomical configuration of the duodenum provides a plausible explanation for this pattern. When atresia involves the first portion of the duodenum, the short proximal segment and its proximity to the pylorus may restrict cranial mobilization, allowing the distal segment to rest in a caudal position after mobilization. When atresia is postampullary, the longer proximal duodenal segment may permit the distal segment to be mobilized more readily in a cranial direction. Aligning the anastomosis with this natural orientation may reduce the need for forced rotation or excessive traction and may facilitate tension-free reconstruction [14]. This anatomical rationale differentiates parallel anastomosis from techniques that depend on a predefined anastomotic configuration.

A wide, tension-free anastomosis is a central technical principle in surgery for duodenal atresia [4,10,19]. Kimura et al. [10] introduced the diamond-shaped anastomosis to increase the anastomotic lumen, and favorable long-term outcomes have been reported with this configuration [3,20]. Parallel anastomosis is designed to create a comparably wide opening while maintaining the natural orientation of the proximal and distal segments [14]. Several series have supported the feasibility and safety of laparoscopic duodenoduodenostomy [6,7,11,21], and systematic reviews have reported outcomes comparable to those of open repair [8,22]. The present findings extend these reports by showing that orientation-based parallel anastomosis could be completed in both natural orientations without conversion to open surgery; however, the small sample size and limited follow-up prevent firm conclusions about comparative safety or long-term outcomes.

Previous studies have mainly compared laparoscopic with open repair [9,17,22] or assessed outcomes according to anastomotic configuration [12,23]. In contrast, anastomotic orientation itself has rarely been examined as a separate anatomical variable. Jhala et al. [18] evaluated whether anastomotic technique affected outcomes, but their analysis did not stratify patients by distal segment orientation or atresia location. The present study therefore focused on the natural orientation of the distal duodenal segment as observed intraoperatively during a single standardized procedure.

A distinctive feature of this study is that group assignment was determined by an intraoperative anatomical finding—the natural orientation of the distal duodenal segment—rather than by differences in operative technique. Because the same standardized procedure was used in both groups, technique-related variability was reduced, allowing perioperative outcomes to be described across two anatomical configurations encountered during the same operative approach. The groups nevertheless differed significantly in atresia location, which also formed the basis of the observed association. Accordingly, the outcome comparison should not be interpreted as isolating the effect of orientation alone, because unmeasured confounding related to atresia location cannot be excluded. Awareness of the relationship between atresia location and natural orientation may help surgeons anticipate the intraoperative configuration and select enterotomy sites and suture placement along the most natural, tension-free axis. Whether preserving this natural orientation directly improves anastomotic tension, surgical ergonomics, or postoperative function remains a hypothesis that should be examined in prospective studies. To our knowledge, this is the first study to systematically describe this relationship during laparoscopic parallel duodenoduodenostomy.

This study has several limitations. First, its retrospective design creates the possibility of selection and information bias. Second, the cohort was small, especially the caudal orientation group, which limited statistical power and generalizability. More detailed subclassification of atresia location (e.g., D1, D2, D3) was not feasible because the number of patients was limited and precise anatomical localization is difficult in

https://doi.org/10.13029/aps.2026.00087

neonatal duodenal atresia. Third, the study was conducted at a single center using a standardized institutional technique, so the findings may not be directly applicable to centers that use different operative strategies. Fourth, because no comparison group underwent diamond-shaped anastomosis, the relative advantages of parallel anastomosis could not be determined. Finally, follow-up was relatively short, which limited assessment of long-term anastomotic and functional outcomes. In particular, the minimum follow-up of 0.8 months in some patients was insufficient for evaluation of late complications such as anastomotic stricture or functional dysmotility; therefore, the reported complication rates should be interpreted in light of this limitation.

In conclusion, during laparoscopic orientation-based parallel anastomosis, the natural orientation of the distal duodenal segment was significantly associated with the anatomical location of duodenal atresia. The operation was completed in both cranial and caudal orientations, with no conversion to open surgery. Short-term perioperative outcomes did not differ significantly between the orientation groups, but these results should be interpreted cautiously because of the small sample size, limited follow-up, and lack of a conventional anastomosis control group. Larger studies with longer follow-up are needed to validate this anatomical association and determine its clinical relevance.

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Authors' contributions

Conceptualization: MJB, WK, SL. Data curation: MJB, SJK. Formal analysis: SJK, WK. Investigation: WK, SP. Methodology: MJB, SL. Visualization: WK, SL. Writing–original draft: MJB, SJK, WK. Writing–review & editing: MJB, SL, JMS. All authors read and approved the final manuscript.

Conflict of interest

Sanghoon Lee is an editorial board member of this journal, but was not involved in the peer reviewer selection, evaluation, or decision process of this article. No other potential conflict of interest relevant to this article was reported.

Funding

None.

Data availability

All data generated or analyzed during this study are included in this published article. For other data, these may be requested through the corresponding author.

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https://doi.org/10.13029/aps.2026.00087

Case Report

Adv Pediatr Surg. 2026 Jun;32(1):41-46
pISSN 2635-8778 · eISSN 2635-8786
https://doi.org/10.13029/aps.2026.00073

APS Advances in Pediatric Surgery

Pediatric benign cystic mesothelioma presenting as acute abdomen: a case report

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Benign cystic mesothelioma (BCM) is a rare intra-abdominal tumor and is particularly uncommon in pediatric patients. Its nonspecific clinical and radiological features often make preoperative diagnosis challenging. We report the case of a 4-year-old girl who presented with acute abdominal pain and vomiting. Computed tomography revealed a large, multiloculated cystic mass occupying the lower abdomen, which was initially suspected to be a lymphatic malformation. During laparoscopic exploration, a hemorrhagic, multiloculated cystic mass with hemoperitoneum was identified and completely resected with preservation of the right ovary. Histopathological examination confirmed BCM, showing predominant clusters of epithelioid cells interspersed with cyst-like spaces on hematoxylin and eosin staining. The patient recovered uneventfully and had no recurrence during 30 months of follow-up. This case describes an unusual presentation of BCM as an acute abdomen complicated by hemoperitoneum in a child and emphasizes the importance of surgical exploration and histopathological evaluation in establishing the diagnosis.

Keywords: Benign cystic mesothelioma; Pediatric; Pediatric tumor; Case reports

INTRODUCTION

Among intra-abdominal cystic lesions, benign cystic mesothelioma (BCM) of the peritoneum is a rare tumor that arises from the peritoneal mesothelium lining the serous cavity. Its clinical symptoms are nonspecific, and definitive diagnosis requires histological confirmation. Although BCM is classified as benign, it may show locally aggressive behavior and carry a high local recurrence rate. To date, no evidence-based treatment strategy has been established for BCM. Here, we report a rare case of intra-abdominal BCM in a 4-year-old girl and emphasize the importance of considering BCM in the differential diagnosis of cystic abdominal lesions in children.

CASE REPORT

Ethics statement

Written informed consent for publication of this case report and the accompanying images was obtained from the patient's parent. This case report was prepared in accordance with the principles of the Declaration of Helsinki and the CARE guidelines.

Patient information

A 4-year-old girl presented to the emergency department with abdominal pain, abdominal distension, and vomiting that had persisted for 5 days. She had initially been treated for entero-

Received: March 31, 2026; **Revised:** May 15, 2026; **Accepted:** May 27, 2026
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colitis at a local clinic. Although the vomiting had subsided 2 days before presentation, her oral intake remained poor.

Clinical and diagnostic findings

The patient appeared lethargic and was crying because of persistent periumbilical pain. Physical examination revealed a soft but distended abdomen, with a firm mass palpable in the right abdomen. She was hemodynamically stable. Initial laboratory evaluation was unremarkable except for an elevated erythrocyte sedimentation rate of 58 mm/hr. Contrast-enhanced computed tomography (CT) demonstrated a large, multiloculated cystic mass measuring approximately 10×12 cm, occupying nearly the entire lower abdomen and pelvic cavity (Fig. 1). The mass showed no enhancement after intravenous contrast administration and had no communication with the abdominal viscera. Based on these findings, an intra-abdominal lymphatic malformation originating from the omentum or peritoneum was suspected.

Therapeutic intervention

Emergency surgery was performed because of persistent abdominal pain, progressive distension, and suspected intra-abdominal bleeding. Laparoscopic exploration was performed using two 5-mm trocars placed at the umbilicus and left lower quadrant and one 3-mm trocar placed in the suprapubic area. Intraoperatively, bloody ascites was identified, along with a hemorrhagic cystic mass measuring approximately 15×15 cm and showing no communication with adjacent viscera. Extracorporeal aspiration of the mass was attempted but was ineffective because of internal septations and organized blood clot. After intracorporeal decompression and shrinkage of the tumor, the mass was found to be attached to the right ovary. Careful dissection enabled complete resection with ovarian preservation, and the specimen was retrieved using an endoscopic bag (Fig. 2). The left ovary was intact, and no bowel or omental abnormalities were observed.

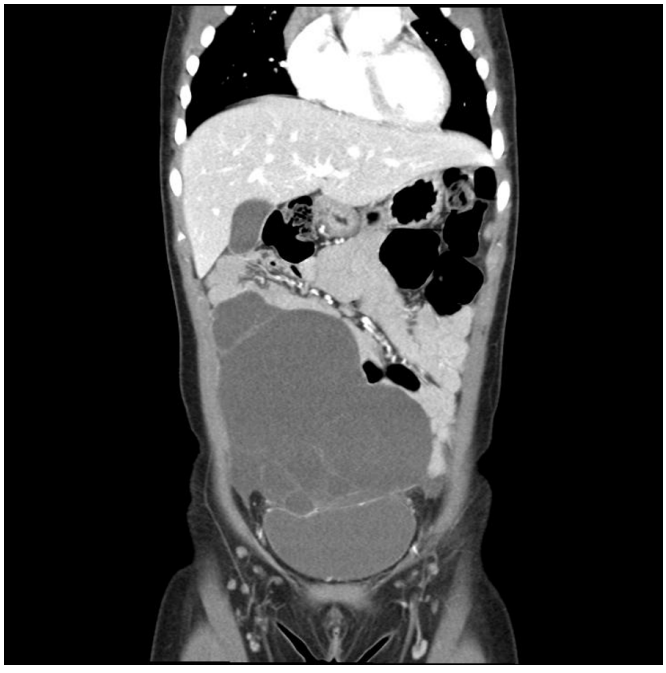

Fig. 1. Abdominal computed tomography scan showing a large, multiseptated hypodense mass in the lower abdomen.

Follow-up and outcomes

The patient resumed oral intake on the first postoperative day and was discharged on postoperative day 4 without complications. The pathological diagnosis was benign multicystic mesothelioma of the peritoneum (Fig. 3). Immunohistochemically, the epithelioid cells were positive for WT1 (Wilms tumor 1), supporting mesothelial origin. Calretinin showed focal weak positivity in the outer lining mesothelial cells but was negative in the mural nodules. D2-40 (podoplanin) and CD31 (cluster of differentiation 31) were negative. Overall, the immunoprofile supported the diagnosis of BCM. The patient had an uneventful postoperative course and underwent surveillance ultrasonography every 6 months. At 30 months postoperatively, she had no functional deficits and showed no evidence of recurrence.

DISCUSSION

In pediatric patients with intra-abdominal cystic lesions, the most common initial differential diagnoses include lymphatic malformation, omental or mesenteric cyst, mature cystic teratoma, peritoneal inclusion cyst, and bowel duplication cyst. Preoperatively and intraoperatively, our initial impression was that the lesion represented a lymphatic malformation because it appeared as a multiseptated cystic mass attached to the ovary without communication with other intra-abdominal structures. However, subsequent histopathological examination confirmed the diagnosis of BCM.

BCM is a rare disease that arises from mesothelial cells lining the body's serous cavities. It predominantly affects women, with approximately 80% of cases occurring in women around 37 years of age [1,2]. Fewer than 200 cases have been reported in the literature [3]. BCM is especially rare in pediatric patients,

https://doi.org/10.13029/aps.2026.00073

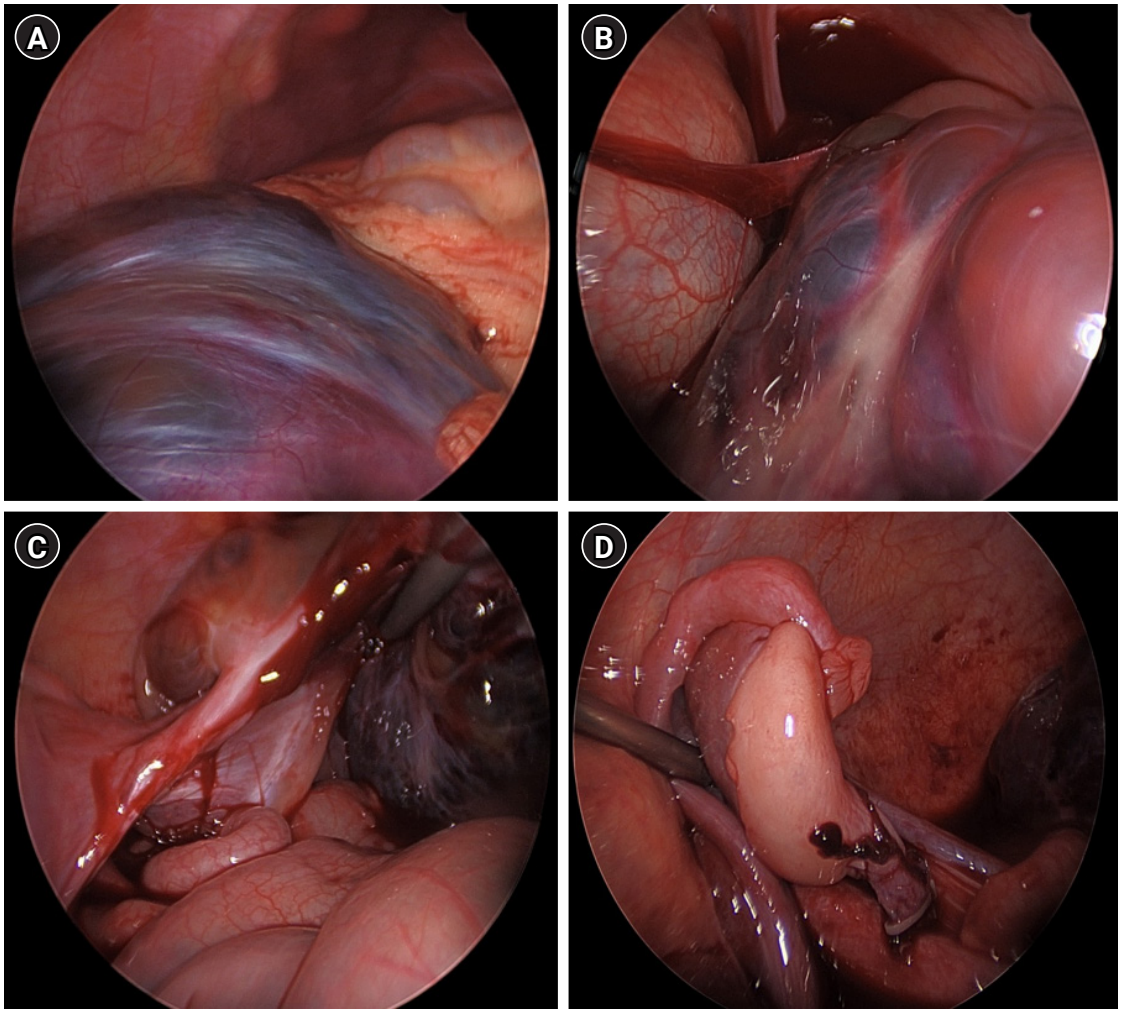

Fig. 2. Intraoperative laparoscopic findings. (A) Large multicystic mass containing hemorrhagic contents. (B) Hemorrhagic ascites. (C) Mass attached to the right ovary. (D) Complete excision of the mass with ovarian preservation.

with only a few cases reported [4]. Pediatric mesothelioma also appears to differ from adult mesothelioma, with fewer male patients, a predominance of peritoneal primary tumors, and less aggressive behavior, particularly in patients with peritoneal primary disease [5]. Most patients remain asymptomatic until the lesion becomes large enough to compress surrounding structures. Initial symptoms include vague abdominal discomfort, tenderness, a palpable mass, and abdominal distension. Because the tumor often involves the pelvic peritoneum, it may affect structures such as the rectum, bladder, or uterus, leading to symptoms such as such as urinary disturbances, bowel obstruction, or dyspareunia in adult patients. Ultrasonography usually reveals multiloculated, anechoic cystic structures. CT shows a low-attenuation, thin-walled, multicystic mass and is useful for defining the lesion's extent and location. Magnetic resonance imaging is considered the most informative imaging modality; cystic areas appear hyperintense on T2-weighted images, and contrast enhancement is often seen in the septa after gadolinium administration.

Diseases that should be considered in the differential diagnosis of BCM include cystic lymphatic malformation, peritoneal inclusion cyst, malignant mesothelioma, and peritoneal serous tumors. Cystic lymphatic malformation is common in children and is characterized by thin-walled, multilocular cystic masses, often arising in the mesentery. Pathologically, these lesions show cysts lined by endothelial cells, with positivity for D2-40 and CD31 and negativity for mesothelial markers. Imaging findings may be similar to those of BCM, but chylous fluid and endothelial lining can help distinguish cystic lymphatic malformation [6]. Peritoneal inclusion cysts typically occur in adolescent females with a history of prior abdominal surgery or inflammation [7]. Malignant lesions in the differential diag-

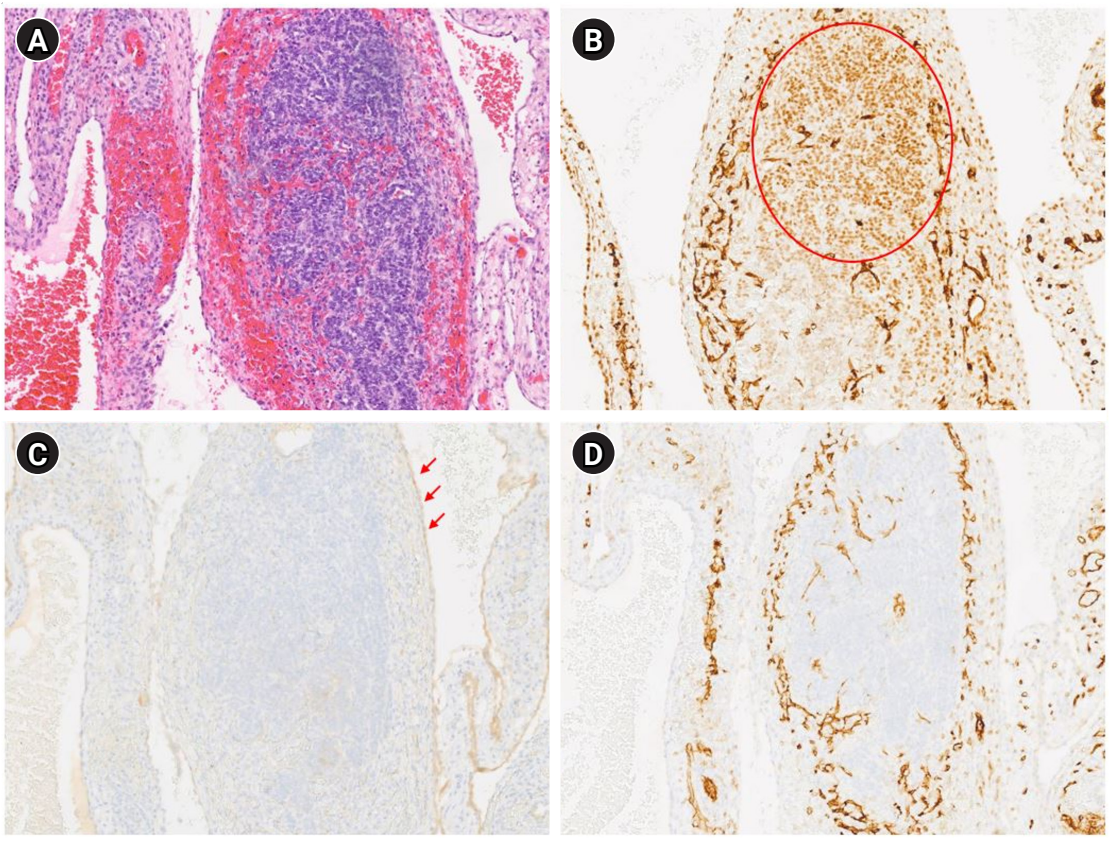

Fig. 3. Histopathological and immunohistochemical findings of the tumor. (A) H&E staining (×100) shows predominant clusters of epithelioid cells interspersed with cyst-like spaces. (B–D) Immunohistochemically (×100), the epithelioid cells show positive reactivity for WT1 (circle) (B), whereas calretinin shows focal weak positivity in the outer lining mesothelial cells (arrows) (C) but is negative in the mural nodules. (D) The cells are also negative for CD31; positive staining is observed only in the adjacent vascular endothelium.

nosis include malignant mesothelioma and peritoneal serous tumors. Malignant mesothelioma is rare in children and presents with diffuse peritoneal thickening, ascites, and a mass. Pathological findings include invasive growth, cytological atypia, and increased mitotic activity; immunohistochemistry may show loss of BRCA1-associated protein 1 or methylthioadenosine phosphorylase [8].

Histologically, BCM is composed of a monolayer of squamous or cuboidal epithelial cells. Diagnosis is supported by positive immunohistochemical staining for mesothelial markers, such as calretinin, WT1, cytokeratin 5/6, AE1/AE3, D2-40, human mesothelial cell 1, mesothelin, and thrombomodulin [9,10]. However, expression of these markers may vary depending on the morphological and proliferative state of the lesion. In the present case, immunohistochemistry demonstrated heterogeneous staining patterns. Although the mural nodules were negative for calretinin, the attenuated mesothelial cells lining the outer surface showed focal weak positivity. This finding suggested mesothelial origin despite the absence of diffuse calretinin expression. Previous studies have reported that the sensitivity of calretinin in mesothelial lesions is not absolute, ranging from approximately 90% to 95%, and may be reduced in certain histological contexts, including reactive or proliferative changes [11]. Therefore, despite the lack of diffuse calretinin expression, the lesion was considered to be of mesothelial origin and was diagnosed as BCM.

Although BCM is classified as benign, it has a high propensity for local recurrence, and malignant transformation has been suspected in rare cases [12,13]. Given this high recurrence rate, complete surgical resection remains the mainstay of treatment. Long-term surveillance is essential, even in pediatric patients, because of the potential for recurrence. For patients with recurrence, some authors have suggested cytoreductive surgery (CRS) combined with hyperthermic intraperitoneal chemotherapy (HIPEC) as a therapeutic option [5]. Malekzadeh et al. [14] reported various complications in pediatric patients with peritoneal mesothelioma who underwent CRS and HIPEC with cisplatin, including pancreatitis, acute tubular

https://doi.org/10.13029/aps.2026.00073

necrosis, hyperbilirubinemia, bilateral pleural effusions, pneumothorax, and two cases each of anemia and coagulopathy. Although data on CRS and HIPEC for benign mesothelioma remain limited, several studies have documented their use in patients with malignant mesothelioma, with recurrence rates ranging from 42% to 57% [5,14-17]. The efficacy of CRS and HIPEC in pediatric BCM appears to be limited. Given the high risk of recurrence associated with BCM, close postoperative surveillance is recommended.

This case demonstrates an unusual and potentially misleading presentation of benign multicystic peritoneal mesothelioma as an acute abdomen complicated by hemorrhage. Despite its generally indolent nature, this entity should be included in the differential diagnosis of pediatric intra-abdominal cystic masses. Because imaging alone is often insufficient for definitive diagnosis, a cautious and well-planned surgical approach is warranted, with histopathological examination serving as the diagnostic standard. Given the potential for recurrence, careful long-term follow-up is recommended.

ARTICLE INFORMATION

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Authors' contributions

Conceptualization: SHN. Data curation: JP, HYP, SHN. Formal analysis: JP. Methodology: JP. Visualization: HYP. Supervision: SHN. Writing–original draft: JP. Writing–review & editing: JP, SHN. All authors read and approved the final manuscript.

Conflict of interest

So-Hyun Nam is an editor-in-chief of this journal, but was not involved in the peer reviewer selection, evaluation, or decision process of this article. No other potential conflict of interest relevant to this article was reported.

Funding

None.

Data availability

Not applicable.

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https://doi.org/10.13029/aps.2026.00073

Instructions for authors

Advances in Pediatric Surgery

Enacted: December 2, 1994
Latest Revision: February 26, 2026

Advances in Pediatric Surgery (Adv Pediatr Surg, APS) is the official journal of the Korean Association of Pediatric Surgeons and an international, peer-reviewed journal published twice a year, on June 30th and December 31st. We aim to provide broad and in-depth development of pediatric surgery by publishing high quality research and case reports from around the world. The categories of manuscripts are original articles, case reports, reviews and letters to the editor.

Manuscripts should adhere to the Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals, issued by the International Committee of Medical Journal Editors (ICMJE; http://www.icmje.org/recommendations/), unless otherwise specified.

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The conflicts of interest declaration should be added as follows.

Conflicts of Interest: OOO has been an Editorial Board member of Advances in Pediatric Surgery since OOO but has no role in the decision to publish this article. No other potential conflicts of interest relevant to this article were reported.

MANUSCRIPT PREPARATION

All manuscripts must meet the following basic requirements to be eligible for review by the Journal. Any manuscript that does not conform to the following requirements will be considered inappropriate and may be returned.

1. General Text Style

Language: Manuscripts should be submitted in English. Authors should use the past tense to describe past events and data. Use the present tense for authors' opinion and generally accepted facts.

Format of manuscript: Manuscripts should be submitted in the file format of Microsoft Word 2010 or higher. Manuscripts should be typed on an A4-sized document, be double-spaced on 21.0×29.7 cm (A4) paper with 3.0-cm margins at the top, bottom, and left. Standard font size is 10-12 pt. The file format of figures should be .ppt, .jpg or .tif.

Equipment and drugs: For all equipment and non-generic drugs mentioned in the manuscript, the manufacturer's name should be provided in parentheses at the first mention. Following AMA style, the city and country of the manufacturer are not required. Generic names should be used for all drugs; if a proprietary (brand) name is necessary for the study, it should follow the generic name in parentheses.

Units: SI units should be used for measurements. The unit of temperature is degrees Celsius (°C).

Abbreviations: Use abbreviations sparingly and only when they ease the reader's understanding. Avoid using abbreviations in the title unless they are widely recognized (e.g., DNA, COVID-19). All abbreviations must be spelled out at their first mention in the abstract and again in the main text, followed by the abbreviation in parentheses. Thereafter, the abbreviation should be used consistently. Standard units of measure (e.g., kg, mL, hr) do not need to be defined.

Numbers: In the text, numbers equal to or less than nine should be written as text. Numbers larger than nine should be Arabic numerals, except when beginning a sentence.

Reporting of sex, gender, race, and ethnicity: Ensure correct use of the terms sex (reporting biological factors) and gender (reporting identity, psychosocial or cultural factors). Unless inappropriate, report the sex and/or gender of study participants. If the study was done involving an exclusive population, for example in only one sex, authors should justify why, except in obvious cases (e.g., prostate cancer). Authors should define how they determined race or ethnicity and justify their relevance.

Declaration of AI and AI-assisted technologies in the writing process: Authors are required to disclose whether AI-assisted technologies were used in the production of the submitted work at the time of manuscript submission. It must be clearly reported in a dedicated section of the Methods, or in the Acknowledgements section for article types lacking a Methods section. This disclosure should provide details about the specific tools used, including the model name, version, and manufacturer, along with an explanation of the capacity in which they were utilized. Authors should affirm that there is no plagiarism of text or images in materials produced by AI. It is not acceptable to cite AI-generated material as a primary source.

2. Reporting Guidelines for Specific Study Designs

For specific study designs, such as randomized controlled trials, diagnostic accuracy studies, meta-analyses, observational studies, and non-randomized studies, authors should follow the relevant reporting guidelines. Recommended sources include the EQUATOR Network (https://www.equator-network.org/) and the National Library of Medicine (https://www.nlm.nih.gov/services/research_report_guide.html). APS requires compliance with the reporting guidelines summarized in Table 1 for the listed article types.

3. Publication Types

APS publishes the following types of manuscripts: original articles, review articles, systematic reviews and meta-analyses, case reports, editorials, and correspondences. Manuscripts including fewer than six cases are categorized as case reports,

Table 1. Reporting guidelines for specific study designs

Initiative	Type of study	Source
CONSORT	Randomized controlled trials	https://www.equator-network.org/reporting-guidelines/consort/
TREND	Non-randomized controlled studies	https://www.cdc.gov/hivpartners/php/trend-statement/index.html
STROBE	Observational studies	https://www.equator-network.org/reporting-guidelines/strobe/
STARD	Diagnostic/prognostic studies	https://www.equator-network.org/reporting-guidelines/stard/
PRISMA	Systematic reviews and meta-analyses	https://www.equator-network.org/reporting-guidelines/prisma/
CARE	Case reports	https://www.equator-network.org/reporting-guidelines/care/

whereas those reporting six or more cases are considered original articles.

Original articles: These include original basic or clinical studies that are scientifically sound and provide significant new knowledge. The content should contribute to the diagnosis, treatment, and fundamental understanding of pediatric surgical diseases.

Review articles: These are usually invited by the Editorial Board and provide a comprehensive overview of a specific topic. Authors who wish to submit an unsolicited review article should contact the Editorial Board before submission.

Systematic reviews and meta-analyses: These should provide a comprehensive and structured overview of published material on a clearly defined subject. Authors must describe in detail how the evidence was identified, including the sources searched and the inclusion and exclusion criteria applied. Meta-analyses should quantitatively synthesize the results of two or more studies to address a specific research question or association. All submissions must adhere to the PRISMA guidelines (http://www.prisma-statement.org).

Case reports: These describe rare clinical cases or those that provide a significant new contribution to diagnosis and treatment.

Editorials: These are invited commentaries on articles recently published in the journal or perspectives on active research areas, fresh insights, and debates within the field of pediatric surgery.

Correspondences: This section welcomes readers' comments on articles published in the journal within the last 6 months or other topics of general interest to pediatric surgeons.

4. Original Articles

The manuscripts for original articles should be organized in the following order: title page, abstract, main text, references, tables, figure legends, and figures. Pages are numbered consecutively, beginning with the abstract as page 1. The total word count should not exceed 5,000 words.

Title page

Title page should include (1) the title of the article (less than 50 words); (2) full names of all authors (First name, Middle initial, LAST NAME in capitals) and institutional affiliation including the name of department(s) and institution(s) of each author; (3) name, full address (including the postal code) of the institutional affiliation, telephone number, and e-mail address of the corresponding author; (4) a running title of 50 characters or less including blank spaces; and (5) notes (disclaimers). Notes include conflict of interest, funding, data availability statement, and authors' contributions according to the CRediT taxonomy (https://credit.niso.org/), additional contributions, and ORCID of all authors. All contributors who do not meet the criteria for authorship should be listed in an additional contribution section.

Abstract

The abstract must be a structured summary consisting of the Purpose, which states the primary aim of the study; Methods, describing the study design, participants, and procedures; Results, presenting the key findings with relevant numerical data; and Conclusion, highlighting the main takeaways and any significant or unexpected observations. The word count should not exceed 300 words. Neither the authors' names nor their affiliations should appear on the Abstract page.

Keywords

These should be listed at the bottom of the abstract to be used as index terms, less than 5 words. Medical Subject Heading (MeSH; http://www.nlm.nih.gov/mesh) terms are highly recommended for selection of keywords.

Main text

The main text of the manuscripts should have pages for the

INTRODUCTION, METHODS, RESULTS, and DISCUSSION sections.

INTRODUCTION: Briefly describe the purpose(s) of the investigation, including relevant background information.
METHODS: Describe the research plan, materials or subjects, and methods used. Explain in detail how the disease was confirmed and how subjectivity in observations was controlled. When experimental methodology is the main issue of the paper, describe the process in detail so as to recreate the experiment as precisely as possible. When quoting specific materials, equipment, or proprietary drugs, the name of the manufacturer must be given in parentheses. Generic names should be used instead of commercial names.

Institutional Review Board (IRB) approval, when applicable, must be stated. Describe the study design (prospective or retrospective, inclusion and exclusion criteria, duration of the study) and the study population (demographics, length of follow-up). Explanations of the experimental methods should be concise, yet enable replication by a qualified investigator.
RESULTS: Results should be presented in logical sequence in the text, tables, and illustrations and repetitive presentation of the same data in different forms should be avoided. Any data mentioned in the Methods must be presented in the Results section.
DISCUSSION: Results should be interpreted for readers. Emphasize new and important observations. Do not merely repeat the contents of the Results. Explain the meaning of the observations with its limitations. The answer to the purpose of the research should be connected to the results.

References

APS reference follows the description below. Otherwise, it follows Citing Medicine: The NLM Style Guide for Authors, Editors, and Publishers (http://www.nlm.nih.gov/citingmedicine). The journal title should be abbreviated according to the NLM Catalog: Journals referenced in the NCBI Databases (http://www.ncbi.nlm.nih.gov/journals). The reference number should be cited in the main text in square brackets, e.g., [1]. All authors' names are listed when there are six or fewer authors. When there are more than six authors, only the first three authors' names are given, followed by 'et al.' Limit the number of references to 50 for original articles.

- Journal article

1. Yang HB, Cho MJ, Cho YJ, et al. Perception on the intestinal malrotation: a 2021 survey conducted by the Korean Association of Pediatric Surgeons. Adv Pediatr Surg 2025;31:59-65.
2. Molla YD, Alebel MT, Alemu HT. Neonatal surgical mortality in East Africa: a systematic review and meta-analysis. J Pediatr Surg 2026 Jan 23 [Epub]. https://doi.org/10.1016/j.jpedsurg.2026.162942

- Book

3. Tyler DS, editor. Sabiston textbook of surgery: the biological basis of modern surgical practice. 22nd ed. Elsevier; 2025.

- Chapter in a book

4. Neumayer L, Vargo D. Principles of preoperative and operative surgery. In: Townsend CM Jr, Beauchamp RD, Evers BM, Mattox KL, editors. Sabiston textbook of surgery: the biological basis of modern surgical practice. 19th ed. Elsevier Saunders; 2012. p. 211-39.

- Dissertation

5. Hong GD. The relationship between low serum cholesterol level and cancer mortality [dissertation]. Seoul National University; 2015.

- Conference paper

6. Rice AS, Brooks JW. Canabinoids and pain. In: Proceedings of the 10th World Congress on Pain; 2002 Aug 17-22; San Diego, CA. IASP Press; 2003. p. 437-46.

- Online sources

7. American Cancer Society. Cancer facts and statistics [Internet]. American Cancer Society; c2026 [cited 2026 Jan 20]. Available from: https://www.cancer.org/research/cancer-facts-statistics.html

- Preprint

8. Sharma N, Sharma P, Basu S, et al. The seroprevalence and trends of SARS-CoV-2 in Delhi, India: a repeated population-based seroepidemiological study [Preprint]. Posted 2020 Dec 14. medRxiv 2020.12.13.20248123. https://doi.org/10.1101/2020.12.13.20248123

Tables

- Tables should be numbered sequentially with Arabic numerals in the order in which they are mentioned in the text.
- Tables should be understandable and self-explanatory, without references to the text.
- If an abbreviation is used in a table, it should be defined in

a footnote below the table.

- Additional information for any clarification should be designated for citation using alphabetical superscripts a), b), c) or asterisks (*) for statistical significance. The explanation for superscript citation should follow these examples: a) Not tested. *P<0.05, **P<0.01, ***P<0.001.
- Statistical measures, such as the standard deviation (SD) or standard error of the mean (SE), should be identified.
- If a table has been previously published, it should be accompanied by the written consent of the copyright holder, and the footnote must acknowledge the original source.

Figures

- General requirements: Figures must be cited in the text and numbered consecutively using Arabic numerals in the order of their citation (e.g., Fig. 1, Fig. 2A). Figures should not be embedded within the text. Each figure must be submitted as an individual file. Figure legends should begin on the next page after the last table. Each figure must have its own legend. Abbreviations and any additional clarifications should be described within each figure legend. Footnotes below figures should follow the order of abbreviations first, followed by symbols. Symbols must be marked with lowercase alphabet letters (a), b), c), etc.) in the order of usage, or with asterisks (*) to indicate statistical significance.
- File formats and resolution: Figures must be submitted in EPS, TIFF, or PDF format, with minimum resolutions of 1,200 dpi for line drawings, 600 dpi for grey-scale works (e.g., gel or blot images), and 300 dpi for color or half-tone artwork.
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5. Review Articles

These are organized as follows: title page, unstructured abstract less than 300 words, main text, references, tables, figure legends, and figures. The main text consists of the INTRODUCTION, MAIN BODY, and CONCLUSION sections. The number of references should be limited to 80. Otherwise, it keeps the style and format of original articles.

6. Systematic Reviews and Meta-Analyses

Systematic reviews and meta-analyses should be organized in the following order: title page, structured abstract (Purpose, Methods, Results, and Conclusion; limited to 300 words), main text, references, tables, figure legends, and figures. Except for these specific requirements, they must follow the general style and format of original articles. All submissions in this category must comply with the PRISMA guidelines (http://www.prisma-statement.org).

7. Case Reports

These should be organized in the following order: title page, unstructured abstract less than 250 words, main text, references, tables, figure legends, and figures. The main text consists of the INTRODUCTION, CASE REPORT, and DISCUSSION sections. The total word count should not exceed 3,000 words. A maximum of 20 references and total 6 figures or tables are allowed. Otherwise, it follows the style and format of original articles. It should be described according to CARE statement (https://www.equator-network.org/reporting-guidelines/care/).

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Editorials are invited by the editors and should be commentaries on articles recently published in the journal. Editorial

Table 2. Recommended maximums for articles submitted to APS[a)]

Type of article	Abstract (word)	Text (word)[b)]	References	Tables & Figures
Original Article	Structured, 300	5,000	50	NL
Review	Unstructured, 300	NL	80	NL
Systematic Review	Structured, 300	NL	NL	NL
Case Report	Unstructured, 250	3,000	20	6
Editorial	-	1,000	10	4
Correspondence	-	1,000	5	4

APS, Advances in Pediatric Surgery; NL, not limited.
[a)]The requirements for the number of references, tables and figures and length of the main text can be consulted with the Editorial Office;
[b)]Excluding abstract, tables, figures, acknowledgments, and references.

topics could include active areas of research, fresh insights, and debates in the field of pediatric surgery. Editorials should not exceed 1,000 words, excluding references, tables, and figures. A maximum of 10 references and total 4 figures or tables are allowed.

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It is organized as follows: title page, main text, and references. The word count should not exceed 1,000. A maximum of 5 references and total 4 figures or tables are allowed.

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After the paper has been accepted for publication, the authors should submit the final version of the manuscript. The names and affiliations of the authors should be double-checked, and if the originally submitted image files were of poor resolution, higher-resolution image files should be submitted at this time. Symbols (e.g., circles, triangles, squares), letters (e.g., words, abbreviations), and numbers should be large enough to be legible on reduction to the journal's column widths. All symbols must be defined in the figure caption. If references, tables, or figures are moved, added, or deleted during the revision process, renumber them to reflect such changes so that all tables, references, and figures are cited in numeric order.

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The authors will receive the final version of the manuscript as a PDF file. Upon receipt, the authors must notify the editorial office (or printing office) of any errors found in the file within two days. Any errors found after this time are the responsibility of the authors and will have to be corrected as an erratum.

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Minor errors will be corrected directly in the online version of the article. An indication of the correction, along with the date it was made, will be added to the article information in both the HTML and PDF versions. A separate correction note will not be published.

History

Enacted on December 2, 1994
Revised on August 26, 1999
Revised on June 30, 2001
Revised on June 30, 2007
Revised on June 30, 2014
Revised on April 5, 2022
Revised on February 26, 2026

Author's checklist

Advances in Pediatric Surgery

This checklist is provided to shorten the length of period from the submission to the final decision of publication.
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