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Synchronous Low-Grade Appendiceal Mucinous Neoplasm, Perforated Ascending Colon Diverticulitis, and Mature Ovarian Cystic Teratoma in a 52-Year-Old Female: Diagnostic Challenges and Surgical Decision-Making

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A R T I C L E I N F O

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A B S T R A C T

Introduction. Low-grade appendiceal mucinous neoplasm (LAMN) is a rare mucin-producing epithelial tumor identified in roughly 0.13–1% of appendectomies, with a recognized risk of pseudomyxoma peritonei (PMP) on rupture. Synchronous coexistence with perforated ascending colon diverticulitis and an ipsilateral ovarian mature cystic teratoma is exceptional and creates a triple-layered diagnostic and operative challenge. **Case Presentation.** A 52-year-old Indonesian female presented with one month of right lower quadrant (RLQ) pain that worsened over forty-eight hours, accompanied by nausea and vomiting. Examination revealed McBurney tenderness, local muscular defense, and a palpable RLQ mass. Leukocytosis with neutrophilic predominance (white blood cells $19.18\times10^3/\mu L$; neutrophils 91%) was noted. Ultrasonography demonstrated a lobulated, hyperechoic pelvic mass measuring 10.46 cm. Contrast-enhanced computed tomography showed a solid–cystic pelvic lesion with fat and calcification consistent with mature cystic teratoma alongside a periappendicular infiltrate. Exploratory laparotomy disclosed ~50 mL of purulent fluid, an abnormally enlarged appendix, multifocal ascending colon diverticulitis with perforation, dense adhesions, and a right ovarian mass. Right hemicolectomy with transverse colon stump and end ileostomy together with total abdominal hysterectomy and bilateral salpingo-oophorectomy (TAH-BSO) were performed. Histopathology confirmed LAMN with periappendicular infiltrate and a mature cystic teratoma of the right ovary.**Conclusion.** Coexistence of LAMN, perforated colonic diverticulitis, and mature ovarian teratoma can mimic adnexal or inflammatory disease and obscure recognition of the appendiceal neoplasm. Vigilant intra-operative inspection of the appendix and adjacent colon, oncologically appropriate resection, and definitive histopathology are essential to prevent PMP.

1. Introduction

The vermiform appendix is a small, blind-ending lymphoid-rich tubular structure attached to the cecum. Although historically considered a vestigial organ, it is increasingly recognized for its immunologic role and as a reservoir for commensal flora that supports recovery of the colonic microbiome after dysbiosis.[1,2] It is also home to a heterogeneous spectrum of neoplastic and non-neoplastic conditions ranging from acute appendicitis and diverticula to neuroendocrine tumors and mucinous neoplasms. Among these, low-grade appendiceal mucinous neoplasm (LAMN) is a distinctive entity defined by neoplastic mucinous epithelium that replaces the normal appendiceal mucosa, accompanied by intraluminal and often extra-appendiceal mucin accumulation.[1-3]

LAMN is uncommon, accounting for 0.13–1% of all appendectomy specimens depending on the series. A

large German cohort of 108,247 appendectomies reported an incidence of only 0.13%, whereas selected American and Asian series approached 1%.[3-5] Despite its rarity, recognition of LAMN matters because intra-peritoneal release of mucin and neoplastic epithelium—whether through frank rupture or through inapparent transmural leak—can give rise to pseudomyxoma peritonei (PMP), a slowly progressive but ultimately lethal condition characterized by gelatinous ascites and a redistribution phenomenon that coats peritoneal surfaces.[6-9]

Clinically, LAMN is treacherous. The classical teaching that it presents with right lower quadrant pain mimicking acute appendicitis applies to a minority of cases. The majority are detected incidentally during imaging or surgery performed for another indication.[2,10,11,12] The radiologic vocabulary developed around the mucocele—"onion-skin sign" on ultrasonography, well-defined cystic tubular mass with mural calcification on CT, and the "volcano sign" at colonoscopy—is helpful when present, but is absent in a substantial proportion of cases.[10,12,13] Differentiating LAMN from an adnexal mass is particularly difficult in women older than fifty, in whom both pathologies coexist at appreciable rates and the imaging features can overlap.[11,14]

Coexistent right lower quadrant pathology magnifies these difficulties. Diverticular disease of the right colon, although less prevalent than left-sided disease in Western populations, is well described in Asian and African cohorts. Inflammation of ascending colon diverticula produces wall thickening, pericolic fat stranding, and on occasion perforation, all of which radiologically overlap with appendicular abscess and with the periappendicular infiltrate that frequently accompanies LAMN.[4,13,15] Adding a mature cystic teratoma of the right ovary—with its tell-tale fat, calcium, and dermoid plug—produces an imaging picture in which the gynecologic lesion captures the radiologist's attention, while the more clinically meaningful LAMN remains under-appreciated until laparotomy.[14,16]

Surgical management of LAMN is fundamentally about removing the lesion intact before mucinous spill occurs. Current international guidance from the American Society of Colon and Rectal Surgeons (ASCRS) and PSOGI supports appendectomy with negative margins when disease is confined to the appendix. Right hemicolectomy is recommended for tumors at the appendiceal base, for positive margins, for synchronous colonic pathology, and when intra-operative findings cannot exclude invasive adenocarcinoma.[1,6,17,18] When PMP is established, definitive treatment shifts to cytoreductive surgery combined with hyperthermic intraperitoneal chemotherapy (HIPEC) at high-volume centers.[8,9]

Despite this clarity at the extremes, an under-discussed gray zone exists when LAMN coexists with perforated colonic diverticulitis and an ovarian mass requiring its own oncologic clearance. In low- and middle-income regional hospitals, multidisciplinary input must be assembled rapidly without recourse to intra-operative frozen-section pathology or on-site peritoneal oncology programs. The literature offers few case-based templates that integrate the surgical decision tree across all three pathologies.[11,14,15]

To our knowledge, the simultaneous occurrence of histologically confirmed LAMN, multifocal perforated ascending colon diverticulitis, and an ipsilateral mature cystic ovarian teratoma in a single patient has not been previously documented in the surgical literature from a district referral hospital setting. This case report aims to (i) describe the clinical, radiologic, intra-operative, and pathologic features of a 52-year-old female with this rare triad; (ii) analyze the diagnostic pitfalls that led to an incomplete preoperative diagnosis; (iii) detail the intra-operative decision pathway that converted a presumed gynecologic procedure into a combined oncologic colectomy plus TAH-BSO; and (iv) synthesize current literature into a practical surveillance pathway aimed at preventing pseudomyxoma peritonei.

2. Case Presentation

Ethics statement

Written informed consent for publication of de-identified clinical data and images was obtained from the patient. Institutional approval was waived for single-patient case reports as per local policy.

Demographic and presenting complaint

A 52-year-old multiparous Indonesian female presented to the emergency department of Klungkung Regional General Hospital with right lower quadrant (RLQ) abdominal pain that had persisted for one

month and acutely worsened over the forty-eight hours preceding admission. The pain was crampy, intermittent at first and then constant, and was accompanied by three episodes of non-bilious, non-bloody vomiting and by nausea. The patient denied fever, weight loss, hematemesis, melena, hematochezia, urinary symptoms, vaginal bleeding, or vaginal discharge. Flatus and stool passage were normal. The patient was post-menopausal and had no history of malignancy, chronic illness, prior abdominal surgery, or recent travel. She had been referred from Gema Santi Nusa Penida Regional General Hospital after an initial three-day in-patient stay during which intravenous Ringer's lactate, ceftriaxone 2 g intravenously every 24 hours, ibuprofen 400 mg three times daily, and intravenous omeprazole 40 mg twice daily had been administered without clinical improvement.

Past medical and surgical history

The patient initially experienced epigastric pain that migrated to the RLQ over one month—a migration pattern that may suggest acute appendicitis when it occurs over hours, but which over weeks favors a sub-acute inflammatory or neoplastic process. An outpatient consultation with a general practitioner during that month had yielded only oral analgesia without symptomatic improvement. There was no history of tuberculosis, hepatitis, diabetes mellitus, hypertension, or coagulopathy. The patient denied non-steroidal anti-inflammatory drug overuse, smoking, alcohol intake, and herbal-medicine use. Menarche occurred at age 13 and menopause at age 50; she had three vaginal deliveries and reported no prior pelvic infections.

Physical examination

On arrival, the patient was alert and oriented with a Glasgow Coma Scale of E4V5M6. Vital signs were blood pressure 120/70 mmHg, heart rate 89 beats per minute, respiratory rate 20 breaths per minute, axillary temperature 36.0 °C, and oxygen saturation 98% on room air. The skin and conjunctivae were not pale or icteric. Cardiopulmonary examination was unremarkable. Abdominal examination revealed mild distension with tenderness localized to McBurney's point, voluntary guarding, and a firm, ill-defined, tender palpable mass in the RLQ approximately 10 cm in greatest dimension. Rovsing's sign was positive. Bowel sounds were present but reduced. A digital rectal examination was unremarkable; a per-vaginal examination revealed a non-tender cervix, no adnexal tenderness on bimanual palpation, and confirmed an extra-uterine RLQ mass.

Laboratory investigations

Initial laboratory studies are summarized in Table 1. Table 1 presents the complete blood count, leukocyte differential, hepatic and renal function, electrolytes, and random blood glucose obtained on admission. The principal abnormalities were marked leukocytosis with neutrophilic predominance (white blood cells $19.18\times10^3/\mu L$; neutrophils 91%), suggesting an active inflammatory or infective process, and mildly elevated serum creatinine (1.4 mg/dL) consistent with pre-renal azotemia from inadequate oral intake. Hemoglobin and platelet counts were within reference ranges, lymphocytes and eosinophils were depressed in a typical pattern of acute bacterial stress, and electrolytes were within reference ranges. Liver enzymes were normal. Tumor markers (CEA, CA-125, and CA 19-9) were not available at the index admission.

Ultrasonography

As shown in Figure 1, transabdominal ultrasonography performed on admission demonstrated a hyperechoic, lobulated lesion with well-defined borders, thickened walls, and regular edges in the midline of the pelvic cavity. The lesion measured AP 10.20 × LL 10.44 × CC 10.46 cm. The lesion abutted the bowel loops in the RLQ; the typical onion-skin layering described in classical mucocele was not appreciated, and the appendix could not be reliably visualized due to overlying bowel gas. The provisional ultrasonographic interpretation was a pelvic abscess versus an intra-abdominal mass of indeterminate origin. The probe was placed both transabdominally and over McBurney's point; vascularity within the lesion was mild on colour Doppler.

Table 1. Initial laboratory test results on admission.

Test Group / Subgroup	Parameter	Result	Unit	Reference range
Hematology – Complete blood count	Hemoglobin	15.4	g/dL	10.8 – 16.5
	White blood cells*	**19.18**	$\times 10^3/\mu L$	3.5 – 10.0
	Red blood cells	5.2	$\times 10^6/\mu L$	3.5 – 5.5
	Hematocrit	44.7	%	35 – 55
	Platelets	155	$\times 10^3/\mu L$	145 – 450
Leukocyte differential	Neutrophils†	**91**	%	39.3 – 73.7
	Lymphocytes	4.2	%	18.0 – 48.3
	Monocytes	4.4	%	4.4 – 12.7
	Eosinophils	0.04	%	0.60 – 7.30
	Basophils	0.11	%	0.00 – 1.70
Red-cell indices	MCV	85.4	fL	81.1 – 96.0
	MCH	29.5	pg	27.0 – 31.2
	MCHC	34.5	%	31.5 – 35.0
	RDW-CV	12.8	%	11.5 – 14.5
	MPV	7.62	fL	6.90 – 10.6
Liver enzymes	AST	35	U/L	8 – 37
	ALT	31	U/L	13 – 42
Renal function	Urea	36	mg/dL	10 – 50
	Creatinine‡	**1.4**	mg/dL	0.6 – 1.2
Electrolytes	Sodium (Na)	145	mmol/L	135 – 145
	Potassium (K)	3.5	mmol/L	3.5 – 4.5
	Chloride (Cl)	103	mmol/L	95 – 105
Glycemia	Random blood glucose	121	mg/dL	80 – 200

*Notes: *Marked leukocytosis with neutrophilic predominance (91%) suggested an acute inflammatory or infective focus. †Neutrophil predominance >85% in a clinically septic-appearing abdomen mandated urgent imaging and surgical evaluation. ‡Mild creatinine elevation reflected pre-renal azotemia from poor intake; it normalized after fluid resuscitation.*

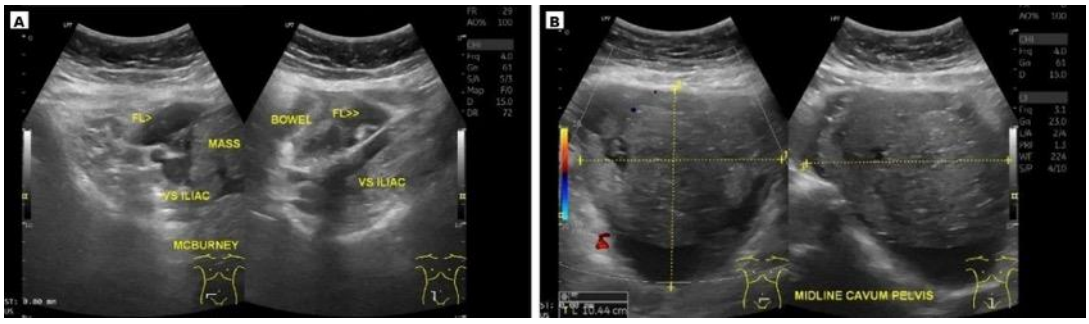

Figure 1. Abdominal ultrasonography (A and B) showed a hyperechoic, lobulated lesion (10.46 cm) with thick walls and well-defined borders in the midline pelvis, with adjacent bowel and the iliac vessels labelled; appearance favored an abscess or intra-abdominal mass of indeterminate origin.

Contrast-enhanced computed tomography

Contrast-enhanced CT of the abdomen and pelvis (Figure 2) was performed to characterize the pelvic mass and the right lower quadrant infiltrate. Two principal abnormalities were demonstrated. First, in the RLQ a focal densification of the bowel wall with adjacent fat stranding and entrapped air, accompanied by an enhancing tubular structure within an inflammatory phlegmon, was suggestive of a periappendicular infiltrate with mucinous content; classic features of LAMN such as mural calcification

or an elongated low-density tubular cyst were not unequivocally present. Second, in the pelvis a heterogeneous solid–cystic mass with internal echoes, fat density, calcifications, and a discrete septation strongly favored a right ovarian mature cystic teratoma.

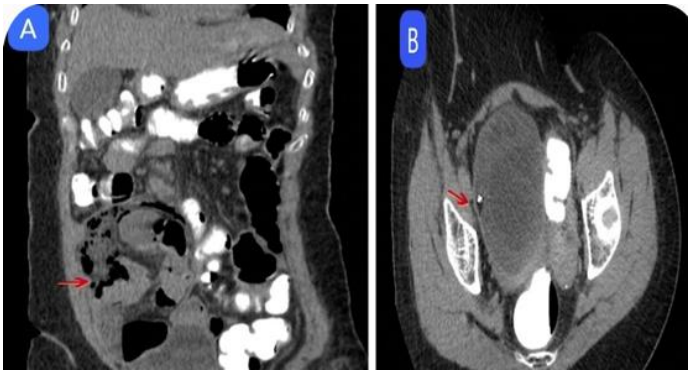

Figure 2. Contrast-enhanced abdominal CT. (A) Densification with surrounding fat stranding and intramural air density in the RLQ, accompanied by an enhancing tubular structure within a colonic phlegmon, suggestive of periappendicular infiltrate. (B) A septated solid–cystic pelvic mass with fat, internal echoes, and calcification—features classical for a mature cystic teratoma.

On the basis of these imaging findings, the working preoperative diagnosis was: (i) right ovarian mature cystic teratoma, (ii) periappendicular infiltrate with possible abscess, and (iii) ascending colon inflammatory mass of indeterminate etiology. The differential diagnoses entertained were appendiceal mucocele, mucinous neoplasm of the appendix, complicated diverticulitis of the right colon, and—less likely—a cecal adenocarcinoma. Tumor markers were ordered but the result was not available before surgery.

Operative findings and surgical strategy

After hydration, intravenous broad-spectrum antibiotics (ceftriaxone 2 g IV every 24 hours plus metronidazole 500 mg IV every 8 hours), and informed consent for an exploratory laparotomy with possible right hemicolectomy and TAH-BSO, the patient was taken to the operating theatre. A combined surgical team consisting of the digestive surgery service and the obstetrics and gynecology service performed the procedure. The abdomen was entered via a lower midline incision and methodically explored. Approximately 50 mL of purulent peritoneal fluid was aspirated and sent for culture. The appendix was identified as abnormally enlarged, with a thickened, dilated lumen and a serosa coated with fibrin and mucin-like material; no frank free intra-peritoneal mucin pools or peritoneal nodules consistent with established pseudomyxoma peritonei were visualized.

Dense inflammatory adhesions were encountered between the ascending colon and the right lobe of the liver, the gallbladder fundus and the transverse mesocolon, the cecum and the parietal peritoneum, and the right adnexa and the right ovarian mass. Adhesiolysis was performed sharp and blunt under direct vision. The ascending colon revealed multiple inflamed diverticula, two of which had frankly perforated and were sealed by adjacent omentum and small bowel loops; the perforation sites were proximal to the periappendiceal phlegmon, and pus tracked along the right paracolic gutter. The right ovary contained a 10-cm thick-walled cystic mass with intra-cystic sebaceous content. The contralateral adnexa appeared grossly normal. The uterus showed mild fibroid changes.

After consultation between the surgical and gynecologic teams, and given the synchronous presence of (i) an abnormal appendix highly suspicious for a mucinous neoplasm, (ii) perforated ascending colon diverticulitis, and (iii) an ovarian mass requiring oncologic clearance in a post-menopausal patient, the operative plan was extended. An oncologically formal right hemicolectomy was performed with high ligation of the ileocolic and right colic vessels, en-bloc removal of the diseased ascending colon and appendix and their lymphovascular pedicles, and resection of the involved omentum. Given pre-existing contamination from diverticular perforation and the risk of an anastomotic

complication in an already inflamed bed, a transverse colon stump and an end ileostomy were fashioned rather than a primary ileo-transverse anastomosis. The gynecologic team then performed a total abdominal hysterectomy with bilateral salpingo-oophorectomy (TAH-BSO). Copious warm saline lavage, peritoneal drain placement, and a layered abdominal closure completed the procedure.

Histopathology

Gross examination of the right hemicolectomy specimen revealed an enlarged appendix measuring 9.5 × 3 × 2.5 cm with a dilated, mucin-filled lumen and a flattened mucosa. Histopathology (Figure 3, panels A–D) demonstrated a denuded mucosal lining with proliferation of flat, mucin-producing columnar epithelium of low-grade cytologic atypia, dispersed villous and undulating papillary configurations, loss of the lamina muscularis mucosae, prominent submucosal fibrosis, and abundant intraluminal extracellular mucin. Lymphoid tissue in the submucosa was markedly diminished. The serosa of the mesoappendix and adjacent appendicular bed showed dense polymorphonuclear and mononuclear inflammatory infiltrates with dilated congested vessels and focal extra-appendiceal mucin extrusion without identifiable neoplastic epithelium beyond the appendiceal wall. The resection margins of the ileum, transverse colon stump, and mesentery were free of neoplastic epithelium. Multifocal diverticulosis with peri-diverticular abscess formation and serosal fibropurulent inflammation was documented in the ascending colon segment. The constellation supported a diagnosis of low-grade appendiceal mucinous neoplasm (LAMN) with localized periappendicular mucinous and inflammatory spill but no high-grade dysplasia and no invasion. Histopathology of the right adnexectomy specimen (Figure 3, panel E) demonstrated a thick-walled fibrotic ovarian cyst lined by keratinized stratified squamous epithelium with skin appendages, sebaceous glands, mature adipose tissue, and cartilaginous foci—features diagnostic of a mature cystic teratoma. No immature elements, no germ-cell neoplasia in situ, and no malignant transformation were identified. The contralateral ovary, both fallopian tubes, the uterine corpus, and the cervix were unremarkable on routine sections.

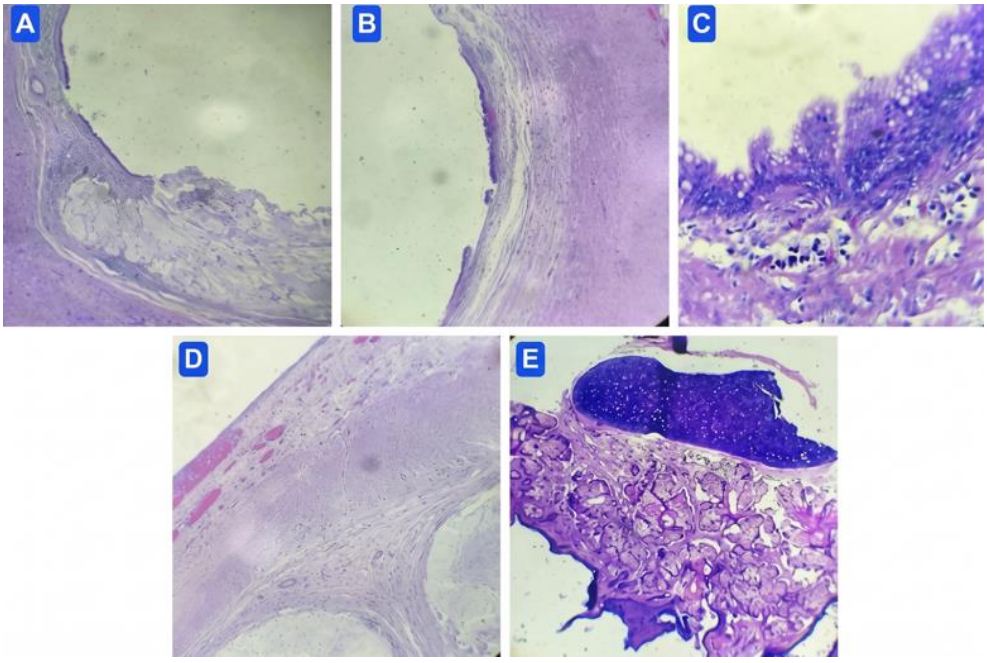

Figure 3. Histopathology of the appendix and ovarian specimens (hematoxylin–eosin). (A) Appendiceal lumen distended by intra-luminal mucin and flattened mucinous epithelium. (B) Mucosal denudation with absent lymphoid tissue and loss of crypts. (C) Higher-magnification view (×40) showing low-grade mucinous epithelium with villous undulation. (D) Periappendiceal infiltrate with polymorphonuclear and mononuclear cells and focal mucinous extravasation. (E) Right ovarian cyst wall lined by keratinized stratified squamous epithelium with skin appendages, sebaceous glands, mature adipose tissue, and a focus of cartilage—features diagnostic of a mature cystic teratoma.

Postoperative course

The patient was transferred to the intensive care unit (ICU) postoperatively for one day for hemodynamic monitoring, then to the general surgical ward for four additional days. The postoperative regimen comprised intravenous ceftriaxone 2 g every 24 hours and metronidazole 500 mg every 8 hours for seven days, escalating oral diet from clear fluids to soft solids by day 3, multimodal analgesia with intravenous paracetamol and rescue intramuscular ketorolac, and standard venous thromboprophylaxis. The peritoneal drain was removed on postoperative day 4, the ileostomy was functioning by day 2, and the abdominal wound healed by primary intention. The patient was discharged on postoperative day 5 with oral cefixime 200 mg twice daily for one week, paracetamol 500 mg three times daily, ibuprofen 400 mg three times daily as needed, omeprazole 20 mg twice daily, ileostomy care training, and an outpatient surveillance plan including serial CEA, CA 19-9, and CA-125 measurements and a follow-up contrast-enhanced CT of the abdomen and pelvis at three months. Reversal of the ileostomy was planned for three months after the index operation pending surveillance and nutritional optimization.

3. Discussion

Low-grade appendiceal mucinous neoplasm is in itself uncommon. PSOGI-defined LAMN was identified in only 0.13% of 108,247 appendectomies in one large German series and in 1% of selected American series.[1-3] Even rarer is its synchronous occurrence with histologically confirmed perforated ascending colon diverticulitis and ipsilateral mature cystic teratoma of the ovary—a constellation that, to our knowledge, has not been documented in detail in surgical literature. The three pathologies share an anatomical address (right lower quadrant) but radically different biological behaviors: LAMN is an indolent epithelial neoplasm whose principal hazard is mucinous spill into the peritoneum; diverticulitis is an acute inflammatory disease whose hazard is perforation and sepsis; and mature cystic teratoma is a benign germ-cell tumor whose hazard, in a post-menopausal woman, is occult malignant transformation. Each demanded oncologically and physiologically appropriate clearance.[6,16,17]

The clinical phenotype was dominated by the most acutely symptomatic process—colonic diverticulitis with perforation—and by the most radiologically striking lesion—the teratoma. The LAMN, the most prognostically meaningful of the three, was the quietest. This sequence is consistent with the observation in published series that LAMN often masquerades as another disease and is recognized only after imaging or surgery for another indication.[11,14,15]

Three principal pitfalls operated in this case. First, the temporal evolution of the pain—an indolent epigastric ache migrating over a month to the RLQ—departed from the textbook acute-appendicitis trajectory and led both the patient and the initial outpatient provider to rely on analgesia. Second, the radiologic signal-to-noise ratio was dominated by the teratoma. Fat, calcium, and septation on CT are stereotyped "aha" findings that anchor the radiologist's report; meanwhile the LAMN's tubular cystic enhancement was buried inside a phlegmon attributed to periappendicular infiltrate, exactly the pattern Kindie and colleagues describe in their report of LAMN mimicking an adnexal tumor and Lu and colleagues describe as "diagnostic uncertainty" in chronic right-sided pain.[11,14] Third, in the absence of preoperative tumor markers and intra-operative frozen-section pathology, the operative team had to rely on macroscopic appearance and clinical judgment to identify the appendix as neoplastic; only the unusual size and texture of the appendiceal wall, against a background of multifocal diverticular perforation, raised suspicion.[6,12,15]

LAMN arises from neoplastic mucinous epithelium replacing the normal columnar mucosa of the appendix. Molecularly, GNAS and KRAS mutations are characteristic, supporting a clonal monoepithelial origin distinct from cecal adenocarcinoma.[1,2] Mucin retention within the obstructed appendix produces progressive distension, mural attenuation, loss of muscularis mucosae, submucosal fibrosis, and lymphoid atrophy—each documented in this case. As intraluminal pressure rises, mucinous spill can occur through frank rupture or microscopic transmural leak. Once neoplastic epithelium reaches the peritoneal cavity, the redistribution phenomenon—gravitational pooling in the pelvis, sub-diaphragmatic

recesses, and omentum—drives the development of PMP.[7-9]

The presence of periappendicular mucinous and inflammatory extravasation in our specimen, in the absence of identifiable neoplastic epithelium beyond the appendiceal wall, is best classified under PSOGI's framework as "low-grade mucinous neoplasm confined to appendix with localized peritoneal extension" (pT4a)—a category at intermediate risk of recurrence as PMP that mandates structured imaging and tumor-marker surveillance.[1,6,18,19]

Right-sided diverticulitis differs from its sigmoid counterpart in epidemiology and pathogenesis. It is more common in younger Asian patients and typically reflects true congenital diverticula rather than acquired pulsion diverticula. When the diverticular pouch obstructs, the same pathophysiologic sequence as left-sided disease applies: bacterial overgrowth, local inflammation, perforation, and pericolic abscess.[4,15] The proximity of perforated ascending colon diverticulitis to a LAMN-bearing appendix is anatomically plausible. Inflammatory adhesions tether the appendix to a diseased segment and can either occlude the appendiceal lumen and predispose it to mucinous distension, or distort the appendiceal wall during inflammation and contribute to the periappendicular infiltrate that confounds radiology. We did not find a published anatomically detailed coexistence series, but the case literature suggests that any inflammatory process that thickens the caeco-colonic junction can mask a mucinous neoplasm.[15]

In a post-menopausal woman presenting with RLQ pain and a 10-cm pelvic mass, the differential diagnosis is broad. (1) Adnexal neoplasia—benign serous or mucinous cystadenomas, mature cystic teratoma, borderline ovarian tumors, and frank ovarian carcinoma. (2) Appendiceal pathology—periappendicular abscess, mucocele of any etiology, LAMN, appendiceal neuroendocrine tumor, and appendiceal adenocarcinoma. (3) Colonic pathology—diverticular abscess, cecal adenocarcinoma, and Crohn's stricture. (4) Uterine pathology—pyometra, large fibroid, leiomyosarcoma. (5) Mesenteric or peritoneal pathology—tuberculous peritonitis, lymphoma, gastrointestinal stromal tumor. The radiologic "fingerprints" of mature cystic teratoma (fat, calcification, septation) are highly specific, and once present the diagnosis is rarely missed; what is more often missed is a second concurrent pathology, especially LAMN, whose radiologic features are non-specific.[12,13,16]

Ultrasonography is rapid and inexpensive, and in expert hands the "onion-skin sign" of layered echogenic mucin within a tubular cyst is reasonably specific for an appendiceal mucinous neoplasm.[10,12] In our patient the lesion was hyperechoic and lobulated but without the classic layering; we do not therefore criticize the original ultrasonographic interpretation. Contrast-enhanced CT remains the cornerstone modality, with reported sensitivity around 83% and specificity around 92% for LAMN, but its diagnostic accuracy collapses in the setting of an adjacent inflammatory mass, as occurred here. MRI offers superior soft-tissue contrast and may distinguish solid from cystic components and characterize mucin, but data on its accuracy for LAMN are limited.[10,12,13] Colonoscopy can demonstrate the "volcano sign" at the appendiceal orifice and contribute to differential diagnosis, but it is rarely available before emergency surgery and is uncomfortable in a patient with peritonitis. Tumor markers (CEA, CA 19-9, CA-125) lack sensitivity and specificity individually but, taken serially, are useful for surveillance.[6,8,17,18]

Definitive diagnosis of LAMN is histopathologic. The PSOGI Delphi consensus and subsequent classifications define LAMN as a low-grade mucinous epithelial neoplasm with one or more of: loss of muscularis mucosae, fibrosis of the submucosa, "pushing" invasion, undulating or flat epithelial growth, mucin dissection of the wall, and rupture with extra-appendiceal mucin.[1,2,20] Our patient's specimen displayed all of these features. The differential under the microscope includes appendiceal diverticulum—where the mucosa herniates through a wall defect without neoplastic epithelium—and high-grade appendiceal mucinous neoplasm (HAMN), which features high-grade cytologic dysplasia.[2,4] Lowes and colleagues recently codified the histomorphologic criteria that separate LAMN from complicated appendiceal diverticular disease in the largest series to date, demonstrating that misclassification of diverticular disease as LAMN occurred in 71% of pathologist consultations; their criteria—retention of

normal mucosal architecture, regular crypt arrangement, and absence of nuclear abnormalities throughout the crypts—anchor the distinction adopted in our case.[4]

The decisive question in our case was whether to limit resection to an appendectomy plus drainage of pericolic abscess and a planned interval gynecologic procedure, or to perform a synchronous oncologic right hemicolectomy plus TAH-BSO. Five arguments supported escalation. (i) The appendix was macroscopically suspicious for a neoplasm. (ii) The ascending colon was the site of multiple perforated diverticula; a damage-control approach with right hemicolectomy and end ileostomy avoided the substantial leak risk of a primary anastomosis in an actively infected bed.[6,17] (iii) The ovarian mass required oncologic clearance because, in a post-menopausal patient, the probability of an occult borderline or malignant component was non-trivial.[16] (iv) The patient had already undergone three days of unsuccessful conservative management at an outside facility; further temporization risked frank rupture of the appendix and frank establishment of PMP.[7,8,9] (v) Multi-staged surgery imposes a logistic and financial burden on the patient and her family in a regional district setting; one definitive procedure was likely to be both more oncologically adequate and more humane.

Counter-arguments included the operative time of a combined three-team procedure, the loss of bowel continuity from an end ileostomy, and the absence of frozen-section pathology to confirm the LAMN diagnosis intra-operatively. After balancing these considerations and obtaining informed consent, the decision to proceed with a combined definitive procedure was made by consensus. Glasgow and colleagues' ASCRS guidelines explicitly endorse right hemicolectomy when synchronous colonic pathology coexists with a suspected appendiceal neoplasm.[6] The 2019 abdominal-radiology and HIPEC review by Bartlett and colleagues, and the 2025 integrated review by Mitamura and colleagues, both reinforce that oncologically appropriate resection at the index operation reduces downstream PMP risk.[12,17]

Primary ileo-transverse colonic anastomosis is the standard reconstruction after right hemicolectomy in the absence of contamination. In our case, ~50 mL of frank pus tracked along the right paracolic gutter, and pre-existing diverticular perforation rendered the operative field heavily contaminated. The risk of an anastomotic leak under those conditions has been reported to exceed 15% in some series. An end ileostomy and transverse-colon stump provided proximal diversion, allowed unhurried recovery of the inflamed colonic wall, and permitted controlled reversal in three months. This staged strategy follows damage-control principles applicable in regional hospitals where intensive postoperative imaging and re-laparotomy resources are limited.[6,15,17]

In a post-menopausal woman with a 10-cm pelvic mass, the residual ovarian function is negligible, and the risk of occult malignancy or torsion exceeds the benefit of preserving the contralateral ovary. The decision for bilateral salpingo-oophorectomy plus hysterectomy followed standard gynecologic-oncologic practice and was performed by the obstetrics and gynecology team in the same operative sitting, taking advantage of established surgical access. Final histopathology fortunately confirmed a benign mature cystic teratoma without immature elements or malignant transformation, an outcome which was not assured pre-operatively and which justifies oncologic clearance in similar scenarios.[16]

Even when LAMN is judged to be confined and adequately resected, focal extra-appendiceal mucinous extravasation—as identified histologically in our patient—places her at intermediate risk of subsequent PMP.[6,18,19] Recommended surveillance comprises (i) clinical review at three months and every six months thereafter for the first three years; (ii) serial CEA, CA 19-9, and CA-125 measurements every three to six months; (iii) annual contrast-enhanced CT or MRI of the abdomen and pelvis for five years; and (iv) prompt referral to a peritoneal-surface oncology center at the first evidence of mucinous peritoneal deposits. Although our hospital does not offer on-site cytoreductive surgery with HIPEC, the surveillance pathway above is achievable in a district setting and ensures timely referral if PMP develops. Chua and colleagues' multi-center series demonstrated meaningful long-term survival after CRS plus HIPEC for appendiceal-origin PMP, reinforcing the value of early detection.[8,9]

Several recent reports illuminate the diagnostic difficulty of LAMN. Kindie and colleagues described a LAMN mimicking a malignant ovarian tumor in an Ethiopian patient; Lu and colleagues reviewed eleven reports of preoperative diagnostic uncertainty; Liu and colleagues reported a peri-orificial LAMN managed by double purse-string appendectomy; Edwards and colleagues distinguished a perforated appendiceal diverticulum from a neoplasm in chronic appendicitis.[11,14,15,21] In contrast to the single-pathology phenotype of those reports, our patient carried three concurrent pathologies. Our case is therefore best understood as an extension of those reports: when imaging suggests adnexal pathology in the RLQ in a woman over 50, the surgical team should plan operatively for the possibility of a coexistent appendiceal mucinous neoplasm and a coexistent colonic perforation, and should construct an operative roadmap that can flex from gynecologic-only surgery to combined oncologic surgery on the basis of intra-operative findings. The 2025 integrative review by Mitamura and colleagues argues for a similar treatment-strategy framework based on clinical, histological and molecular features.[17]

Table 2 presents a structured comparison of our case with the four most directly relevant published reports. The unique feature of the present case is the synchronous occurrence of three independent right lower quadrant pathologies and the corresponding need for a combined three-team operative plan, whereas the comparator series uniformly describe a single appendiceal pathology with at most one additional finding.

Table 2. Comparison of the present case with the most relevant published reports of LAMN with diagnostic or operative complexity.

Author, Year (Country)	Patient (age / sex)	Clinical presentation	Imaging findings	Operative procedure	Final pathology & outcome
Present case, Sandika & Yustina, 2026 (Indonesia)¶	**52 / F**	**One-month RLQ pain with two-day exacerbation, McBurney tenderness, palpable RLQ mass**	**USG: lobulated pelvic mass 10.46 cm; CT: solid-cystic adnexal mass with fat and calcification, plus periappendicular infiltrate**	**Right hemicolectomy + transverse colon stump + end ileostomy + TAH-BSO (combined surgery and gynecology teams)**	**LAMN + perforated ascending colon diverticulitis + mature ovarian cystic teratoma; ICU 1 d, ward 4 d, structured 5-yr PMP surveillance**
Kindie et al., 2025 (Ethiopia)	45 / F	Chronic RLQ pain with palpable mass	CT suggested malignant adnexal lesion	Right hemicolectomy + right salpingo-oophorectomy	LAMN initially mistaken for ovarian malignancy; uneventful recovery
Lu et al., 2024 (USA)	61 / F	Intermittent abdominal pain with diagnostic uncertainty over 14 months	CT: cystic appendiceal mass mimicking abscess	Appendectomy with mucinous-spill precautions	LAMN confined to appendix; surveillance instituted, no PMP at 6 months
Liu et al., 2025 (China)	58 / F	Incidental finding during colonoscopy for screening	Cystic lesion at appendiceal orifice on CT	Appendectomy with double purse-string suture at appendiceal base	LAMN at appendiceal orifice; complete resection, no recurrence at follow-up
Edwards et al., 2024 (USA)	70 / M	Chronic right lower abdominal pain	CT showing chronic appendicitis with cystic dilatation	Laparoscopic appendectomy	Perforated appendiceal diverticulum — distinguished from LAMN on histology

Notes: ¶The present case is highlighted in the first row. Abbreviations: F = female; M = male; LAMN = low-grade appendiceal mucinous neoplasm; RLQ = right lower quadrant; USG = ultrasonography; CT = computed tomography; TAH-BSO = total abdominal hysterectomy with bilateral salpingo-oophorectomy; ICU = intensive care unit; PMP = pseudomyxoma peritonei

Several limitations merit explicit acknowledgement. First, preoperative tumor markers (CEA, CA 19-9, CA-125) were not available in time to inform the operative plan; this is common in regional Indonesian hospitals but constrains the diagnostic algorithm we can endorse. Second, intra-operative frozen-section pathology was not available; the operative escalation to right hemicolectomy was therefore informed by macroscopic findings rather than microscopic confirmation. Third, molecular profiling (GNAS, KRAS, TP53) was not performed, limiting comparison with biologically characterized cohorts.[1,2] Fourth, we cannot extrapolate from a single case to a general algorithm; further multi-center experience will be required to define when prophylactic peritonectomy or empirical HIPEC may be justified at the index

operation in a patient with focal mucinous extravasation. Fifth, our follow-up at the time of writing is short; long-term PMP risk will be quantified only after several years of surveillance.

The reported incidence of appendiceal mucinous neoplasms has risen progressively over the past two decades. Marmor and colleagues, in a population-based analysis of United States data between 2000 and 2009, documented an increase in age-adjusted appendiceal cancer incidence from 0.97 to 1.32 per 100,000 person-years, attributable in part to improved pathologic recognition of mucinous tumors and to increased use of cross-sectional imaging.[5] Smeenk and colleagues, in a Dutch population-based study, reported that appendiceal mucinous neoplasms account for approximately half of all cases of pseudomyxoma peritonei.[22] Female predominance is consistent across these series, with the mean age at diagnosis between fifty-five and sixty years. Our patient's demographic profile is therefore typical of the at-risk population, and the prevalence of the disease is high enough that surgeons in district hospitals should expect to encounter several cases over a career. Reliable incidence data for Indonesia are not available; the present case is a small contribution to addressing that gap and emphasizes the need for a national appendiceal pathology registry.

Molecular characterization of LAMN has matured. Whole-exome and targeted sequencing studies have repeatedly identified activating mutations of GNAS (codons 201 and 227) and KRAS (codons 12, 13, and 61) as defining drivers of low-grade mucinous neoplasms.[1,2,17] TP53 mutations and chromosomal complexity are more common in high-grade mucinous neoplasms and in invasive adenocarcinoma, whereas LAMN typically displays a relatively quiet genome. The clinical implication is that biologic targeting—either of the cyclic adenosine monophosphate–protein kinase A pathway downstream of GNAS or of the MAPK cascade downstream of KRAS—remains investigational; current trials of MEK inhibitors and of GNAS-targeted strategies are preliminary. Molecular profiling is not currently mandated for management decisions in LAMN confined to the appendix, but emerging data suggest that in patients with established PMP, mutational status may stratify the response to cytoreductive surgery and HIPEC.[6,8,9,17]

District referral hospitals in low- and middle-income countries provide care for the majority of surgical patients globally yet contribute only a small fraction of published surgical literature. Several practical realities shape decisions here that differ from those in tertiary centers. Frozen-section pathology is rarely available; intra-operative consultation must rely on macroscopic appraisal and on the operating surgeon's pattern recognition. Tumor-marker turnaround time is days rather than hours, so surgical plans cannot await results in an unstable patient. Magnetic resonance imaging is often not accessible during emergency admission, and computed tomography may be limited to a single dual-phase study. Cytoreductive surgery with HIPEC is centralized at a few tertiary referral centers, often in a different province, with delays in referral that are measured in months rather than weeks. These constraints place a premium on definitive index operations whenever it can be done safely, and on robust postoperative surveillance pathways that flag PMP early so that timely referral can salvage long-term outcome. The strategy adopted in this case—oncologically formal right hemicolectomy with end ileostomy, concurrent TAH-BSO, and structured five-year surveillance with tumor markers and cross-sectional imaging—reflects an attempt to apply the principles of evidence-based surgical oncology to a resource-realistic delivery model.[6,8,17]

Drawing the threads of this case together, several practical lessons emerge for surgeons working in district referral hospitals. A high index of suspicion for an unrecognized appendiceal mucinous neoplasm should accompany every evaluation of a woman over fifty who presents with a right lower quadrant pelvic mass, even when imaging is dominated by an adnexal lesion; in ambiguous radiology, preoperative measurement of carcinoembryonic antigen, carbohydrate antigen 19-9 and CA-125, together with a radiology report that actively searches for a tubular cystic mass, mural calcification and the onion-skin sign in addition to commenting on the dominant lesion, materially improves diagnostic accuracy. When the appendix appears macroscopically abnormal at laparotomy, an en-bloc oncologic resection is generally preferable to a simple appendectomy, especially when the adjacent colon is also diseased or when frozen-

section pathology is unavailable; in the setting of perforated colonic diverticulitis with right-sided contamination, an end ileostomy and transverse colon stump remain safer than a primary ileo-transverse anastomosis. The operative note should document the precise location and amount of any extra-appendiceal mucin, and the pathologist should be asked to sample generously around the appendiceal serosa, the mesoappendix and the peritoneal recesses so that PSOGI staging is accurate.[1,2,7,8,9] A structured five-year surveillance pathway with serial tumor markers and cross-sectional imaging is essential, and prompt referral to a peritoneal-surface oncology center should be triggered at the first evidence of mucinous peritoneal deposits. Above all, a multidisciplinary roadmap—surgery, gynecology, radiology and pathology working in deliberate sequence before the operating-theatre door opens—saves intra-operative time and improves oncologic adequacy, and is in our view the single most important institutional investment for any district hospital that wishes to manage complex right lower quadrant pathology safely.[6,11,12,17,18]

4. Conclusion

Low-grade appendiceal mucinous neoplasm is a rare but consequential diagnosis whose timely recognition prevents progression to pseudomyxoma peritonei. When it coexists with perforated ascending colon diverticulitis and a mature ovarian cystic teratoma, the radiologic spotlight tends to fall on the adnexal lesion and the most acutely symptomatic colonic process, while the appendiceal neoplasm remains under-appreciated until laparotomy. In our 52-year-old patient, careful intra-operative inspection of the appendix and the adjacent colon, oncologically appropriate resection by right hemicolectomy with transverse colon stump and end ileostomy, concomitant TAH-BSO performed by the gynecology team, and complete histopathologic characterization combined to deliver an outcome consistent with current PSOGI and ASCRS guidance. The case reinforces the value of an explicit multidisciplinary roadmap—surgery, gynecology, radiology, and pathology in deliberate sequence—in district referral hospitals, and the importance of a structured five-year surveillance pathway with serial tumor markers and cross-sectional imaging to ensure that pseudomyxoma peritonei, the principal long-term threat, is detected promptly if it develops.

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