

Mucinous tumors of the ovary

Morphologic spectrum · pathogenesis · diagnostic interpretation

Benign cystadenoma | borderline tumor | primary mucinous carcinoma

Dr Abu Suraih Sakhri

MBBS, MD (Pathology)

www.abusuraihsakhri.com

Learning objectives

- Classify ovarian mucinous tumors by epithelial proliferation and stromal invasion.
- Recognize the key gross and microscopic findings.
- Explain the proposed roles of KRAS and possible cells of origin.
- Distinguish primary ovarian disease from metastatic and peritoneal mucinous disease.

Ovarian epithelial tumor classification

Epithelial differentiation



Mucinous phenotype



Behavioral category

Ovarian epithelial neoplasms are classified by both epithelial type and degree of proliferation/invasion.

Two distinct axes describe a mucinous neoplasm

Axis	Question answered	Major categories
Differentiation	What epithelial type is present?	Mucinous, serous, endometrioid
Behavior	How does epithelium grow?	Benign, borderline, invasive

A mucinous phenotype does not alone establish a tumor's malignant potential.

Common as tumors; Uncommon as ovarian cancers

20–25%

Of all ovarian neoplasms are mucinous

≈3%

Of all ovarian cancers are primary mucinous carcinomas

Different denominators explain why these proportions should not be compared as if equivalent.

Clinical age distribution

- Mucinous tumors occur principally in middle adult life.
- They are rare before puberty.
- They are also uncommon after menopause.
- Age is contextual information, not a microscopic criterion for malignancy.

Most mucinous tumors are not invasive

≈80%

Benign

≈10%

Borderline

≈10%

Malignant

Approximate distribution in the ovarian tumor frequency table; Distinct from the fraction of all ovarian cancers.

Three levels of mucinous tumor behavior

Benign

Simple mucinous lining

No invasive growth described

Borderline

Epithelial proliferation

No stromal invasion

Carcinoma

Invasive architecture

Expansile and/or destructive stromal invasion

Type I ovarian carcinoma: Conceptual progression

Benign precursor



Borderline proliferation



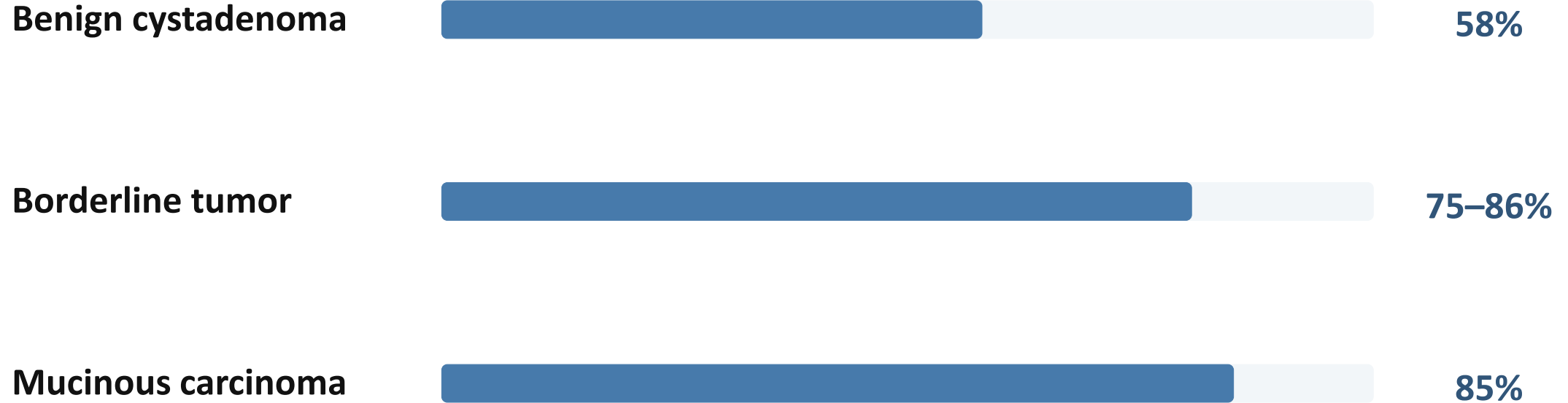
Low-grade carcinoma

Mucinous carcinoma within the type I epithelial ovarian carcinoma pathway; Not every individual tumor must follow each step.

KRAS is a recurring molecular alteration

- KRAS is a proto-oncogene frequently mutated in ovarian mucinous tumors.
- Mutations are reported in benign, borderline, and malignant categories.
- This shared molecular feature is compatible with a lineage relationship among morphologically different areas.
- It does not itself define stromal invasion.

KRAS mutations span the morphologic spectrum



Frequencies reported, 11th ed.; Borderline values represent a range.

Shared KRAS mutations: What a single tumor can show

Benign-appearing area



Borderline-appearing area



Malignant-appearing area

Identical KRAS mutations across distinct morphologic regions in a reported study support a possible early initiating alteration, not certainty about individual progression.

Initiation is different from invasion

Molecular alteration

A KRAS mutation may occur early in tumor development.

Supports pathogenesis

Morphologic progression

Epithelial architecture and cytology can vary.

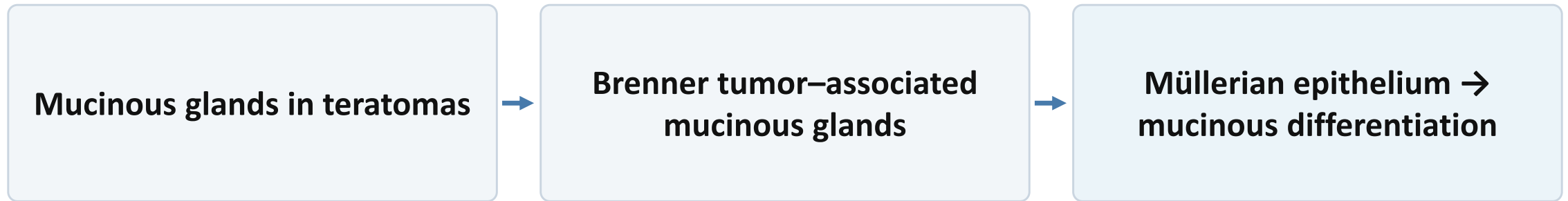
Requires histology

Invasive disease

Expansile or destructive patterns indicate carcinoma.

Requires evaluation of growth pattern

Possible cells of origin remain diverse



These are proposed origins, not three required sequential stages.

Why histogenesis has been debated

- Normal ovarian tissue lacks a straightforward resident counterpart of benign mucinous epithelium.
- The diversity of gastric, intestinal, and occasional endocervical differentiation complicates simple origin models.
- Associated teratomatous, Brenner, and müllerian epithelia supply plausible alternative origins.
- No single pathway is presented as universal.

Three proposed origin routes

Teratomatous

Mucin-producing glands within teratoma

Potential source in a subset

Brenner-associated

Mucinous glands associated with a Brenner tumor

Potential source in a subset

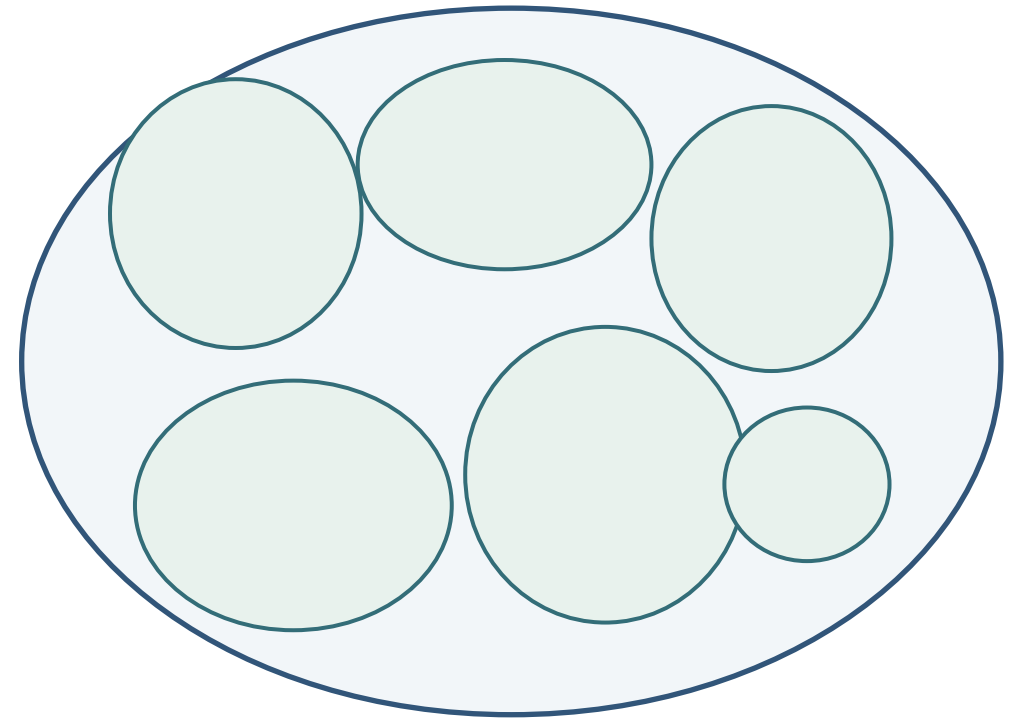
Müllerian

Müllerian epithelium differentiates toward mucin

Possible pathway for other tumors

Multiloculation is the signature gross architecture

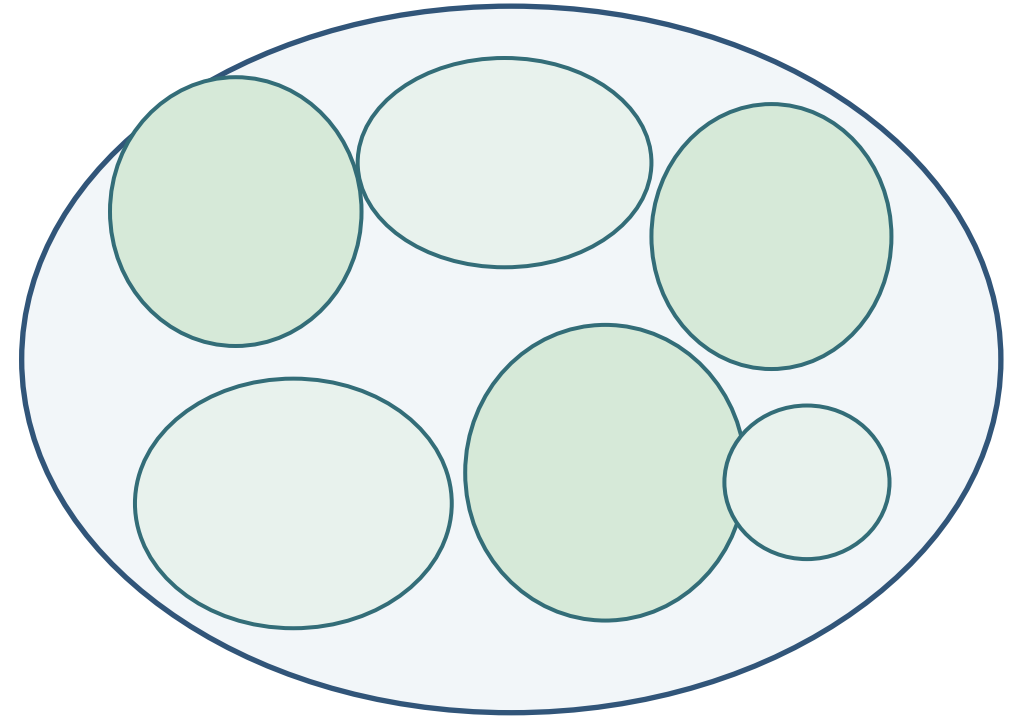
- Multiple cystic spaces separated by delicate septa.
- A single mass may contain numerous independent mucin-filled locules.
- Gross configuration guides examination but does not alone determine behavior.



Original gross architecture schematic

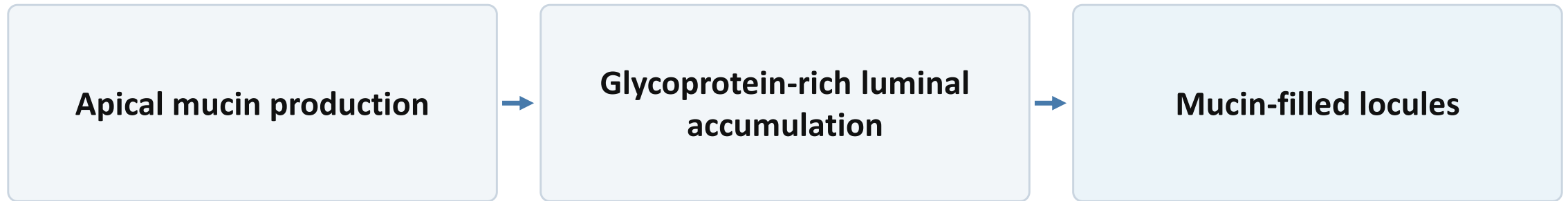
The locules contain gelatinous secretions

- The cysts are filled with sticky, glistening material.
- The fluid as glycoprotein-rich.
- The luminal content reflects a mucin-secreting epithelial phenotype.



Original gross architecture schematic

From secretory epithelium to cystic enlargement



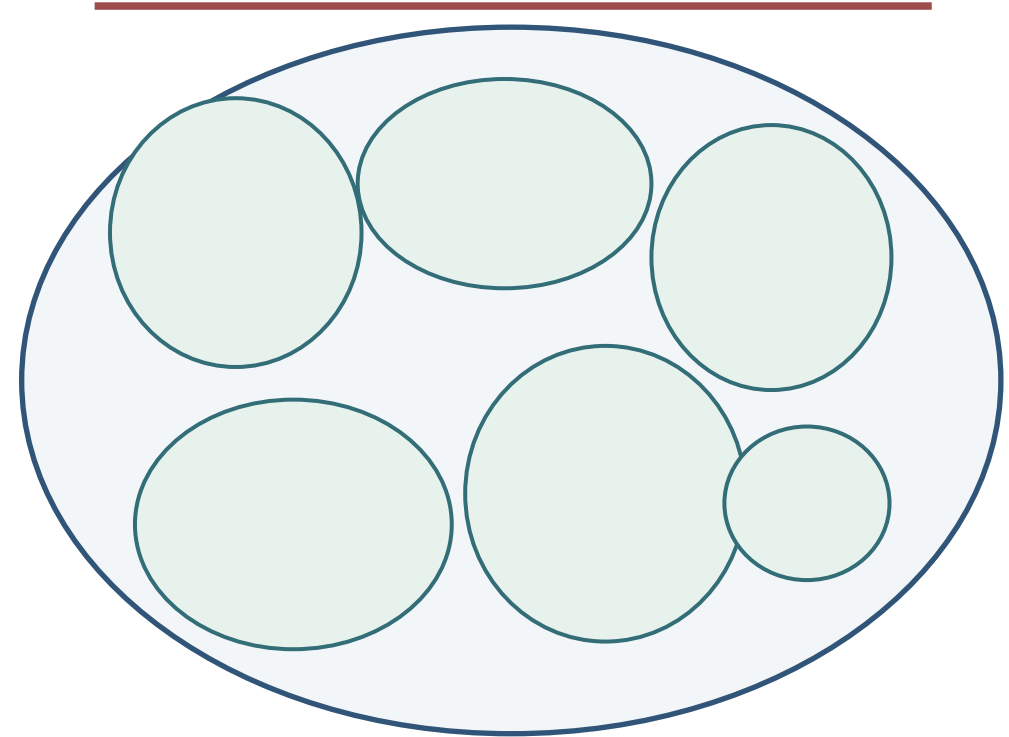
This schematic links described histologic secretion to the gross appearance; It does not assert a measured growth rate.

Large size is characteristic, not diagnostic of cancer

- Mucinous ovarian neoplasms can form very large multicystic masses.
- The textbook documents extraordinary examples weighing more than 25 kg.
- Tumor size alone cannot distinguish cystadenoma, borderline neoplasm, and carcinoma.
- Histologic architecture and invasion remain central to classification.

The ovarian surface is usually not involved

- Unlike serous tumors, primary mucinous tumors rarely involve the ovarian surface.
- The expected gross pattern is predominantly cystic within the ovary.
- Surface or extraovarian disease warrants a broader primary-versus-secondary assessment.



Original gross architecture schematic

Primary mucinous tumors are usually unilateral

≈5%

Of primary mucinous cystadenomas and carcinomas are bilateral

Clinical implication

Bilateral mucinous ovarian masses demand exclusion of another primary

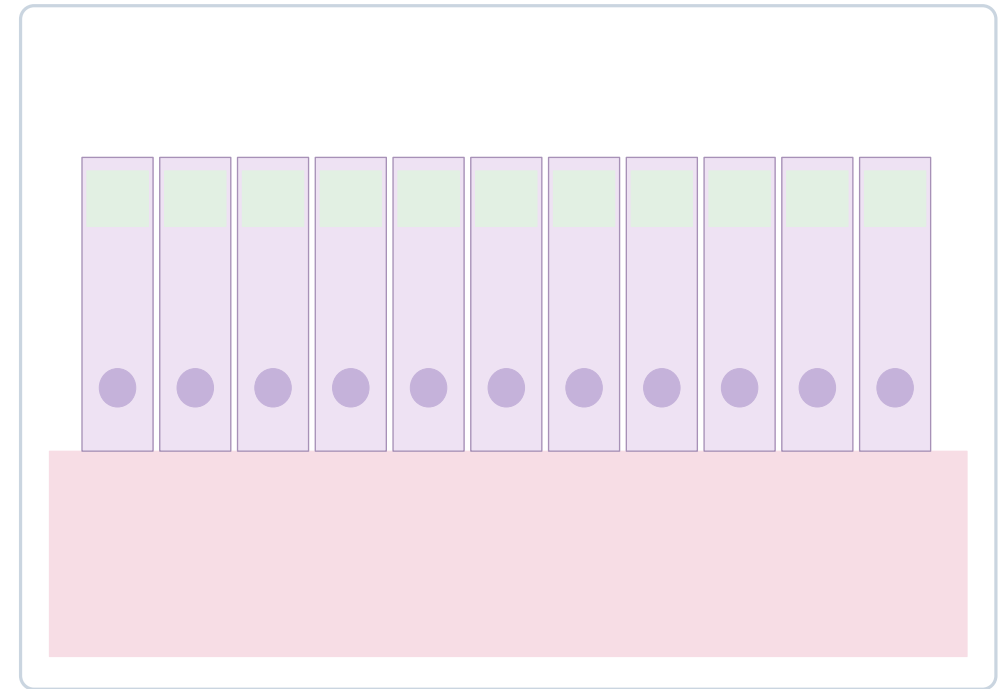
The approximately 5% figure refers to cystadenomas and carcinomas as stated in the morphology passage.

Gross clues require microscopic correlation

Gross observation	What it supports	What it does not prove
Multiple cysts	Mucinous macroscopic pattern	Benignity
Gelatinous fluid	Mucin secretion	Primary ovarian origin
Large size	Substantial cystic growth	Invasion
Bilateral masses	Concern for secondary involvement	Definite metastasis

Benign epithelium: Tall, columnar and nonciliated

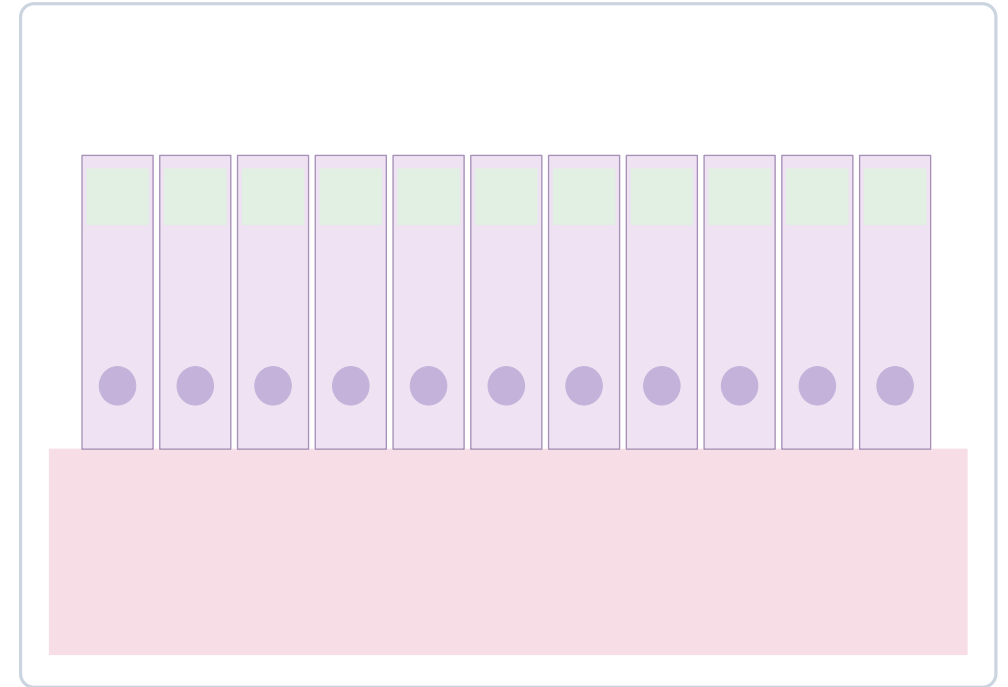
- Tall columnar lining cells surround cystic spaces.
- Mucin accumulates toward the luminal (apical) surface.
- Cilia are characteristically absent.



Schematic — not a histologic specimen

Apical mucin is a functional morphologic clue

- The cytoplasm shows apical mucin.
- Mucin secretion accounts for the viscous cyst contents.
- Cell shape and secretion are more informative together than either finding alone.



Schematic — not a histologic specimen

Mucinous differentiation may resemble gut or gastric epithelium

Predominant patterns

Gastric-type differentiation

Intestinal-type differentiation

Less common pattern

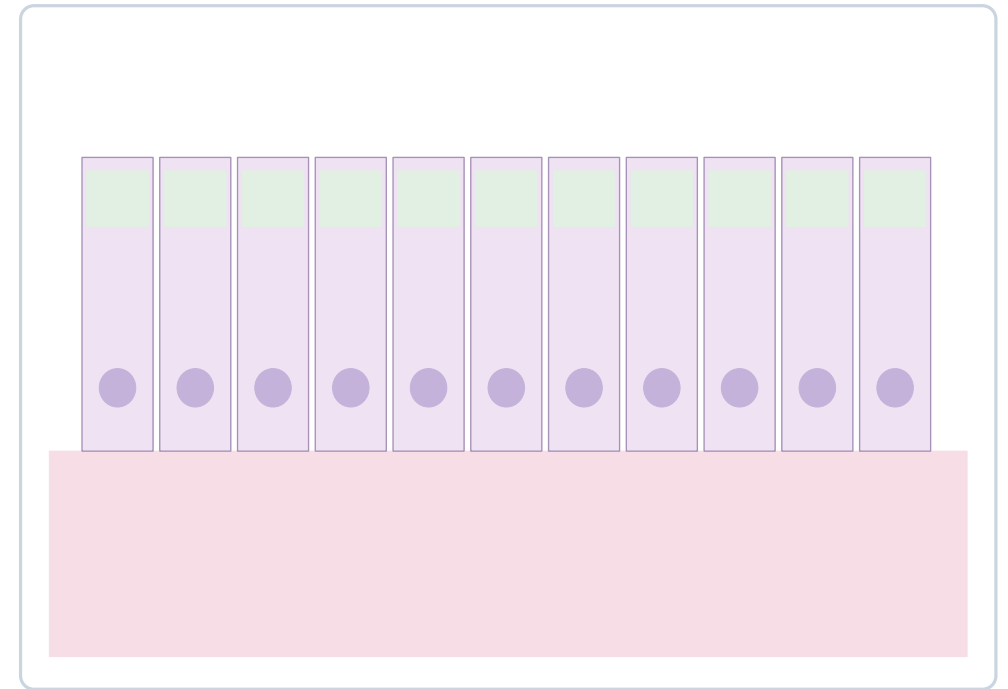
Endocervical-type mucinous differentiation

Diagnostic principle

Recognize mucinous differentiation without assuming a gastrointestinal primary.

Benign cystadenoma retains an orderly epithelial lining

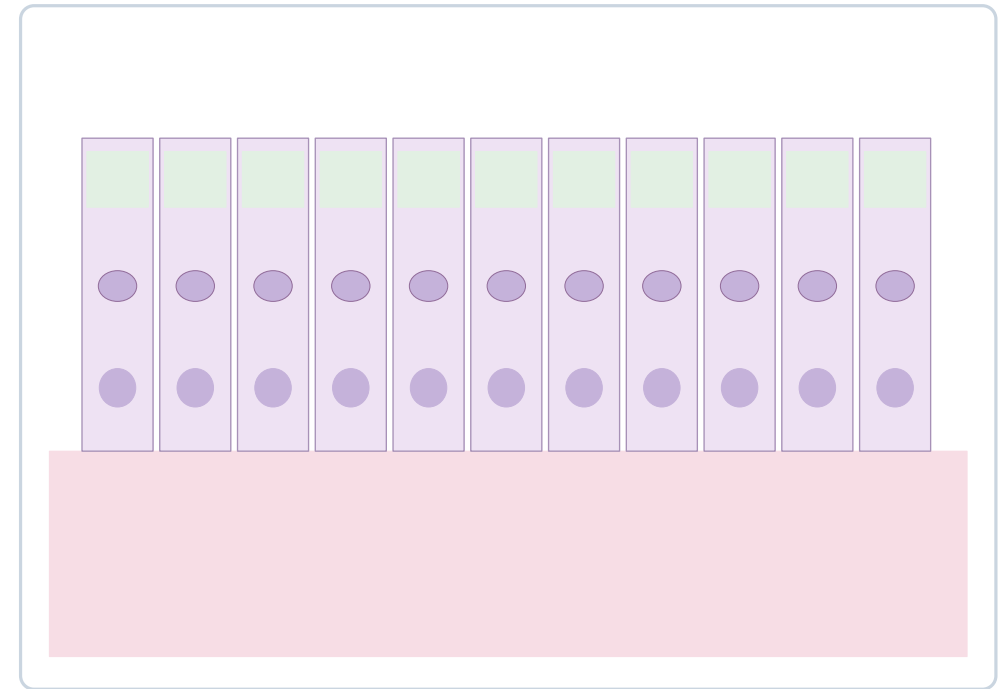
- The cystic spaces are lined by mucinous epithelium.
- The benign category does not show the proliferative architecture defining a borderline tumor.
- A smooth epithelial lining does not by itself address all regions of a heterogeneous mass.



Schematic — not a histologic specimen

Borderline tumor: Epithelial stratification

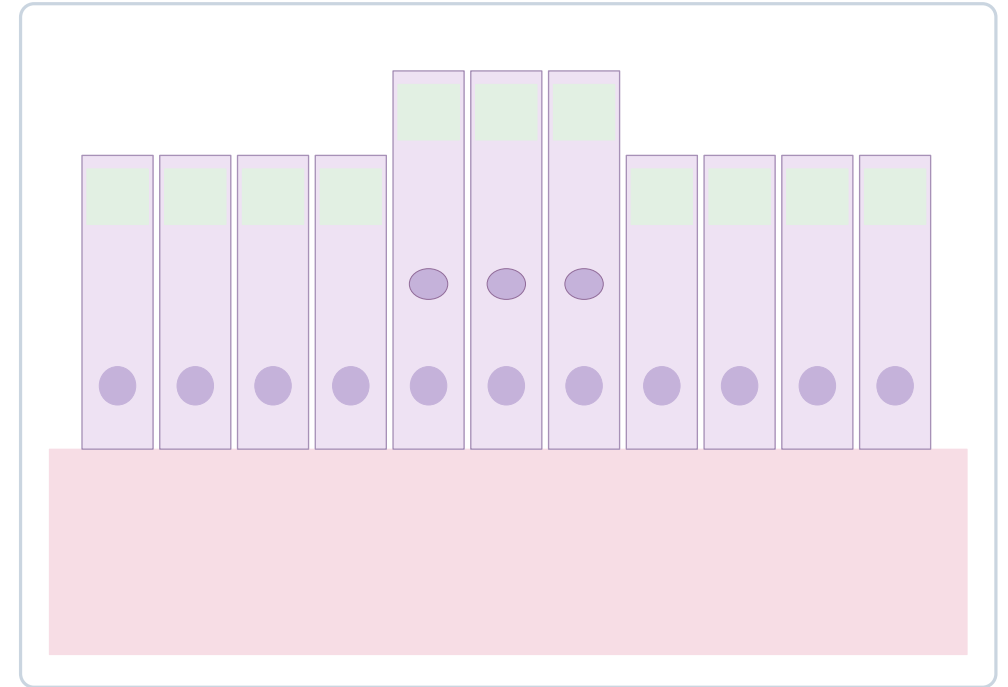
- Multiple epithelial cell layers replace the simple benign arrangement.
- Architectural proliferation is more complex than cystadenoma.
- Stratification is not synonymous with stromal invasion.



Schematic — not a histologic specimen

Borderline tumor: Tufting into the lumen

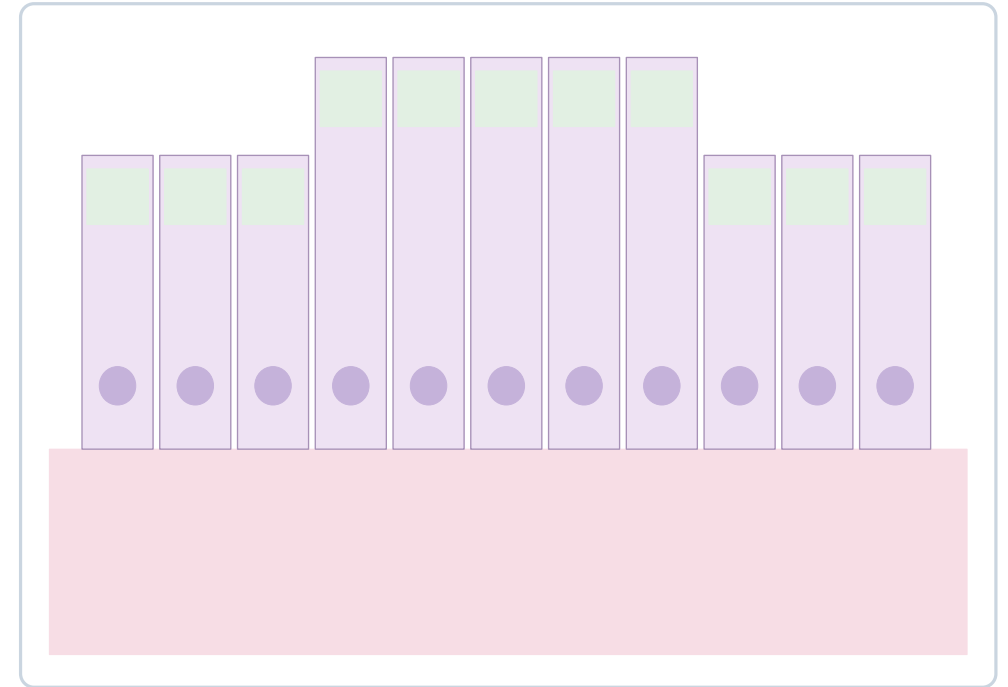
- Focal epithelial tufts project from the lining into a cyst or gland lumen.
- This is an intraluminal proliferative change.
- Interpret together with stratification, papillary growth, and invasion status.



Schematic — not a histologic specimen

Borderline tumor: Papillary intraglandular growth

- Papillae arise within glandular or cystic spaces.
- The growth increases architectural complexity.
- Papillary proliferation alone does not demonstrate destructive stromal infiltration.



Schematic — not a histologic specimen

Borderline mucinous lesions may mimic bowel adenomas

Ovarian mucinous borderline tumor

Intestinal adenoma–like appearance

Shared architectural resemblance

Stratification

Tubular adenoma–like change

Morphologic analogy

Papillary or villous growth

Villous adenoma–like change

Morphologic analogy

Critical distinction

Ovarian site and full lesion assessment

Do not infer bowel origin from
resemblance alone

The borderline decision hinges on lack of invasion



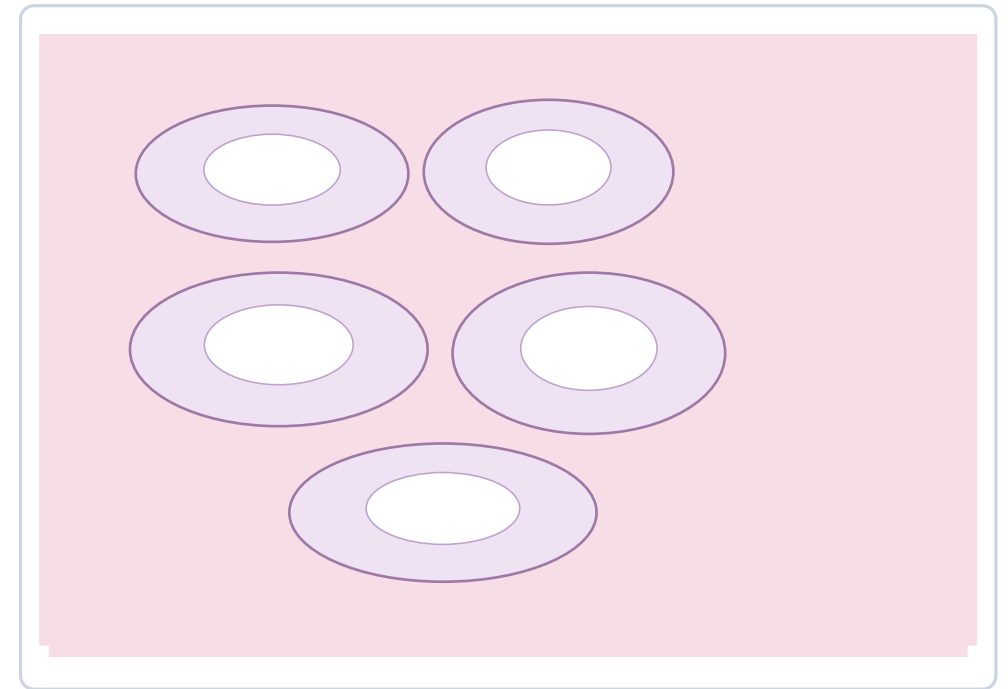
Borderline morphology is defined by proliferation; Carcinoma requires invasive morphology, not merely conspicuous intraluminal growth.

Assess cytologic atypia separately from invasion

Question	Microscopic feature	Consequence
Is epithelium proliferative?	Stratification, tufting, intraglandular papillae	Supports borderline category
Is atypia marked?	Marked epithelial atypia	Consider intraepithelial carcinoma terminology
Is stromal invasion present?	Expansile or destructive invasive pattern	Supports mucinous carcinoma

Expansile invasion: Confluent glandular growth

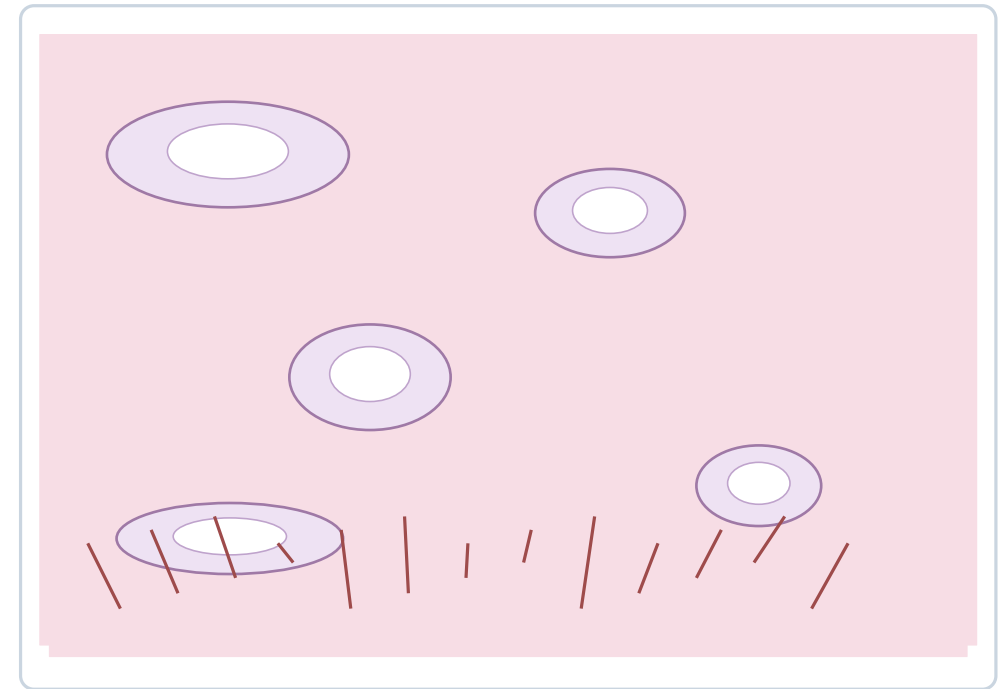
- Crowded, confluent mucinous glands form an expansile growth pattern.
- Robbins recognizes this architecture as a form of invasion.
- Absence of an obvious desmoplastic response does not exclude carcinoma.



Schematic — not a histologic specimen

Destructive invasion: Glands infiltrate desmoplastic stroma

- Another invasive pattern involves stromal infiltration.
- Desmoplastic stromal response accompanies destructive infiltration.
- This pattern differs from confluent but relatively pushing glandular growth.



Schematic — not a histologic specimen

Two invasive patterns can coexist in one carcinoma

Expansile

Confluent glandular growth

A recognized invasive pattern

Destructive

Desmoplastic stromal invasion

An alternative invasive pattern

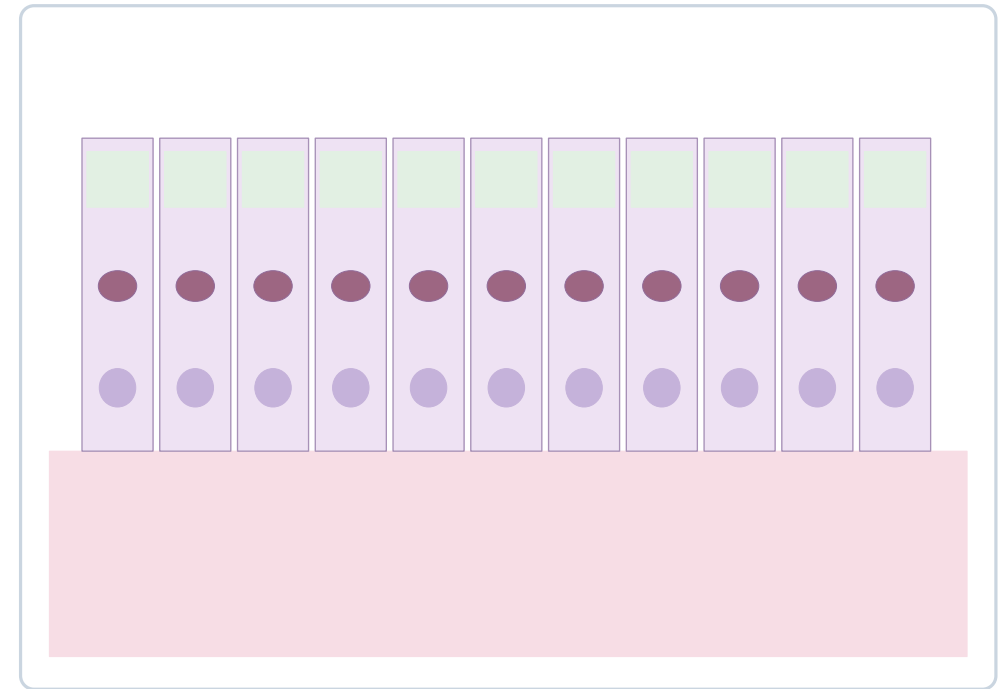
Same lesion

Both architectures may be present

Evaluate all represented areas

Intraepithelial carcinoma: Marked atypia, no invasion

- Some authors use this designation for marked epithelial atypia without invasive features.
- Severe epithelial cytology and stromal invasion should not be conflated.
- The term as terminology used by some authors.



Schematic — not a histologic specimen

Atypia and invasion are not interchangeable

Atypia	Stromal invasion	Interpretive category
Not prominent	Absent	Benign/borderline context by architecture
Marked	Absent	Noninvasive “intraepithelial carcinoma” terminology
Variable	Present	Mucinous carcinoma

Simplified educational matrix, not a replacement for complete diagnostic criteria.

Morphologic spectrum need not be uniform within a mass

Benign region



Borderline region



Malignant region

The cited molecular study examined tumors containing more than one morphologic category. Regions in a single lesion can differ, so a single sampled field cannot define the whole tumor.

Heterogeneity changes the diagnostic question

- The source documents distinct benign, borderline, and malignant regions in some tumors.
- A representative simple lining does not exclude more proliferative or invasive areas elsewhere.
- An adequate morphologic assessment therefore asks whether higher-grade regions are present.
- This is a sampling implication drawn from the source's documented heterogeneity, not a numeric sampling protocol.

Three questions organize microscopic assessment

Mucinous differentiation?



**Borderline proliferation /
atypia?**



**Expansile or destructive
invasion?**

Classify what the lesion is, then its proliferative severity, then whether it invades.

An ovarian mucinous tumor may be secondary

Primary ovarian tumor

Usually unilateral

Primary ovarian mucinous neoplasm considered

Metastatic mucinous adenocarcinoma

Often requires active exclusion

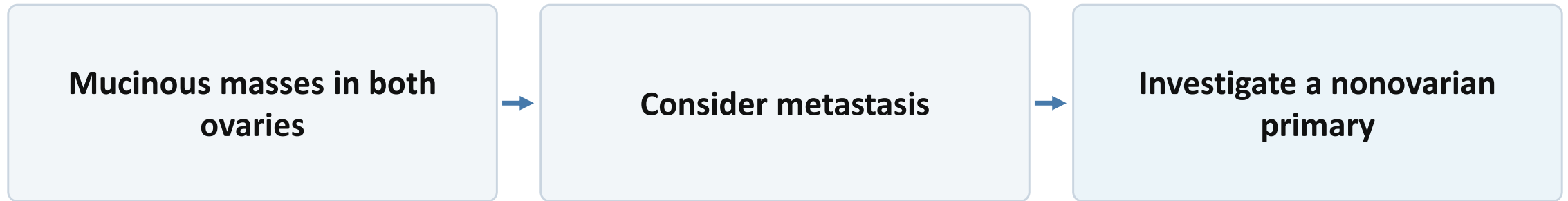
Extraovarian primary must be investigated

Peritoneal mucinous disease

Appendiceal source often implicated

Do not default to ovarian primary

Bilateral ovarian mucinous masses: The next diagnostic step



Bilateral presentation must prompt exclusion of metastatic disease because most primary ovarian mucinous lesions are unilateral.

Why the appendix matters

- Mucinous epithelial neoplasms may originate in the appendix.
- Almost all pseudomyxoma peritonei cases to an extraovarian primary, usually appendiceal.
- Ovarian involvement may occur as part of disseminated appendiceal disease.
- The historical assumption of frequent primary ovarian origin is not supported by the source's current interpretation.

Pseudomyxoma peritonei: An anatomic pattern of disease

Mucinous ascites



**Peritoneal cystic epithelial
implants**



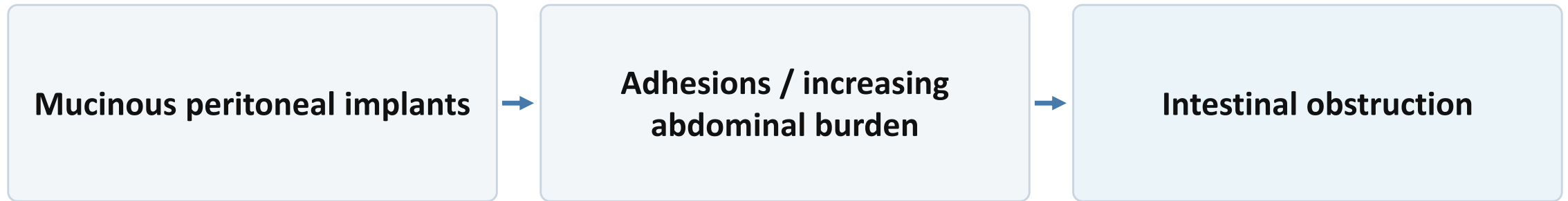
**Adhesions and ovarian
involvement**

This is a clinical-pathologic syndrome rather than proof of a primary ovarian neoplasm.

Mucinous ascites does not establish the primary site

Observation	Correct inference	Unsupported leap
Mucinous ascites	Mucin is present in the peritoneal cavity	The ovary generated it
Ovarian mucinous implants	Ovary is involved	Ovary is the primary
Appendiceal tumor identified	Potential nonovarian source	All ovarian lesions must be independent primaries

Peritoneal disease can lead to obstruction



Advanced pseudomyxoma peritonei may cause intestinal obstruction and death.

Mucinous versus serous: Gross distribution

Feature	Mucinous	Serous
Cyst contents	Sticky gelatinous mucin	Serous fluid
Usual distribution	Primary tumors commonly unilateral	Bilaterality relatively common
Surface involvement	Rare in primary mucinous tumors	Can involve ovarian surface
Epithelial phenotype	Mucinous, usually nonciliated	Tubal-like; benign lining ciliated

Borderline architecture differs by epithelial phenotype

Mucinous borderline

Epithelial stratification; Tufting;
Intraglandular papillae

Can resemble intestinal adenomas

Serous borderline

Stromal papillary complexity and
epithelial stratification

Serous/tubal-like epithelium

Shared diagnostic question

Is stromal invasion present?

Essential distinction from invasive
carcinoma

Symptoms usually follow tumor size or extraovarian involvement

- Ovarian tumors can remain asymptomatic until large.
- Abdominal distention or pain may reflect the size of a mucin-filled mass.
- Urinary or gastrointestinal symptoms can follow compression or invasion.
- Peritoneal dissemination creates additional complications beyond an ovarian mass.

Localized noninvasive disease: Favorable reported outcome

>95%

Approximate 10-year survival for stage I noninvasive “intraepithelial carcinoma”

From the specific textbook morphology passage. Population, definitions, and modern staging comparability were not independently reverified.

Localized invasive disease: Favorable reported outcome

≈90%

Approximate 10-year survival for stage I invasive mucinous malignancy

Stage I figure; Do not extrapolate to advanced stage or metastatic ovarian involvement.

Spread beyond the ovary changes the prognosis

- Extraovarian mucinous carcinomas as usually fatal.
- The stage I outcome figures should not be applied to advanced disease.
- Accurate discrimination from metastatic mucinous adenocarcinoma is especially consequential.
- The source provides no numeric survival estimate here for advanced primary mucinous ovarian carcinoma.

Case 1 · Multilocular cyst with simple mucinous lining

- Illustrative findings: A large unilateral mucin-filled cystic ovarian mass.
- Microscopy: Tall columnar nonciliated epithelium with apical mucin; Simple architecture.
- Interpretation: Findings favor mucinous cystadenoma; Mass size does not alone justify carcinoma.

Recognize the benign epithelial pattern before considering growth-related symptoms.

Case 2 · Stratification and intraglandular papillae

- Illustrative findings: Mucinous ovarian epithelium shows stratification, tufting, and intraglandular papillary growth.
- No stromal invasion is identified in the described sections.
- Interpretation: A borderline mucinous pattern; Architecture is proliferative but noninvasive.

Proliferation is not itself stromal invasion.

Case 3 · Crowded confluent mucinous glands

- Illustrative findings: Mucinous glands grow in a tightly confluent pattern.
- No conspicuous desmoplastic stromal response is described.
- Interpretation: Expansile invasion can still establish mucinous carcinoma.

Do not require desmoplasia to recognize every invasive mucinous carcinoma.

Case 4 · Bilateral ovarian lesions and gelatinous ascites

- Illustrative findings: Bilateral ovarian mucinous masses, mucinous ascites, and peritoneal implants.
- Diagnostic action: Seek an extraovarian primary, especially appendix.
- Interpretation: Pseudomyxoma peritonei is not evidence of an ovarian primary by itself.

Establish tumor origin before assigning an ovarian primary diagnosis.

Four recurrent interpretive errors

Error	Why it is wrong	Better question
“Large = malignant”	Huge benign mucinous masses occur	Is there invasion?
“Stratified = invasive”	Borderline tumors stratify	Where is stromal invasion?
“No desmoplasia = benign”	Expansile invasion exists	Are glands confluent?
“Ovary involved = primary”	Appendiceal metastasis is possible	Is a nonovarian primary present?

Integrating morphology with site of origin

Identify mucinous phenotype



**Classify proliferative / invasive
pattern**



**Resolve primary ovarian vs
metastatic**

Each step answers a different question; A complete diagnosis requires integrating all three.

The six essential conclusions

- Most ovarian mucinous tumors are benign or borderline; Primary carcinoma is uncommon.
- KRAS mutations occur across benign, borderline, and carcinoma categories.
- Multiloculation, gelatinous mucin, and nonciliated columnar cells define typical morphology.
- Borderline proliferation differs from expansile or destructive invasion.
- Bilaterality and pseudomyxoma peritonei demand evaluation for extraovarian origin.
- Stage and primary-site assignment are central to meaningful prognosis.

Recommended reading

- Robbins, Cotran & Kumar. Pathologic Basis of Disease. 11th edition (2026).
- Chapter: The Female Genital Tract; ovarian epithelial tumor and mucinous tumor sections.
- All mechanisms, morphologic statements, and reported frequencies in this lecture are textbook-grounded.
- Constructed cases and native vector drawings are educational schematics—not patient specimens.