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CASE REPORT

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Retained crystal ball in pediatric gastrointestinal tract: a cautionary case report

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Abstract

Introduction Decorative crystal balls, also known as superabsorbent polymer gel beads, pose a significant hazard when ingested due to their ability to expand upon exposure to water. Diagnosing crystal ball ingestion remains challenging because of their transparency to radiation, making them difficult to visualize using X-ray imaging. Small crystal balls may not be detected in their early stages, only becoming visible once they fully swell and cause intestinal obstruction. This often results in some crystal balls remaining in the distal intestine after primary surgery aimed at removing the proximal crystals.

Case presentation A 2-year-old girl was referred to our hospital with persistent vomiting and fever. She was diagnosed with acute intestinal obstruction, and imaging revealed features of dynamic obstruction. Emergency laparotomy identified an obstruction in the mid-terminal ileum caused by a superabsorbent polymer gel bead (crystal ball). A jelly-like mass measuring 4x4.5 cm was removed and sent for histopathological examination. Intestinal anastomosis was performed during the initial surgery to restore bowel continuity. Postoperatively, complications arose, including infection in the abdominal cavity and breakdown of the anastomosed area. A previously missed gel bead, referred to as "crystal baby," which had not been identified during the initial surgery, caused severe leakage and infection. Given the high risk of further anastomotic complications, a double-lumen ileostomy was performed. The child's condition improved, and follow-up imaging one month after surgery revealed no further obstruction.

Conclusion This case highlights the diagnostic and surgical challenges associated with crystal balls (superabsorbent polymer gel beads) and emphasizes the need for careful management to prevent severe complications. It also underscores the risks of intestinal anastomosis in such cases and the necessity of alternative approaches, such as ileostomy, to ensure better outcomes.

Keywords Case report, Foreign bodies, Superabsorbent polymer gel beads, Crystal balls, Abdominal infection, Young children

Introduction

Foreign body ingestion is a common issue among children aged 2–3 years. Infants and young children often explore objects by placing them in their mouths as part of their developmental process [1] Decorative crystal balls, also known as superabsorbent polymer gel beads [2], are widely used for ornamentation in both residential and commercial environments. These small, water-absorbent beads expand upon contact water [3] (Fig. 1). Hydrogel beads, depending on the density of their cross-linked polymers, the pH level of the solution, the concentration of ions, and the purity of the surrounding water, can expand up to 30 to 60 times their volume [4–7]. Due to their small size or initial inability to absorb water, certain beads may migrate to the terminal ileum and remain undetected during primary surgery [6, 7]. Once hydrated,

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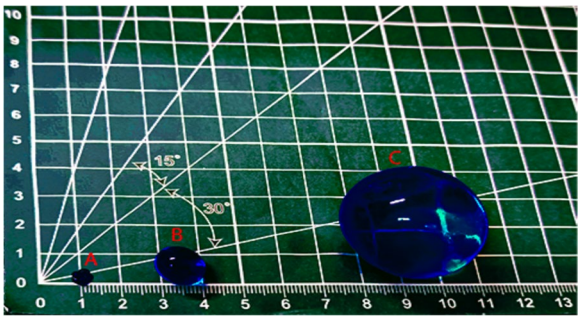

Fig. 1 Depicts the volumetric changes in a decorative crystalline sphere following an **A**: 5 min **B**: 1 h **C**: 1 day aqueous submersion period

these beads can rapidly expand, posing a risk of obstruction within the digestive tract [4, 6]. Given this potential, a thorough examination of the gastrointestinal tract is necessary to ensure that no undetected beads remain. Clinicians face a substantial challenge in identifying these small foreign bodies during primary exploration. If left undiscovered, these beads can lead to serious postoperative complications, including leakage, peritonitis, and abdominal infections. The difficulty in visualizing these objects on standard imaging further complicates diagnosis, making awareness of their potential risks critical in pediatric surgical cases. "*This manuscript was prepared following the CARE guidelines (*https://www.care-statement.org*)*".

Case

A 2-year-old girl was admitted with a 2-day history of persistent vomiting, occurring six to seven times daily, and a fever reaching 38.4 °C. Despite the administration of ibuprofen, her fever subsided, but vomiting persisted with bilious fluid being expelled. Given the suspicion of acute intestinal obstruction, further evaluation was performed. Laboratory investigations revealed an elevated C-reactive protein level of 15.81 mg/L, a white blood cell count of 7.87×10^9/L with 59.5% neutrophils, and a hemoglobin level of 116 g/L. Abdominal X-ray showed multiple air-fluid levels (Fig. 2A), and abdominal ultrasound demonstrated a well-defined mass in the terminal ileum (Fig. 2B). Surgical exploration was deemed necessary based on the clinical and imaging findings.

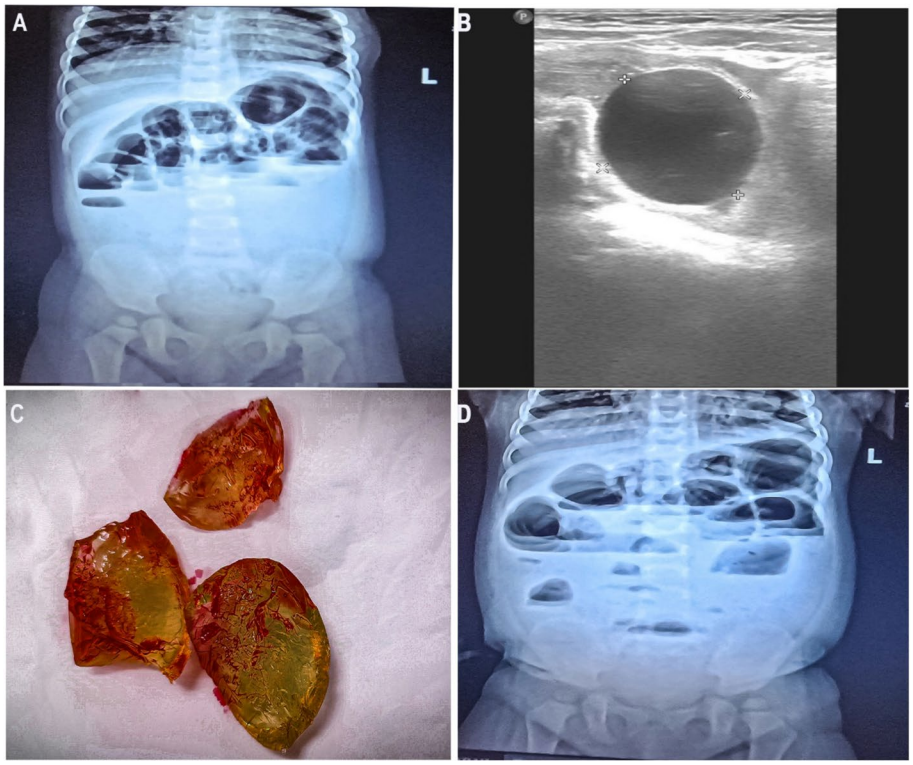

Fig. 2 **A** Abdominal radiograph (upright) revealing multiple air-fluid levels in the upper abdomen, with no air observed in the pelvic cavity and no foreign bodies identified. **B** Ultrasound image showing a well-defined mass in the terminal ileum. **C** A large, deep gelatinous mass measuring 4×4.5 cm was removed and sent for histopathological examination. **D** Abdominal X-ray (upright) on the third postoperative day still revealed obstruction with multiple air-fluid levels in the upper abdomen and no air in the pelvic cavity. No foreign bodies were detected

During exploratory laparotomy, a crystal ball was found obstructing the mid-section of the terminal ileum. A longitudinal ileotomy was performed, revealing a large, firm jelly-like mass measuring 4×4.5 cm within the intestinal lumen. The gelatinous mass was extracted in three pieces and sent for histopathological analysis, which revealed multiple gelatinous materials with numerous fungal hyphae, without any formed tissue (Fig. 2C). Intestinal anastomosis was performed at the ileotomy site using a single-layer 4/0 barbed suture to restore bowel continuity. Postoperatively, on day three, the child developed a high-grade fever of 39.4 °C and resumed vomiting bilious fluid. Laboratory results revealed a slightly raised white blood cell count of 8.27×10^9/L with 71.8% neutrophils, and a markedly elevated C-reactive protein level of 150.78 mg/L, Hemoglobin was 92 g/L. Abdominal ultrasound demonstrated signs of ongoing obstruction, and radiography confirmed the presence of dilated bowel loops (Fig. 2D). These findings raised concern for a potential postoperative complication, necessitating further evaluation and management.

On re-exploration, 150 mL of turbid fluid was found in the peritoneal cavity, and the peritoneal surfaces were covered with purulent exudate (Fig. 3A). Extensive intra-abdominal adhesions were noted, and the proximal small bowel was edematous and dilated. A disrupted anastomosis was found with signs of infection and fecal material leakage (Fig. 3B). A brittle crystal ball was identified within the distal transverse colon and was manually crushed without injury to the bowel wall (Fig. 3C). After decompression of the proximal bowel and confirmation of the small bowel and colon patency, the disrupted anastomosis was temporarily repaired using a double-layer 4–0 absorbable suture. The abdominal cavity was then irrigated with large amounts of warm saline and diluted iodine povidone to cleanse it, while pus and adhesions were carefully removed from the inter-loop areas. Given the severe infection and risk of anastomotic failure, a double-lumen ileostomy was performed. A 4-cm transverse incision was made in the right lower quadrant, and the dehiscence, located 20 cm from the ileocecal junction, was utilized to create the double lumen ileostomy. A drain was placed, and the patient was transferred to the Pediatric Intensive Care Unit for monitoring. One month after surgery, follow-up radiographs revealed no evidence of residual obstruction (Fig. 3D), and the child's recovery progressed as expected. Plans for ileostomy reversal were made, and the patient was discharged in stable condition.

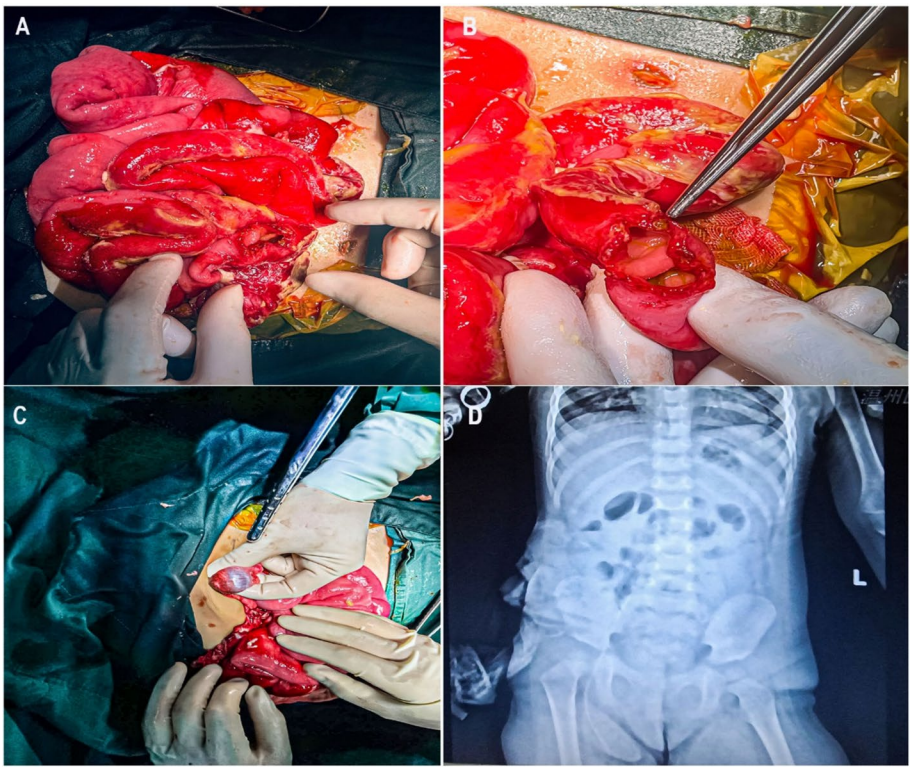

Fig. 3 **A** Severe intra-abdominal infection with purulent exudate covering the intestines. **B** A barbed suture previously used in the anastomosis is visible, with signs of leakage at the anastomosed region. **C** The brittle crystal ball was manually crushed without damaging the bowel wall. **D** One month after the second surgery, the erect X-ray revealed no evidence of obstruction

Discussion

In cases of non-severe foreign body obstruction in children, where the patient remains stable, close monitoring through regular evaluations is essential to determine whether the obstruction resolves spontaneously [8]. In such instances, conservative management is often sufficient, allowing the foreign body to pass through the gastrointestinal tract without intervention. However, if there is a concern that the foreign body may become further engorged, exacerbating the obstruction, endoscopic intervention should be considered, especially for objects that are readily accessible [8, 9]. Conversely, when the obstruction is classified as severe or when complications such as bowel perforation or pressure-induced ischemia arise, surgical intervention becomes necessary to remove the foreign body and address any resultant damage to the intestinal tract [10, 11].

Fortunately, most crystal gel balls pass through the gastrointestinal tract spontaneously, with over 80% excreted naturally [12]. Endoscopy is required in approximately 10–20% of cases for initial removal [13], while less than 1% necessitates surgical exploration due to complications such as obstruction or incomplete removal [5, 14, 15]. Although severe cases attract the most attention, they are rare, as the majority of ingested gel balls pass without harm.

While only 1% of cases necessitate intervention, such as surgical removal, it is important to note that the majority of these instances involve infants under 18 months old, who are at higher risk for complications. Table 1 illustrates that the mean age of reported cases is 11 months, emphasizing the elevated danger these gel balls present to younger children. In comparison, older pediatric patients typically experience natural passage of the ingested gel balls without significant complications [16]. This variation in risk likely stems from differences in intestinal dimensions and movement between age groups, with the smaller intestines of younger children potentially increasing the chances of obstruction or retention of the gel balls.

Owing to their diminutive size, gel beads present a unique challenge for clinical recognition. Early

Table 1 Summary of case studies showing laparotomy as the common intervention for gel ball removal

First Author	Age (months)	Duration(days)	Imaging	No. of FBs	Size(mm)	Location	Intervention	Suture	Outcome
Zamora et al.	8	0.625	CT	1	35	Distal Ileum	Laparotomy	N/M	Uneventful
Al-Saied et al.	9	7	US	2	33	Duodenum	Laparotomy	Double layer	Uneventful
Pham et al.	10	1	X-ray	6	35	Ileocecal	Laparotomy	N/M	Uneventful
Moon et al.	18	4	US	1	30	Jejunum	Laparoscopic	Single layer	Uneventful
Al-Saied et al.	12	30	US	1	35	Jejunum	Laparotomy	Double layer	Uneventful
Mirza et al.	6	25	CT	1	25	Proximal jejunum	Laparotomy	N/M	Death
Muthukumaran et al.	18	2	US	1	30	Jejunoileal	Laparotomy	N/M	Uneventful
Al-Saied et al.	7	7	X-ray	1	40	Terminal ileum	Laparotomy	Double layer	Uneventful
Nicodemus et al.	14	1	CT	2	28	Mid Ileum	Laparotomy	N/M	Uneventful
Mirza et al.	18	2	US	3	10	Mid Ileum	Laparotomy	N/M	Uneventful
Mercado et al.	11	3	CT	1	36	Jejunoileal	Laparotomy	N/M	Uneventful
Lee et al.	12	2	CT	2	35	Jejunum	Laparoscopic	N/M	Reoperated
Lip et al.	22	4	X-ray	1	25	Mid Ileum	Laparotomy	N/M	Reoperated
Singh et al.	9	30	US	1	40	Duodenum	Crushing	Not done	Uneventful
Komatsu et al.	15	3	US	1	35	Duodenum	Endoscopy	Not done	Uneventful
Mohamed et al.	6	0.7	X-ray	1	35	Distal ileum	Laparoscopic	N/M	Uneventful
Kim et al.	12	0.4	US	12	45	Stomach	Endoscopy	None done	Uneventful
Bradford et al.	10	3	CT	1	25	Distal ileum	Laparotomy	N/M	Uneventful
Wang et al.	1	4	US	1	30	Terminal ileum	Laparotomy	N/M	Uneventful
Wang et al.	12	4	US	1	28	Duodenum	Crushing	N/M	Uneventful[a]
Yang et al.	18	3	US	4	20	Proximal jejunum	Laparotomy	Double layer	Uneventful
Bollettini et al.	11	2	US	1	25	Proximal jejunum	Laparotomy	N/M	Uneventful
Khan et al.	12	8	US	1	30	ileocecal junction	Laparotomy	Double layer	Uneventful

[a] N/M Not mentioned indicates that the original report did not specify the suture layer or other details

identification is particularly difficult in young children aged 1–3 years, who are unable to articulate when ingestion occurs [17]. These beads often remain asymptomatic until they expand and cause obstruction, at which point parents seek medical attention. Consequently, most cases are presented only after the obstruction has already occurred, necessitating immediate surgical intervention to prevent further complications.

The absorption capacity of superabsorbent polymer gel beads (crystal balls) may be influenced by factors such as gastrointestinal pH and water purity [4, 6]. In instances of multiple gel beads, majority exhibit simultaneous swelling, albeit at varying rates. Nevertheless, in rare cases, some beads demonstrate initial resistance to water absorption and fail to swell [6, 18]. This initial resistance to absorption is a contributing factor to the delayed onset of symptoms following the ingestion of SAP beads.

The challenge in diagnosing crystal ball ingestions lies in their radiation-transparent properties, which make them difficult to detect via standard X-ray imaging, particularly in the early stages before full swelling occurs [4]. Obstruction is typically noted only when the crystal ball has enlarged sufficiently to cause dilated bowel loops, multiple air-fluid levels in the upper abdomen, and the absence of air in the pelvic cavity [19]. In most cases, ultrasound has proven to be an effective and safe diagnostic tool. This imaging modality can reveal the crystal ball as a circular, echo-free cyst with well-defined borders, providing a more accurate and rapid diagnosis [20, 21].

Most decorative crystal balls are successfully removed during the initial surgical intervention [9]. However, in rare instances, one or more crystal balls may migrate to the terminal ileum and remain undetected during primary surgery. This can occur because of the small size of the object or its inability to absorb water, which was initially obstructed in the upper intestine [6]. When the upper crystal ball is removed, the ball in the terminal ileum may absorb water, leading to subsequent obstruction of the lower bowel.

While laparoscopic surgery has been used in some gel ball cases [22], open surgery may be preferable in most instances involving crystal ball ingestion, particularly when there is suspicion of a retained object in the distal ileum. Open surgery allows for a thorough exploration of the entire bowel, ensuring that any remaining foreign bodies are identified and removed [5, 14]. The chart (Fig. 4) highlights the prevalence of laparotomy as the intervention of choice and shows the imaging modalities that are commonly used for assessment in these cases.

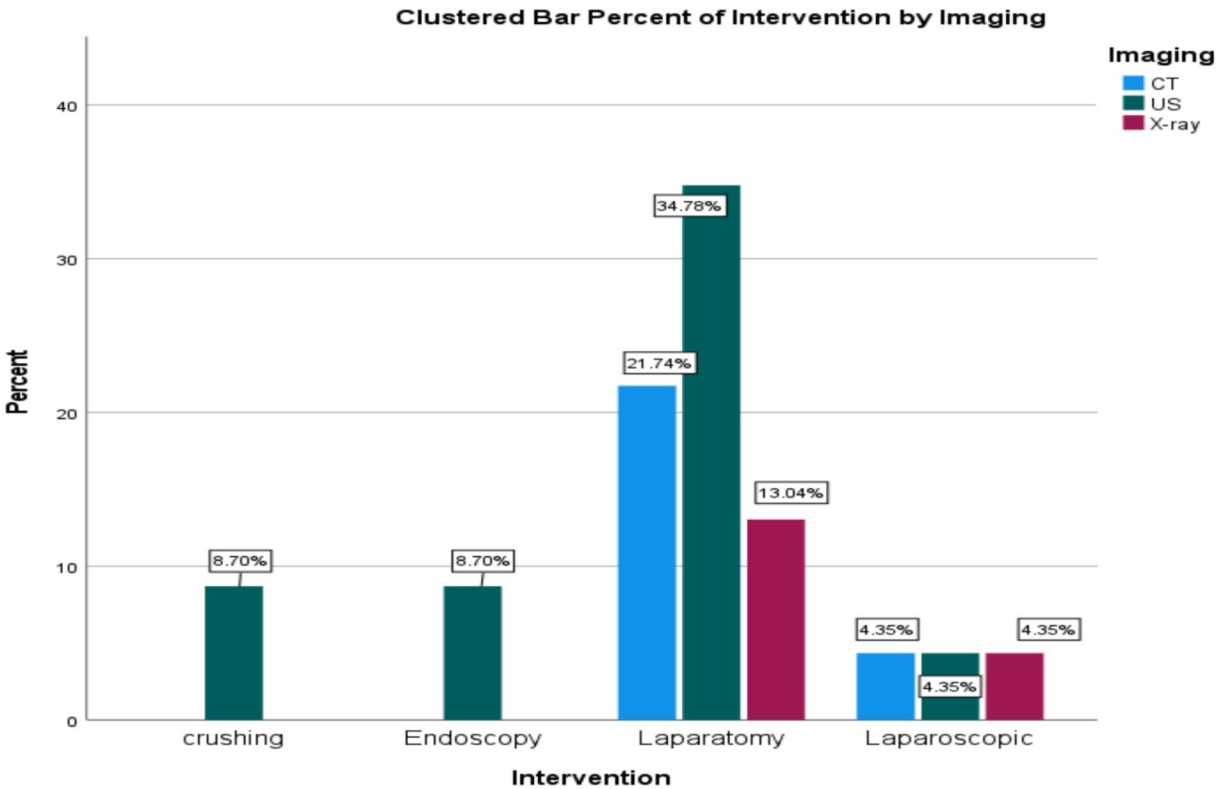

Fig. 4 Clustered bar chart showing percentages of imaging modalities used across different interventions for gel ball foreign body cases

In the present case, a previously undetected crystal ball in the distal ileum contributed to a complication at the site of the anastomosis. The second crystal ball led to the accumulation of fecal material and increased pressure at the anastomosis, ultimately resulting in the breakdown of the surgical connection. This highlights the importance of thoroughly investigating retained foreign bodies, particularly in cases where postoperative complications arise.

Although single-layer sutures are typically favored for their time efficiency and generally comparable efficacy in preventing anastomotic leaks [23], In many gel ball cases, double-layer sutures have been successfully utilized, often resulting in an uneventful postoperative course. the use of barbed single-layer sutures in this case may have contributed to the anastomotic leak, leading to peritonitis and severe intestinal infection. This outcome underscores the critical importance of suture material selection in complex surgical procedures, particularly when addressing foreign body-induced obstructions.

The occurrence of an anastomotic leak within 3 days, compounded by persistent obstruction due to the retained foreign body, highlights a technical failure in the surgical procedure. Identifying this complication is crucial for understanding potential risks and improving future surgical practices.

Conclusion

Complications associated with the ingestion of crystal balls (superabsorbent polymer gel beads) remain a significant challenge for clinicians. This case underscores the critical necessity of enhanced vigilance in the management of ingested foreign bodies, particularly those composed of gel beads, which may not exhibit immediate expansion or manifest visible symptoms. Intraoperatively, it is imperative to conduct a comprehensive examination of the entire gastrointestinal tract to detect unidentified beads. Techniques such as contrast-enhanced imaging, meticulous palpation of bowel loops, and visual inspection of both the small and large intestines are essential in ensuring the absence of overlooked foreign bodies. When foreign body ingestion is suspected, surgeons should consider implementing more extensive exploration, especially when dealing with beads that may not exhibit immediate swelling. This proactive approach can potentially mitigate complications such as obstruction, infection, or bowel perforation. Preventive measures, including fluoroscopy or intraoperative ultrasound, could significantly facilitate the identification of beads that might otherwise remain undetected, thereby enhancing the likelihood of favorable patient outcomes.

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Authors' contributions
F.M.: Conceptualized the study, collected data, and drafted the manuscript. Y.Y. and W.Q.Z.: Reviewed and revised the manuscript for important intellectual content and contributed to the preparation of the discussion. L.B.Z.: Corresponding author, supervised the study, provided critical analysis, and contributed significantly to the final manuscript revisions. All authors have read and approved the final manuscript.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
This case report complies with all ethical guidelines. Ethical approval was not required for this study as per institutional policies, but informed consent was obtained from the patient's guardians to share their anonymized medical information.

Consent for publication
Written informed consent for publication of this case report and any accompanying images was obtained from the patient's guardians.

Competing interests
The authors declare no competing interests.

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