



Endoscopic management of magnet ingestion and its adverse events in children

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Background and Aims: Magnet ingestion has recently increased among children. Multiple magnets can lead to serious adverse events owing to pressure necrosis of trapped bowel wall; therefore, urgent removal of the magnet is recommended. However, awareness of magnet ingestion and adverse events associated with it are lacking among the general population and some healthcare professionals. Herein, we demonstrate the adverse events associated with prolonged retention of ingested magnets and endoscopic management of ingested magnets in children.

Methods: We present a case series of 3 patients with magnet ingestion. Foreign body ingestion was confirmed on fluoroscopy. After fluoroscopy, all children underwent EGD under propofol sedation in a left lateral position. A Roth net was used to remove magnets.

Results: Three patients (median age 5 years), each with ingestion of 2 magnets of different shapes and sizes and with variable periods of ingestion, underwent EGD. In 2 patients, both magnets were Successfully removed. In 1 patient, 1 magnet could not be removed because it became dislodged deep in the jejunum. All 3 patients had developed magnet-related fistula (gastroduodenal: 1 patient; duodenojejunal: 2 patients). Patients with duodenojejunal fistula were managed conservatively. There was mild self-limited bleeding during magnet removal in 1 patient. There were no major adverse events related to endoscopic removal.

Conclusions: Endoscopic removal of magnets is feasible and safe in children. Few patients with fistulas can be managed conservatively. There is an unmet need to increase societal awareness of magnet ingestions and adverse events associated with it. (VideoGIE 2022;7:302-7.)

INTRODUCTION

Foreign body ingestion is common in children. Some foreign bodies, such as button batteries, sharp objects, and magnets, require urgent removal because of adverse events associated with prolonged retention.¹ Magnet ingestion in children has increased noticeably in the past 5 years as the use of magnets in toys has grown substantially.² Ingestion of multiple magnets can be hazardous and lead to adverse events such as perforation, fistula formation, intestinal obstruction, and bleeding owing to pressure necrosis of the bowel wall trapped between the magnets. General population and primary healthcare professionals are not well aware of these adverse events associated with magnet ingestion. Often, parents are told to wait for spontaneous passage of the magnets in the stool. The longer the time elapsed before seeking gastroenterologist consultation, the higher the chances are of developing adverse events. Guidelines recommend urgent removal of multiple-

magnet ingestions, even in asymptomatic patients, when amenable to endoscopic retrieval.^{1,3} In this case series, we present cases of magnet ingestion, adverse events with prolonged ingestion, and endoscopic management of ingested magnets.

METHODS

Three children with magnet ingestions confirmed by history and fluoroscopy were examined clinically for signs and symptoms of peritonitis before proceeding for EGD. After obtaining informed consent from parents, EGD (GIF 170, Olympus, Tokyo, Japan) was performed with the patient under sedation (propofol/ketamine) and in a left lateral position. A Roth net was used to remove magnets. Through-the-scope (TTS) clips (EZ clip, Olympus) were used to close the fistula. After the procedure, patients were observed in the recovery room for a few hours.

TABLE 1. Characteristics of patients with magnet ingestion

Case no.	Age (y)	Sex	No. of magnets	Shape of magnet	Size of magnet (width × length, mm)	Duration of ingestion (d)	Endoscopic characteristics			Peri-procedural adverse events	Clinical success	
							Location of magnets	Extraction of magnets	Adverse events related to magnets			
1	4	F	2	Round	20 × 20	30	1 in stomach 1 in duodenal bulb	Both removed	Gastroduodenal fistula	Endo-clip applied	No	Yes
2	7	M	2	Bullet shaped	20 × 35	90	1 in duodenum 1 in jejunum	1 removed 1 slipped deep into jejunum and could not be removed	Duodenojejunal fistula	Conservative	No	Yes
3	5	M	2	Round	15 × 15	2	1 in duodenal bulb 1 in jejunum	Both removed	Duodenojejunal fistula	Conservative	Minimal ooze at fistulous site	Yes

PPI, Proton pump inhibitor; TTS, through the scope.

RESULTS

Three patients, each with ingestion of 2 magnets of different shapes and sizes, underwent EGD (Table 1; Video 1, available online at www.giejournal.org).

Case 1

A 4-year-old girl presented with a 10-day history of mild abdominal pain. On x-ray of the abdomen, 2 round, radio-opaque objects were seen in the epigastric region (Fig. 1A). Her parents gave a history of magnet ingestion 30 days earlier. However, they waited for spontaneous passage of the magnets through the stool.

After confirmation of 2 radio-opaque objects on fluoroscopy, the patient underwent EGD under sedation. EGD showed 1 round magnet adhering to and penetrating through the gastric mucosa on the lesser curvature (Fig. 1B). The gastric magnet was grasped in the Roth net (30 × 60 mm, Steris Endoscopy, Mentor, Ohio, USA) and dislodged from the gastric mucosa via application of gentle traction and was retrieved from the body. After removal, a full-thickness defect was noted in the gastric mucosa at the magnet site (Fig. 1C). EGD then passed into the duodenal bulb, where another magnet was located (Fig. 1D). The second magnet had been dislodged from the adherent site because of the absence of magnetism after removal of the first magnet. The second magnet was removed with a Roth net, and a full-thickness defect was seen on the anterior wall of the duodenal bulb (Fig. 1E). Pressure necrosis from the magnets in the stomach and duodenal bulb caused full-thickness defects in both gastric and duodenal mucosa. Both defects were closed with TTS clips.

Postprocedure, the patient was stable. She was hospitalized for 1 day and given intravenous antibiotics, proton pump inhibitors (PPIs), and fluids. On day 2, she was started on a liquid diet followed by a pureed diet and discharged on oral antibiotics and PPIs. The patient was doing well, and repeat EGD after 1.5 years was normal (Fig. 2).

Case 2

A 7-year-old boy presented with a 2-week history of abdominal pain. On fluoroscopy, 2 bullet-shaped radio-opaque objects were seen in the umbilical region (Fig. 3A and B). On questioning, he gave history of magnet ingestion almost 3 months previously, which he did not reveal earlier out of fear.

He underwent EGD under sedation. The scope was pushed deep down into the duodenum (D3-D4), where a bullet-shaped magnet was seen adherent to the duodenal mucosa (Fig. 3C). The magnet was grasped into a Roth net (30 × 60 mm, Steris Endoscopy), dislodged from the mucosal site with gentle traction, and removed from the body. The EGD scope was passed again in search of a second magnet. There was large duodenojejunal fistula at the first magnet site (Fig. 3D). The EGD scope was advanced through the fistulous opening into the jejunum to locate the second magnet; however, even after deep insertion into the jejunum, the second magnet was not found because it was dislodged deep into the small bowel. Enteroscopic removal of the magnet was advised; however, the patient's parents did not give consent for this. Duodenojejunal fistula closure was not done because the defect appeared well apposed.

Postprocedure, the patient was stable and discharged on request. His parents were asked to inform about symptoms and passage of the magnet into the stool. After 36

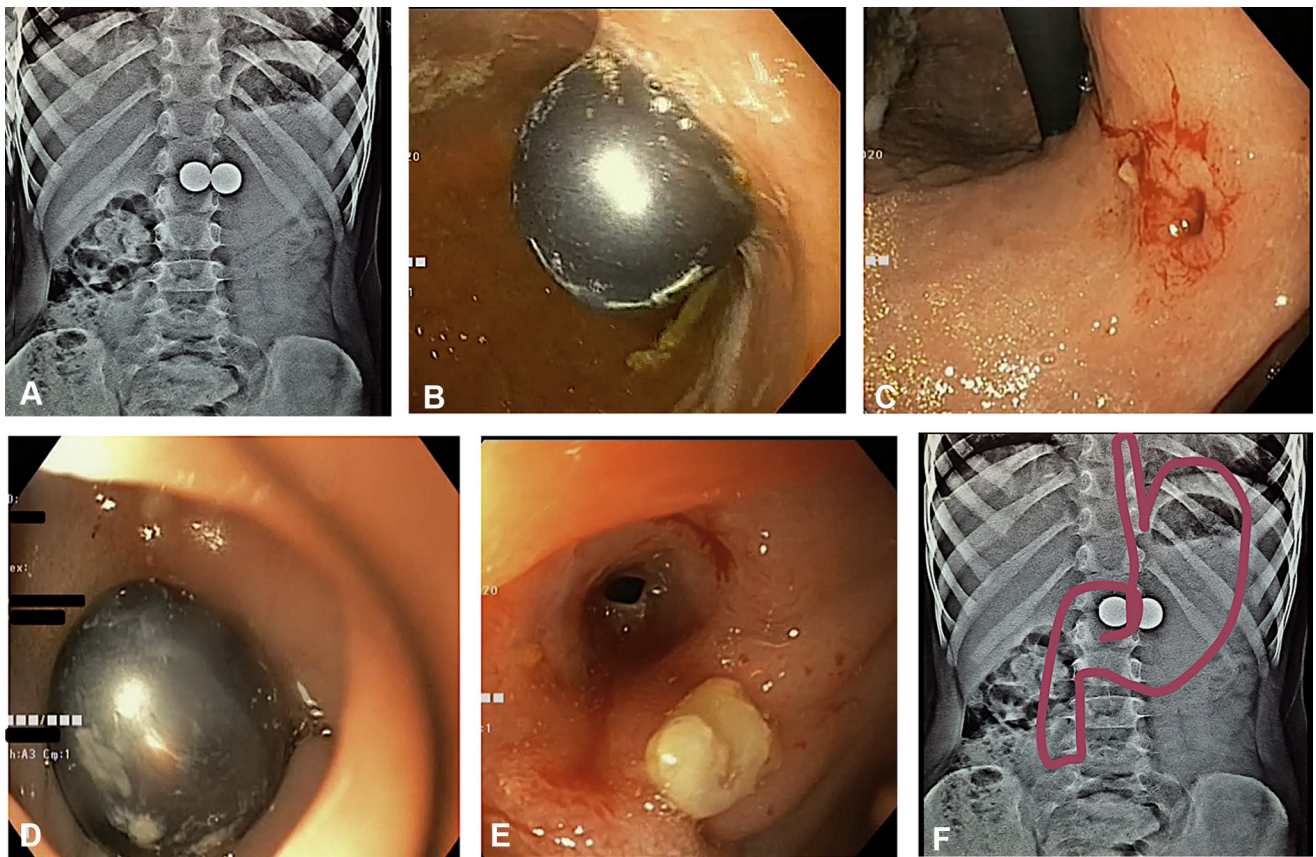


Figure 1. Case 1 with magnet ingestion. **A**, Two round, radio-opaque objects in the epigastric region on fluoroscopy. **B**, Endoscopy showed a magnet embedded in the stomach mucosa. **C**, Endoscopy showed a full-thickness defect in the gastric mucosa on the lesser curvature at the first magnet site. **D**, Endoscopy showed the second magnet in the duodenal bulb. **E**, Endoscopy showed a full-thickness defect in the duodenal mucosa in the duodenal bulb at the second magnet site. **F**, Schematic picturization of 2 magnets in the stomach and duodenal bulb on fluoroscopic image.

hours, the magnet was noticed in the stool. On follow-up over the telephone after 8 months, the patient's parents reported that he was doing well and had gained weight.

Case 3

A 5-year-old boy had ingested 2 magnets 2 days earlier and had reported abdominal pain for the past 24 hours. X-ray of the abdomen showed 2 round, radio-opaque magnets in the epigastric region. Because of a lack of infrastructure at his local center, he was referred to our center for endoscopic removal of the magnets.

He underwent EGD, which showed 1 magnet in the duodenal bulb adherent to the antero-superior wall of the bulb (Fig. 4A). The first magnet was grasped with a Roth net (30 mm, Shaili Endoscopy, Vadodara, Gujarat, India) and dislodged from the duodenal mucosa. During dislodgement, mild bleeding was seen. After removal of the first magnet, the EGD scope was passed again into the duodenum in search of the second magnet. The EGD scope was inserted deep into the third and fourth parts of the duodenum; however, the second magnet could not be located. On slow withdrawal, a fistulous opening was noticed in the superior wall of the duodenal

bulb at the site of the first magnet (Fig. 4B). The scope was then advanced through the fistulous opening, where the second magnet was seen in the jejunal loop (Fig. 4C). The magnet was then grasped into the Roth net and removed (Fig. 4D). Duodenojejunal fistula closure was not done.

The patient was hospitalized for 2 days. On the first day, he was kept nil per os and given intravenous antibiotics, fluids, and PPIs. On day 2, he was started on a liquid diet, and on day 3, he was discharged on oral antibiotics and PPIs. At 2 weeks of follow-up, the patient was asymptomatic.

DISCUSSION

Foreign body ingestion is a GI emergency requiring endoscopic intervention. It is more common in children and persons with mental illness. Many foreign bodies pass spontaneously into the stool; however, some foreign bodies require endoscopic or surgical intervention. Depending on the timing of endoscopic intervention, European Society of Gastrointestinal Endoscopy (ESGE) has

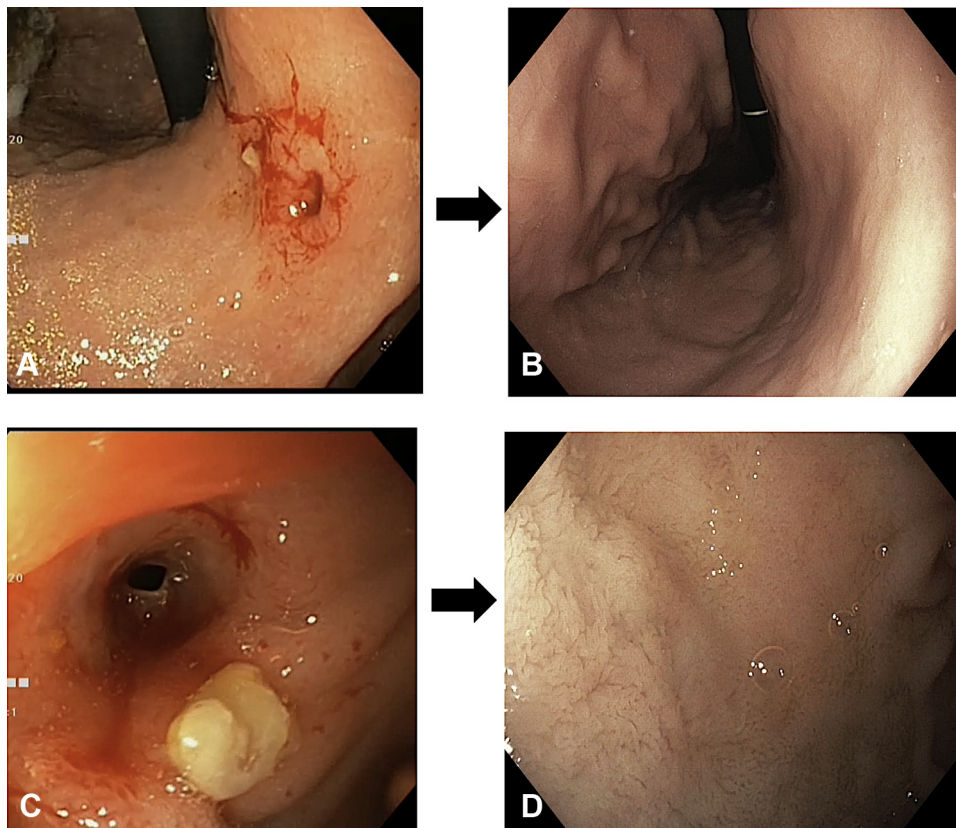


Figure 2. Follow-up endoscopy at 1.5 years in case 1 showed complete healing of fistula in the stomach (A and B) and duodenal bulb (C and D), respectively. **A**, Full-thickness defect in the gastric mucosa on the lesser curvature after gastric magnet removal. **B**, Complete healing of the gastric defect on follow-up EGD at 1.5 years. **C**, Full-thickness defect in the duodenal mucosa in the duodenal bulb at the second magnet site. **D**, Complete healing of the duodenal defect on follow-up EGD at 1.5 years.

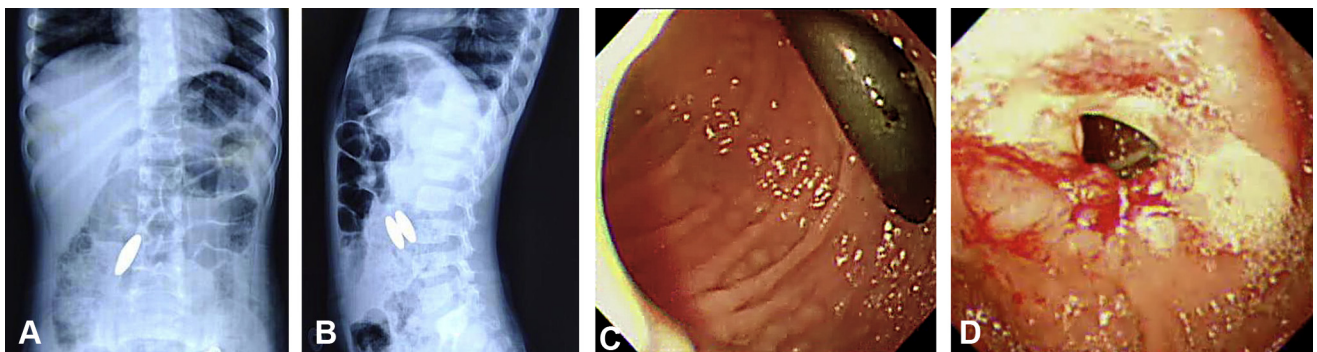


Figure 3. Case 2 with magnet ingestion. **A**, Fluoroscopic antero-posterior view showing overlapping bullet-shaped, radio-opaque objects in the umbilical region. **B**, Fluoroscopy, lateral view, showing 2 bullet-shaped radio-opaque objects in the umbilical region. **C**, Endoscopy showed a large bulged-shaped magnet adherent to the duodenal mucosa in the third part of the duodenum. **D**, Endoscopic view of the duodenojejunal fistula after removal of the first magnet.

classified foreign body ingestion as emergent, urgent, and non-urgent as per the nature of the foreign bodies and their location. Magnets are categorized as urgent and should be removed within 24 hours of ingestion to prevent adverse events associated with prolonged retention.¹

Magnet ingestion has been significantly increased over the past 1 to 2 decades.⁴ Currently, neodymium magnets

are used, which have stronger magnetic power (5- to 30-fold) compared to traditional iron magnets.⁵ One magnet is unlikely to cause symptoms; however, 2 or more are likely to cause adverse events by attracting to each other across the different segments of the GI wall. Multiple magnet ingestion can lead to life-threatening adverse events such as perforation, intestinal obstruction, volvulus,

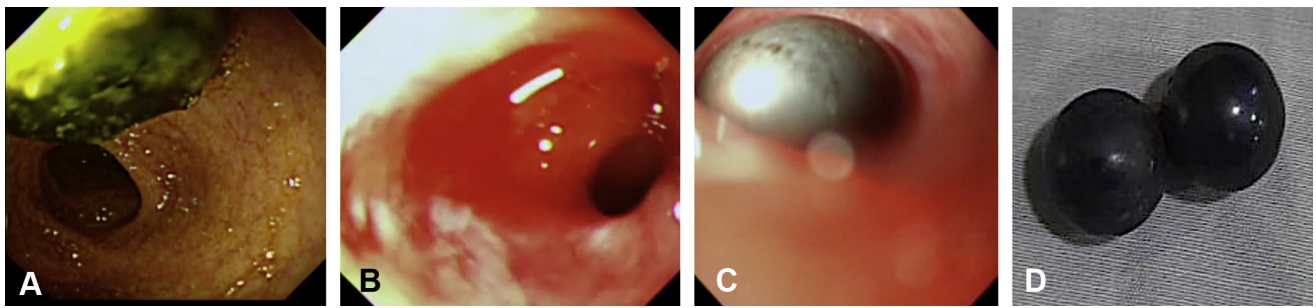


Figure 4. Case 3 with magnet ingestion. **A**, Endoscopy showed magnet adherent to the superior wall of the duodenal bulb. **B**, Endoscopic view of the duodenojejunal fistula after first magnet removal. **C**, Endoscopic view of the second magnet through the duodenojejunal fistula. **D**, Both magnets removed from the body.

fistula, bleeding, and death. Simultaneous ingestion of 2 magnets is considered relatively safe compared to ingestion at different time intervals.⁶ However, that was not the case in this case series: All 3 patients had ingested both magnets simultaneously, and all 3 developed fistulas. Fluoroscopy should be interpreted carefully even when only 1 magnet is visualized; 2 views (anteroposterior and lateral view) should be obtained when necessary (Fig. 3A and B).³ Moreover, 2 magnets appearing close to each other on fluoroscopy does not necessarily mean they are in 1 loop; they may be lying in 2 separate segments of bowel and penetrating intervening bowel walls. Whether magnet ingestion is simultaneous or at different time periods, urgent removal is advocated for multiple magnets.⁷

Guidelines recommend urgent removal of multiple magnets when the location is amenable to endoscopic retrieval by either EGD or colonoscopy.³ Balloon (single or double) enteroscopy can be attempted if available in selective cases. Endoscopic removal is minimally invasive and safe compared to surgery but may not always be feasible. Endoscopic retrieval of magnets (EGD, colonoscopy) is successful in 66% to 89% of cases.^{6,8} Success of endoscopic retrieval is dependent on the location of magnets, time lapsed from ingestion, and available expertise. Deeply embedded magnets are difficult to retrieve.⁹ Attempts can be made to detach the magnet from the embedded mucosa by applying gentle traction with a retrieval device in an upward/downward direction after grasping the magnet (Case 1). Endoscopic accessories used for removal are Roth nets, snares, retrieval baskets, and multiprong and alligator forceps (for disc-like magnets). Manipulation of metallic foreign-body forceps is difficult in the vicinity of magnets, so first open the forceps from a minimal distance and then move it toward the magnet. Mild mucosal erosions and bleeding can be observed during removal (Case 3). There are no major adverse events reported with endoscopic removal. Surgery is indicated for symptomatic patients with adverse events, inaccessible location of magnet for endoscopic removal, and nonprogression of the magnets on serial radiography (every 8-12 hours).³ Surgery may be

required in 11% to 50% after failed endoscopic removal.^{8,10} All 3 patients underwent endoscopic removal, and magnets were successively removed in 2 patients; however, 1 patient with failed retrieval of distal magnet was managed conservatively.

Magnet-related entero-enteric fistulas usually remain in a tight and well-apposed state and therefore do not allow leakage of bowel contents or even air into the peritoneum. Cai et al¹¹ reported no pneumoperitoneum in 35 children with multiple-magnet ingestion and GI perforation. Magnetic compression anastomosis is based on a similar principle for making an iatrogenic anastomosis between 2 bowel loops with the help of magnets. Nevertheless, anastomoses made by magnets are usually a side-to-side bypass and can be a risk factor for blind loop syndrome; large fistulas are at high risk of intestinal ischemic necrosis caused by adhesions or internal fistula compression.¹¹ All 3 patients in this case series had GI fistulas without any signs of peritonitis or pneumoperitoneum. Only gastroduodenal fistula closure was done because it did not look to be in a tight, well-apposed state like other fistulas. TTS clips were used because the fistula opening was small. Use of over-the-scope clips in children has increased substantially for various GI indications; however, the choice to use it largely depends on provider expertise, the size and site of the fistula, and the age and weight of the child.¹²

Long-term follow-up was available for 2 children. In case 1, the gastroduodenal fistula was completely healed on follow-up EGD at 1.5 years. Case 2, with a conservatively managed fistula, is doing well at 8 months. There is limited literature available on the long-term consequences of asymptomatic fistulas and endoscopic management. Asymptomatic small- to medium-sized duodenojejunal fistulas in a closed and tight state can be managed conservatively. Further studies with larger sample sizes are required to see the course of magnet-related entero-entric fistula.

Awareness of ingestion of blunt objects such as magnets and button batteries and the related adverse events is low in the general population. Often magnet ingestion goes unnoticed in children, and later these patients often present with GI symptoms. Healthcare professionals involved in

child health care should be cautious when evaluating children with GI problems with an unclear history of ingestion. In this series, 1 child's parents waited for spontaneous passage of magnets, and in another patient, ingestion went unnoticed for 3 months because it was not witnessed. Parents, caregivers, healthcare professionals, and even children should be educated about the potential dangers and serious injuries resulting from magnet ingestion through nationwide public awareness campaigns.^{10,13}

Endoscopic intervention is safe in children, and urgent removal should be attempted. Some entero-enteric fistulas in a well-apposed state can be managed conservatively. There is a high need to increase awareness of magnet ingestion and its adverse events.

DISCLOSURE

All authors disclosed no financial relationships.

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<https://doi.org/10.1016/j.vgie.2022.03.008>

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