

US Features of Transient Small Bowel Intussusception in Pediatric Patients

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Objective: To describe the sonographic (US) and clinical features of spontaneously reduced small bowel intussusception, and to discuss the management options for small bowel intussusception based on US findings with clinical correlation.

Materials and Methods: During a five years of period, 34 small bowel intussusceptions were diagnosed on US in 32 infants and children. The clinical presentations and imaging findings of the patients were reviewed.

Results: The clinical presentations included abdominal pain or irritability ($n = 25$), vomiting ($n = 5$), diarrhea ($n = 3$), bloody stool ($n = 1$), and abdominal distension ($n = 1$), in combination or alone. US showed multi-layered round masses of small (mean, 1.5 ± 0.3 cm) diameters and with thin (mean, 3.5 ± 1 mm) outer rims along the course of the small bowel. The mean length was 1.8 ± 0.5 cm and peristalsis was seen on the video records. There were no visible lead points. The vascular flow signal appeared on color Doppler images in all 21 patients examined. Spontaneous reduction was confirmed by combinations of US ($n = 28$), small bowel series ($n = 6$), CT scan ($n = 3$), and surgical exploration ($n = 2$). All patients discharged with improved condition.

Conclusion: Typical US findings of the transient small bowel intussusception included 1) small size without wall swelling, 2) short segment, 3) preserved wall motion, and 4) absence of the lead point. Conservative management with US monitoring rather than an immediate operation is recommended for those patient with typical transient small bowel intussusceptions. Atypical US findings or clinical deterioration of the patient with persistent intussusception warrant surgical exploration.

Intussusception is one of the most common causes of acute abdominal distress in the early childhood, and the ileocolic type accounts for most of the cases of bowel invagination (1). Small bowel intussusception (SBI) is much less frequently diagnosed, and it is usually associated with a lead point (2 - 4) or it occurs postoperatively (5). Because an unreduced intussusception can potentially cause bowel obstruction and mesenteric vascular compromise leading to bowel ischemia/necrosis, early diagnosis and treatment of this malady are very important. Although US is highly accurate for the diagnosis of intussusception with a reported sensitivity of 98% - 100% for the ileocolic type (1, 6), diagnosis of SBI is more difficult with a reported US detection rate of 76.4% (7, 8). Because hydrostatic or pneumatic reduction is not effective in most of the cases, these patients are usually managed by surgical means.

In the recent literature (9 - 11), however, careful US examination and/or careful interpretation of the CT scan have disclosed many SBIs that were reduced sponta-

neously without any intervention. Conservative observation was warranted in those patients and Doi et al. (11) suggested the term of 'benign SBI' for those idiopathic transient SBIs. With the wider use of US with its improved resolution and the better appreciation of the appearance of SBI, more and more cases are being diagnosed. Many of these cases may be transiently invaginated benign SBIs that do not need immediate surgical intervention. However, delayed surgical treatment could lead to a severe morbidity in some patients, and transient SBI has to be distinguished from the more severe forms requiring prompt surgical treatment. Because the symptomology is often nonspecific for most patients with SBIs, differentiation between the surgically managed SBIs and naturally reduced SBIs, based on a clinical presentation, is not always an easy task.

The purpose of this study was to describe the detailed sonographical and clinical features of the patients with spontaneously reduced idiopathic SBIs and to compare these features with previously described surgically managed SBIs in the literature (7, 8) and therefore, to establish treatment guideline for patients with sonographically detected SBIs.

MATERIALS AND METHODS

During the past 5 year period, a total of 34 SBIs were detected in 32 infants and children with the use of US. One of these patients had two SBIs that occurred at the same time, and another SBI appeared on the US study performed 7 days after the disappearance of the first SBI in one patient. There were 18 boys and 14 girls with an age range from three months to 12 years (mean age: 4 years). US examination was performed by a pediatric radiologist using different scanners including HDI 3500/5000 (Advanced Technology Laboratories, Bothell, WA, USA) and Sequoia (Acuson, Mountain View, CA, USA). After screening the solid abdominal organs using a convex transducer, 8 - 15 or 5 - 12 MHz linear transducers were then used for the detailed evaluation of the bowel and mesentery. Video recording was done for 14 patients. Color-coded Doppler examination was performed for 21 patients. Color Doppler imaging (CDI) was optimized for a low flow rate with the gain set at the highest possible overall level, while the noise was kept to a minimum.

The medical records were analyzed in terms of the initial presentation, other clinical problems, the operative findings and the clinical course after admission. On the US images, the shape and location of the intussusceptions were assessed. Next, the diameter of the lesions, thickness of the outer-rim and the length of the invaginated bowel were

measured on transverse and longitudinal images by using the electronic callipers of the US equipment or the picture archiving and communications system, or by using manual calipers to measure sizes on the hard copy images referring to the scales provided adjacent to the same images. In addition, any trapped fluid retention between telescoped bowel wall, the vascular flow signal on CDI, and the peristaltic motion of the invaginated bowel were reviewed on the US images, including the video records. The presence of adjacent mesenteric lymph nodes, bowel dilatation or thickening, any visible lead point and free fluid collection were also checked on the US images. Plain abdominal radiographs obtained within a day of the US were also reviewed for any bowel distension. Other radiological images including small bowel series and CT scans were also reviewed.

Although surgically managed SBI was not included in this study, there are two recent articles from the same institution (7, 8) concerning the detailed clinical and US features of surgically managed SBI. Because the cases seemed to overlap in these two papers, the clinical and US findings of this study were compared with the data that appeared in the latest article of the larger series (7).

RESULTS

Twenty-nine of the 32 (91%) patients had acute onsets of gastrointestinal symptoms including abdominal pain or irritable crying (n = 25), vomiting (n = 5), diarrhea (n = 3), bloody stool (n = 1), and abdominal distension (n = 1); these symptoms presented in combination or alone. Among the symptoms, five patients presented a cyclic nature of the abdominal pain or irritability. Abdominal distension and irritability were noted four days after surgical reduction of the ileocolic intussusception in a baby. The remaining three patients underwent US examination because of the scrotal mass, fever, and facial edema. The clinically important medical histories included recent ileocolic intussusception that was reduced by either air enema (n = 2) or surgical manipulation (n = 1), Henoch-Schonlein purpura (HSP, n = 2), nephrotic syndrome (n = 2), and post-chemotherapy state of lymphoma (n = 1). The final diagnosis that was noted in the discharge summary was acute viral gastroenteritis and/or mesenteric lymphadenopathy in 20 patients with gastrointestinal symptoms.

On US, SBI appeared as a crescent-in-doughnut (Fig. 1) or a multi-layered round mass (Figs. 2, 3B) on a transverse scan and the short segmental sandwich sign (mean 1.8 ± 0.5 cm, range 1.1 - 2.8 cm) was seen on a longitudinal scan (Fig. 1). The location of the SBI was the right abdomen in

21 patients, left abdomen in 10, and the paraumbilical region in one, along the course of the small bowel. The outer diameter ranged between 1 - 2.5 cm (mean: 1.5 ± 0.3 cm, range: 1 - 2.5 cm) and the thickness of the outer rim ranged from 2 and 5 mm with a mean thickness of 3.5mm. Real time evaluation on the video records showed peristalsis of the invaginated bowel wall in all of the 14 patients that were recorded. The blood flow signal appeared on color Doppler images for all the 21 patients we examined. One patient exhibited fluid retention between the intussusceptum and the intussusceptum (Fig. 4) without wall thickening. In this patient, the intussuscepted bowel exhibited active wall motion that was reduced during the US evaluation. While a specific leading cause was not found, mesenteric lymph nodes ($n = 29$) and swollen adjacent bowel wall ($n = 2$) were seen. Free fluid collection was not noted in any patient.

Radiographs revealed the ileus pattern of gas distribution in three patients including a patient who underwent surgical reduction of the ileocolic intussusception (Fig. 3). In 13 patients, the SBI was reduced before the completion of the initial US examination. A repeated US was performed within a day of the initial US examination for 15 patients with unreduced SBI and none of them exhibited persistent SBI. The subsequent small bowel series did not demonstrate any SBI in six patients including three patients who had negative follow-up US examinations. Three patients underwent CT scan and intussusception was not seen in any of these patients. In two patients, surgical exploration was performed because of the progressive abdominal pain and distension. However, the intussus-

ception was not seen on the operative field. In the remaining patients, the gastrointestinal symptoms disappeared or improved with conservative management, and all the patients were discharged with improved state of health. In a patient with idiopathic postoperative SBI, the follow-up radiograph demonstrated improved bowel distension that corresponded to non-visualized SBI on repeated US

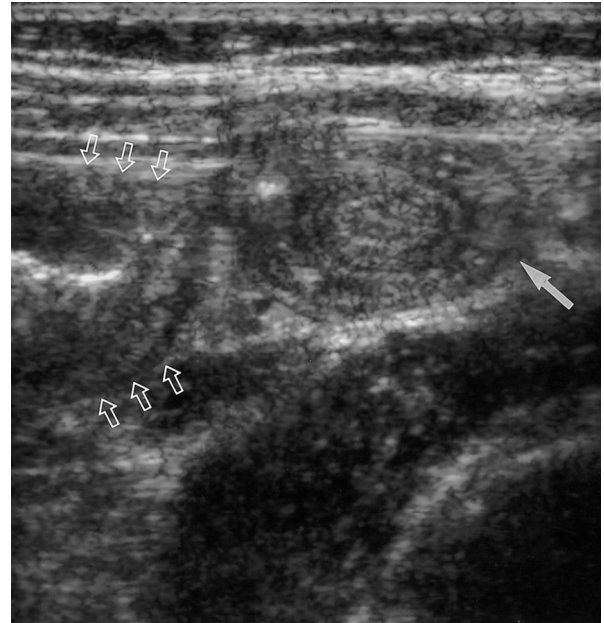


Fig. 2. Small bowel intussusception associated with ileocolic intussusception in a 3-year-old girl. Immediate post-enema US reveals a multi-layered mass (solid arrow) suggesting small bowel intussusception, adjacent to the swollen reduced terminal ileum (open arrows). The small bowel intussusception spontaneously reduced during US examination and her abdominal pain subsided.

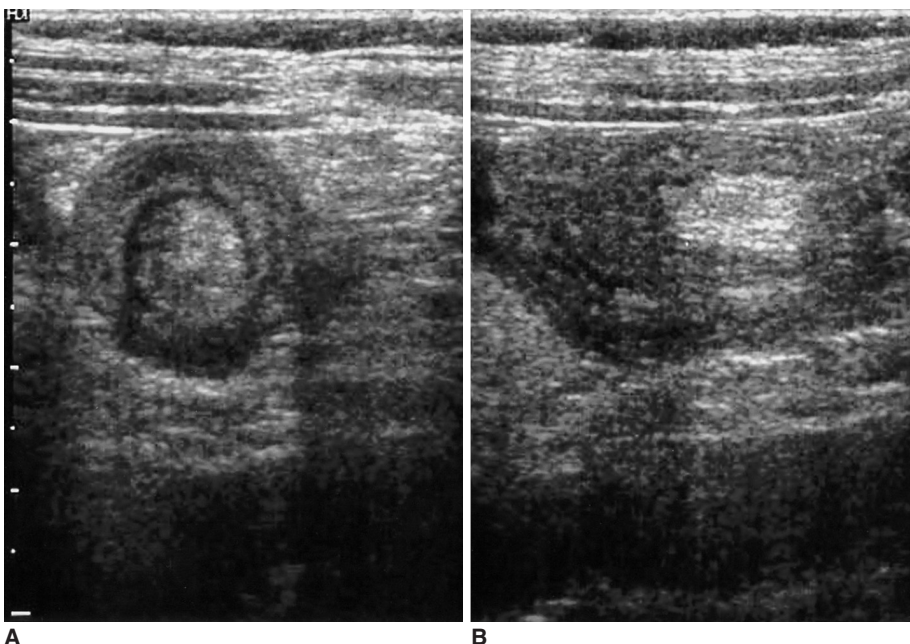


Fig. 1. Typical benign small bowel intussusception in a 9-year-old boy with abdominal pain after chemotherapy for mediastinal lymphoma. Transverse (A) and longitudinal (B) US scans show crescent-in-doughnut (A) and sandwich sign (B). The diameter of the doughnut is 1.9 cm and the length of the lesion is 2.5 cm.

examinations, and the patient had a good clinical recovery (Fig. 3).

Table 1 summarizes the difference between benign SBI in this study and the surgically managed SBI in the literature (7).

DISCUSSION

In general, the SBI occurs in older children (mean age, 4 years) rather than large bowel intussusception (the children are usually less than 2 years of age), and it is more frequently found in the left abdomen. The characteristic

presentation suggesting intussusception such as cyclic abdominal pain, palpable mass, and jelly stool is usually absent (7, 8); therefore, diagnosis based on clinical examination is problematic unless imaging studies are performed. Although nonspecific gastrointestinal symptoms were common in this study, in many cases the causal relationship between the symptoms and SBI was uncertain. Many of the patients had other problems too such as acute viral gastroenteritis, mesenteric lymphadenopathy, large bowel intussusception, HSP, and a post-laparotomy status; all of these factors potentially cause abdominal symptoms. SBI may also occur inciden-

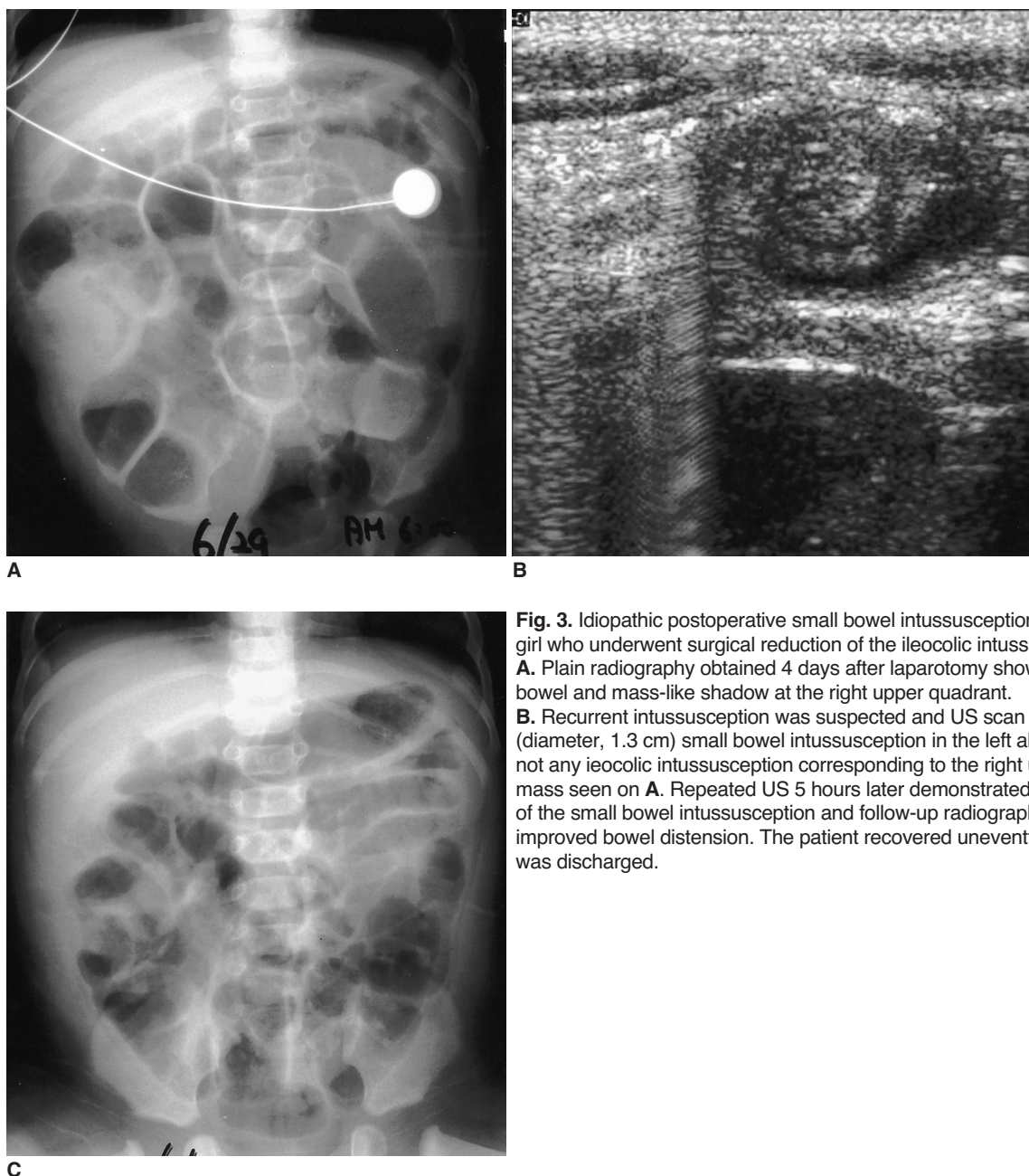


Fig. 3. Idiopathic postoperative small bowel intussusception in a 3 month-old-girl who underwent surgical reduction of the ileocolic intussusception. **A.** Plain radiography obtained 4 days after laparotomy shows the distended bowel and mass-like shadow at the right upper quadrant. **B.** Recurrent intussusception was suspected and US scan revealed a small (diameter, 1.3 cm) small bowel intussusception in the left abdomen. There was not any ieocolic intussusception corresponding to the right upper abdominal mass seen on **A**. Repeated US 5 hours later demonstrated the disappearance of the small bowel intussusception and follow-up radiography (**C**) shows improved bowel distension. The patient recovered uneventfully thereafter and was discharged.

Table 1. Transient Small Bowel Intussusception and Surgically Managed Small Bowel Intussusception

	Transient SBI (n = 32)	Surgically Managed SBI* (n = 19)
Clinical features		
Male; female	18;14	10;9
Mean age (range)	4 years (3 months-12 years)	4 years7months (4 months-15 years)
Presentation	Gastrointestinal symptoms (91%)	Gastrointestinal symptoms (> 89.5%)
Pain/irritability	27 (90%)	17 (89.5%)
Bloody stool	1 (0.03%)	5 (26.3%)
Mass	0 (0%)	3 (15.8%)
Management	Conservative treatment except two	Surgical treatment
Bowel ischemia/necrosis	0 (0%)	8 (42.1%)
Outcome	Spontaneously reduced	Clinical deterioration until surgery
US features		
Location (Right;Left;Middle)	21;10;1	9;3;7
Transverse diameter	1.5 ± 0.3 (1 - 2.5) cm	2.9 (2 - 4.3) cm
Thickness of outer rim	3.3 ± 1 (2 - 5) mm	7.2 (4 - 12) mm
Length	1.76 ± 0.49 (1.1 - 2.8) cm	Short except two (> 10 cm)
Lead point	0 (0%)	8 (44.4%)
Peristaltic wall motion	Present	No comment
Flow signal on CDI	21 (100%)	2 (100%)
Ascites	0 (0%)	11 (58%)
Fluid retention	1 (3%)	5 (38%)*
Bowel distention [†]	3 (1%)	14 (73.7%)

Note. * Data appeared in the reference 9, ** Data from the reference 10, [†]Noted on a plain radiography, SBI = small bowel intussusception



Fig. 4. Fluid retention between the walls of invaginated bowel in a 2-year-old boy who presented with intermittent irritable crying. Longitudinal US scan shows the short-segmental small bowel intussusception with entrapped fluid (arrows) between the intussusceptient and intussusceptum. Repeated US 1 hour later did not demonstrate the small bowel intussusception any more and the patient discharged with an improved state.

tally in asymptomatic patients. The speculated factors predisposing children to develop SBI are 1) swelling of the bowel wall, 2) abnormal gastrointestinal motility, and 3) scar or adhesion of the bowel from previous insult (9). Inflammation, chemotherapy, hemorrhage, prior surgery or necrosis may be related with those factors. The common association of mesenteric lymph adenopathy and ileocolic intussusception may lend support to the above speculations.

The most outstanding difference between the benign and complicated groups of SBI in this study was the size of the intussuscepted bowel. Transitory SBI tends to have a smaller (less than 2.5 cm) diameter than the surgically managed SBI (7) where the mean outer diameter was 2.9 cm (range: from 2 - 4.3 cm) overlapping with the size range of the ileocolic type (3 - 5 cm). The lesion generally gets larger as swelling of the bowel wall progresses, as was demonstrated by the different outer rim thickness between the two groups (mean: 3.5 vs. 7.2 mm for the benign and complicated cases, respectively). The lead point contained within the intussusception may also increase the size, which was present in 46% of the surgically managed SBI cases (7). Transient SBI contains less mesenteric fat and lymph nodes, and this is probably due to a short segmental invagination (Figs. 2, 3). In fact, the length of the intussus-

ception is the main factor in distinguishing the majority of SBIs detected at CT that are self-limiting from the minority that require surgery (12). Visible wall motion on real time US observation may also suggest an easy reduction.

Other US findings that are known to be associated with difficult intussusception reduction include the presence of bowel obstruction, free fluid, and fluid trapped between the intussuscepted bowel wall (13); all of these findings were more frequent in the patients with surgically managed SBI than for benign SBI (Table 1). Although the CDI was employed for prediction of the reducibility and viability of the bowel (14 - 16), the vascular flow did not always exclude a necrotic bowel (17). The flow signal appeared in both benign and surgical SBIs including those with necrotic bowel (7, 8), and CDI does not seem to be effective for the prediction of spontaneous reducibility of the SBI.

If the US finding is typical for benign SBI, then the patient may be managed conservatively and monitored by subsequent imaging to confirm a spontaneous reduction. Follow-up US is the best imaging modality for this purpose in infants and young children if it is carefully performed by the experienced radiologist. However, US evaluation may be occasionally compromised by bowel gas and the irritable status of the small child. If radiologist or sonographer is not convincing whether the SBI is reduced or not in a symptomatic patient, CT scan or a barium meal may be helpful. On the other hand, barium enema did not demonstrate SBI in this study and for the other reports (7, 8). Although hydrostatic enema reduction was successful in some SBI complicated with large bowel intussusception (18, 19), in general, pneumatic or hydrostatic reduction is not effective for treatment of SBI. Therefore, enema is not recommended for both the diagnosis and treatment of SBI except in limited cases complicated with large bowel intussusception or the ileoileal type near the ileocecal valve.

This study included SBIs associated with HSPs (n = 2) or prior abdominal surgery (n = 1). Emergency laparotomy is generally considered for both HSP-associated SBI and idiopathic postoperative SBI (5), though there have been limited cases that were successfully managed by conservative therapy (20). However, the SBIs in this study appeared to be very typical benign SBIs, and spontaneous reductions confirmed by US corresponded to the clinical recovery. Suspicion of the residual ileoileal intussusception of the ileoileocolic type may arise when the SBI is seen immediately after the pneumatic reduction of the large bowel intussusception. However, in this study, those SBIs associated with large bowel intussusception exhibited the typical US findings of transitory SBI without wall thicken-

ing; this was in contrast to the markedly swollen adjacent terminal ileum that was invaginated before the enema (Fig. 2). These SBIs disappeared spontaneously during US examination. Therefore, those SBIs were likely to be incidental benign SBIs rather than a residual component of the ileoileocolic intussusception. I believe that even for the SBIs in patients with HSP, recent abdominal surgery, or a recently reduced large bowel intussusception, they can be managed conservatively with careful monitoring rather than immediate surgery if US finding is typical for benign SBI and of course, if the clinical state of the patient is not deteriorating.

In summary, the typical US findings of the benign without wall swelling SBI include 1) a small outer diameter (less than 2.5 cm), 2) short (less than 3 cm) segmental invagination, 3) peristaltic wall motion, and 4) absence of a specific lead point. Conservative management of the patient with US monitoring rather than an immediate operation is recommended for these types of typical transient SBIs. Atypical US findings or clinical deterioration of the patient with persistent intussusception warrant surgical exploration.

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