UDC 616.33/.34-005.1-06:616.341-006-072.1
DOI: 10.14739/2310-1237.2025.3.338154

Comparative assessment of video capsule endoscopy and computed tomography in the diagnosis of small bowel tumors in patients with gastrointestinal bleeding

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A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation; D – writing the article; E – critical revision of the article; F – final approval of the article

Aim: this study aimed to comprehensively compare the diagnostic capabilities of modern video capsule endoscopy (VCE) and standard computed tomography (CT) in detecting small bowel tumors in patients presenting with gastrointestinal bleeding.

Materials and methods. We performed a retrospective analysis of diagnostic data from 128 patients exhibiting clinical manifestations of small bowel bleeding. The patients were divided into two clinically comparable groups based on their chosen diagnostic approach. Group I comprised 65 patients who underwent VCE, while Group II included 63 patients whose diagnosis was facilitated by contrast-enhanced CT. A crucial inclusion criterion for all patients in both groups was prior gastroscopy and colonoscopy that failed to identify the source of bleeding.

Results. The study's findings demonstrated a substantial difference in the diagnostic efficacy of the methods. In the VCE group, tumors as a cause of bleeding were identified in 11 (16.9 %) patients, whereas in the CT group, an analogous diagnosis was established in only 6 (9.5 %) patients. A pivotal observation was that among Group II patients with negative CT results, subsequent application of VCE led to the detection of an additional 7 small bowel tumors, none exceeding 10 mm in size. This clearly indicates the superior diagnostic value of VCE for identifying small bowel neoplasms, particularly those of diminutive size, compared to CT.

Conclusions. This research substantiates that VCE exhibits significantly higher diagnostic effectiveness compared to CT for detecting small bowel tumors up to 10 mm. The detection rate was 16.9 % for VCE versus 9.5 % for CT ($p < 0.05$), thereby justifying its application for the early and precise diagnosis of this pathology.

Keywords: small bowel tumors, video capsule endoscopy, computed tomography, pathomorphological examination of tumors, gastrointestinal bleeding.

Pathologia. 2025;22(3):207-212

Порівняльне оцінювання відеокапсульної ендоскопії та комп'ютерної томографії в діагностиці пухлин тонкої кишки в пацієнтів із шлунково-кишковою кровотечею

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Мета роботи – детальне порівняльне оцінювання діагностичних можливостей сучасної технології відеокапсульної ендоскопії (ВКЕ) та стандартної комп'ютерної томографії (КТ) для виявлення пухлин тонкої кишки в пацієнтів із шлунково-кишковою кровотечею.

Матеріали і методи. Здійснили ретроспективний аналіз діагностичних даних 128 пацієнтів із клінічними проявами кровотечі з тонкої кишки. Пацієнтів поділили на дві клінічно зіставні групи залежно від діагностичного методу, що застосували. До групи I залучили 65 пацієнтів, яким виконано ВКЕ, а до групи II – 63 пацієнти, в яких діагностику здійснили за допомогою контраст-підсиленої КТ. Важливий критерій залучення для всіх пацієнтів обох груп – попередня гастроскопія та колоноскопія, під час яких джерела кровотечі не виявлено.

Результати. У результаті дослідження встановили суттєву різницю за діагностичною ефективністю методів. У групі ВКЕ пухлини як причину кровотечі виявлено в 11 (16,9 %) пацієнтів, а в групі КТ цей діагноз встановлено лише у 6 (9,5 %) пацієнтів. У пацієнтів із групи II, які за даними КТ мали негативний результат, під час наступної ВКЕ виявлено ще 7 пухлин тонкої кишки, що за розмірами не перевищували 10 мм. Ці дані підтверджують вищу діагностичну цінність ВКЕ для виявлення новоутворень тонкої кишки, особливо невеликих, порівняно з КТ.

Висновки. ВКЕ має суттєво вищу діагностичну ефективність порівняно з КТ для виявлення пухлин тонкої кишки розміром менше ніж 10 мм. Частота виявлення пухлин становила 16,9 % для ВКЕ та 9,5 % для КТ ($p < 0,05$). Ці дані обґрунтовують доцільність застосування ВКЕ для ранньої та точної діагностики цієї патології.

Ключові слова: пухлини тонкої кишки, відеокапсульна ендоскопія, комп'ютерна томографія, патоморфологічне дослідження пухлин, шлунково-кишкова кровотеча.

Патологія. 2025. Т. 22, № 3(65). С. 207-212

The past decade has witnessed a rising incidence of malignant neoplasms within the digestive system. Among these, small bowel tumors represent a distinctive position, accounting for approximately 3% of all gastrointestinal malignancies [1]. The primary challenge in their diagnosis stems from the small intestine's anatomical intricacies, rendering it less accessible to conventional endoscopic modalities such as gastroscopy and colonoscopy [2]. Pathologies in this segment of the intestine can often remain asymptomatic for extended periods or present with non-specific clinical signs. This frequently culminates in delayed diagnosis, which, in turn, precipitates the development of complications and the dissemination of the neoplastic process [3].

Technological advancements, notably the advent of video capsule endoscopy (VCE) into clinical practice, have transformed the non-invasive and comprehensive examination of the small intestine. Unlike enteroscopy, VCE does not permit biopsy or therapeutic interventions. However, enteroscopy is an invasive procedure necessitating general anesthesia and is associated with a relatively high risk of complications. Furthermore, even with balloon-assisted enteroscopy, complete visualization of the entire small bowel can be challenging due to adhesions or complex anatomical variations. Thus, VCE emerges as a compelling alternative for such patients [4,5,6,7,8].

The diagnostic utility of traditional radiological methods, such as computed tomography (CT) and magnetic resonance imaging (MRI), is limited in detecting small bowel tumors, particularly when their size is less than 10 mm. This limitation can be attributed to intestinal peristalsis during the procedure, abdominal organ movements during patient respiration, and the high probability that small lesions may be missed if they do not fall within the scanner's plane of section. In our view, the strategic deployment of video capsule endoscopy offers a valuable opportunity to enhance the early diagnosis of small bowel neoplasms in patients with gastrointestinal bleeding [9,10,11,12,13].

Aim

This study aimed to comprehensively compare the diagnostic capabilities of modern video capsule endoscopy and standard computed tomography in detecting small bowel tumors in patients presenting with gastrointestinal bleeding.

Materials and methods

This study rigorously adhered to the bioethical principles outlined in the Helsinki Declaration. All participating patients provided informed consent prior to their inclusion in the study. A comprehensive analysis was performed on the diagnostic data of 128 patients suffering from small bowel bleeding. Patient ages ranged from 17 to 65 years, with a mean age of 41.0 ± 1.1 years. The cohort included 60 (46.8 %) males and 68 (53.2 %) females.

Patients were stratified into two distinct groups based on their diagnostic approach. Group I comprised 65 patients with clinical presentations of small bowel bleeding who underwent video capsule endoscopy between 2010 and 2024. Prior to VCE, all patients in this group had undergone gastroscopy and colonoscopy, neither of which identified the source of bleeding. Group II included 63 patients with small bowel bleeding whose diagnosis was performed using a radiological method, specifically contrast-enhanced computed tomography, also between 2010 and 2024. Similarly, all patients in Group II had previously undergone negative gastroscopy and colonoscopy for the bleeding source.

The patient groups were comparable in terms of age and gender, ensuring homogeneity for analysis. It is pertinent to note that the study is retrospective in nature, and patient allocation to groups was based on clinical practice rather than randomization. This approach may introduce selection bias and is acknowledged as a limitation of this study.

All patients in both groups were prepared for their respective examinations using polyethylene glycol preparations according to standard instructions and followed a low-residue diet for three days prior to the procedure.

Video capsule endoscopy was performed using the OMOM1, OMOM2, and OMOM HD systems. The system typically consists of a specialized antenna belt, a data recorder for video capture, a disposable video capsule, and dedicated software. Patients, in a fasting state, swallowed the video capsule with a small amount of water. The capsule traversed the gastrointestinal tract propelled by intestinal peristalsis, transmitting images to the recorder for storage. Data from the recorder were subsequently downloaded to a computer program for detailed physician analysis.

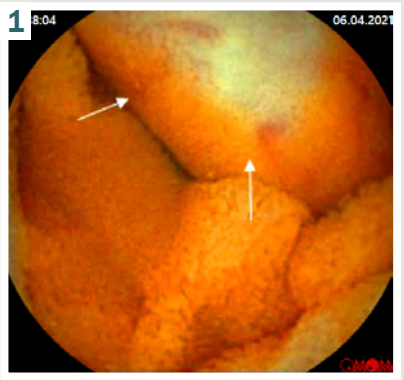
Computed tomography scans were performed on GE Revolution EVO (128 slices) and Siemens Somatom Go (32–64 slices) tomographs, with the administration of iodine-containing contrast agents administered for enhancement.

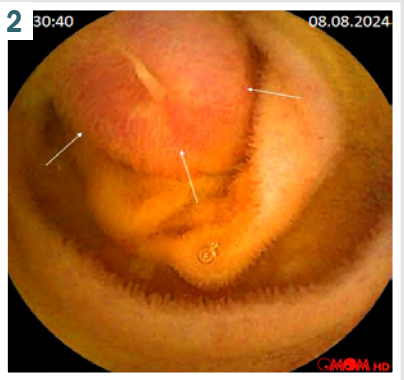
Following surgical interventions, resected gross specimens were dispatched for pathohistological examination. Biopsy samples were fixed in 10 % neutral buffered formalin solution (pH 7.4) for 24–36 hours. Histological sections, 4–5 μm thick, were prepared from paraffin blocks using a rotary microtome. These sections were then stained with hematoxylin and eosin (H & E) and subjected to periodic acid-Schiff (PAS) reaction. Additionally, immunohistochemical (IHC) analysis was conducted using monoclonal antibodies against CD138, CD68, CD20, and α-SMA. Microscopic examination was carried out using a Zeiss "Primo Star" light microscope.

Results

The examination results for patients in Group I are presented in *Table 1*.

As shown, VCE identified the following causes of bleeding: erosive enteritis in 24 (36.9 %) patients, small bowel angioectasias in 15 (23.0 %), small bowel tumors in 11 (16.9 %), Crohn's disease in 8 (12.3 %), and small bowel diverticula in 2 (3.0 %) patients. In 11 patients within this group, small bowel tumors were determined to be the





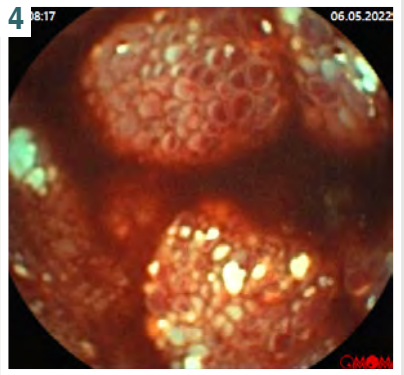


Fig. 1. GIST of the Jejunum (indicated by arrows).

Fig. 2. NET of the Upper Third of the Ileum with Surface Ulceration (indicated by arrows).

Fig. 3. Lymphoma of the Jejunum (indicated by an arrow).

Fig. 4. Hemangioma of the Jejunum.

Fig. 5. Adenocarcinoma of the Ileum.

cause of bleeding. All these patients underwent surgical intervention involving resection of the tumor-containing small bowel segment. Pathohistological examination of the resected tumors revealed the following diagnoses: gastrointestinal stromal tumors (GIST) in 4 cases *(Fig. 1)*, neuroendocrine tumors (NET) in 3 *(Fig. 2)*, lymphomas in 2 *(Fig. 3)*, adenocarcinoma in 1 *(Fig. 5)*, and hemangioma in 1 case *(Fig. 4)*. The sizes of these tumors ranged from 5 mm to 10 mm.

The results of examinations conducted in Group II patients are summarized in *Table 2*.

As observed, in 46 (73 %) patients within this group, computed tomography failed to identify the source of bleeding. Crohn's disease of the small bowel was diagnosed in 8 (12.6 %) patients, tumors in 6 (9.5 %), and diverticula in 3 (4.7 %). Consequently, in 6 patients of Group II, small bowel tumors were identified as the cause of bleeding. These patients subsequently underwent surgical resection of the affected segment. Postoperative histological examination of these tumors revealed the following diagnoses: 1 GIST, 1 NET, 1 lymphoma, and 3 adenocarcinomas. The sizes of these tumors ranged from 20 mm to 50 mm.

To evaluate the diagnostic efficacy of each modality, a comparative statistical analysis was performed. The detection rate for small bowel tumors was significantly greater in the VCE group (Group I) at 16.9 % (11 of 65 patients) versus the CT group (Group II), where the rate was 9.5 % (6 of 63 patients). This difference was statistically significant ($p < 0.05$, χ^2 test). Additionally, there was a statistically significant disparity in the size of the tumors identified by each method. VCE was more adept at detecting smaller tumors (ranging from 5 mm to 10 mm), while CT typically identified much larger lesions (ranging from 20 mm to 50 mm) ($p < 0.001$, Mann–Whitney U-test).

Table 1. Results of examination in Group I patients

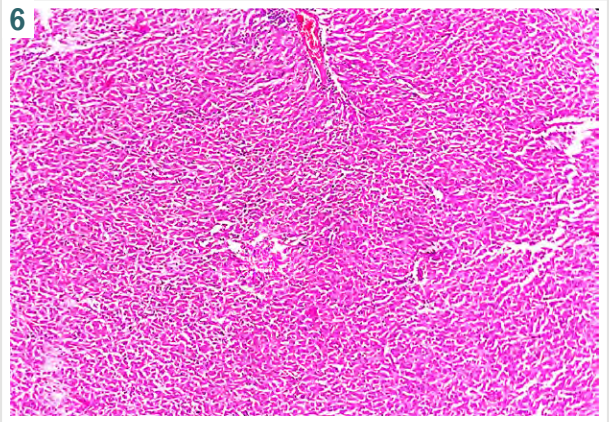
Diagnosis	Number of patients	%
Erosive Enteritis	24	36.9
Small Bowel Angioectasias	15	23.0
Small Bowel Tumors	11	16.9
Crohn's Disease	8	12.3
Small Bowel Diverticula	2	3.0
Source Undetermined	5	7.6
Total	65	100.0

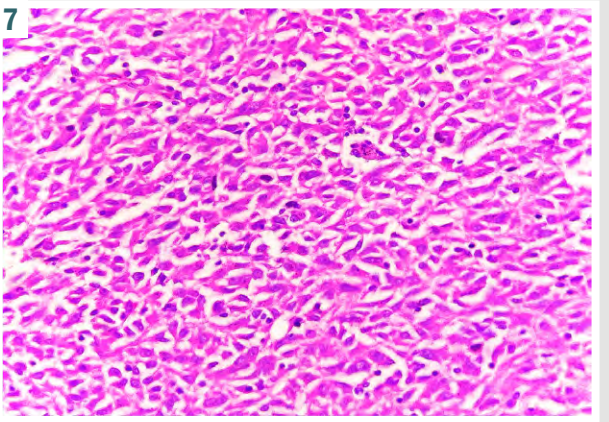
Table 2. Results of examination in Group II patients

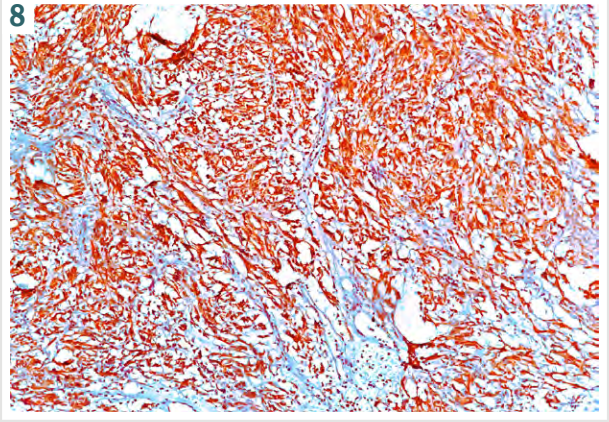
Diagnosis	Number of patients	%
Source undetermined	46	73.0
Crohn's disease	8	12.6
Tumors	6	9.5
Diverticula	3	4.7
Total	63	100.0

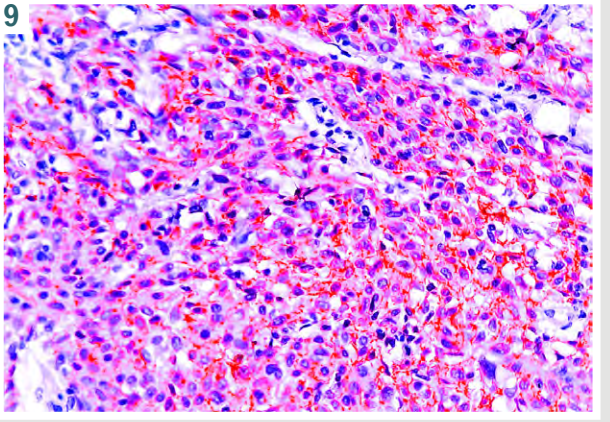
A key finding of the study was that patients in whom CT did not detect a source of bleeding (n = 46) subsequently underwent video capsule endoscopy. VCE results in this subgroup revealed: 7 additional small bowel tumors, 28 erosive enteropathies, 8 angioectasias, and 3 cases of small bowel Crohn's disease. Histological analysis of these newly identified tumors confirmed that 5 were GISTs *(Figs. 6, 7, 8, 9)*.

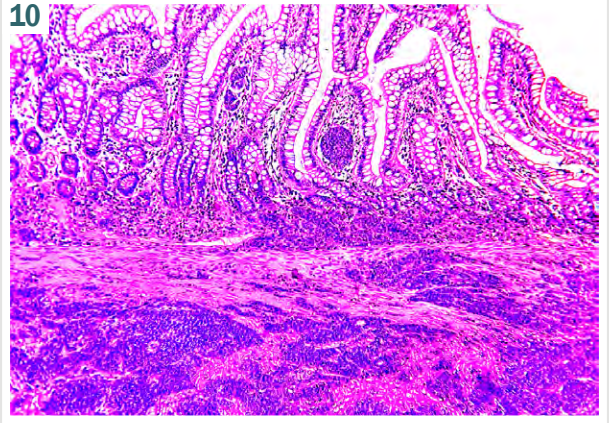
Importantly, the size of these tumors typically did not exceed 10 mm.

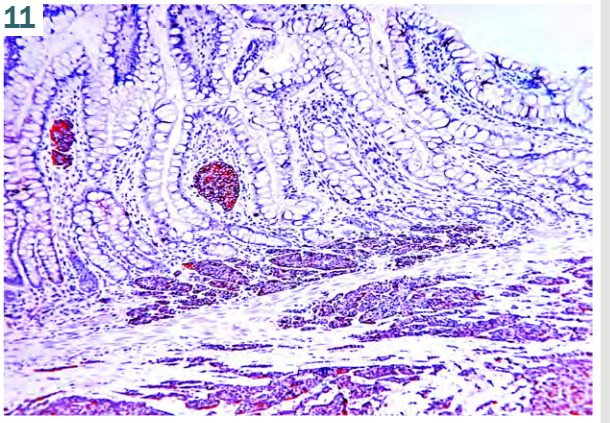












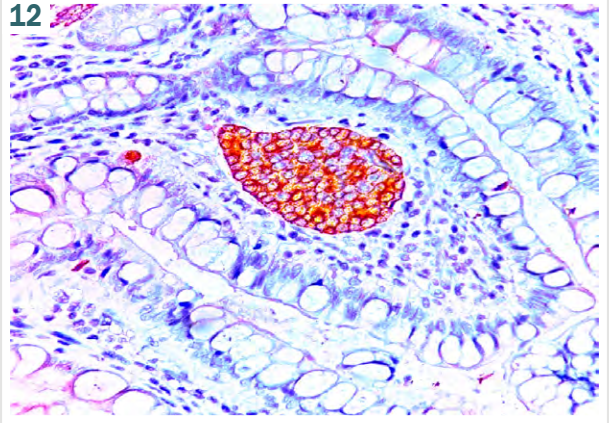


Fig. 6. Gastrointestinal stromal tumor (GIST) of the small intestine. **A:** low-power view (H & E, ×40) reveals a spindle-cell tumor arising from the muscularis propria.

Fig. 7. Gastrointestinal stromal tumor (GIST) of the small intestine. **B:** high-power view (H & E, ×400) shows spindle cells arranged in fascicles with eosinophilic cytoplasm and elongated nuclei.

Fig. 8. Gastrointestinal stromal tumor (GIST) of the small intestine. **C:** Immunohistochemical staining for KIT (CD117) demonstrates strong cytoplasmic and membranous positivity. ×100.

Fig. 9. Gastrointestinal stromal tumor (GIST) of the small intestine. **D:** Immunohistochemical staining for KIT (CD117) demonstrates strong cytoplasmic and membranous positivity. ×400 and 2 were NETs *(Figs. 10, 11, 12)*.

Fig. 10. Well-differentiated neuroendocrine tumor (NET) of the small intestine. **A:** Low-power view (H & E, ×100) displays nests and trabeculae of uniform cells involving the mucosa and submucosa.

Fig. 11. Well-differentiated neuroendocrine tumor (NET) of the small intestine. **B:** Chromogranin A and synaptophysin immunostains show diffuse cytoplasmic positivity in neoplastic cells. ×100.

Fig. 12. Well-differentiated neuroendocrine tumor (NET) of the small intestine. **C:** Chromogranin A and synaptophysin immunostains show diffuse cytoplasmic positivity in neoplastic cells. ×400.

Discussion

In this study, we meticulously compared the diagnostic utility of video capsule endoscopy and computed tomography for identifying small bowel tumors in patients presenting with obscure gastrointestinal bleeding. Our findings demonstrated a statistically significant superiority of VCE. The tumor detection rate was 16.9 % in the VCE-first group (Group I), compared to 9.5 % in the CT-first group (Group II) ($p < 0.05$).

Furthermore, our research underscored a key advantage of VCE in identifying small neoplasms. Tumors detected via VCE were considerably smaller (5–10 mm) than those found by CT (20–50 mm), a difference that was statistically significant ($p < 0.001$). This was further evidenced in 46 patients from the CT group, where initial scans were negative; a follow-up VCE successfully identified 7 additional tumors, all under 10 mm.

Taken together, these findings strongly suggest that video capsule endoscopy is a substantially more sensitive modality for the early diagnosis of small bowel tumors, particularly for detecting small lesions missed by standard CT.

Our results are consistent with and augment findings from other studies. For instance, Heo et al. presented a retrospective study evaluating the role of VCE in identifying the cause of obscure gastrointestinal bleeding in patients with negative CT heterography [14]. In their study, 30 patients underwent VCE after negative CT enterography, and a definitive diagnosis was established in 17 (57 %) of these patients based on VCE results. Our research not only corroborates these conclusions but also encompasses a larger patient cohort and employs newer generation video capsule systems with improved technical parameters.

Conclusions

1. The application of video capsule endoscopy possesses high diagnostic value for detecting small bowel tumors, especially those up to 10 mm in size, in patients with gastrointestinal bleeding following negative gastro- and colonoscopy results.

2. Video capsule endoscopy demonstrated significantly superior efficacy compared to computed tomography in diagnosing small bowel tumors up to 10 mm that manifested as gastrointestinal bleeding, with detection rates of 16.9 % versus 9.5 % ($p < 0.05$) respectively.

3. The findings corroborate that diagnostic efficiency for small bowel tumors is markedly enhanced through the utilization of video capsule endoscopy, enabling earlier and more precise diagnosis and facilitating timely and appropriate treatment.

Limitations of the study

Despite the compelling results, it is imperative to acknowledge the limitations of this work. Firstly, the retrospective and non-randomized nature of the study introduces a risk of selection bias, as the choice of diagnostic method might have been influenced by the patient's initial condition or other clinical factors. Secondly, the extended patient recruitment period (14 years) spans a period of significant evolution in both CT and VCE technologies, which could have impacted comparative effectiveness at different time points. Future prospective, randomized controlled trials are necessary to further validate the obtained results.

Ethical approval

The Bioethics and Academic Integrity Committee of the Shupyk National Healthcare University of Ukraine reviewed the materials presented in this article and confirmed that they comply with all applicable ethical standards, including those outlined in the Declaration of Helsinki, the Council of Europe Convention on Human Rights and Biomedicine, and other relevant regulatory documents (Protocol No. 3, 10 October 2025).

Funding

The study was performed without financial support.

Конфлікт інтересів: відсутній.
Conflicts of interest: authors have no conflict of interest to declare.

Надійшла до редакції / Received: 28.08.2025
Після доопрацювання / Revised: 10.11.2025
Схвалено до друку / Accepted: 18.11.2025

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