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Perforated Epithelioid Gastrointestinal Stromal Tumor Presenting as Acute Abdomen – A Rare Case Report

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Abstract

Background: *Gastrointestinal stromal tumors (GISTs) are the most common mesenchymal neoplasms of the gastrointestinal tract, arising from the interstitial cells of Cajal. Small bowel GISTs are less frequent than gastric tumors and more often display high-risk histological features. Spontaneous perforation is a rare, life-threatening complication, reported in fewer than 2% of cases, and constitutes a surgical emergency associated with peritoneal tumor dissemination and adverse oncological outcome.*

Case Presentation: *A 62-year-old woman presented with a one-day history of sudden-onset, severe, diffuse abdominal pain associated with nausea and vomiting. Examination revealed a rigid, board-like abdomen with generalized peritonism. Contrast-enhanced computed tomography demonstrated an exophytic, heterogeneous jejuno-ileal mass with central necrosis, intraperitoneal free gas, and free fluid, raising suspicion of a perforated small bowel neoplasm. Emergency exploratory laparotomy revealed generalized purulent peritonitis and a firm, exophytic tumor arising from the mesenteric border of the small bowel with a discrete perforation and surrounding haemorrhagic necrosis. En-bloc segmental small bowel resection with primary end-to-end jejuno-ileal anastomosis was performed after copious peritoneal lavage. Histopathology showed epithelioid tumor cells arising from the muscularis propria with haemorrhage, necrosis, and ulceration; immunohistochemistry demonstrated diffuse CD117 positivity, confirming epithelioid GIST.*

Conclusion: *Perforated small bowel GIST is a rare cause of acute abdomen that is seldom diagnosed pre-operatively and demands prompt surgical intervention. Emergency en-bloc resection with an intact pseudocapsule, thorough peritoneal lavage, and primary anastomosis where feasible remain the cornerstones of management. Perforation itself confers high-risk status irrespective of tumor size or mitotic index, mandating adjuvant imatinib therapy and structured long-term surveillance.*

1.Introduction

GISTs originate from the interstitial cells of Cajal and commonly express CD117 (c-KIT). Small bowel GISTs are relatively uncommon and may present with pain, bleeding, obstruction, or perforation. Perforation with generalized peritonitis is rare and associated with significant morbidity. Gastrointestinal stromal tumors (GISTs) are the most prevalent mesenchymal neoplasms of the gastrointestinal tract, with an estimated annual incidence of 11–14.5 cases per million population worldwide[1]. These tumors originate from the interstitial cells of Cajal (ICC) or their pluripotent precursor stem cells, which comprise the autonomic pacemaker network regulating gastrointestinal peristalsis. The molecular hallmark of GIST is a gain-of-function mutation in the KIT proto-oncogene (encoding the CD117 receptor tyrosine kinase), identified in approximately 80% of cases. Mutations in the PDGFRA gene (platelet-derived growth factor receptor alpha) account for a further 5–7%, while the remaining ‘10–15% of cases — termed ‘wild-type’ GISTs — are increasingly associated with deficiencies of the succinate dehydrogenase (SDH) complex or NF1 mutations.

The stomach represents the most common primary site (~60% of cases), followed by the small intestine (~30%), with the remainder distributed among the colorectum, oesophagus, and extra-gastrointestinal locations[2]. Small bowel GISTs exhibit a higher proportion of high-risk features at presentation compared to gastric counterparts, including greater mitotic activity and increased metastatic potential[3]. Clinically, small bowel GISTs most commonly manifest with occult or overt gastrointestinal haemorrhage, abdominal pain, or an incidentally identified mass on cross-sectional imaging. Acute presentations including obstruction and, rarely, spontaneous perforation with generalized peritonitis represent the most diagnostically and surgically demanding scenarios.

Histologically, GISTs are categorized as spindle cell (~70%), epithelioid (~10–20%), or mixed cell type. The epithelioid subtype is characterized by polygonal cells with abundant pale cytoplasm arranged in nests or sheets, and is preferentially associated with PDGFRA mutations in the gastric setting, with variable molecular profiles in small bowel tumours[4]. Spontaneous GIST perforation is rare, estimated to occur in fewer than 2% of all presentations, and carries profound prognostic implications owing to intraperitoneal tumor cell dissemination[5].

Herein, we present a case of spontaneously perforated epithelioid GIST arising from the jejuno-ileal region, presenting as an acute abdomen with generalized peritonitis, managed with emergency exploratory laparotomy and bowel resection with primary anastomosis. This report is prepared in accordance with the SCARE 2023 guidelines for reporting surgical case reports[6].

2. Case Presentation

2.1 Patient Demographics and Presenting Complaint

A 62 -year-old female patient, presented to the emergency department with sudden-onset, severe, diffuse abdominal pain of one-day duration. The pain was constant and non-radiating, associated with nausea and vomiting. There was no preceding history of similar episodes, altered bowel habit, haematochezia, melaena, or clinically significant weight loss.

2.2 Clinical Examination

On presentation, the patient was haemodynamically stable. Abdominal examination demonstrated a rigid, board-like abdomen with diffuse tenderness to palpation, involuntary guarding, and generalized rebound tenderness, consistent with frank peritonism. Bowel sounds were markedly diminished . No external herniae were identified.

2.3 Laboratory Investigations

In summary: leukocytosis (13×10^9/L; normal range 4.0–11.0×10^9/L); elevated C-reactive protein (12.1 mg/L); haemoglobin 9.8 g/dL. Renal biochemistry and liver function tests were within normal limits. Coagulation profile (PT, INR and aPTT) was within normal limits. Blood group and cross-match done.

2.4 Imaging Findings

Contrast-enhanced computed tomography (CECT) of the abdomen and pelvis demonstrated an exophytic, heterogeneous mass arising from the distal jejunum/proximal ileum, measuring approximately 5x4 cm. The mass exhibited asymmetric mural thickening, with central low-attenuation areas consistent with necrosis and heterogeneous peripheral enhancement following contrast administration. Intraperitoneal free gas was identified. Free intraperitoneal fluid with peritoneal thickening and fat stranding was consistent with generalized peritonitis. No hepatic metastases or mesenteric lymphadenopathy were identified. Primary CT differential diagnoses included: perforated GIST, perforated small bowel adenocarcinoma, and perforated Meckel's diverticulum.

2.5 Pre-operative Differential Diagnosis

Based on the clinical and radiological findings, the ranked pre-operative differential diagnoses were: (i) perforated gastrointestinal stromal tumor; (ii) perforated primary small bowel adenocarcinoma; (iii) perforated Meckel's diverticulum; (iv) perforated well-differentiated neuroendocrine tumor (carcinoid); and (v) perforated primary small bowel lymphoma. The exophytic growth pattern and central necrosis on CT imaging favoured a mesenchymal or submucosal origin, with GIST the leading pre-operative consideration.

2.6 Operative Findings

Following fluid resuscitation, intravenous antibiotic administration (covering Gram-negative organisms and anaerobes), and informed written consent, emergency midline exploratory laparotomy was undertaken under general anaesthesia. Intraoperatively, generalized purulent peritonitis was confirmed with turbid free fluid throughout the peritoneal cavity. A firm, exophytic tumor mass measuring approximately 4x4 cm was identified arising from the mesenteric border of the small bowel. A discrete perforation with surrounding haemorrhagic necrosis was evident at the tumor surface (Figures 1 and 2). On gross intraoperative inspection, the tumor was firm, exophytic, and bosselated, with a congested, dusky red-to-grey serosal surface and a central haemorrhagic-necrotic perforation defect measuring approximately 1–2 cm on visual estimation, consistent with the pre-operative imaging appearances. Systematic intraperitoneal exploration confirmed no hepatic or peritoneal metastases.

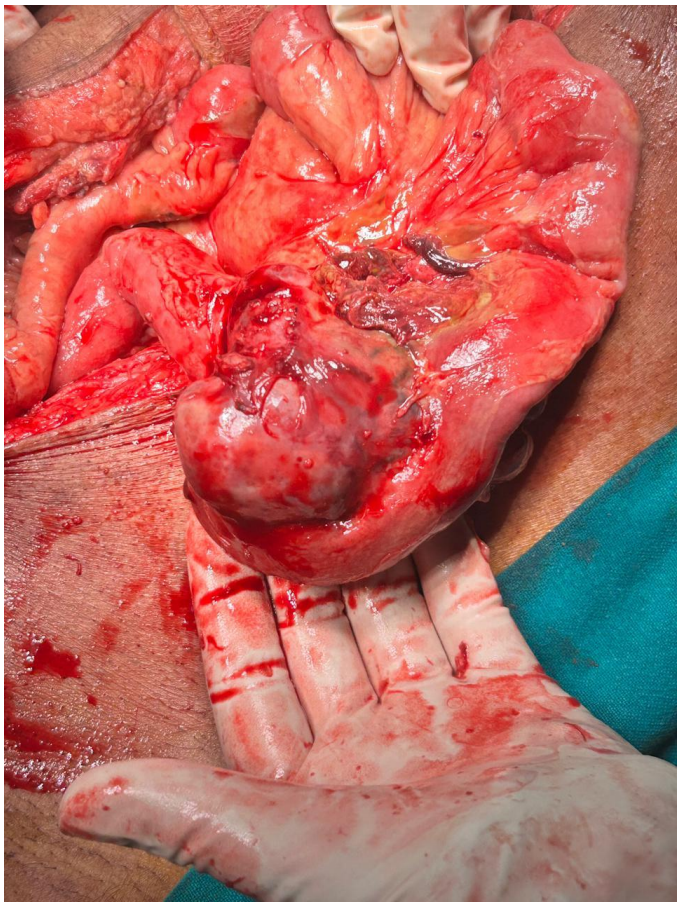


Figure 1. Intraoperative photograph showing the exteriorised tumor-bearing bowel loop, with the exophytic mass and its perforation site visible amid the small bowel loops.

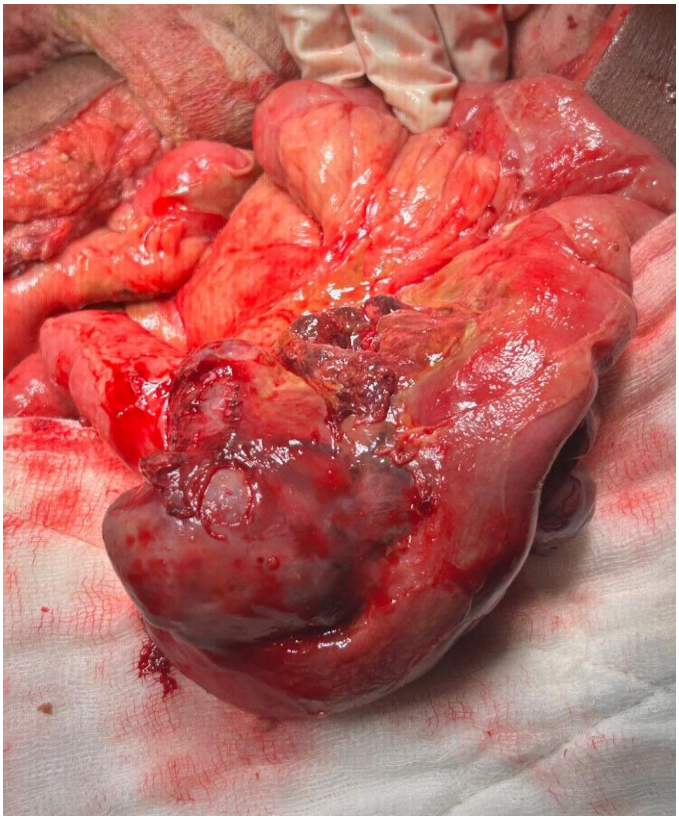


Figure 2. Intraoperative photograph (closer view) of the perforated tumor surface, showing a central haemorrhagic-necrotic defect at the site of spontaneous perforation.

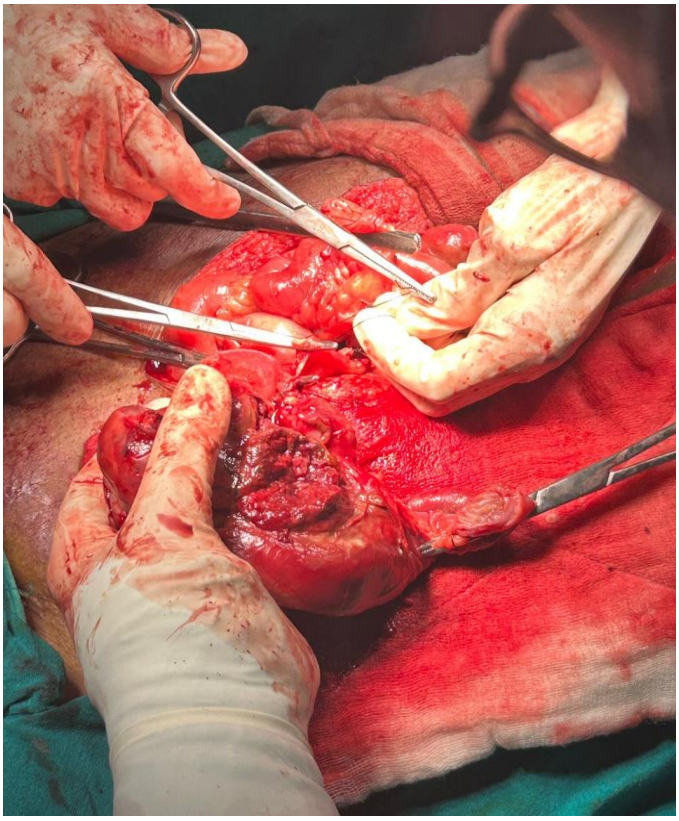


Figure 3. Intraoperative photograph showing mobilisation and exteriorisation of the tumor-bearing bowel segment with artery forceps in preparation for resection.

2.7 Surgical Procedure

En-bloc segmental small bowel resection was performed following mobilisation and exteriorisation of the tumor-bearing bowel loop (Figure 3) and isolation of the segment between bowel clamps (Figure 4), incorporating the tumor with macroscopically clear bowel margins of 6 cm proximally and 4cm distally. The tumor-bearing segment was excised en-bloc with an intact pseudocapsule (Figure 5); the freshly resected specimen (Figure 6) was set aside for histopathological submission. The mesentery was divided with appropriate clearance. Following resection, the peritoneal cavity was lavaged copiously with warm normal saline (>10 litres) until the effluent was clear. Bowel continuity was restored by primary end-to-end jejuno-ileal anastomosis (Figure 7). No diverting stoma was fashioned. The abdomen was closed in layers (Figure 8)

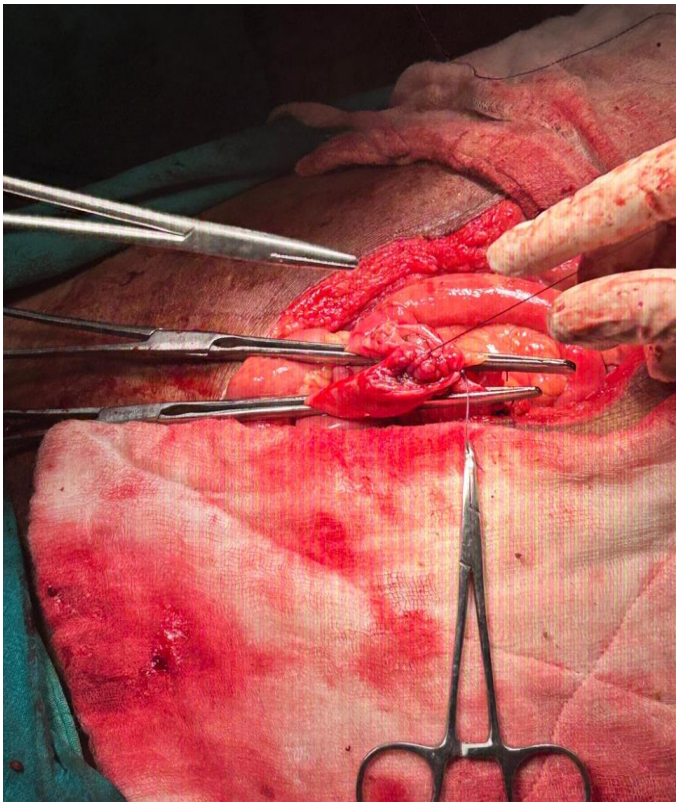


Figure 4. Intraoperative photograph showing the tumor-bearing bowel segment isolated between bowel clamps prior to en-bloc excision.

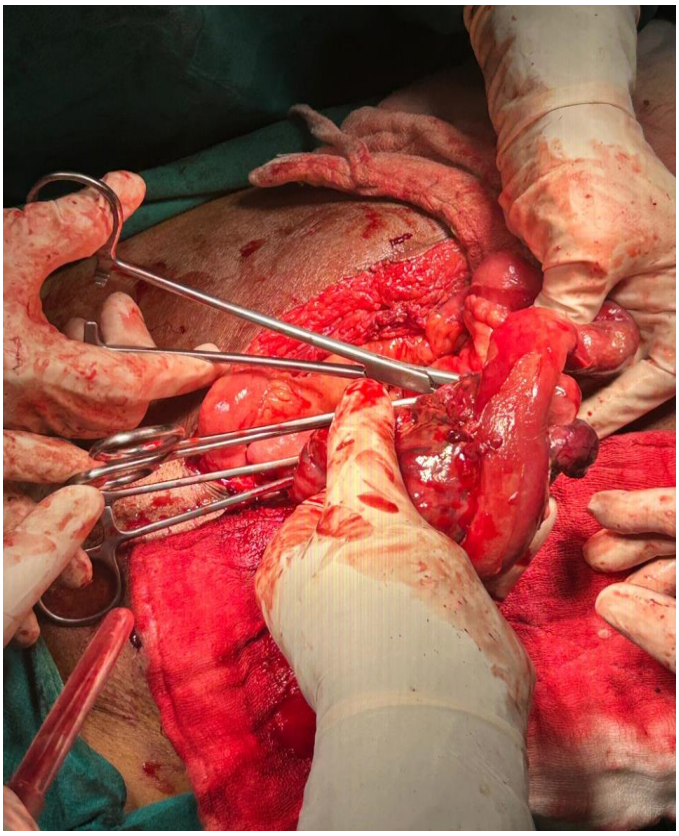


Figure 5. Intraoperative photograph showing the tumor-bearing segment clamped and mobilised, with the haemorrhagic-necrotic tumor surface visible, immediately before division of the bowel and mesentery.

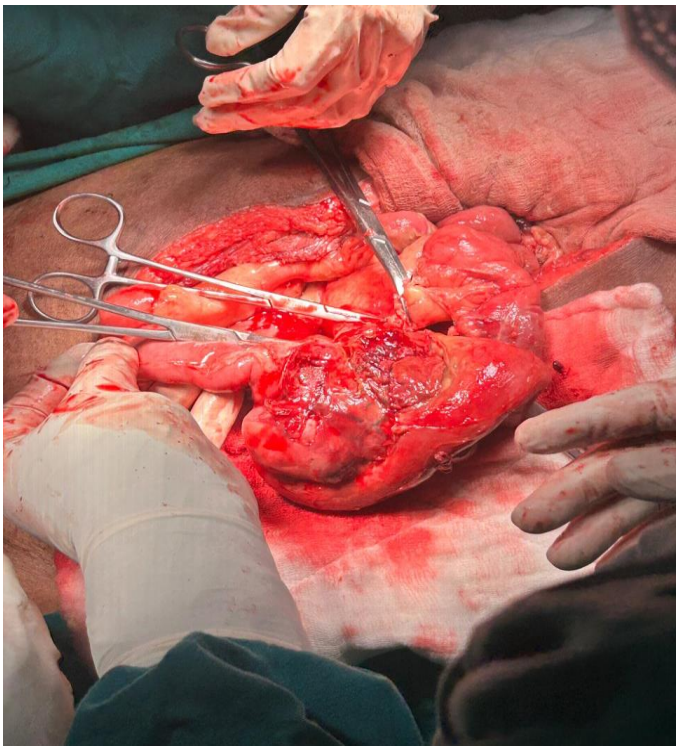


Figure 6. Intraoperative photograph of the freshly resected specimen, showing the exophytic tumor with its haemorrhagic, necrotic external surface.

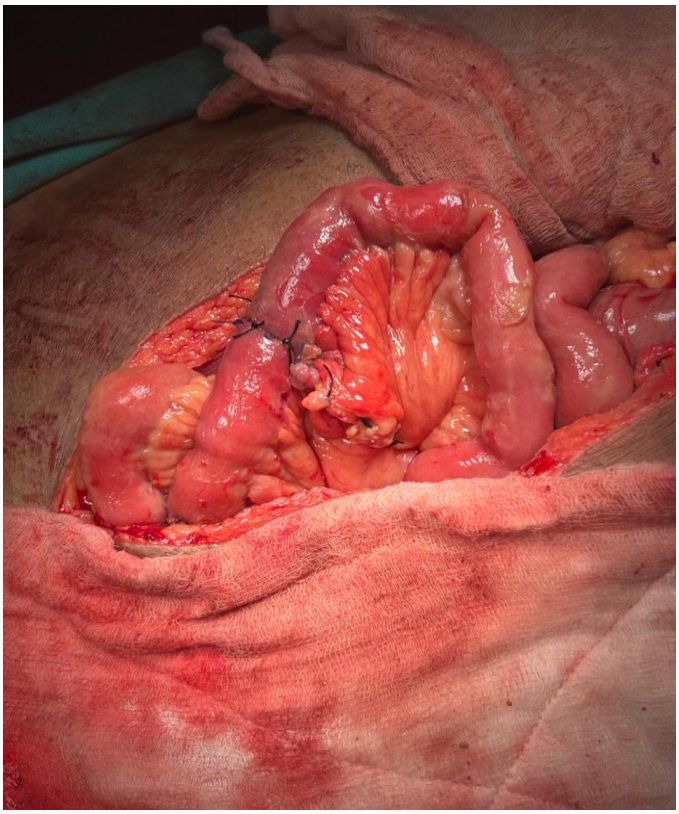


Figure 7. Intraoperative photograph showing the completed hand-sewn end-to-end jejuno-ileal anastomosis, with healthy bowel proximally and distally.



Figure 8. Postoperative photograph of the closed midline laparotomy incision with interrupted skin sutures.

2.8 Histopathology

Gross examination of the resected specimen (Figure 9) showed a firm, exophytic tumor arising from the bowel wall, measuring approximately 6 × 5 cm on gross pathological examination, with a tan-white to yellow-brown, focally haemorrhagic and necrotic cut surface. Microscopy (Figure 10) showed epithelioid tumor cells arising from muscularis propria with areas of hemorrhage, necrosis, and ulceration. Immunohistochemistry (Figures 11 and 12) demonstrated diffuse CD117 positivity confirming epithelioid GIST.



Figure 9. Gross pathology photograph of the formalin-fixed resected specimen (accession no. 4021/25) showing the exophytic tumor with a tan-white to haemorrhagic, necrotic cut surface arising from the bowel wall; a segment of adjacent bowel with mesenteric fat is seen proximally, and a ruler is shown for scale.

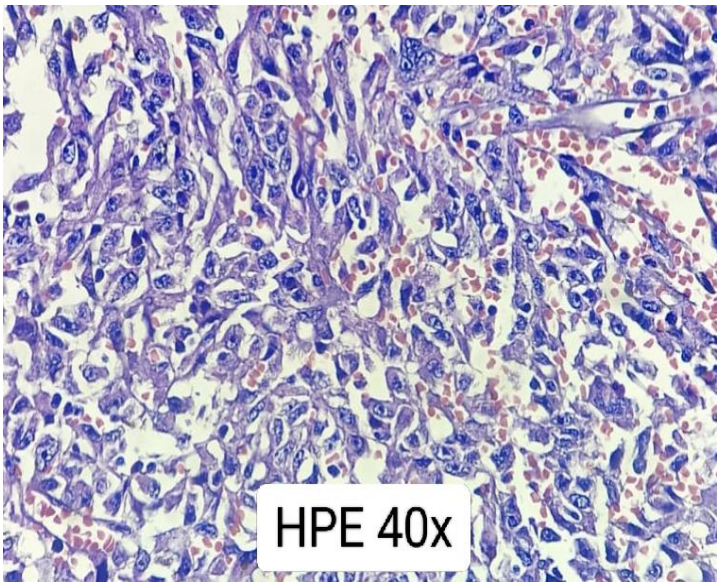


Figure 10. Photomicrograph (haematoxylin and eosin, ×40) showing epithelioid tumor cells with round-to-oval nuclei and moderate eosinophilic-to-clear cytoplasm, admixed with areas of haemorrhage.

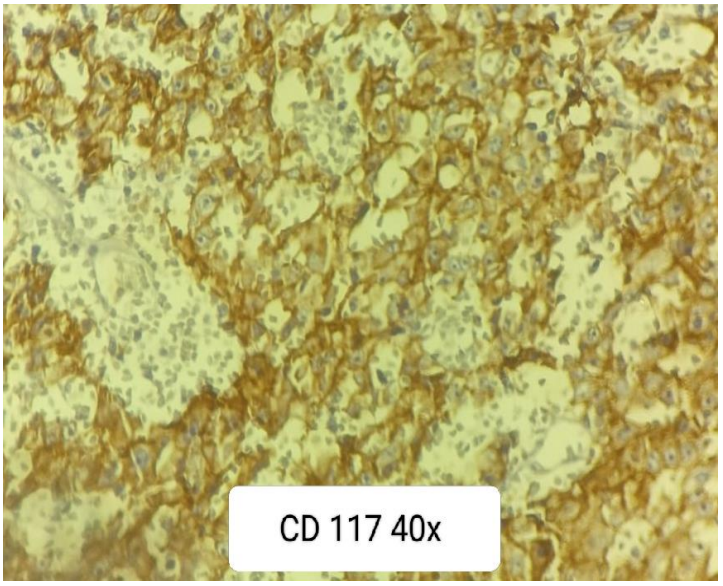


Figure 11. Photomicrograph (immunohistochemistry, CD117/c-KIT, ×40) showing diffuse strong cytoplasmic and membranous positivity in tumor cells.

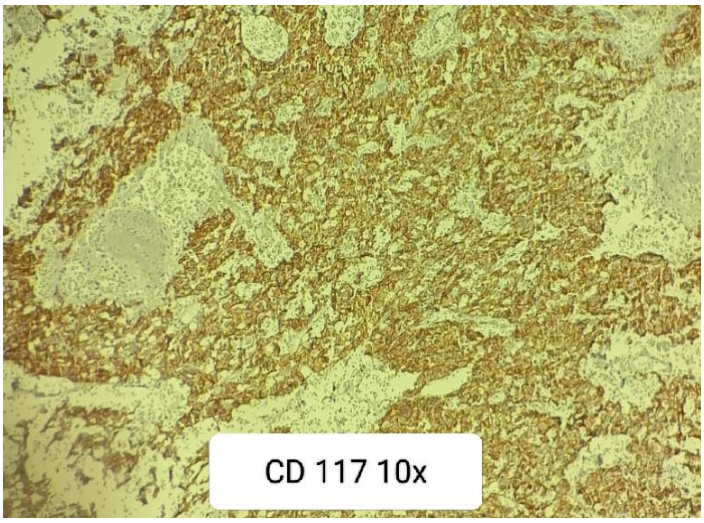


Figure 12. Photomicrograph (immunohistochemistry, CD117/c-KIT, ×10) showing diffuse CD117 positivity across the tumor at lower magnification, confirming homogeneous marker expression.

The postoperative course was uneventful. Oral feeding was resumed after the return of bowel function. The patient was discharged on postoperative day 10. Histopathology confirmed epithelioid GIST with diffuse CD117 positivity. The patient was referred to the medical oncology department for consideration of adjuvant imatinib therapy and remains under regular follow-up.

3. Discussion

3.1 Overview of Gastrointestinal Stromal Tumors

GISTs constitute a biologically and clinically distinct category within the broad spectrum of soft tissue sarcomas and gastrointestinal malignancies. The annual incidence is estimated at 11–14.5 per million globally, with a peak in the sixth and seventh decades of life and an approximately equal sex distribution[7]. Before the molecular characterisation of KIT mutations by Hirota et al. in 1998,7 and the subsequent demonstration of imatinib efficacy by Demetri et al. in 2002,8 GISTs were frequently misclassified as leiomyomas, leiomyosarcomas, or neural tumors, and were managed without effective systemic therapy. The identification of constitutively activating tyrosine kinase mutations as the primary oncogenic driver transformed GIST into one of the earliest paradigms of molecularly targeted oncology[8].

3.2 Molecular Pathogenesis

The oncogenesis of GIST is driven predominantly by gain-of-function mutations in the KIT gene (~80% of cases), most commonly in exon 11 (juxtamembrane domain, ~70% of KIT-mutant GISTs), followed by exon 9 (~10%), and less frequently exons 13 and 17. Exon 11 mutations are associated with the most favourable imatinib response, while exon 9 mutations (predominantly the A502_Y503dup insertion, occurring almost exclusively in small bowel GISTs) exhibit a less robust response to standard-dose imatinib (400 mg/day) and may benefit from high-dose therapy (800 mg/day).

PDGFRA mutations (~5–7%) occur predominantly in gastric tumors of the epithelioid subtype. The D842V substitution in PDGFRA exon 18, accounting for approximately 65% of PDGFRA-mutant GISTs, confers primary imatinib resistance but has become targetable with avapritinib, as demonstrated in the NAVIGATOR phase 1 trial.9 Wild-type GISTs, lacking KIT/PDGFRA mutations, are heterogeneous and include SDH-deficient tumors (characterized by SDHB loss on IHC), NF1-associated tumors, and those harbouring BRAF or RAS pathway alterations. Recognition of molecular subtype is essential before initiating systemic therapy, as therapeutic sensitivities differ substantially.

3.3 Small Bowel GIST: Site-Specific Characteristics

Small intestinal GISTs account for 25–30% of all GISTs and exhibit distinct clinicopathological features relative to the more common gastric tumours.2,3 Histologically, small bowel GISTs more frequently display spindle cell morphology, higher mitotic rates, and greater proportions of high-risk tumors at presentation. The predominant growth pattern is exophytic or transmural, which explains both the less frequent obstructive presentation and the predisposition to intraperitoneal complications, including haemorrhage and perforation. The preferential small bowel location of exon 9 KIT mutations is clinically significant, as these tumors may require modified systemic therapy.

The AFIP/Miettinen classification demonstrates that site of origin is an independent prognostic variable:

small bowel GISTs carry a significantly higher risk of disease-related mortality compared to gastric tumors at equivalent size and mitotic count, underscoring the importance of site-specific risk stratification[3].

3.4 Epithelioid GIST: Pathological and Molecular Characteristics

Epithelioid GISTs are defined by a predominance (≥50%) of polygonal epithelioid cells with abundant clear-to-eosinophilic cytoplasm, distinct cell borders, and rounded nuclei with prominent nucleoli, arranged in nests, sheets, or alveolar patterns[4]. This morphology differs fundamentally from the more common spindle cell architecture and may present a diagnostic challenge, as the cellular appearance can superficially mimic carcinoma, carcinoid tumor, paraganglioma, or metastatic melanoma on haematoxylin and eosin examination.

In the gastric setting, the epithelioid phenotype is strongly associated with PDGFRA mutations, particularly D842V. In small-bowel epithelioid GISTs, as in the present case, KIT mutations may be present, and immunohistochemical profiling alongside molecular analysis is essential to guide therapeutic decision-making. The epithelioid subtype per se does not independently confer a worse prognosis when tumor size, mitotic rate, and site are controlled; however, the co-occurrence of epithelioid morphology, small bowel location, and perforation in the present case is a confluence of adverse features with compounding prognostic implications.

3.5 Mechanisms of Spontaneous Perforation

Spontaneous perforation of GIST is estimated to occur in fewer than 2% of all presentations, though the true incidence may be underreported given the diagnostic confusion in the emergency setting[5]. Two principal pathophysiological mechanisms have been proposed: (i) progressive exophytic tumor expansion with central ischaemia and necrosis consequent to outstripping the vascular supply, leading to pseudocapsule breakdown and rupture into the peritoneal cavity; and (ii) intraluminal mucosal ulceration secondary to direct ischaemic erosion, with sequential transmural perforation. In small bowel GISTs, the exophytic growth pattern renders the former mechanism predominant.

The clinical consequence of either mechanism is peritoneal soiling with viable tumor cells, fundamentally altering the oncological prognosis by creating a microenvironment permissive of peritoneal seeding and implantation. This mechanism mirrors the adverse biological consequences of iatrogenic intraoperative tumor rupture, which is why both events are accorded equivalent prognostic weight in current guidelines[10].

3.6 Differential Diagnosis of Acute Abdomen Secondary to GIST

The acute abdominal presentation of perforated GIST encompasses a broad differential diagnosis. In the emergency setting, the principal alternatives to GIST perforation include: perforated peptic ulcer (gastric or duodenal); Crohn's disease with transmural fistulisation or free perforation; perforated Meckel's diverticulum; primary small bowel adenocarcinoma with perforation; small bowel lymphoma (Burkitt or diffuse large B-cell lymphoma); perforated carcinoid tumor; mesenteric ischaemia with secondary perforation; and, in endemic regions, intestinal tuberculosis or typhoid enteritis[11].

The identification of an exophytic, heterogeneous mass with central necrosis on CT imaging, as opposed to a focal mural defect at a pre-existing ulcer site, should alert the operating surgeon to the possibility of a primary bowel neoplasm rather than an inflammatory perforation. This has direct surgical implications, as the operative strategy for GIST—prioritising en-bloc resection with an intact pseudocapsule and avoidance of rupture—differs meaningfully from the approach to peptic ulcer or diverticular perforation.

3.7 Role of Contrast-Enhanced CT in the Emergency Setting

Contrast-enhanced CT of the abdomen and pelvis is the standard imaging modality for acute abdominal evaluation and provides critical diagnostic and surgical planning information[12]. In the context of GIST, characteristic features on CECT include: an exophytic or endoluminal heterogeneous mass with a

smooth, well-defined pseudocapsular margin; central low-attenuation areas representing necrosis, haemorrhage, or cystic degeneration; peripheral heterogeneous enhancement on portal venous phase; and an exo-intestinal predominant growth pattern.

When perforation supervenes, the CT image is superimposed with findings of intraperitoneal free gas (which may be quantitatively less prominent than in peptic perforation due to the extraluminal nature of tumor rupture), free intraperitoneal fluid with peritoneal enhancement, and mesenteric fat stranding. The absence of lymphadenopathy is characteristic of GIST and helps distinguish it from lymphoma or adenocarcinoma on imaging. Liver metastases, when present, are typically hypervascular on arterial-phase imaging. CT also facilitates preoperative surgical planning by delineating mesenteric and vascular anatomy.

3.8 Histopathological Assessment

Definitive GIST diagnosis and prognostication require thorough histopathological assessment of adequately sampled, formalin-fixed, paraffin-embedded (FFPE) tissue. Macroscopic assessment should document tumor dimensions (three-axis measurement), consistency, haemorrhagic or necrotic areas, cystic change, and resection margin status. Microscopic assessment must include: cell type (spindle, epithelioid, or mixed); mitotic rate (expressed per 50 HPF, counted in the area of highest mitotic activity); depth of invasion; serosal penetration; mucosal involvement; and lymphovascular invasion[13].

In the index case, the combination of epithelioid morphology, muscularis propria origin, haemorrhage, necrosis, and ulceration, while histologically non-specific in isolation, provided a strong indication for GIST in the clinical context of an acute bowel perforation, which was subsequently confirmed by immunohistochemistry.

3.9 Immunohistochemical Diagnosis

Immunohistochemistry plays a pivotal role in confirming the diagnosis of GIST, particularly when histomorphological features overlap with other mesenchymal neoplasms. CD117 (c-KIT), expressed in approximately 95% of GISTs, remains the most sensitive and widely used diagnostic marker. In the present case, diffuse strong CD117 positivity confirmed the diagnosis of epithelioid GIST in conjunction with the characteristic histological features.

DOG1 (Discovered on GIST-1) demonstrates high sensitivity and specificity for GIST, including a proportion of CD117-negative tumours, and is particularly valuable in PDGFRA-mutant GISTs. CD34 is co-expressed in approximately 60–70% of cases and supports the diagnosis, whereas SMA may show focal positivity. In contrast, diffuse desmin positivity favours smooth muscle tumours, while S-100 positivity suggests a neural tumour such as schwannoma. Ki-67 is not routinely required for diagnosis but may provide additional information regarding tumour proliferative activity.

3.10 Surgical Management Principles

Complete surgical resection with histologically negative margins (R0) is the foundation of curative-intent GIST management.15 In the elective setting, laparoscopic resection yields oncologically equivalent outcomes to open surgery for tumors ≤5 cm at experienced high-volume centres. In the emergency setting of perforation with generalized peritonitis, open midline exploratory laparotomy — as performed in the index case — remains the mandatory approach.

Critical intraoperative principles include: (i) en-bloc resection with intact pseudocapsule, avoiding tumor incision, biopsy, or piecemeal removal, as any breach of tumor integrity is equivalent to rupture; (ii) attainment of a macroscopic margin of at least 1–2 cm of normal bowel; (iii) avoidance of extensive lymphadenectomy, which is not indicated as GIST rarely metastasises via the lymphatic route; (iv) copious peritoneal lavage following perforation; and (v) assessment for synchronous hepatic or peritoneal metastases[15]. Primary anastomosis is feasible in haemodynamically stable patients without massive faecal contamination; in unstable patients or those with severe peritoneal soiling, a damage-control strategy with temporary stoma formation is appropriate.

3.11 Oncological Significance of Tumour Rupture and Perforation

Tumour rupture — whether spontaneous or iatrogenic — represents arguably the most adverse prognostic event in GIST management. Analysis from retrospective cohort studies and multivariate analyses consistently demonstrates that rupture increases the risk of peritoneal recurrence fivefold or more compared to intact resection. Rupture effectively converts a potentially curative resection into a scenario biologically analogous to stage IV peritoneal disease, as viable GIST cells are disseminated throughout the peritoneal cavity. In recognition of this profound impact, current ESMO 2022 guidelines classify tumor rupture or perforation as an independent criterion for high-risk status, overriding size and mitotic rate parameters.10 Practically, this means that even a small (e.g., 2 cm), low-mitotic-rate tumor that has perforated is managed identically to a high-risk tumor — with three years of adjuvant imatinib and long-term surveillance imaging.

4. Conclusion

Perforated epithelioid GIST of the small bowel presenting as an acute abdomen with generalized peritonitis is an exceedingly rare surgical emergency. In the acute setting, the clinical and radiological presentation is indistinguishable from other causes of hollow viscus perforation, making pre-operative tissue diagnosis unattainable. Emergency exploratory laparotomy with en-bloc segmental bowel resection, maintaining an intact pseudocapsule, thorough peritoneal lavage, and primary anastomosis in selected stable patients is the cornerstone of management. Histopathological examination with appropriate immunohistochemical profiling, particularly CD117 and DOG1 where available, remains the diagnostic gold standard. and provides essential prognostic data. Risk stratification using the NIH/Fletcher and AFIP/Miettinen systems must be performed, with perforation automatically conferring high-risk status irrespective of tumor size or mitotic rate. All patients require multidisciplinary team review, adjuvant imatinib therapy, molecular mutational analysis, and structured long-term oncological surveillance. Continued reporting of such rare presentations contributes to the evolving evidence base for the complex surgical and oncological management of perforated GIST.

References

1. Joensuu H, Hohenberger P, Corless CL. Gastrointestinal stromal tumor. Lancet. 2013;382(9896):973-83.
2. Kindblom LG, Remotti HE, Aldenborg F, Meis-Kindblom JM. Gastrointestinal pacemaker cell tumor (GIPACT): gastrointestinal stromal tumors show phenotypic characteristics of the interstitial cells of Cajal. Am J Pathol. 1998;152(5):1259–1269.
3. Miettinen M, Makhlouf H, Sobin LH, Lasota J. Gastrointestinal stromal tumors of the jejunum and ileum: a clinicopathologic, immunohistochemical, and molecular genetic study of 906 cases before imatinib with long-term follow-up. Am J Surg Pathol. 2006;30(4):477–489.
4. Schaefer IM, DuBois A, Schildhaus HU, et al. Epithelioid gastrointestinal stromal tumors: a series of 18 cases with emphasis on morphologic and molecular features. Virchows Arch. 2021;479(3):491–502.
5. Nishida T, Goto O, Raut CP, Yahagi N. Diagnostic and treatment strategy for small gastrointestinal stromal tumors. Cancer. 2016;122(20):3110–3118.
6. Sohrabi C, Mathew G, Maria N, et al. The SCARE 2023 guideline: updating consensus Surgical CAse REport (SCARE) guidelines. Int J Surg. 2023;109(5):1136–1140.
7. Hirota S, Isozaki K, Moriyama Y, et al. Gain-of-function mutations of c-kit in human gastrointestinal stromal tumors. Science. 1998;279(5350):577–580.
8. Demetri GD, von Mehren M, Blanke CD, et al. Efficacy and safety of imatinib mesylate in advanced gastrointestinal stromal tumors. N Engl J Med. 2002;347(7):472–480.

9. Heinrich MC, Jones RL, von Mehren M, et al. Avapritinib in advanced PDGFRA D842V-mutant gastrointestinal stromal tumor (NAVIGATOR): a multicentre, open-label, phase 1 trial. Lancet Oncol. 2020;21(7):935–946.
10. Casali PG, Blay JY, Abecassis N, et al. Gastrointestinal stromal tumors: ESMO–EURACAN–GENTURIS Clinical Practice Guidelines for diagnosis, treatment and follow-up. Ann Oncol. 2022;33(1):20–33.
11. Tavernaraki K, Tavernaraki E, Vassiliou I, et al. Unusual causes of acute bowel perforation. Ann Gastroenterol. 2022;35(2):122–134.
12. Sandrasegaran K, Rajesh A, Rydberg J, Rushing DA, Akisik FM, Henley JD. Gastrointestinal stromal tumors: clinical relevance of computed tomography findings. AJR Am J Roentgenol. 2005;184(5):1607–1613.
13. Fletcher CD, Berman JJ, Corless C, et al. Diagnosis of gastrointestinal stromal tumors: a consensus approach. Hum Pathol. 2002;33(5):459–465.
14. West RB, Corless CL, Chen X, et al. The novel marker, DOG1, is expressed ubiquitously in gastrointestinal stromal tumors irrespective of KIT or PDGFRA mutation status. Am J Pathol. 2004;165(1):107–113.
15. Raut CP, Espat NJ, Maki RG, et al. Efficacy and tolerability of 5-year adjuvant imatinib treatment for patients with resected intermediate- or high-risk primary gastrointestinal stromal tumor: the PERSIST-5 Clinical Trial. JAMA Oncol. 2018;4(12):e184060.