Benha Journal of Applied Sciences (BJAS) **print: ISSN 2356–9751**
Vol. (9) Issue (10) (2024), (7- 13) **online: ISSN 2356–976x**

http://bjas.bu.edu.eg
Medical and Health Science

Comparison between Trans-Abdominal Ultrasound and Multislice CT in Evaluation of Patients with Suspected Intestinal Obstruction

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Abstract

Background: Intestinal obstruction is a critical and potentially life-threatening condition that necessitates swift and accurate diagnosis to guide appropriate management strategies. Trans-abdominal ultrasound and multislice computed tomography (MSCT) are pivotal in the diagnostic process, each offering unique advantages and inherent limitations. This review compares these modalities to elucidate their diagnostic efficacy in evaluating suspected intestinal obstruction. **Methods:** This narrative review synthesized findings from key studies and clinical guidelines to evaluate the roles of trans-abdominal ultrasound and multislice computed tomography in the diagnosis of intestinal obstruction. Relevant articles were selected based on their impact on clinical practice and advancements in imaging technology, with a focus on publications from the last ten years that highlight critical comparisons between the two modalities. **Conclusion:** Both trans-abdominal ultrasound and MSCT are indispensable tools in the diagnosis of intestinal obstruction, each contributing uniquely to clinical workflows. Ultrasound is highlighted for its utility in rapid, safe, and cost-effective initial assessments, particularly in sensitive populations such as pregnant women and children, due to its non-ionizing nature. MSCT, on the other hand, excels in providing detailed visualizations of the abdominal cavity, thereby offering higher diagnostic accuracy and better evaluation of associated complications like ischemia or perforation. Effective use of these modalities can significantly enhance the diagnostic accuracy and treatment outcomes for patients with suspected intestinal obstruction.

Keywords: Intestinal Obstruction, Trans-Abdominal Ultrasound, Multislice Computed Tomography, Diagnostic Imaging, Clinical Decision-Making.

Introduction

Intestinal obstruction is a significant clinical challenge that can lead to severe complications if not diagnosed and managed promptly [1]. The ability to accurately identify the presence and cause of obstruction is crucial for determining the appropriate treatment strategy. Imaging plays a fundamental role in this diagnostic process, offering vital insights into the nature and location of the obstruction. As medical imaging technology has evolved, various modalities have become available, each with specific benefits and limitations in the context of diagnosing intestinal obstructions [2, 3].

Among the most commonly employed imaging techniques are trans-abdominal ultrasound and multislice computed tomography (MSCT). Trans-abdominal ultrasound offers a non-invasive, rapid, and cost-effective method to assess patients, particularly useful in settings where access to more advanced imaging technologies is limited [4]. It is especially valued for its safety, as it involves no radiation exposure, making it a preferred choice in pediatric, pregnant, and certain high-risk patient groups. However, its utility can be constrained by operator skill and patient anatomy.

Conversely, MSCT is renowned for its high diagnostic accuracy and detailed visualization capabilities, which are crucial for the comprehensive assessment of intestinal obstruction. MSCT can delineate the intestinal anatomy, identify the precise location and cause of the obstruction, and reveal any associated complications, such as ischemia or perforation [3, 5]. However, concerns about radiation exposure and the use of contrast agents necessitate careful consideration, particularly in vulnerable populations.

The aim of this review is to critically compare trans-abdominal ultrasound and multislice CT in the evaluation of suspected intestinal obstruction. By analyzing the strengths and limitations of each imaging modality, this review seeks to guide clinicians in selecting the most appropriate imaging based on patient-specific factors, clinical settings, and available resources. Through this comparative analysis, the review will contribute to more informed, effective clinical decision-making in the management of intestinal obstruction.

Gross and Radiological Anatomy of the Small Bowel

Gross Anatomy of the Small Bowel:

The small intestine includes the duodenum, jejunum, and ileum. The duodenum is about 25 cm in length and is retroperitoneal and immobile, while the jejunum and ileum are longer, together measuring about 5-6 meters, and are mobile within the abdominal cavity thanks to their attachment to the mesentery. This mobility is critical for their functioning in nutrient absorption and digestion [6].

Ultrasound and CT Imaging of the Small Bowel:

On ultrasound, the small bowel appears as loops with a normal diameter less than 2.5 cm and wall thickness not exceeding 3 mm, featuring five discernible layers from mucosa to serosa. CT imaging offers a more detailed view, showing these loops with clear demarcation and central enhancement. Key pathological findings on both modalities that suggest obstruction include dilation beyond normal size and altered wall thickness [7].

Gross and Radiological Anatomy of the Large Bowel

Gross Anatomy of the Large Bowel:

The large intestine encompasses the cecum, appendix, colon, rectum, and anal canal, with the colon subdivided into ascending, transverse, descending, and sigmoid segments. Much of the large bowel is retroperitoneal, attaching it to the posterior abdominal wall, which limits its mobility compared to the small bowel.

Ultrasound and CT Imaging of the Large Bowel:

Ultrasound distinguishes the large bowel by its larger diameter, up to 6 cm, and the presence of haustrations. Abnormal findings such as dilation exceeding normal limits or the presence of transition points can indicate obstruction. CT scans provide a more comprehensive view, showing the large bowel's diameter and characteristic haustral markings, which are crucial for diagnosing obstruction [6].

Epidemiology, pathophysiology, classification, and clinical presentation of small and large bowel obstructions were shown in Table 1.

Table (1) Comparison of Epidemiology, Pathophysiology, Classification, and Clinical Presentation of Small and Large Bowel Obstructions [8, 9]

Category	Small Bowel Obstruction (SBO)	Large Bowel Obstruction (LBO)
Epidemiology	Accounts for 60-80% of all intestinal obstructions, with a significant cause of morbidity and surgical admissions due to acute non-traumatic abdominal pain. Mortality rates range from 5% to 11%.	Represents at least 25% of all intestinal obstructions, contributing to 2%-4% of surgical admissions. High morbidity (42%-46%) and mortality rates (13%-19%) following surgery.
Pathophysiology	Vital for digestion and absorption. Risk for postoperative complications in emergencies.	Crucial for water absorption and feces formation. Susceptible to various obstructive conditions.
Mechanical Obstruction	Dilation proximal to blockage increases luminal pressure, risking ischemia. Closed-loop obstructions critical and often require immediate surgery.	Colonic obstructions can lead to functional closed-loop conditions, necessitating urgent decompression.
Functional Obstruction	Disrupted motility without physical blockage, often due to electrolyte imbalances or medications, leading to bowel dilation and halted peristalsis.	Similar pathophysiology with disruptions in motility leading to dilation and functional obstruction.
Classification	Ranges from complete obstruction (no passage) to closed-loop obstruction (isolated loop with progressive accumulation, predisposing to volvulus).	Includes partial to complete obstructions with similar classification as SBO. Closed-loop can lead to severe complications like volvulus.
Clinical Presentation	Cardinal symptoms include abdominal pain, vomiting, distension, and dehydration. Early diagnosis and management are crucial.	Similar clinical signs but less frequent vomiting compared to SBO. Early surgical intervention often necessary.

Imaging Modalities for Evaluation of Intestinal Obstruction

Radiological imaging is crucial in the diagnosis and management of bowel obstructions, where clinical assessments alone may not provide sufficient detail for accurate treatment decisions. Early and precise imaging is vital, particularly due to the high mortality rates associated with conditions like ischemia, which can reach up to 25% in severe cases. For small bowel obstruction (SBO), imaging serves to evaluate the severity, identify the cause and location, and detect complications such as volvulus or ischemia. Large bowel obstructions (LBO) similarly require imaging to pinpoint the obstruction site and identify causes like tumors or diverticulitis, while also assessing for serious complications such as perforation [10, 11]. **Figure 1**

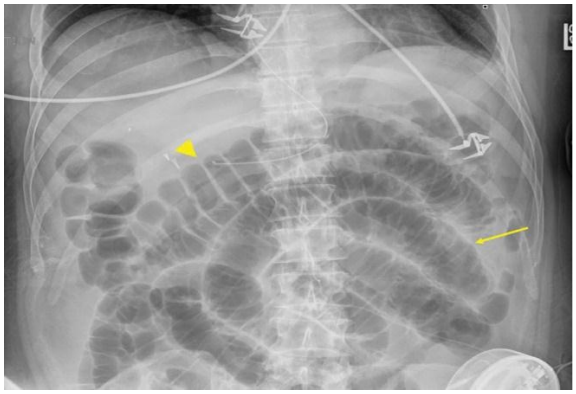

Fig. (1) Postoperative ileus with distended small bowel with plicae circulares (thin arrow) and large bowel with haustra (large arrowhead) [11]

Among the imaging modalities, plain radiographs often serve as the initial approach due to their speed and accessibility, helping to confirm the diagnosis and, in some cases, identify the cause of obstructions like volvulus. However, their utility is limited by a diagnostic accuracy of only 50-80%, and they frequently require supplementary CT imaging for a more definitive evaluation. Ultrasound offers a non-invasive, radiation-free alternative, particularly useful in vulnerable populations like pregnant women and children, capable of visualizing dilated bowel loops and differentiating between mechanical and functional obstructions. Computed tomography (CT) remains the gold standard, providing comprehensive visualization of the abdomen and pelvis, high diagnostic accuracy for the location and nature of obstructions, and detailed assessment of associated complications, critical for guiding surgical interventions and treatment strategies [12]. **Figure 2 and 3**

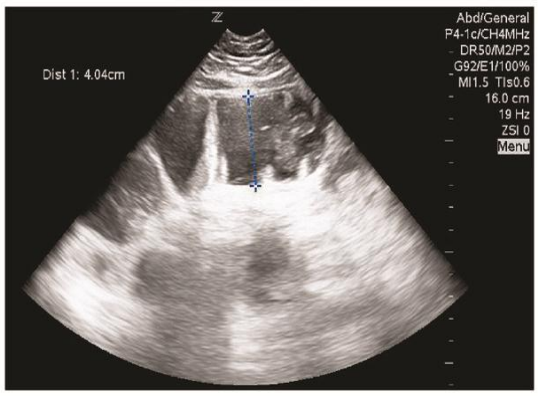

Fig. (2) Surgically found adhesive intestinal obstruction. The ultrasound image, obtained using a phased array transducer, shows a dilated fluid-filled loop of bowel, measuring over 4 cm in width in the left lower quadrant, with sluggish peristalsis compatible with a small bowel obstruction..[13]

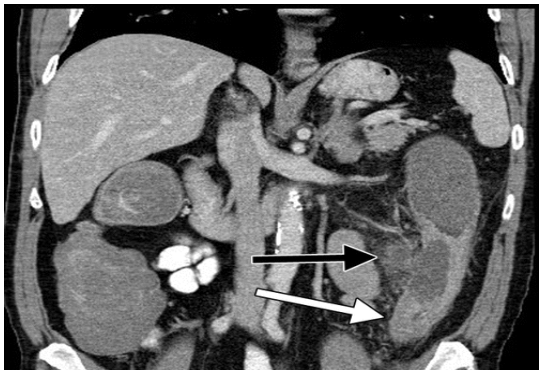

Fig. (1) Midline coronal reformatted CT image of the abdomen and pelvis after administration of intravenous contrast material shows obstructing left colonic adenocarcinoma (white arrow) with adjacent perforation and abscess (blackarrow). [14]

U.S. & CT Findings in the Evaluation of Small & Large Bowel Obstruction

Diagnostic Criteria for Bowel Obstruction by Ultrasound (US)

Ultrasound is a critical imaging tool for diagnosing bowel obstruction, utilizing specific criteria to assess and stage the condition. Key ultrasound signs include dilated bowel loops (diameter > 2.5 cm for small bowel and > 6 cm for large bowel), thickened bowel wall (> 3 mm), abnormal peristalsis (decreased or absent), interloop free fluids, and distinctive intraluminal contents and air. These features help in the early identification and management of bowel obstructions, with specific patterns such as 'bowel jump diameter' indicating severe cases. **Figure 4**

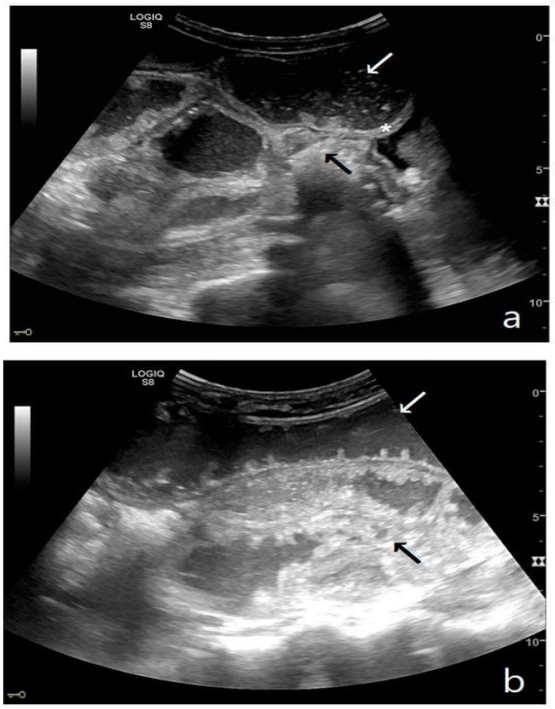

Fig. (4) Evidence of surgically proven intestinal obstruction indicates a decompensated SBO, characterized by fluid-filled, dilated small bowel loops with increased parietal thickening (*) (a) and

free fluid between the bowel loops (a). Decrased peristalsis is noted. Additionally, a ‘caliber jump’ is observed, reflecting the difference in caliber between the swollen loops upstream (white arrows) (a, b) and the collapsed loops downstream of the obstruction (black arrows) (a, b)."The ultrasound criteria are summarized in a table format for clarity (Table 2: Ultrasound Criteria for SBO Diagnosis by Rosano et al. [15]).

Table (2) Ultrasound criteria for small bowel obstruction (SBO) diagnosis [15]

	Simple	Decompensated	Complicated
Bowel Loop Diameter	Increased	Increased	Increased
Parietal Thickness	Normal	Normal or Increased	Increased
Valvulae Conniventes	Not Thickened	Not Thickened	Thickened
Peristalsis	Present or Hyperkinetic	Decreased	Absent
Free Fluid	Absent	Present	Present

Diagnostic Criteria for Bowel Obstruction by Computed Tomography (CT)

Computed tomography provides comprehensive imaging for bowel obstruction, highlighting dilated bowel loops indicative of obstruction upstream from a blockage. CT is proficient in detailing additional signs such as bowel wall thickening, which suggests inflammation or ischemia, air-fluid levels, the "small bowel feces sign," and mesenteric edema. These findings are essential for a thorough assessment of the obstruction and planning for potential surgical interventions. The precise detection of the transition point in both SBO and LBO using CT enhances the diagnostic process, although challenges remain in consistently identifying these zones. **Figure 5**

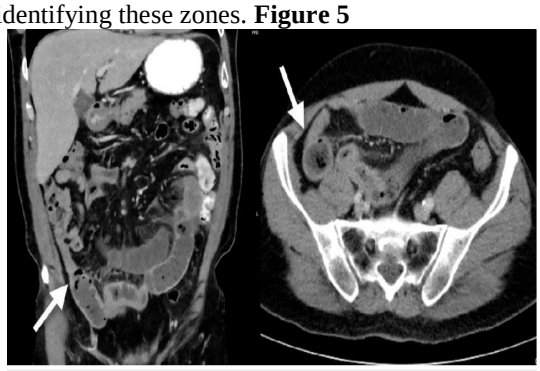

Fig. (5) CT scan of the abdomen showing surgically proven adhesive small bowel obstruction (SBO) with a clear transition point indicated by the white arrow. The findings are consistent with the diagnosis of SBO. CT: computed tomography; SBO: small bowel obstruction.". [3]

Detection of Transition Point and Identification of Obstruction Causes

The ability to pinpoint the transition point where the bowel diameter changes abruptly is crucial for effective management of intestinal obstruction. Ultrasound excels in visualizing dilated loops and identifying transition points, which can indicate the specific cause of the obstruction, such as hernias or tumors. CT's high-resolution imaging facilitates the identification of these transition zones, improving diagnostic accuracy and guiding surgical planning. Despite these advancements, complex cases may require additional diagnostic procedures like endoscopy, especially when imaging results do not correlate clearly with clinical symptoms. Identifying the underlying cause of obstruction, whether mechanical, dynamic, or mesenteric vascular, is essential for appropriate treatment and can be challenging, highlighting the need for comprehensive diagnostic approaches [16].

Common Mechanical Causes of Small Bowel Obstruction (SBO) and Their Diagnostic Characteristics are shown in **Table 3**.

Table (3) Overview of Common Mechanical Causes of Small Bowel Obstruction (SBO) and Their Diagnostic Characteristics [17]

Cause	Description	Diagnostic Method	Key Findings
Adhesions	Fibrous scar tissue often resulting from previous surgeries, accounting for up to 80% of SBO cases.	Ultrasound, CT	Ultrasound: Dilated loops, bowel wall thickness. CT: Unchanged bowel locations, clustering, kinking, "fat notch" and "beak" signs.
External Hernia	Common in developing nations due to delayed surgical interventions,	Ultrasound, CT	Ultrasound: Hernia sac contents, bowel entrapment. CT: Hernia type,

Cause	Description	Diagnostic Method	Key Findings
	causing pressure on intestines leading to obstruction.		complications like ischemia.
Small Bowel Neoplasm	Includes adenoma, GIST, lipoma; causes up to 13% of SBO cases without prior surgery.	Ultrasound, CT	Ultrasound: Visualization of neoplasms. CT: Detailed characterization, location, and complications like ischemia.
Intussusception	Often occurs in children, where part of the intestine slides into another part.	Ultrasound, CT	Ultrasound: "Target" sign for rapid diagnosis. CT: Detailed anatomical images, severity assessment.
Internal Hernia	Rare, can arise from surgery-induced mesenteric defects, causing bowel loops to herniate.	CT	CT: Identification of hernia defects and herniated bowel loops, possible complications like ischemia.
Inflammatory Mass	Resulting from conditions like diverticulitis, appendicitis; may obstruct by blocking the ileocecal valve or causing localized ileus.	Ultrasound, CT	Ultrasound: Mass size and location. CT: Precise pinpointing of the mass and complications.
Mesenteric Ischemia	Inadequate blood flow to the intestines causing tissue damage and potential obstruction.	Doppler Ultrasound, CT	Doppler Ultrasound: Blood flow abnormalities in mesenteric arteries. CT: Bowel wall thickening, pneumatosis intestinalis, portal venous gas.

Functional Cause of Small Bowel Obstruction: Paralytic Ileus

Overview of Paralytic Ileus

Paralytic ileus, also known as dynamic ileus, involves a decrease in bowel motility leading to a slowdown or cessation of gastrointestinal movement. This condition can affect any part of the gastrointestinal tract and is often treated by addressing the underlying cause, managing fluids and electrolytes, and using medications to stimulate bowel motility. Recovery typically starts with the small bowel and progresses to the stomach and colon, usually resolving within three days [18].

Etiology and Diagnosis of Paralytic Ileus

The causes of paralytic ileus are diverse, ranging from post-surgical recovery and neurological disorders like Parkinson's and multiple sclerosis to side effects of medications such as opioids and electrolyte imbalances. Conditions like severe inflammation from appendicitis or pancreatitis, hypothyroidism, and serious infections like septicemia also contribute. Diagnosis is primarily via ultrasound, which assesses bowel motility and detects signs like bowel distension and the absence of peristalsis. CT imaging further aids by showing bowel distension, the absence of bowel wall enhancement, and air-fluid levels within dilated bowel loops, helping to exclude mechanical causes [13]. **Figure 6**

Fig. (6) Contrast-enhanced abdominal computed tomography (axial view) image shows dilated small bowel and colon loops associated with multiple air–fluid levels. There is no evidence of transitional zones or valvulae conniventes, and the findings are consistent with a diagnosis of paralytic ileus. [13]

Common Mechanical Causes of Large Bowel Obstruction

Colorectal Cancer and Other Obstructions

Colorectal cancer is a predominant cause of large bowel obstruction, particularly affecting the left side and sigmoid colon. CT imaging is vital for identifying the tumor's location, assessing the extent of the obstruction, and planning treatment. It shows typical signs such as masses, bowel wall thickening, and dilated loops proximal to the tumor. Other mechanical causes include volvulus, often identified by CT signs like the "whirl sign" and "bird's beak" tapering, and diverticular disease, which shows segmental thickening of the colon wall and may mimic colorectal cancer [9]. **Figure 7-8**

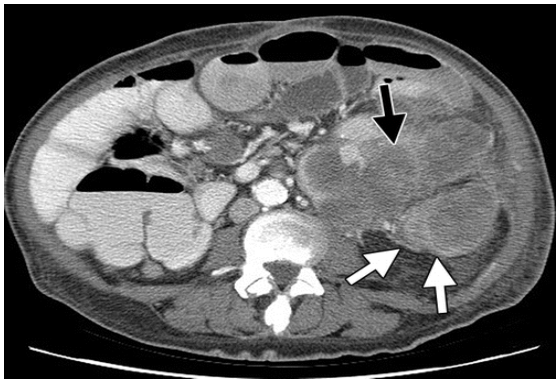

Fig. (6) Transverse CT image of the abdomen and pelvis after intravenous injection of contrast material shows large necrotic metastasis from lung adenocarcinoma (black arrow) in the left abdomen compressing and deviating the descending colon posteriorly (white arrows). Both upstream small bowel and large bowel are dilated. [14]

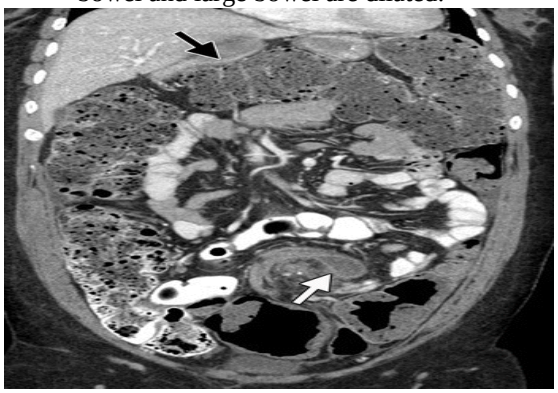

Fig. (7) Images in a 72-year-old woman with LBO caused by sigmoid volvulus. Midline coronal reformatted CT image of the abdomen and pelvis shows dilated, stool-filled colon proximal to the volvulus (black arrow) with a distal "whirl" of the mesentery at the point of volvulus (white arrow). [19]

Functional Causes of Large Bowel Obstruction

Large Bowel Pseudo-Obstruction (Ogilvie's Syndrome)

Ogilvie's syndrome, or large bowel pseudo-obstruction, presents as significant dilation of the colon, especially the cecum, which may extend beyond 9 cm without a visible transition point—a key differentiator from mechanical obstruction. The lack of an obstructive lesion and consistent dilatation across the bowel segment, along with mild mesenteric edema suggesting a mild inflammatory response, are typical findings on CT imaging. This condition requires careful management to avoid complications like perforation due to extreme dilation **[20]**.

Toxic Megacolon

Toxic megacolon is another severe functional disorder primarily linked with inflammatory bowel diseases, notably ulcerative colitis. It involves marked colonic dilation and systemic toxicity. CT imaging is crucial for diagnosing toxic megacolon, revealing colonic dilation, mucosal thickening, and associated complications such as perforation and abscess formation. Factors contributing to toxic megacolon include infections, dehydration, and certain medications like NSAIDs and corticosteroids [21]. These imaging findings guide urgent medical or surgical interventions to manage this life-threatening condition.

Assessment of Severity in Intestinal Obstruction

Determining the severity of large bowel obstruction is critical for appropriate management, as complications can range from treatable with conservative measures to life-threatening conditions requiring immediate surgery. CT and ultrasound are instrumental in this evaluation. Ultrasound can detect early signs of complications such as ischemia, necrosis, and perforation. CT scans offer a detailed view of the bowel, helping to identify ischemia through changes in bowel wall enhancement, necrosis, and other severe outcomes such as perforation and abscess formation. These diagnostic tools are essential for timely and effective treatment planning, reducing the risk of adverse outcomes in patients with intestinal obstruction.

Conclusions

Both trans-abdominal ultrasound and MSCT are indispensable tools in the diagnosis of intestinal obstruction, each contributing uniquely to clinical workflows. Ultrasound is highlighted for its utility in rapid, safe, and cost-effective initial assessments, particularly in sensitive populations such as pregnant women and children, due to its non-ionizing nature. MSCT, on the other hand, excels in providing detailed visualizations of the abdominal cavity, thereby offering higher diagnostic accuracy and better evaluation of associated complications like ischemia or perforation. Effective use of these modalities can significantly enhance the diagnostic accuracy and treatment outcomes for patients with suspected intestinal obstruction.

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