

Computed Tomography and Ultrasound of Omental Infarction in Children: Differential Diagnoses of Right Lower Quadrant Pain¹

소아에서 발생한 대망 경색의 전산화단층촬영술과 복부초음파 소견: 우하복부 통증을 유발하는 다른 질환과의 감별¹

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Purpose: Omental infarction in children occurs rarely and is often confused with other diseases that cause right lower quadrant (RLQ) pain. This study evaluates ultrasonography (US) and computed tomography (CT) findings of omental infarction in children with abdominal pain.

Materials and Methods: The CT and US findings and clinical presentations of nine children diagnosed with omental infarction between 2005 and 2012 were retrospectively reviewed.

Results: Distributions of abdominal pain in the patients included RLQ ($n = 6$), right upper quadrant (RUQ, $n = 1$), periumbilical ($n = 1$), and the epigastric ($n = 1$) region. All patients underwent abdominal CT, and three underwent abdominal US. On CT scan, a typical triangular, heterogeneous fatty mass was seen between the abdominal wall and ascending colon ($n = 6$) or hepatic flexure ($n = 1$). A fatty mass with an enhanced rim that mimicked acute appendicitis was present in two patients. The other two patients had diffuse fat infiltration without mass. On US, a heterogeneously hyperechoic omental mass was seen in the RLQ ($n = 2$) or RUQ ($n = 1$). Three patients underwent appendectomy and partial omentectomy, and pathology confirmed omental infarction.

Conclusion: Knowledge of the typical imaging features of omental infarction and application for diagnosis are important for its differentiation from other conditions that also present with RLQ pain and can avoid unnecessary surgery.

Index terms

Omental Infarction
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INTRODUCTION

The greater omentum is a double-layered peritoneal structure composed mainly of fatty tissue and serpentine gastroepiploic vessels. It attaches to the greater curvature of the stomach and the proximal part of the duodenum, covering the small bowel and reflecting at the level of the pelvic inlet toward the transverse colon like an apron (1). Omental infarction is an uncommon cause of right lower quadrant (RLQ) pain in children who visit the emergency room. Although relatively common in adults, it is rare in children, who account for only 15% of cases (2). Helm-

rath et al. (3) reported just 18 cases of omental infarction in 15 years of experience.

The etiology of omental infarction is unknown. Embryonic vascular variants of the omentum with vascular kinking or torsion of the right epiploic vein may cause omental infarction with RLQ pain (4-6). Thrombosis of an omental vessel due to a heavy meal or obesity can also induce omental infarction (7, 8). Rarely, omental infarction occurs after blunt abdominal trauma such as a bicycle handlebar injury (9).

It is important to differentiate medically treatable omental infarction from other diseases that cause RLQ pain. Omental in-

farction is often confused with surgical conditions such as acute appendicitis or intussusception, as well as with medical conditions such as mesenteric lymphadenitis or acute appendagitis (7). The signs and symptoms of these diseases are similar and include RLQ pain, abdominal tenderness, and vomiting. Laboratory parameters, such as white blood cell (WBC) counts, erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), or other inflammatory findings, are also not diagnostic (7). Therefore, it is important to differentiate it from other conditions to avoid unnecessary surgery by using imaging modalities (10).

The purpose of this study was to evaluate the CT scan and ultrasonography (US) findings of omental infarction in children with RLQ pain and to compare them with those of other diseases that may cause similar RLQ pain and require surgical rather than medical treatment.

MATERIALS AND METHODS

All CT and US image reports from patients under 17 years old between January 2005 and March 2012 were reviewed by use of the Picture Archiving and Communication System and nine archived children with confirmed omental infarction clinically or surgically were found. Three patients who presented with severe abdominal pain and elevated WBC counts underwent appendectomy and omentectomy; the other six were treated conservatively. US and Doppler examinations were performed using a IU21, IU22 US and HDI 5000 with a 5- to 12 MHz linear array

and a 4- to 9 MHz convex transducer (Philips Medical Systems, Bothell, WA, USA) and a LOGIQ E9 with a 6- to 15 MHz linear array and a 2.8- to 5 MHz convex transducer (GE Healthcare, Milwaukee, WI, USA). CT studies were carried out using three MDCT (SOMATOM Sensation 16, Siemens AG, Forchheim, Germany; Lightspeed VCT, GE, Milwaukee, WI, USA; iCT, Philips, Bothell, WA, USA) with IV contrast injection. Based on previous studies (4-6), omental infarction was defined with findings as follows: on CT, heterogenous enhancing mass-like or fatty lesion between the anterior abdominal wall and ascending colon; on US, heterogeneously aggregated fatty mass at similar position as CT; no other pathologic findings such as appendicitis or diverticulitis. If other pathologic conditions could not be ruled out, explorative laparotomy was done for further evaluation. All images were interpreted by two pediatric radiologists who had 10 and 23 years of experience. We also reviewed clinical symptoms, such as abdominal pain, presence of fever, and nausea and/or vomiting. Laboratory findings such as WBC counts, ESR, and CRP were also assessed.

RESULTS

Clinical Presentation

Clinical and laboratory data of the nine patients are summarized in Table 1. There were eight boys and one girl. The mean age was 8.4 years (range, 4-11 years). Presenting symptoms included RLQ pain (*n* = 6), epigastric pain (*n* = 1), right upper

Table 1. Clinical and Laboratory Data of Nine Patients with Omental Infarction

Number*	Sex/Age	Location	Symptom Duration (Days)	Body Temperature (°C)	WBC Count (10 ³ /μL)	Neutrophil Differentiation (%)	ESR (< 27 mm/hr)	CRP (< 0.5 mg/dL)
1 [†]	M/6	RLQ	1	36.8	15700	69	19	3.57
2 [†]	M/10	RLQ	2	36.9	8110	65.7	6	0.64
3	M/4	RLQ	2	36.8	8300	42.2	×	×
4 [†]	M/8	RLQ	2	36.9	11730	69.8	×	×
5	M/5	Epigastric	3	36.9	10050	61.6	×	×
6	M/11	RUQ	4	36.7	13490	55.2	27	25.35
7	M/8	RLQ	0	37.2	10640	64.8	×	×
8	F/11	Periumbilical	2	37.4	13530	83.6	90	296
9	M/10	RLQ	4	37.3	6140	60.8	10	9.46

Note. —*The numbers of patients are all correspond to following Tables 1, 2 and 3.

[†]Patient who underwent surgery.

CRP = C-reactive protein, ESR = erythrocyte sedimentation rate, RLQ = right lower quadrant, RUQ = right upper quadrant, WBC = white blood cells, x = not assessed

quadrant (RUQ) pain ($n = 1$), and periumbilical pain ($n = 1$). The mean duration of symptoms was 2 days (range, 1-4 days). No patient presented with fever (mean body temperature 36.9°C , range, $36.7\text{-}37.4^{\circ}\text{C}$). Six of nine patients showed increased WBC counts ($> 10000 \times 10^3/\mu\text{L}$). Five patients tested ESR count and CRP, and five patients had an elevated ESR count and three had an elevated CRP.

Imaging Interpretation

CT Findings

The CT findings of the nine patients are summarized in Table

2. Seven patients had heterogeneously enhanced mass-like lesion between the ascending colon and the abdominal wall, located in the RLQ (Fig. 1A) in six patients and in the RUQ in one. The lesions were triangular fatty mass in six patients, an oval fatty mass in one. Among these patients, two had rim enhancement around fatty mass. The remaining two patients had only ill-defined diffuse fat infiltration.

US Findings

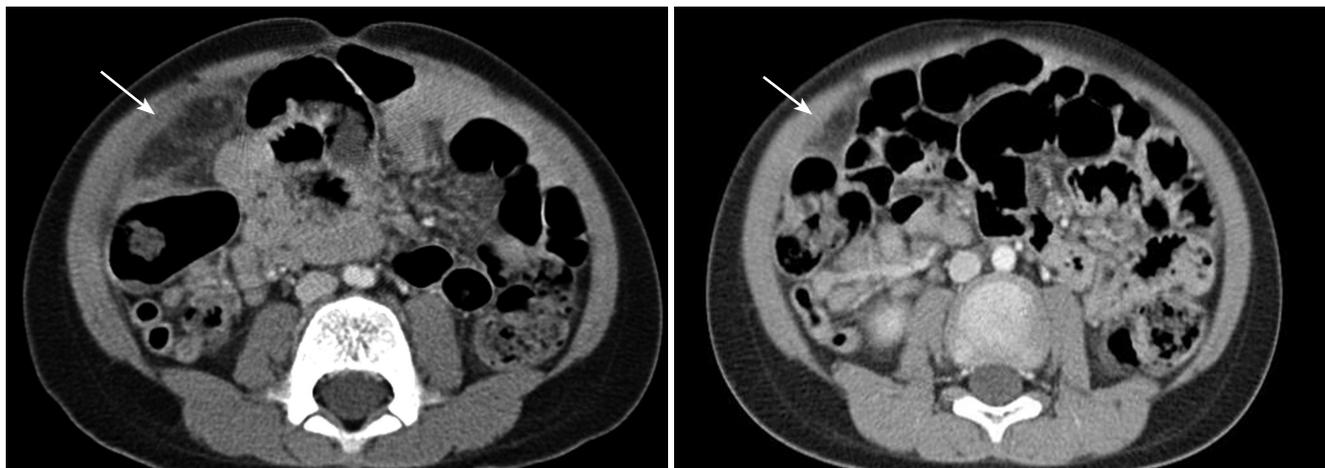
Three patients underwent abdominal US with both gray scale and color Doppler imaging, the findings of which are summarized in Table 3. All three cases had an ill-defined heterogeneous-

Table 2. CT Findings of Omental Infarction

Number*	Location	CT	
		Shape	Enhancement
1	RLQ, A	Triangular	Fatty, rim enhancement
2	RUQ, A	Triangular	Fatty
3	RLQ, A	Triangular	Fatty
4	RLQ, A	Triangular	Fatty
5	RLQ, A	Triangular	Fatty
6	RLQ, A	Triangular	Fatty
7	RLQ, A	Oval	Fatty, rim enhancement
8	RLQ, A	Diffuse	D
9	RLQ, A	Diffuse	D

Note.—*The numbers of patients are all correspond to following Tables 1, 2 and 3.

A = between anterior abdominal wall and ascending colon, D = diffuse fat infiltration, Fatty = fatty mass which containing enhancing strands, RLQ = right lower quadrant, RUQ = right upper quadrant



A **B**
Fig. 1. Postcontrast image from a 4-year-old boy who suffered from RLQ pain for 2 days.
A. A triangular-shaped fatty mass (white arrow) is noted between the posterior right lower abdominal wall and the right colon, suggesting omental infarction.
B. After 1 month with conservative treatment, follow-up abdominal CT scan was done and decreased in size and enhancement of previously noted fatty mass at RLQ (white arrow).
 Note.—RLQ = right lower quadrant

Table 3. US Findings of Omental Infarction

Number*	Ultrasonography		
	Location	Shape	Doppler US
1	RLQ	Triangular	Increased → decreased
2	RUQ	Triangular	Not increased
3	RLQ	Triangular	Not increased

Note.—*The numbers of patients are all correspond to following Tables 1, 2 and 3.
 RLQ = right lower quadrant, RUQ = right upper quadrant, US = ultrasonography

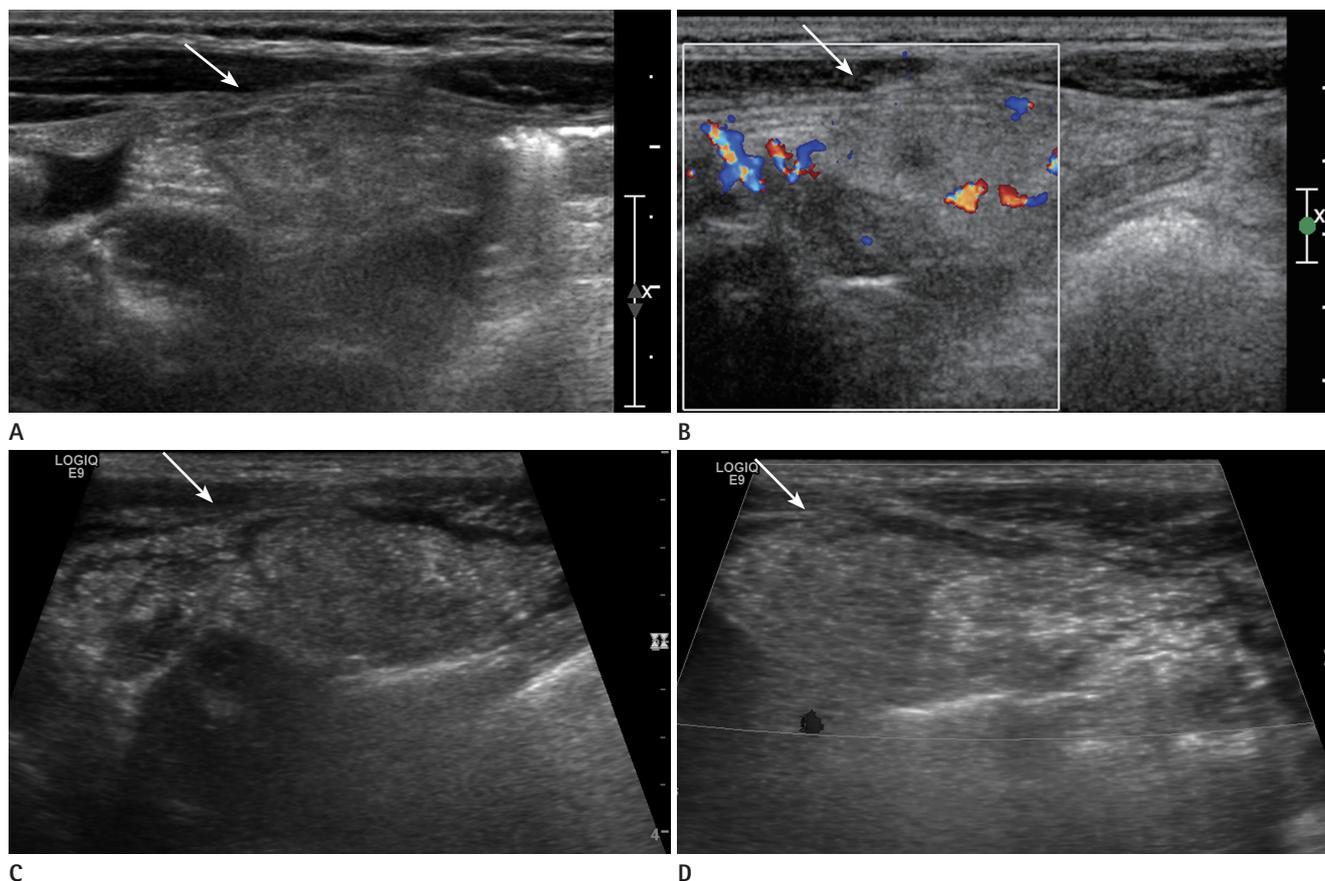


Fig. 2. Abdominal ultrasound of a 6-year-old boy with RLQ pain of 2 days' duration. At presentation, ultrasonography (A, B) showed an aggregated hyperechoic fatty mass (white arrow) with increased vascularity. After 1 day, the symptoms had worsened, and follow-up ultrasonography (C, D) showed an aggregated fatty mass with decreased vascularity. The patient underwent laparoscopic omentectomy, which confirmed omental infarction.

Note.—RLQ = right lower quadrant

ly aggregated fatty mass in the RLQ. Two of these had decreased vascularity of the heterogeneously echoic RLQ mass with color Doppler imaging. The vascularity of the fatty mass was increased in one case, but it had decreased by 1 day later (Fig. 2).

Treatment and Follow-Up

Three patients underwent surgery, at which point omental infarction was confirmed. One patient was diagnosed with omental infarction by ultrasonography and was treated conservatively.

One day later, the patient complained of aggravating abdominal pain. His WBC counts were elevated and neutrophil differentiation was noted. On follow-up ultrasonography, the appendix could not be delineated, so laparoscopic appendectomy and omentectomy was performed to differentiate between perforated appendicitis and omental infarction. Two other patients presented with persistent pain, tenderness and rebound tenderness in the RLQ. With these two patients, appendix was not clearly delineated, so acute appendicitis could not be completely ruled

out. Laparoscopic appendectomy and omentectomy were performed and omental infarction was pathologically confirmed. Their appendices were normal.

Two patients had follow-up CT or US. In one patient, the size and enhancement of omental fat infiltration in the RLQ on CT was decreased after 1 month (Fig. 1B). Another patient underwent follow-up US after 1 month, and the fat infiltrations in the RLQ had disappeared. The remaining four patients were completely relieved from abdominal pain after conservative treatment; they had no surgical or imaging follow-up.

DISCUSSION

Omental infarction is uncommon in children with RLQ pain, with more than 85% of reported cases occurring in adults (4). Its etiology is unclear, but omental infarction can occur with or without omental torsion. It is associated with several predisposing factors, such as obesity, venous congestion after a large meal, vascular kinking, and rarely, blunt trauma (4-9). Left-sided acute omental infarction is far less common than right-sided (8, 11).

The typical CT appearance is a solitary, well-defined, triangular or ovoid mass between the abdominal wall and transverse or ascending colon that has a heterogeneous, sometimes whorled pattern of linear fat strands, and surrounding fat infiltration may be present (4). In this study, the CT findings were typical, a mass between the abdominal wall and ascending colon of the RLQ in six patients and a similar lesion of the RUQ in one.

On US, omental infarction appears as a solid, non-compressible, painful and moderately hyperechoic mass near other normal abdominal structures. The lesion is typically found in the RLQ, just under the abdominal wall overlapping the right colon (4, 5). In our study, two patients had a heterogeneous ill-defined fatty mass in the RLQ and one in the RUQ, located between the abdominal wall and the right colon.

On Doppler ultrasonography, two findings indicative of omental infarction are reported. One is a hyperechoic mass containing poorly defined nodular or linear hypoechoic areas with few vessels within the mass and hyperemia in the peripheral area. On pathology, the hypoechoic area is suggestive of hemorrhagic infarction (6). The other finding is a hyperemic hyperechoic mass that contains an avascular hypoechoic tubular structure (8). In this study, three patients underwent color Doppler ultrasonog-

raphy and two had decreased vascularity, suggesting infarction. The other patient initially presented with a hyperemic hyperechoic mass, but the vascularity was decreased in the follow-up study, suggesting progression of the infarction.

Three patients underwent surgery due to misdiagnosis of acute appendicitis, and all three underwent appendectomy and partial omentectomy. The omentum was an unusual color grossly, and exhibited infiltration of inflammatory cells microscopically. Hemorrhagic congestion and inflammatory cell infiltration are known pathologic findings of omental infarction (4).

Symptoms of omental infarction are similar to other diseases such as acute appendicitis, acute appendagitis, mesenteric lymphadenitis, diverticulitis, and infective enterocolitis. Acute appendicitis is one of the most common emergency causes of RLQ pain. Differentiation of these conditions by clinical and laboratory findings is difficult (9, 12). Yang et al. (13) reported that patients with omental infarction show less fever, nausea, vomiting, lower WBC and neutrophil counts, and lower CRP values, than those with acute appendicitis. CT criteria for acute appendicitis are an enlarged appendix with a diameter of more than 6 mm, or a wall thickness of more than 3 mm, in conjunction with periappendiceal inflammatory changes. The sensitivity and specificity of CT for acute appendicitis have been reported to be 94-98% (14).

Epiplonic appendagitis is defined as inflammation of the epiplonic appendage, which is a round, fat-containing peritoneal pouch, prominent around the sigmoid and descending colons. Therefore, appendagitis typically manifests as LLQ pain and can mimic acute diverticulitis. Typical CT imaging shows a pericolic oval fatty attenuated lesion with an enhanced internal dot and peripheral rim, and surrounding fat infiltration. Adjacent colonic wall thickening is sometimes noted. As mentioned previously, omental infarctions are usually localized to the right lower quadrant and lack the hyperattenuated rim, features which aid diagnosis (15-17). If acute appendagitis occurs at the right side of the abdomen, it usually located at pericolic region, oval-shaped, and smaller than an infarcted greater omentum. In addition, omental infarction does not show central dot which can be found on epiplonic appendagitis. Clinically these two diseases are self-limited condition and tend to resolve spontaneously, so it is less important to differential diagnose these two diseases (17).

Mesenteric lymphadenitis is relatively frequent in children and is a diagnosis of exclusion (18). There are three or more clustered

lymph nodes around the small bowel mesentery and anterior to the psoas muscle. On CT, right-sided mesenteric lymphadenopathy in the absence of other inflammatory conditions is a characteristic finding (19). On US, features indicative of mesenteric lymphadenitis are enlarged mesenteric lymph nodes (over 4 mm in diameter), associated mucosal thickening of the terminal ileum, and lack of other diseases such as appendicitis (20).

Diverticuli typically affect the left lower abdomen, due to the sigmoid colon being most commonly affected. The right colon and rectum are less often affected, and both usually cause RLQ pain. CT findings of acute diverticulitis include asymmetric or circumferential colonic wall thickening with focal pericolic fat infiltration. Colonic diverticuli with inflammation and abscess formation are also noted. Typically, acute diverticulitis is seen in older patients more commonly than is omental infarction, and presents with nausea, vomiting, elevated leukocyte counts, diffuse abdominal pain and/or rebound tenderness (19). The differentiation of acute diverticulitis from omental infarction by identifying inflamed diverticuli under CT or US scan. The mesenteric fat infiltration induced by acute diverticulitis is commonly much extensive than that induced by epiploic appendagitis or omental infarction (17).

Infectious colitis is relatively common, and manifests as acute abdominal pain. It can be indistinguishable from omental infarction or acute appendicitis, particularly when the cause is infection of the ileocecal region by *Yersinia enterocolitica*, *Campylobacter jejuni*, or *Salmonella enteritidis* (19).

This study had several limitations. First, the study population was relatively small. However, omental infarction is uncommon in children and for this reason, most previous studies also involved small groups of patients. Second, although, omental infarction was treated conservatively, only three cases were pathologically confirmed.

In summary, patients with omental infarction presented with RLQ pain and tenderness. The lesion was most commonly located between the abdominal wall and right colon. Typical CT findings were a well-defined, heterogeneously enhanced triangular or ovoid fatty mass. A solid, non-compressible, hyperechoic mass was the typical US finding. Vascularity is decreased as the disease progresses on color Doppler, which is compatible with the general pathology of infarction.

In conclusion, it is important to be familiar with the typical

imaging features of omental infarction to facilitate its differentiation from other conditions that present with RLQ pain.

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소아에서 발생한 대망 경색의 전산화단층촬영술과 복부초음파 소견: 우하복부 통증을 유발하는 다른 질환과의 감별¹

임소연¹ · 홍현숙¹ · 김영통² · 이해경¹ · 이민희¹

목적: 소아에서 대망 경색은 드물게 발생하나 우하복부 통증을 일으키는 다른 질환과 혼동되기 쉽다. 따라서 복부 통증을 호소하는 대망 경색의 환아에서 복부 초음파와 컴퓨터 전산화단층촬영(computed tomography; CT) 소견을 알아보고자 하였다.

대상과 방법: 2005년부터 2012년까지 대망 경색으로 진단된 9예의 CT와 초음파 소견, 임상소견을 후향적으로 분석하였다.

결과: 복부통증은 우하복부(6예), 우상복부(1예), 제대부(1예), 상복부(1예)에 위치하였다. 모든 환아에서 복부 CT를 시행하였고, 3예는 초음파검사도 시행하였다. 복부 CT 스캔에서 복벽과 상행결장(6예)이나 우결장곡(1예) 사이에 삼각형의 저음영의 전형적인 대망 경색의 소견을 보인 환아는 7명이었다. 이 중 두 명의 환아는 복막주렁염과 유사한, 저음영의 지방종괴의 가장자리에 조영증강 테두리가 있는 모양이었다. 두 명의 환아에서는 특정한 종괴 소견 없이 미만성 지방침윤 소견이 관찰되었다. 초음파검사서 비균질한 고에코의 종괴 소견이 우하복부(2예)나 우상복부(1예)에 보였다. 세 명의 환아에서 급성 충수염과의 감별을 위해 부분 대망 절제술과 충수돌기 절제술을 시행하였으며, 모두 대망 경색으로 진단되었다.

결론: 소아에서의 대망 경색의 전형적인 소견을 알고 진단에 적용함으로써 우하복부 통증을 보이는 다른 질환을 감별하여 불필요한 수술을 피할 수 있을 것으로 생각된다.

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