



Imaging Tips for Performing a Perfect Barium Swallow

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Introduction

Barium esophagography offers an excellent tool for assessing swallowing, evaluating esophageal morphology and motility, and demonstrating postoperative complications.

In this presentation, we describe the proper techniques that are fundamental for obtaining quality barium esophagrams.

Barium? Really??



Learning Objectives

- Learn how to obtain a dual-phase barium esophagram.
- Understand the importance of using proper technique when performing the procedure.
- Identify common and uncommon pathologic conditions encountered when obtaining a barium esophagram.

It's the 21st century...
who cares, anyway?

In 2017, 679,392 esophagographies
were performed in the United States alone
(and that doesn't include the 1,340,000
modified barium swallow studies).

Standard Dual-Phase Barium Esophagography

This imaging modality is best suited for the patient who is nondebilitated and relatively mobile.

Before You Start...

Take a very brief patient history. Ask the patient:

Have you had any germane surgeries or endoscopic procedures, recent or remote?

Do you experience dysphagia or odynophagia? Does it occur when ingesting liquids or solids?

Evaluating the Unaltered Esophagus

Intramural
Pseudodiverticulosis



a

Adenocarcinoma



b

Inflammatory Fold
(arrow)



c

(a–c) Oblique esophagrams depict examples of the wide array of pathologic conditions visible on a well-performed study.

Guide for Performing Standard Dual-Phase Esophagography

Standard Dual Phase Barium Esophagogram outline

PATIENT STANDING

1. **Thick barium.** Lateral and frontal phonation views of pharynx ("Say the letter E like you're singing it: EEEEEEEE")
2. Effervescent crystals and *small* amount of water
3. Thick barium. Left posterior oblique position. ("One gulp after another.") Take several (about 3-4) air contrast views of the thoracic esophagus and GE junction.
4. **Thin barium.** Lateral and frontal rapid sequence images or stored fluoro of pharynx and cervical esophagus during a swallow

PATIENT IN PRONE RIGHT ANTERIOR OBLIQUE POSITION

1. **Thin Barium.** A few single swallows to assess peristalsis.
2. Distended views ("chug it like you love it") of each segment of the barium filled esophagus and GE junction.
3. Reflux check: Patient supine, RPO, right lateral
4. For solid dysphagia, stand the patient and give barium tablet or 1/4-1/3 marshmallow. ("Swallow it as whole as you can") washed down with thin barium.

Note.—GE = gastroesophageal, RPO = right posterior oblique.

Obtaining Double-Contrast-enhanced Images of the Esophagus: Supplies

(a) Photograph shows an effervescent agent (E-Z-GAS II, Bracco Diagnostics, Monroe Twp, N.J.) used to distend the lumen with gas.



(b) Photograph shows a high-density (238% weight/volume) barium sulfate (E-Z-HD, Bracco Diagnostics) suspension agent used to coat the mucosa.

Images reprinted, with permission, from Bracco Diagnostics.

Note.—This does not imply an endorsement of a specific brand.

The Too-Often Forgotten Pharynx

All you need to know is
in the following articles:

Rubesin SE, Jessurun J, Robertson D, Jones B, Bosma JF, Donner MW. Lines of the pharynx. *RadioGraphics* 1987;7(2):217–237.

Tao TY, Menias CO, Herman TE, McAlister WH, Balfe DM. Easier to swallow: pictorial review of structural findings of the pharynx at barium pharyngography. *RadioGraphics* 2012;33(7):E189–208.

Standard Dual Phase Barium Esophagogram outline

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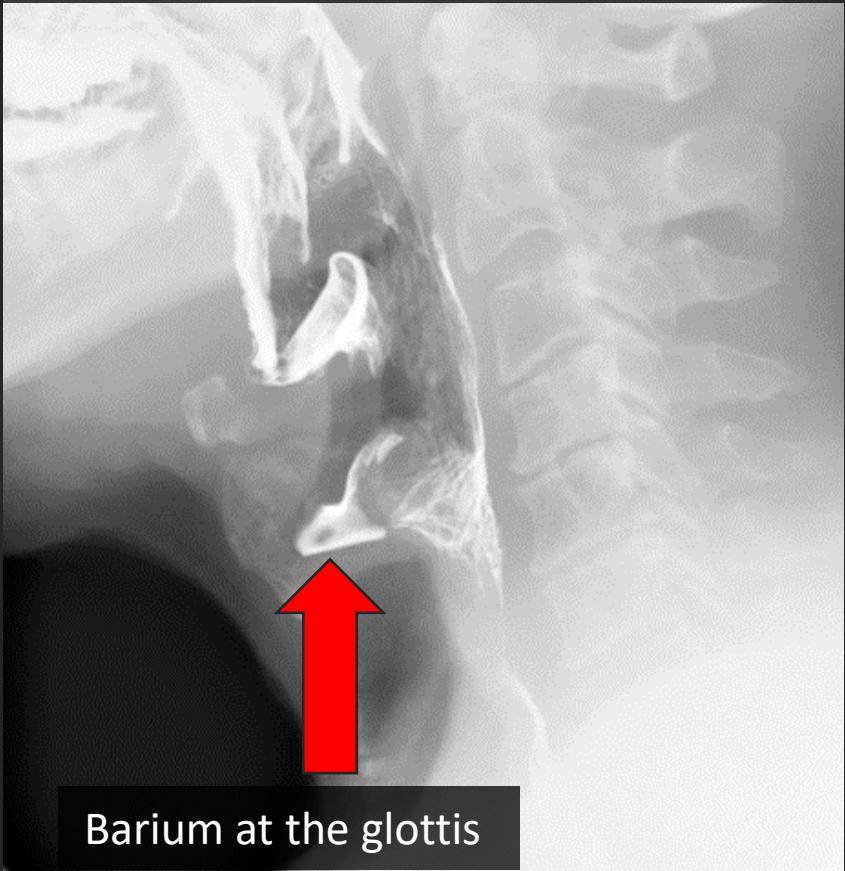
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Start by having the patient swallow high-density barium and obtain the image in the *lateral* position.

Lateral esophagram shows laryngeal penetration, which is easy to visualize on this view.

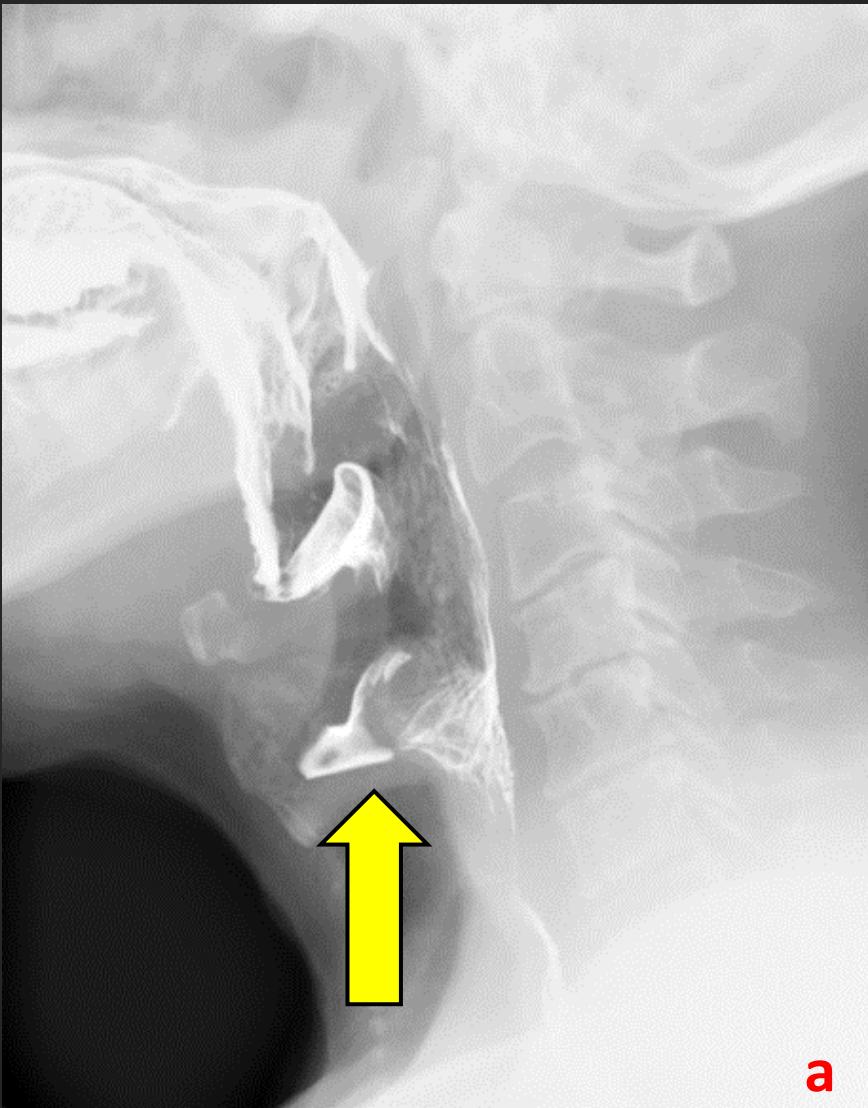


Barium at the glottis

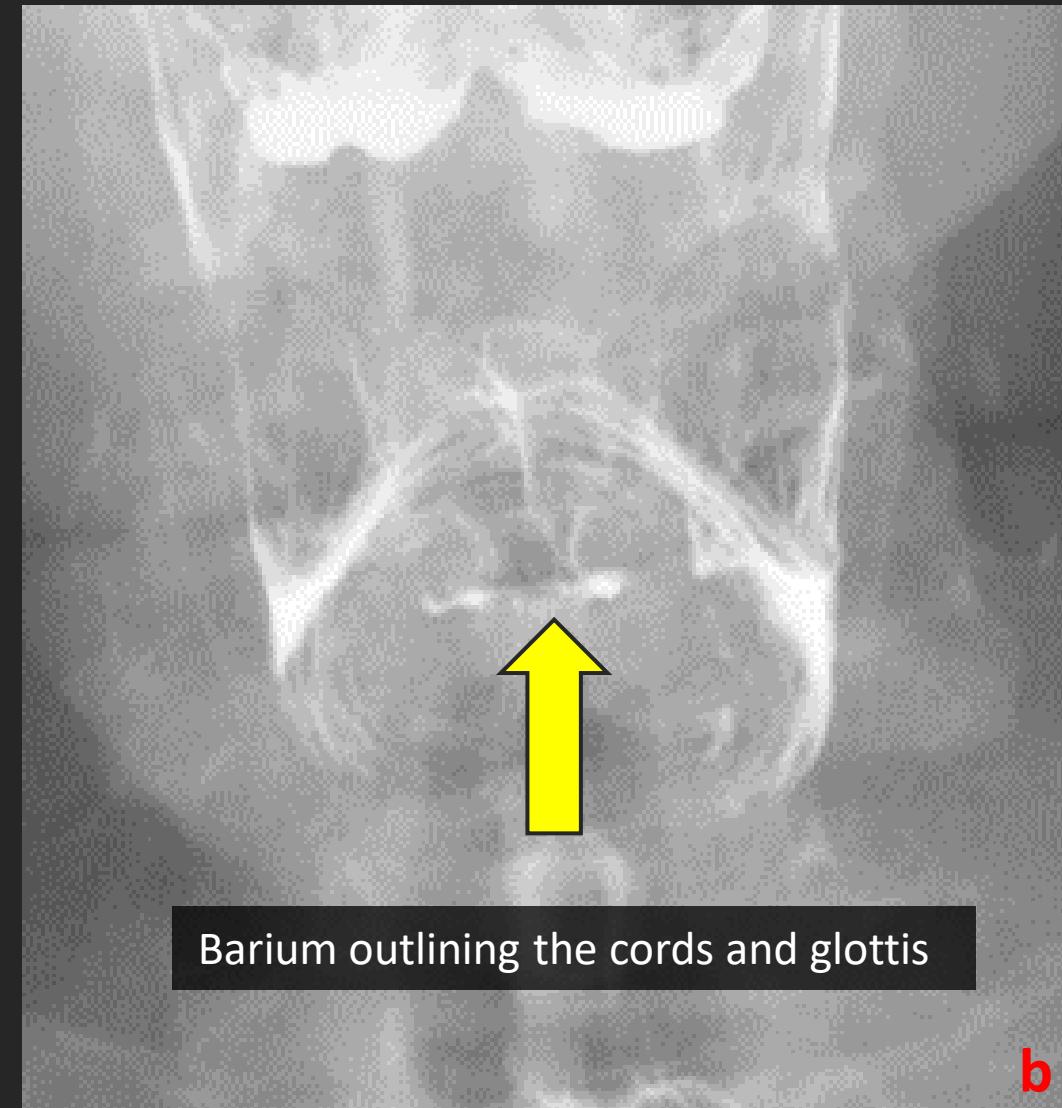


Also, briefly evaluate the esophagus for any unexpected abnormalities before proceeding.

But, one should be able to recognize endolaryngeal structures on the frontal view, too.



a



b

Barium outlining the cords and glottis

Lateral (a) and frontal (b) pharyngograms show barium at the glottis (arrows).

Tell the patient, “Take a small sip of barium, swallow, then say the letter *e* like you’re singing it—eeeeeee.”

Why phonation?



(a) Resting view: pharynx is collapsed



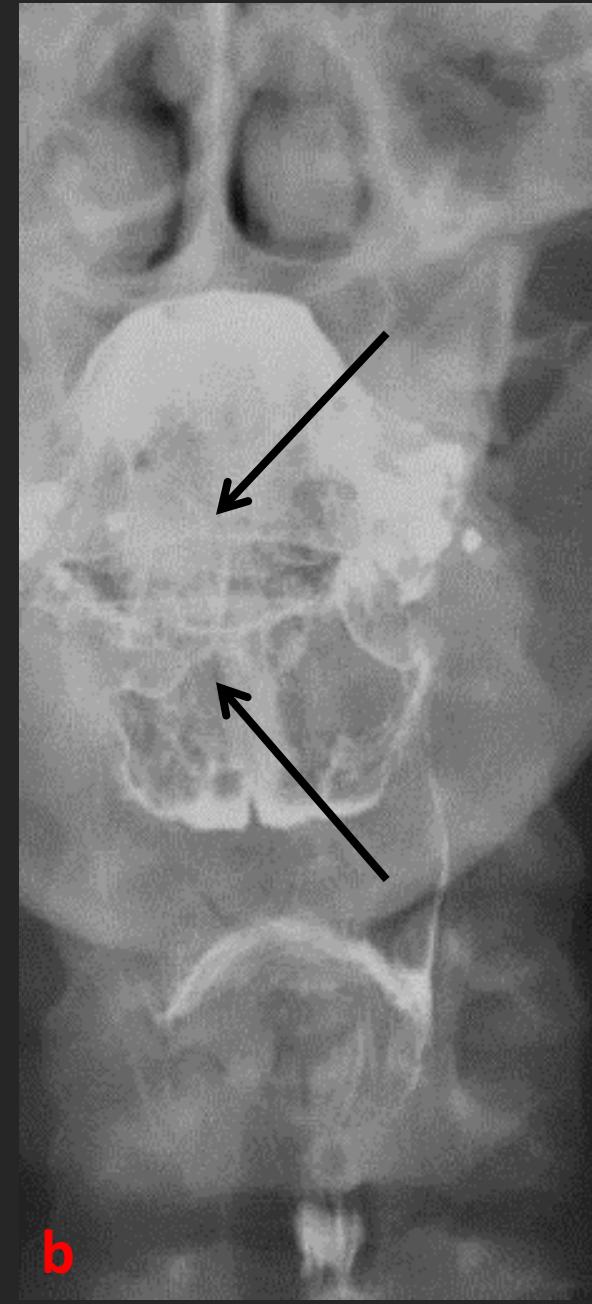
(b) During phonation: pharynx is nicely distended

Lateral views show the pharynx at rest (a) and during phonation (b).

Following are examples of pathologic conditions that can be visualized on double-contrast views of the pharynx, if you take the time to look.

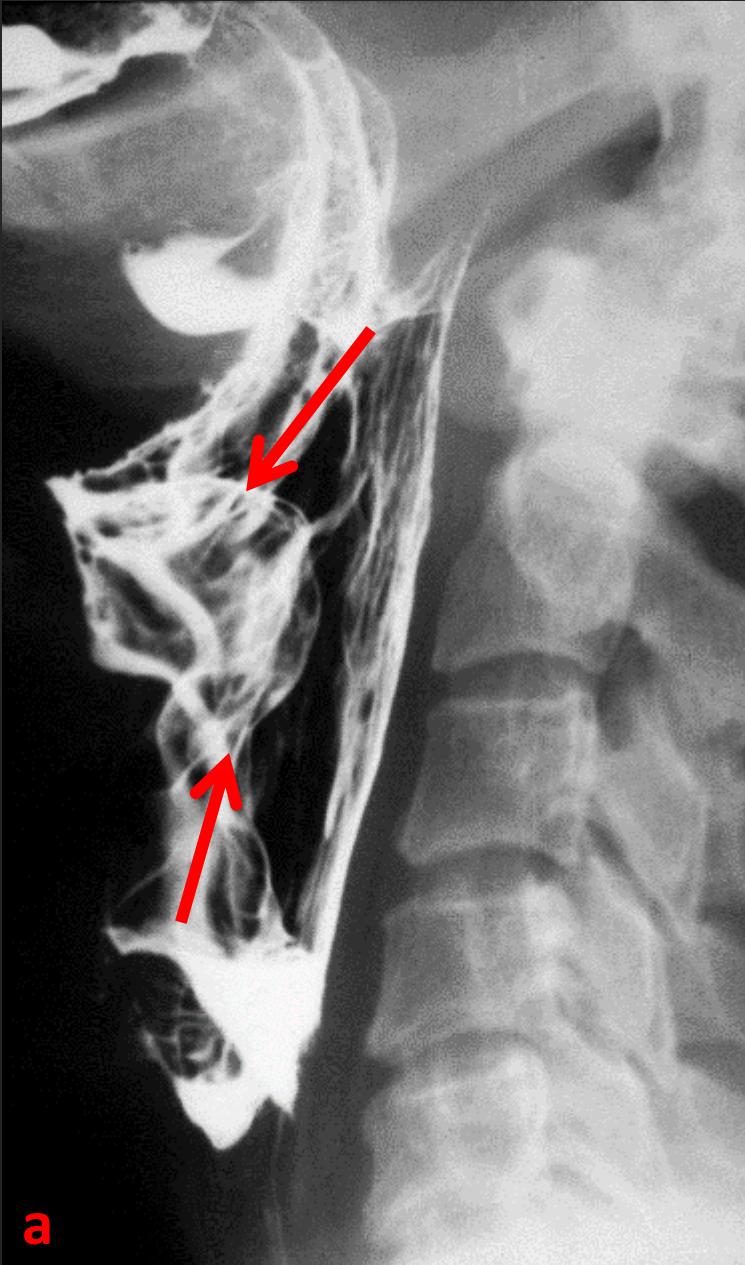
Tonsillar Enlargement

Lateral (**a**) and frontal (**b**) pharyngograms show tonsillar enlargement (arrows).

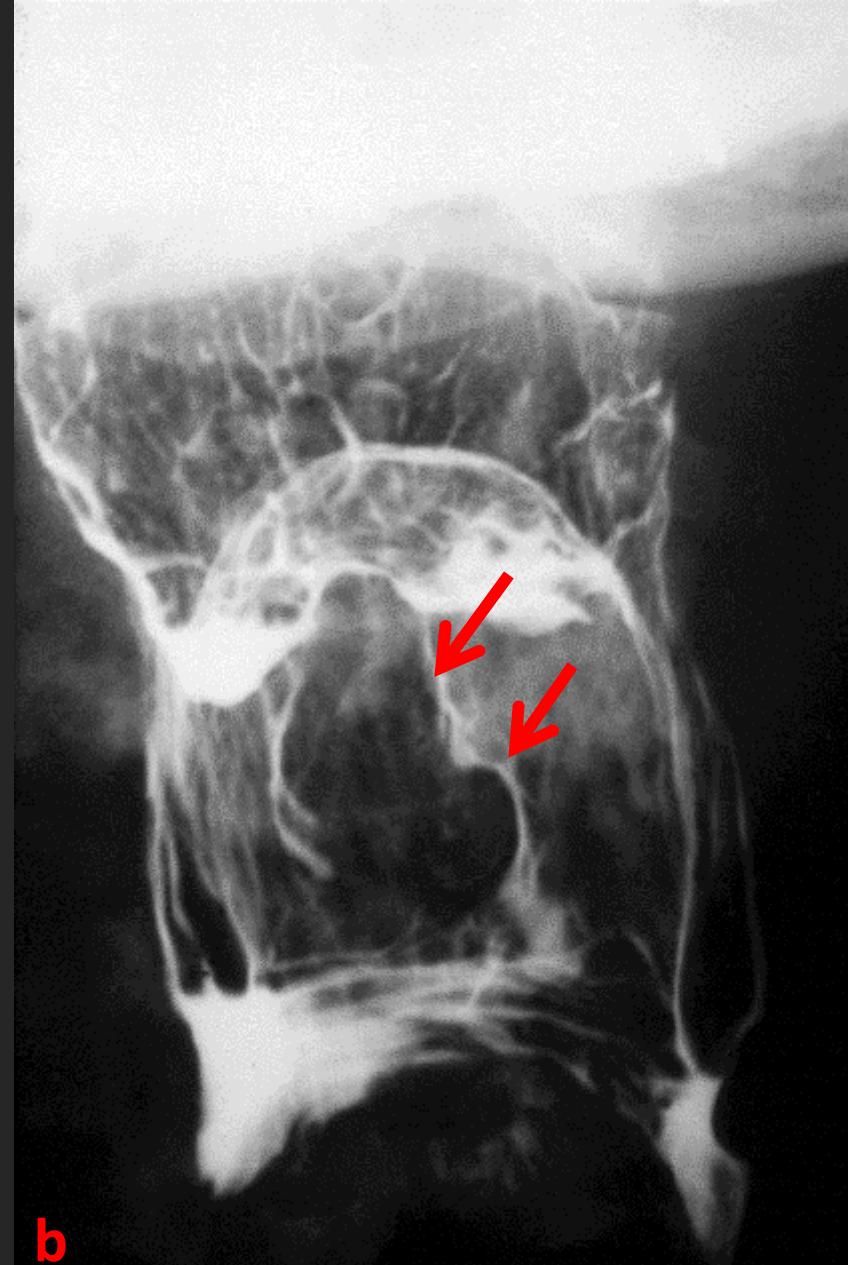


Epiglottic Carcinoma

Lateral (a) and
frontal (b)
pharyngograms
reveal epiglottic
carcinoma
(arrows).

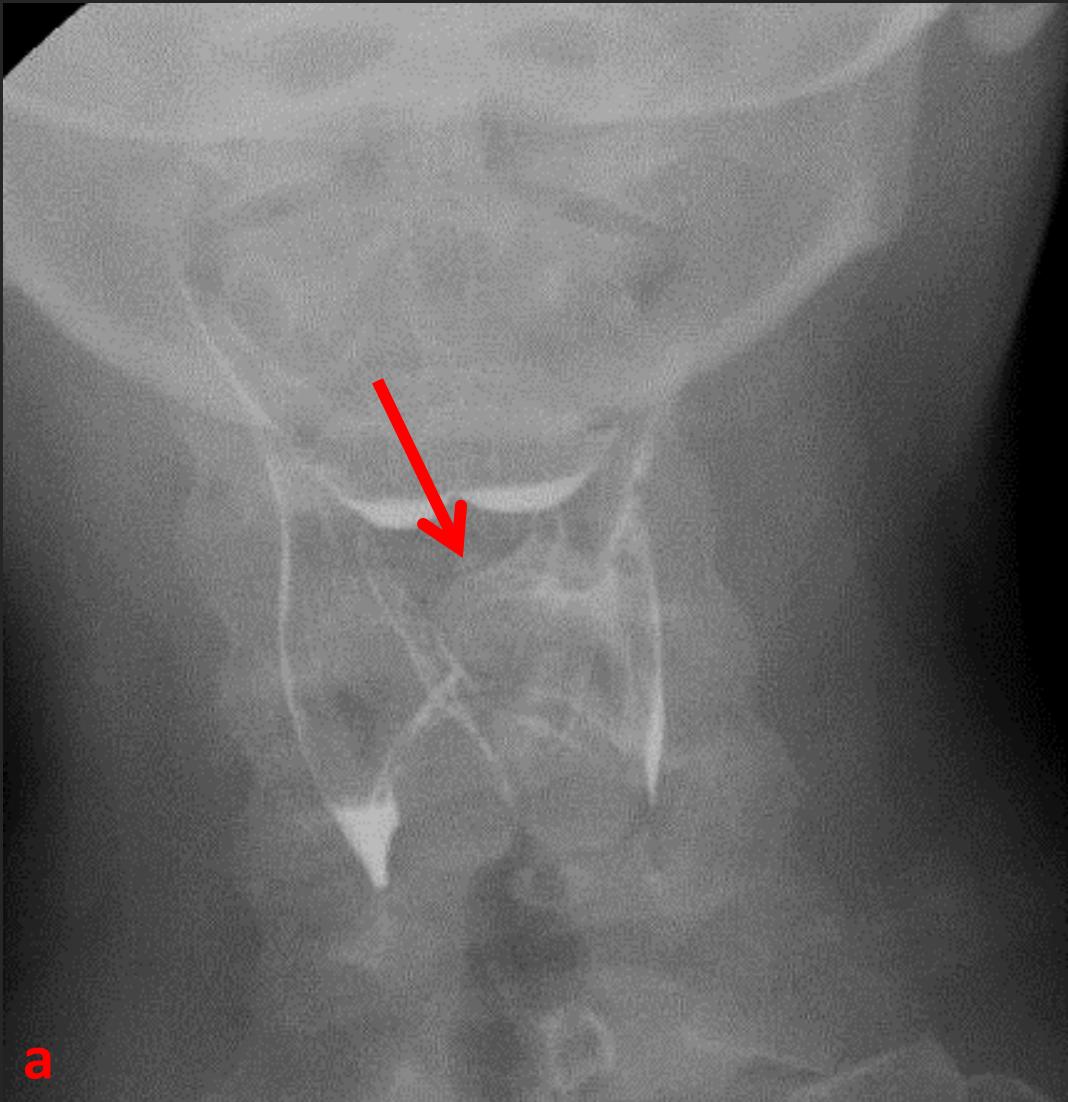


a

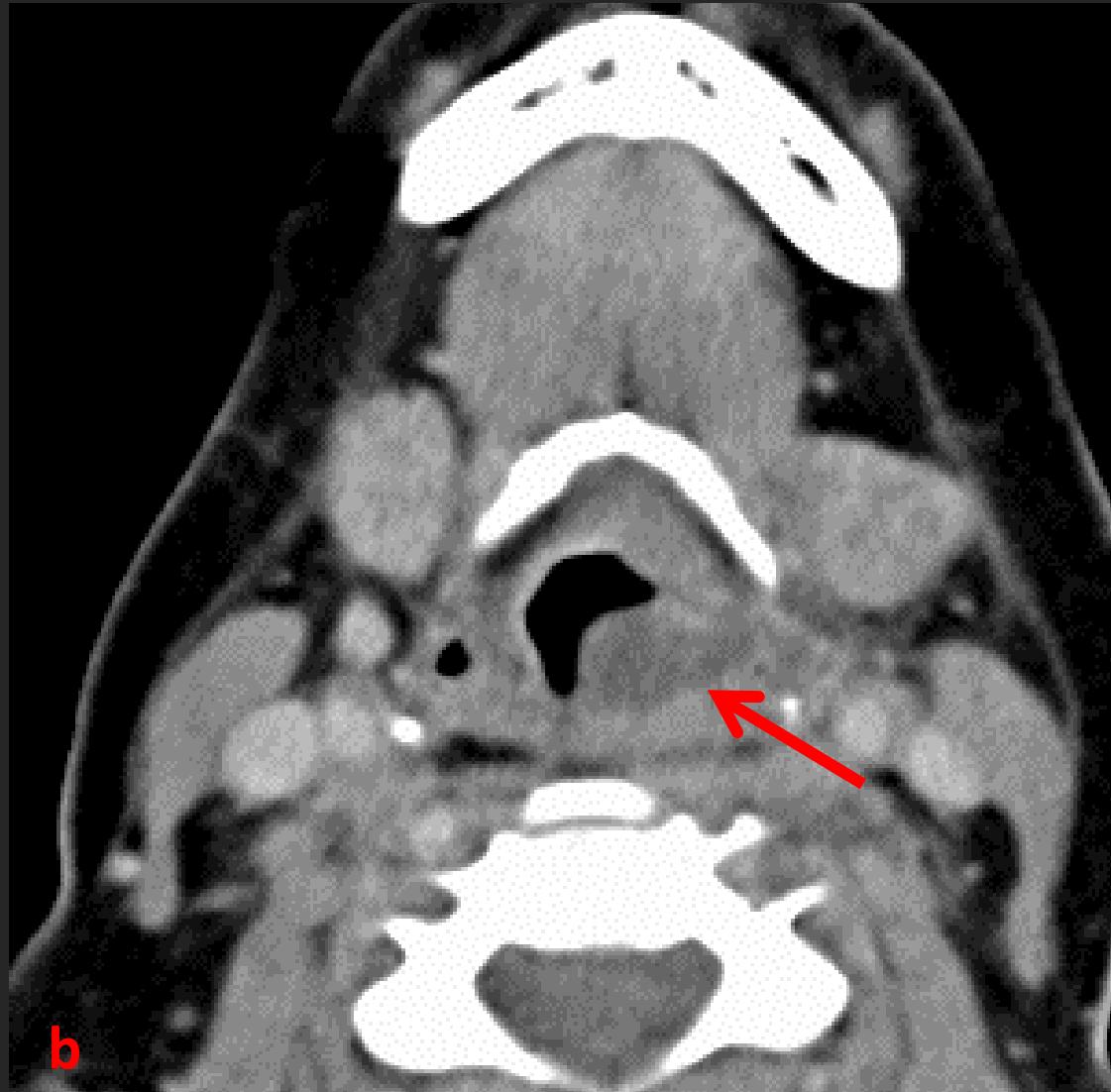


b

Aryepiglottic Fold Retention Cyst



a



b

Frontal pharyngogram (a) and axial CT image (b) show a smooth left aryepiglottic fold mass (arrow).

Double-Contrast Examinations of the Esophagus

Standard Dual Phase Barium Esophagogram outline

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Double-Contrast Examinations of the Esophagus



Crystals should be swallowed with about 5 ml of water.

Tell the patient, “Wash the powder down with the water. Swallow fast, and try not to burp.”

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Double-Contrast Examinations of the Esophagus

Rapid sequential swallows of barium are key for obtaining simultaneous gaseous distension and mucosal coating.

Tell the patient, “**One gulp after another. Chug it like you love it.**”

Oblique esophagrams when the patient followed the swallowing directions correctly (**a**), and when a patient merely sipped the barium (**b**).



Double-Contrast Examinations of the Esophagus

The left posterior oblique (LPO) position minimizes obscuration by the spine.

To obtain this view, tell the patient,
“Turn halfway to your left.”



LPO view shows the esophagus projecting lateral to the vertebral bodies.

Pitfall: Bubble Trouble

(a) LPO esophagram shows undissolved effervescent crystals carpeting the mucosa.

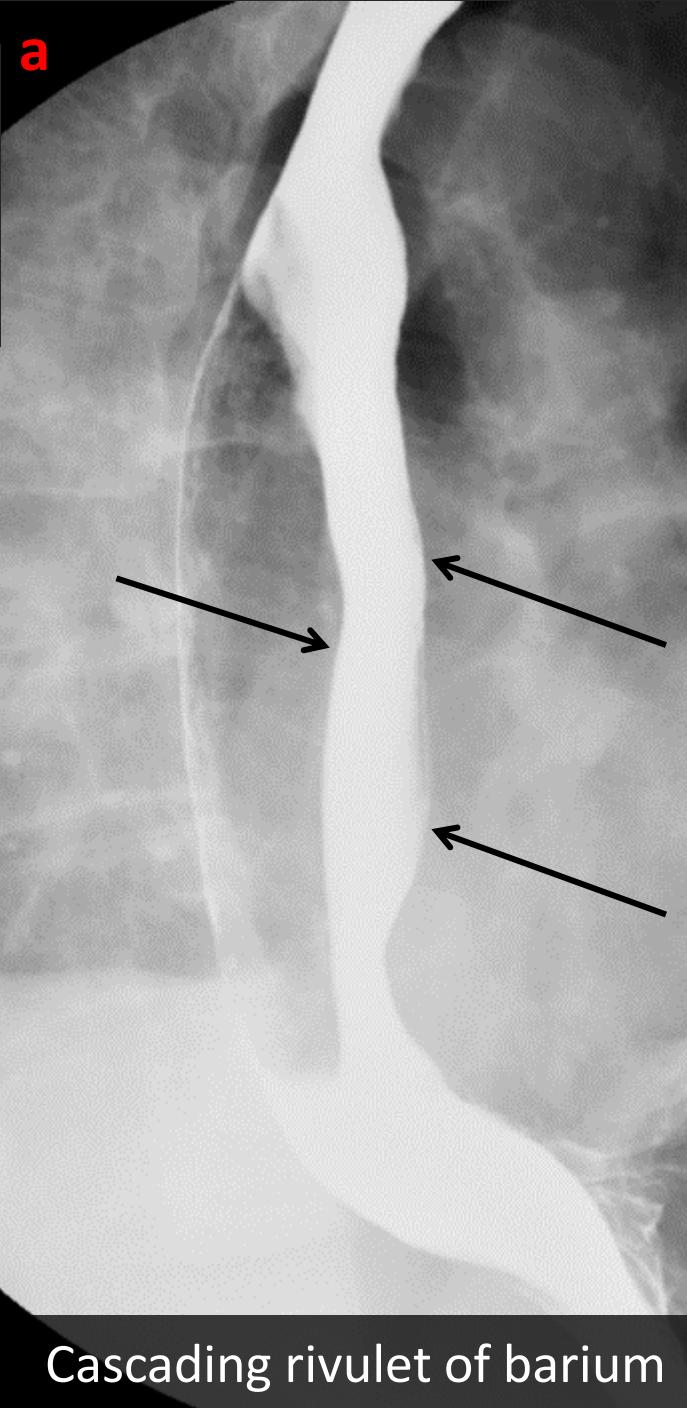
(b) LPO esophagram shows the resolution of the undissolved effervescent crystals after waiting a few seconds.



Pitfall: Streaming

(a) LPO esophagram shows a cascading rivulet of barium (arrows), which partly obscures the mucosa.

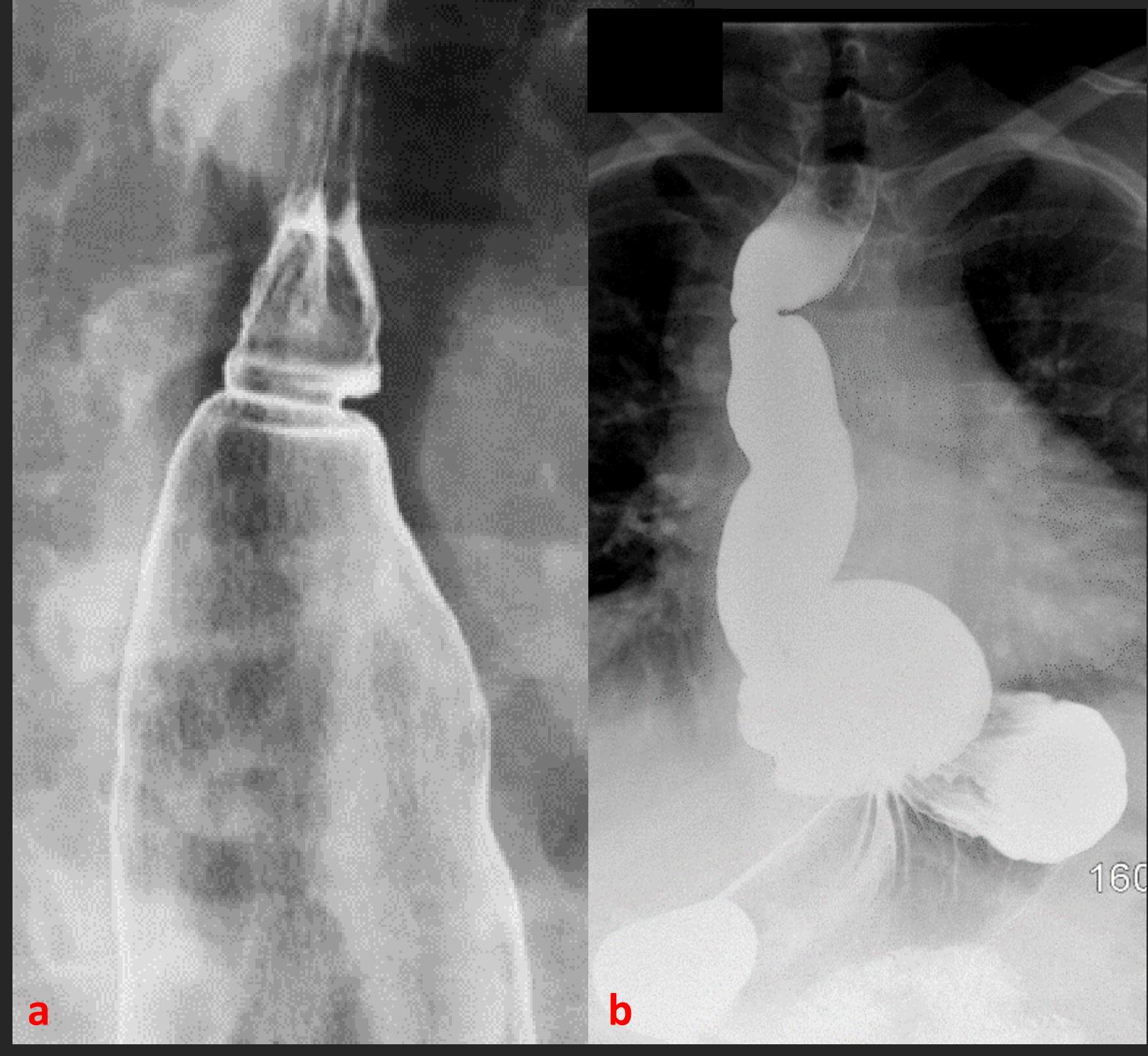
(b) LPO esophagram shows the resolution of the cascading rivulets after waiting a few seconds.

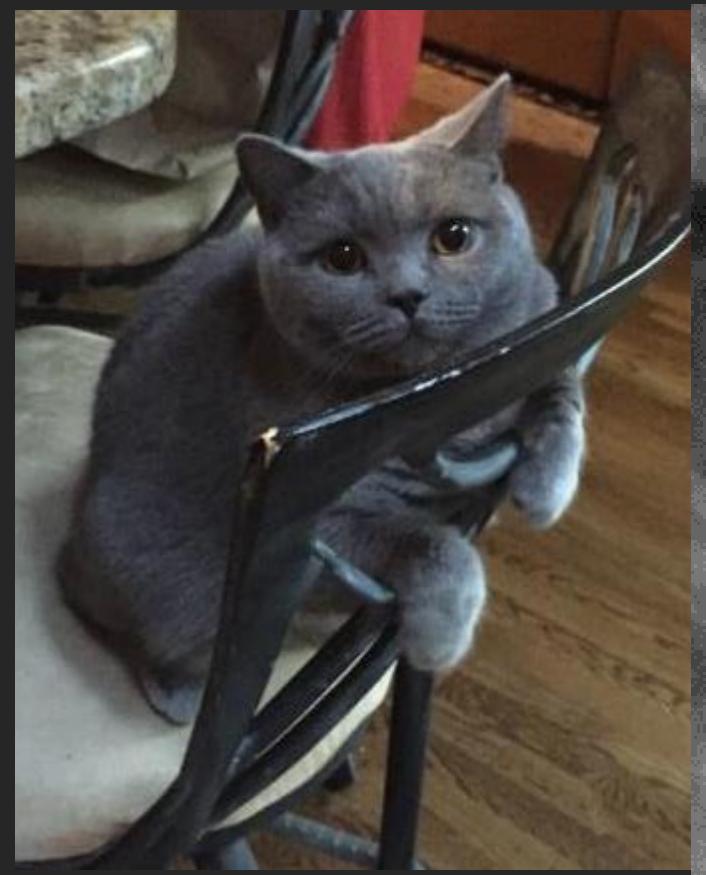


What Double-Contrast Esophagrams Can Demonstrate

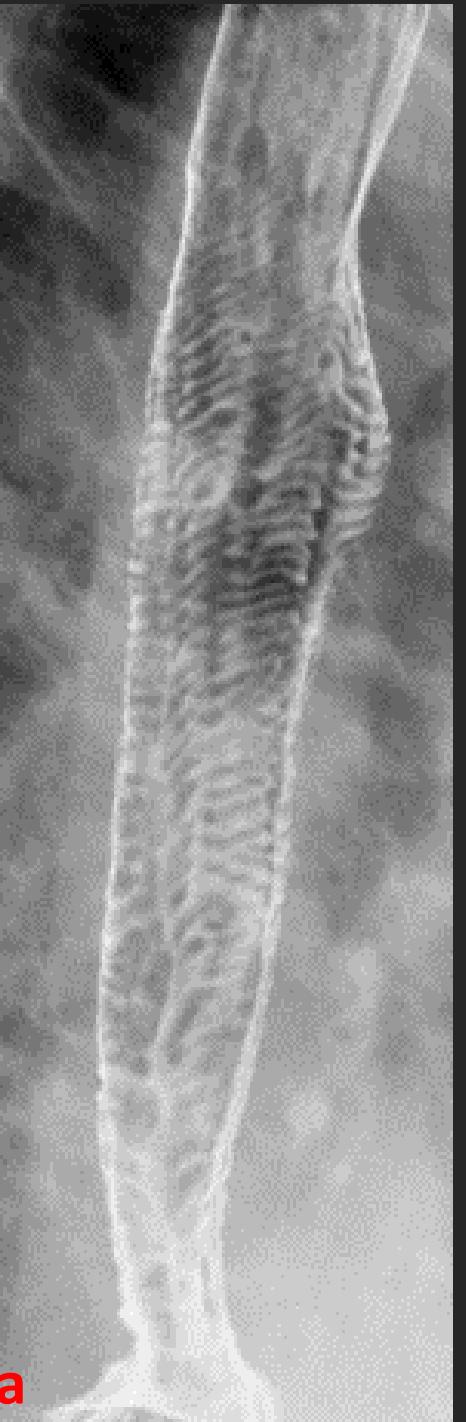
(a) LPO esophagram shows a granular mucosal pattern in a patient with Barrett esophagus.

(b) Supine frontal view shows spontaneous reflux in the same patient.

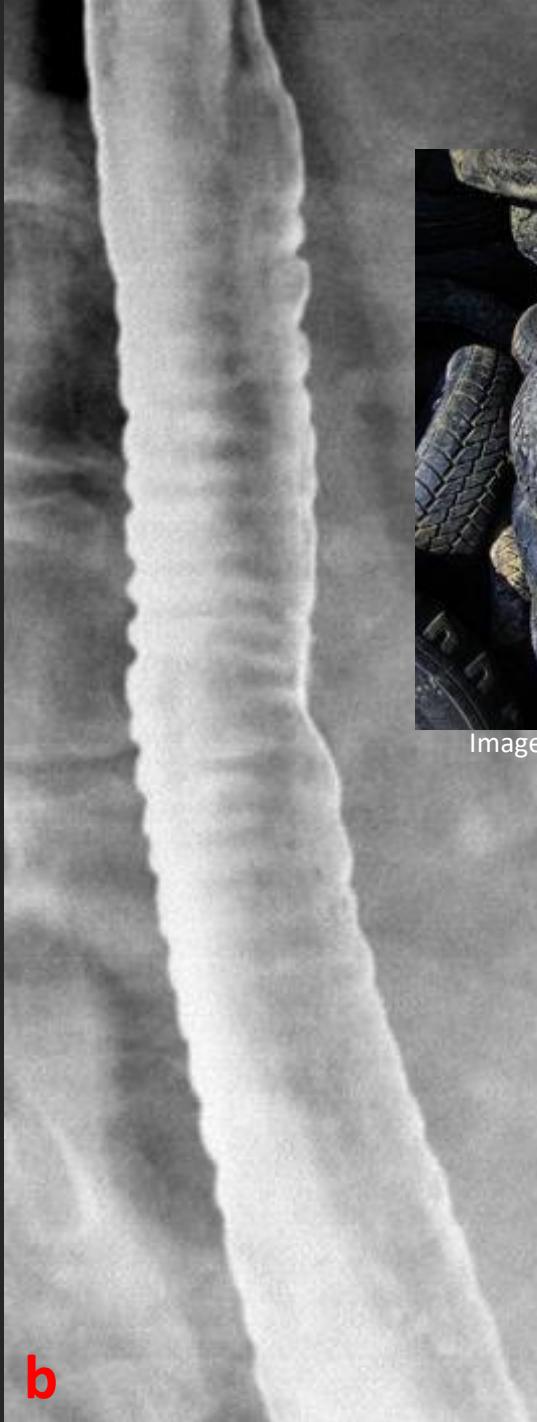




LPO esophagram (**a**) shows a “feline” esophagus. These muscularis mucosae contractions are common with reflux.



a

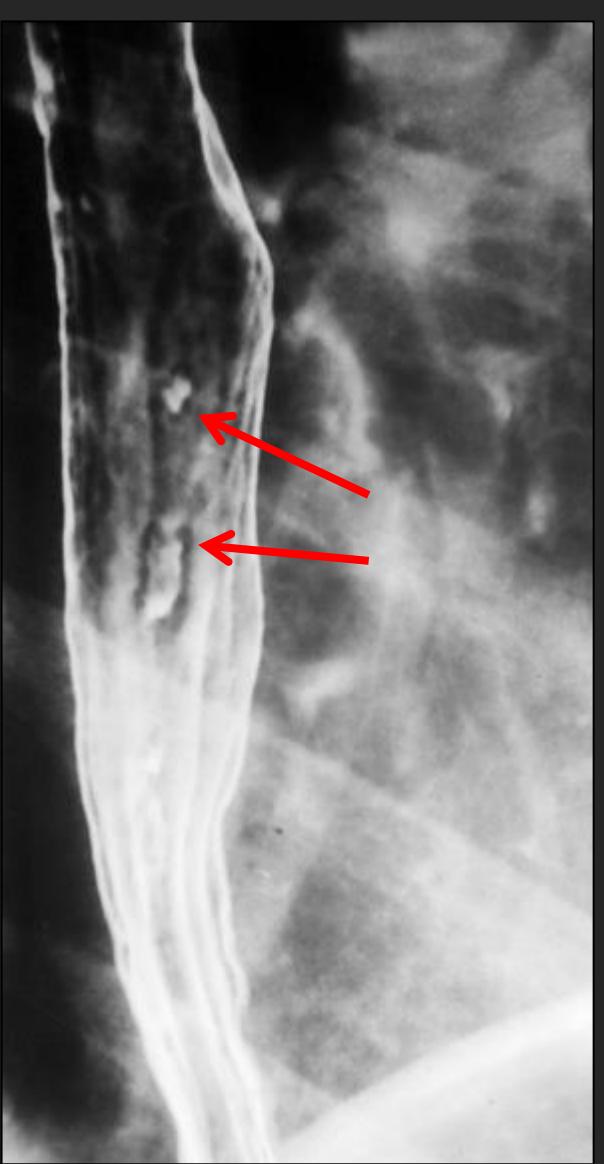


b



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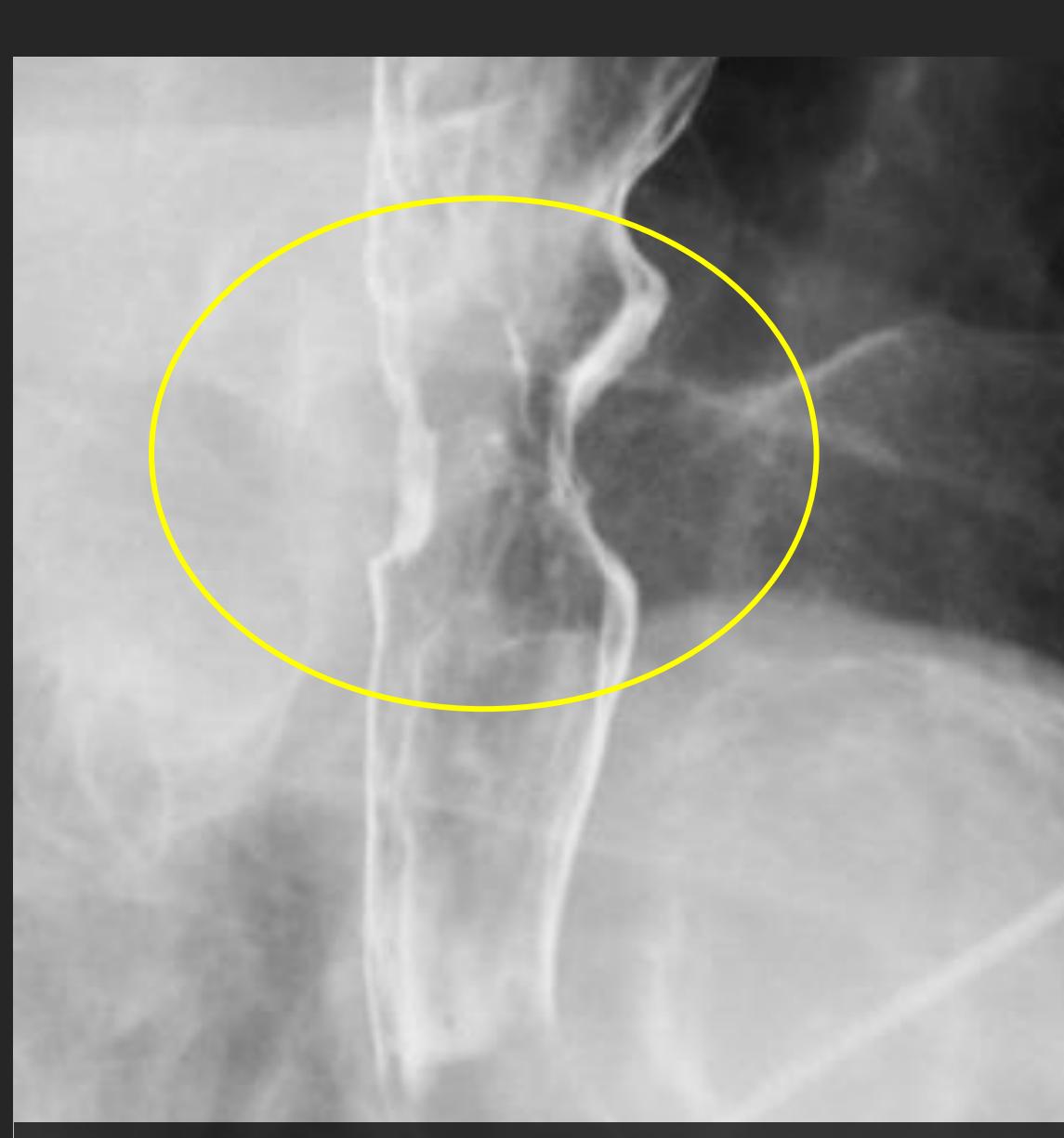
LPO esophagram (**b**) shows a “stacked rings” appearance, one of the manifestations of eosinophilic esophagitis.



LPO esophagram demonstrates discrete ulcers (arrows) in a case of herpetic esophagitis.



LPO esophagram shows "tree bark" mucosal contour in a patient with candidiasis and oral thrush (photo inset).



LPO esophagram reveals circumferential narrowing owing to squamous cell carcinoma (oval).

Single-Contrast Examinations of the Esophagus

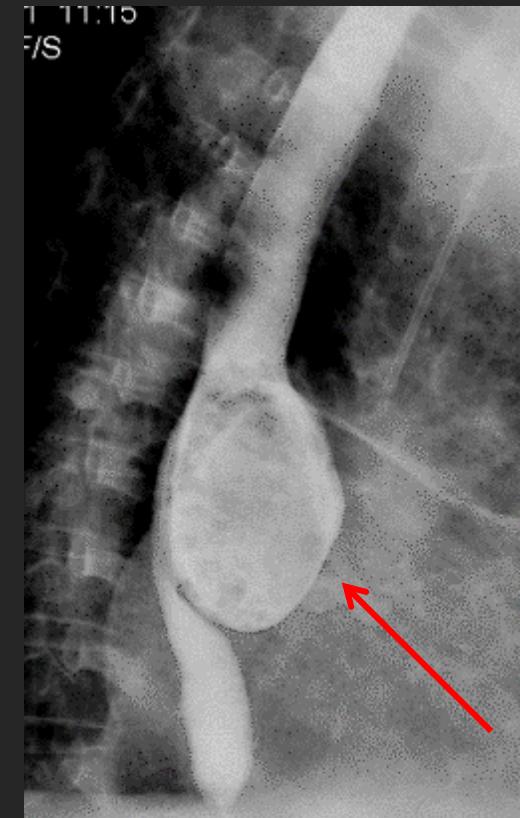
Photograph shows a barium sulfate suspension agent (Liquid E-Z-Paque, Bracco Diagnostics).



Image reprinted, with permission, from Bracco Diagnostics.



Lateral esophagram reveals a cervical esophageal stricture (arrow).



Oblique esophagram shows a midesophageal diverticulum (arrow).

Note.—This does not imply an endorsement of a specific brand.

Obtain frontal and lateral views of the pharynx and cervical esophagus during swallowing, with either “store fluoro loop” sequences or high-frame rate sequential radiography.

Tell the patient, “Take a mouthful and hold it until I tell you to swallow.”

Standard Dual Phase Barium Esophagogram outline

PATIENT STANDING

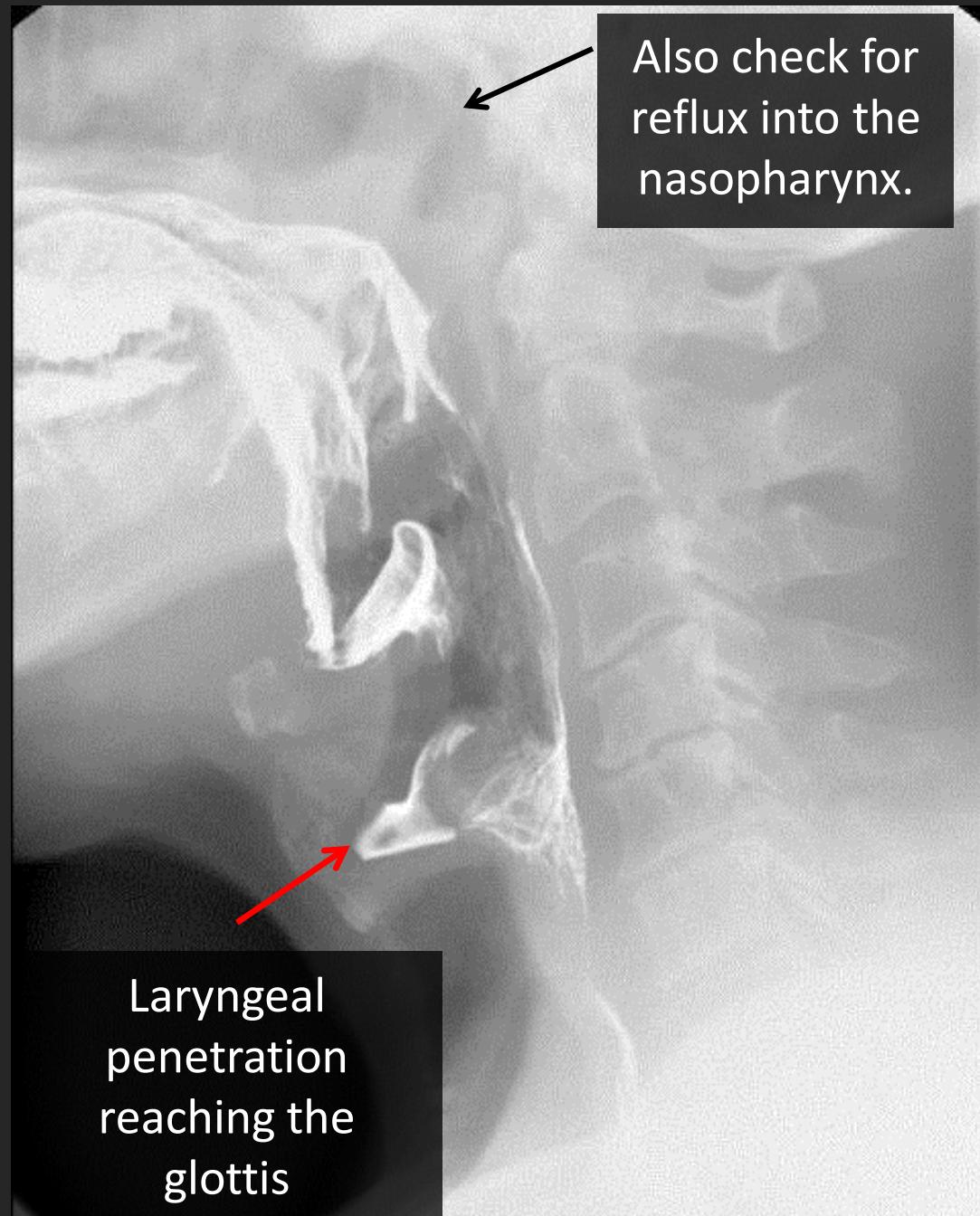
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Start with the patient in the upright position, if possible. This mimics the position the patient would be in during meals.

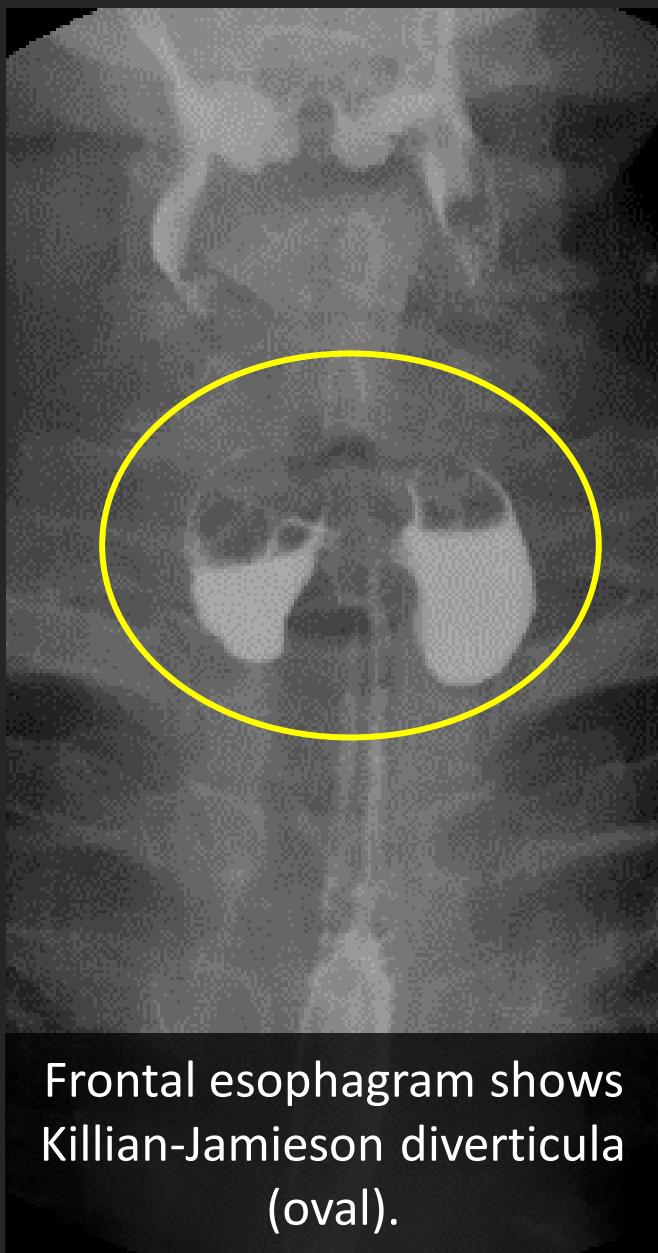
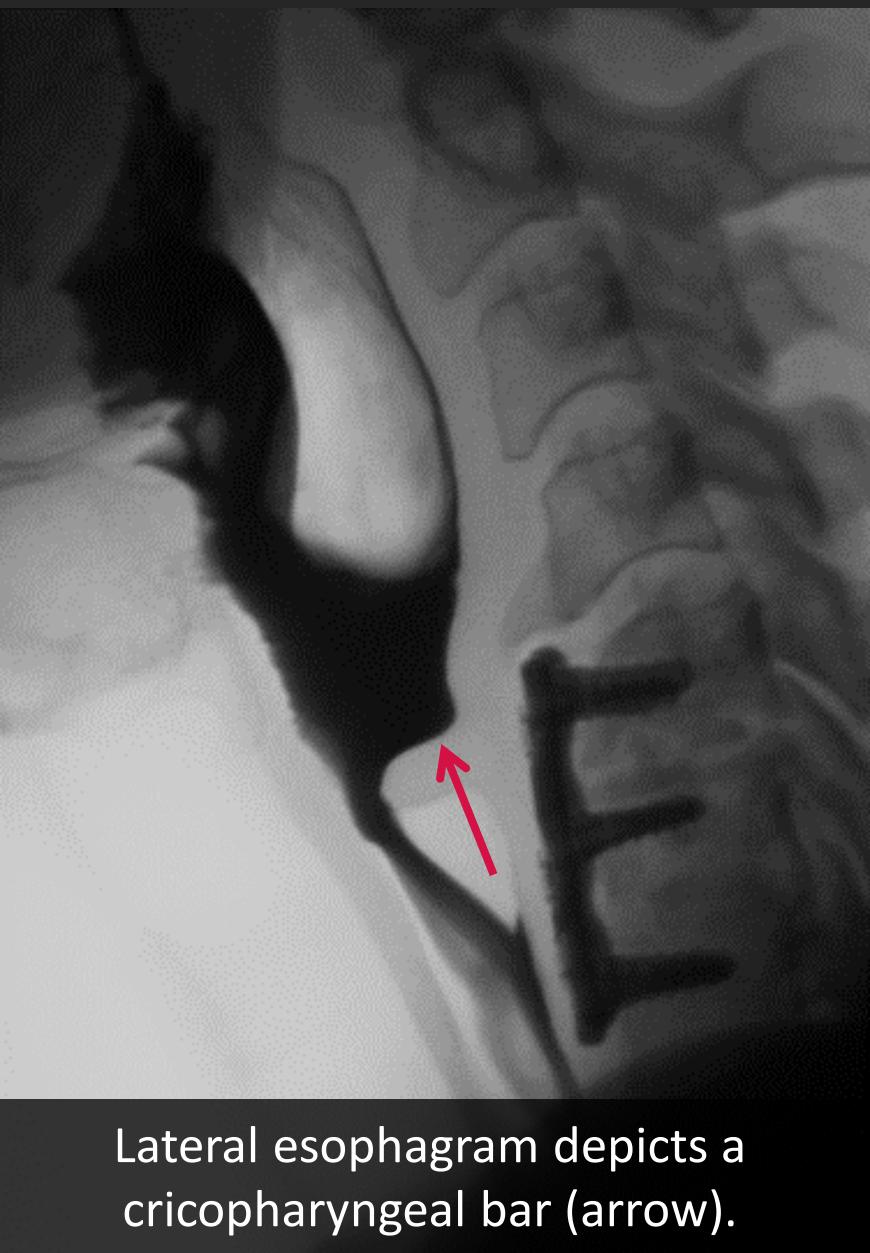
Lateral view shows barium reaching the vocal cords (red arrow).



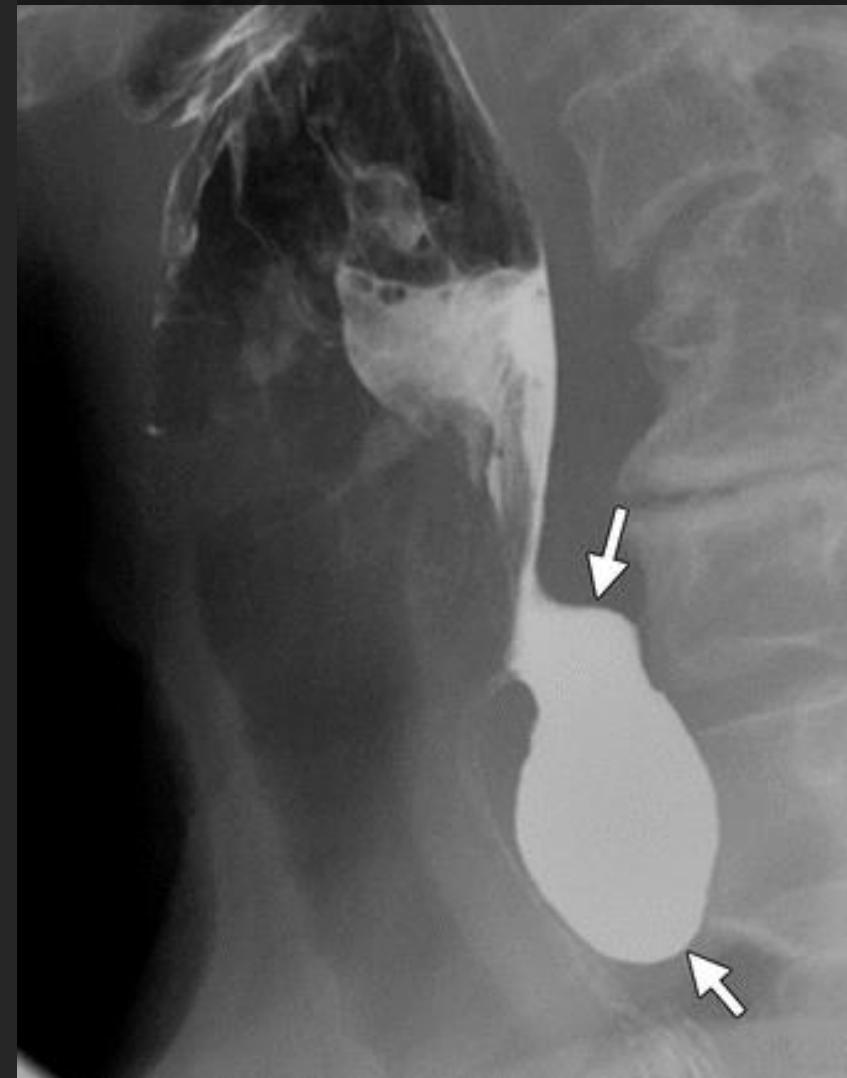


In addition to documenting laryngeal penetration/aspiration, note whether it occurs before, during, or after swallowing.

More to Appreciate than Just Aspiration...

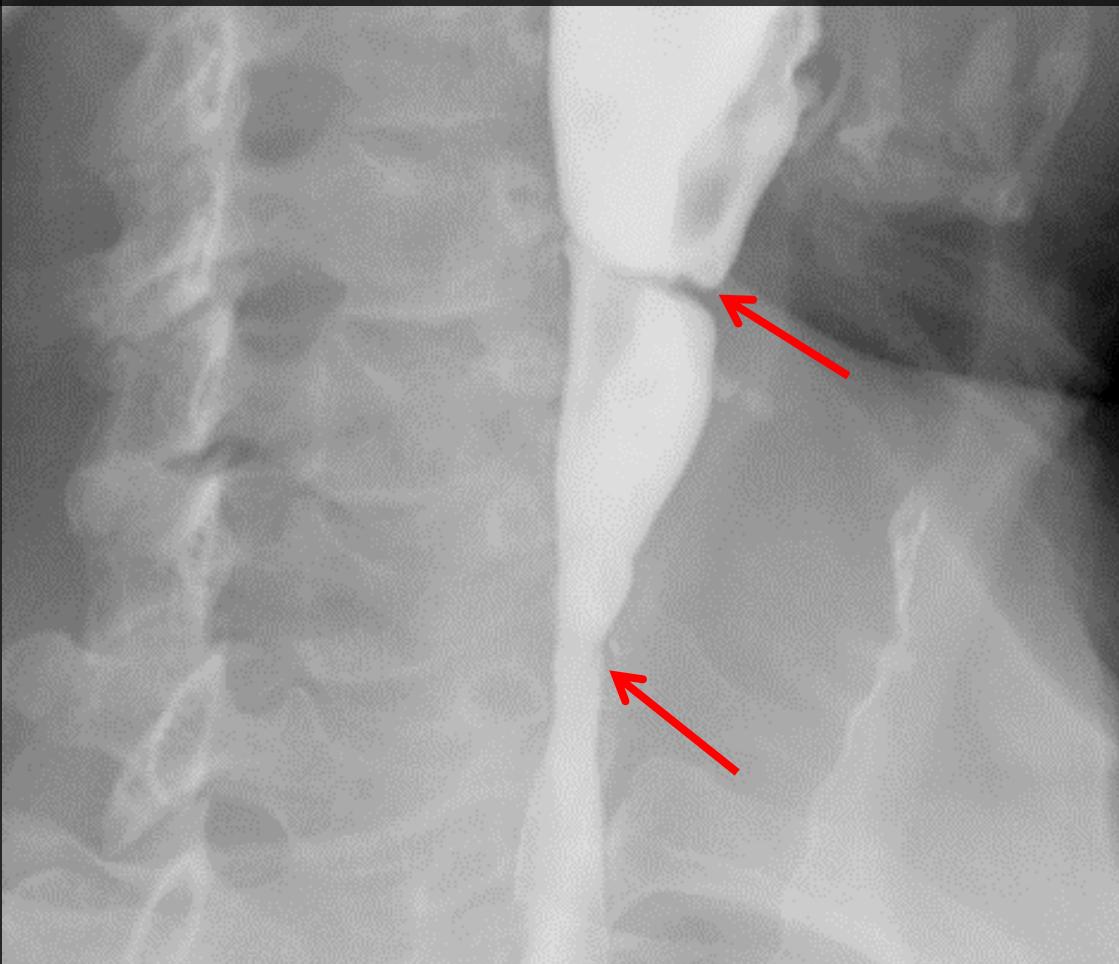


Lateral esophagram shows a Zenker diverticulum (arrows).

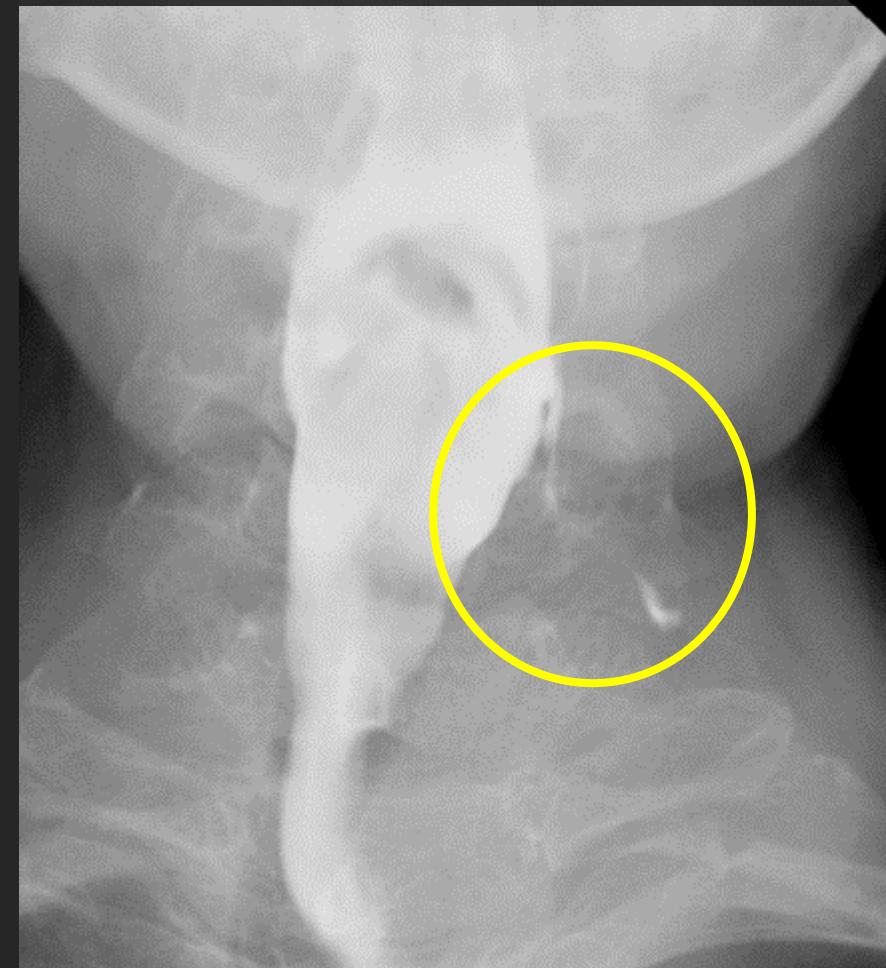


...and Still More!

Oblique esophagram shows lichen planus strictures (arrows).



Frontal esophagram shows a branchial cleft cyst (oval).



Obtaining Prone Oblique Images

Tell the patient,
**“Turn halfway up
on your right side.
Bend your left knee
like a kickstand to
hold you up. Hold
the cup in your left
hand, with the
straw in your
mouth.”**

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Prone Right Anterior Oblique (RAO) View

- Stress test for peristalsis
- Assesses distensibility
- Provides another view of the esophagogastric junction

Single Swallows

Observe peristalsis during three to five individual swallows.

Tell the patient, “Take a mouthful and swallow just once.”

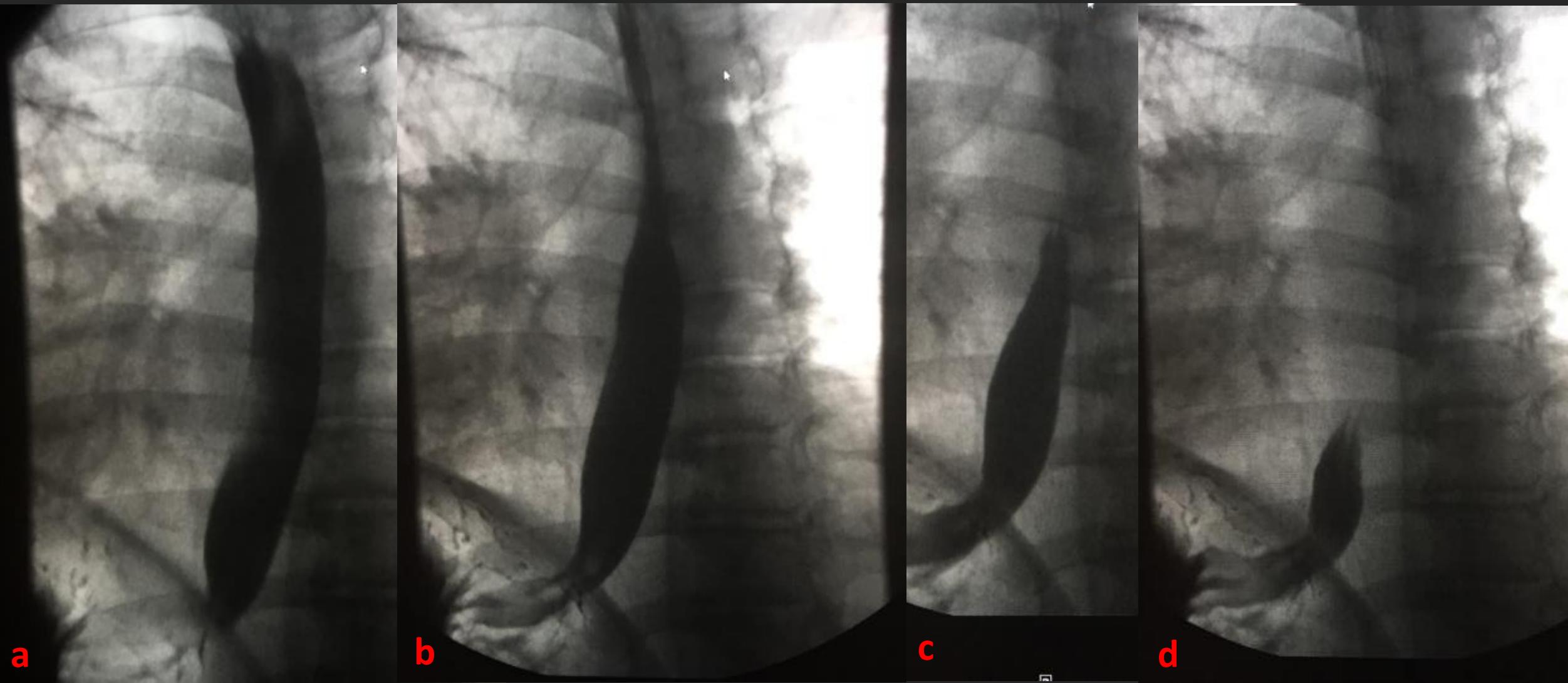
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Follow the tail of the bolus. There should be a smooth, progressing stripping wave, as seen in these sequential prone RAO esophagrams (a–d).

Motility Issues

Remember: repetitive swallows
disrupt primary peristalsis.

Instruct the patient to take single
swallows first.

Multiple Swallows

Repetitive swallows test the distensibility of the lumen and provide another method to evaluate the mucosal contour.

Tell the patient,
“One gulp after another. Drink it like you love it—like it’s iced tea on a hot summer day.”

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What Single-Contrast Images Can Depict

Single-contrast RAO esophagram
shows the “bird’s beak”
appearance of
type 1 achalasia.

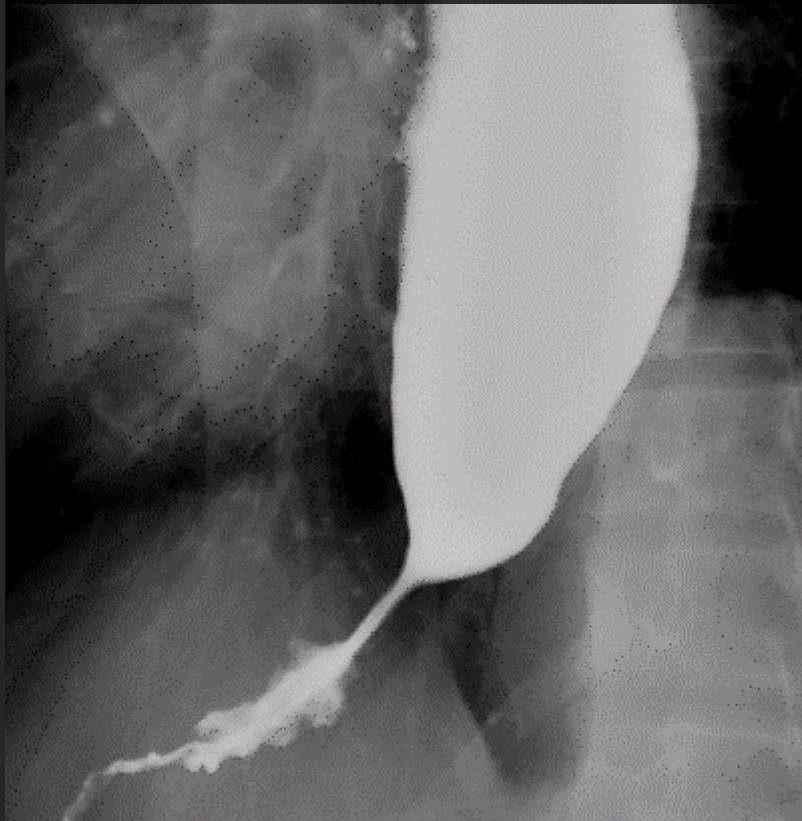
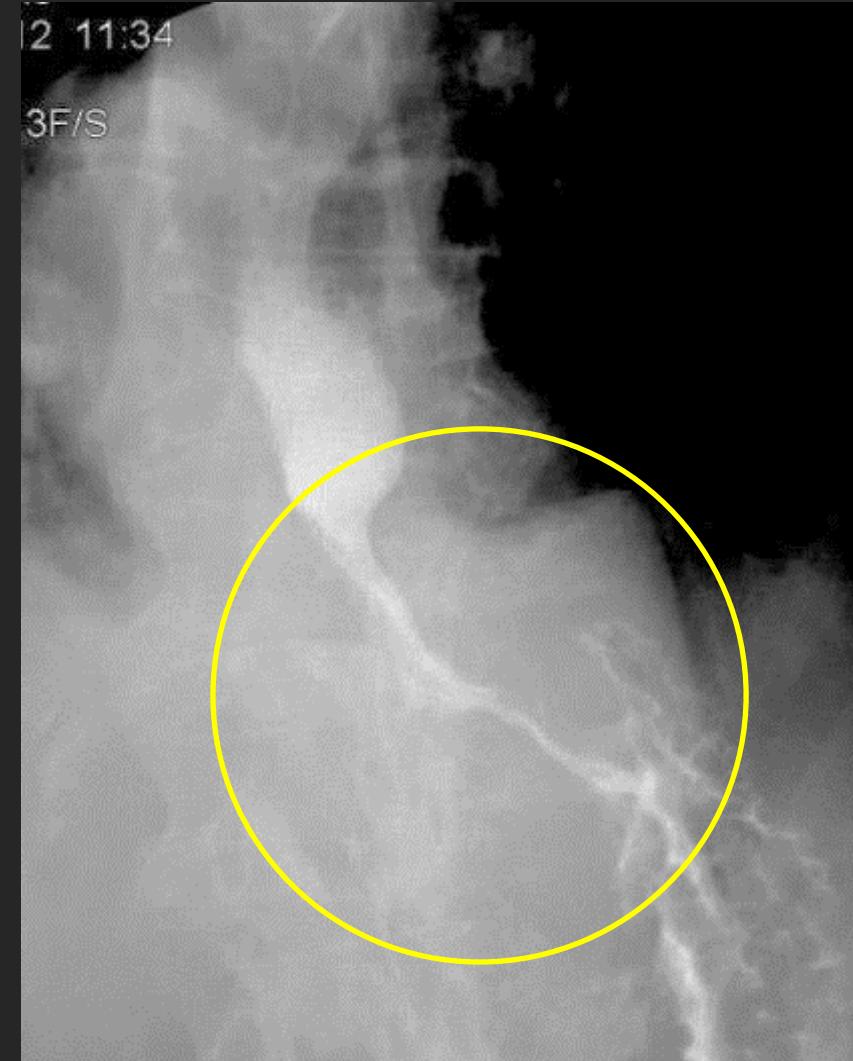


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But don't be fooled!

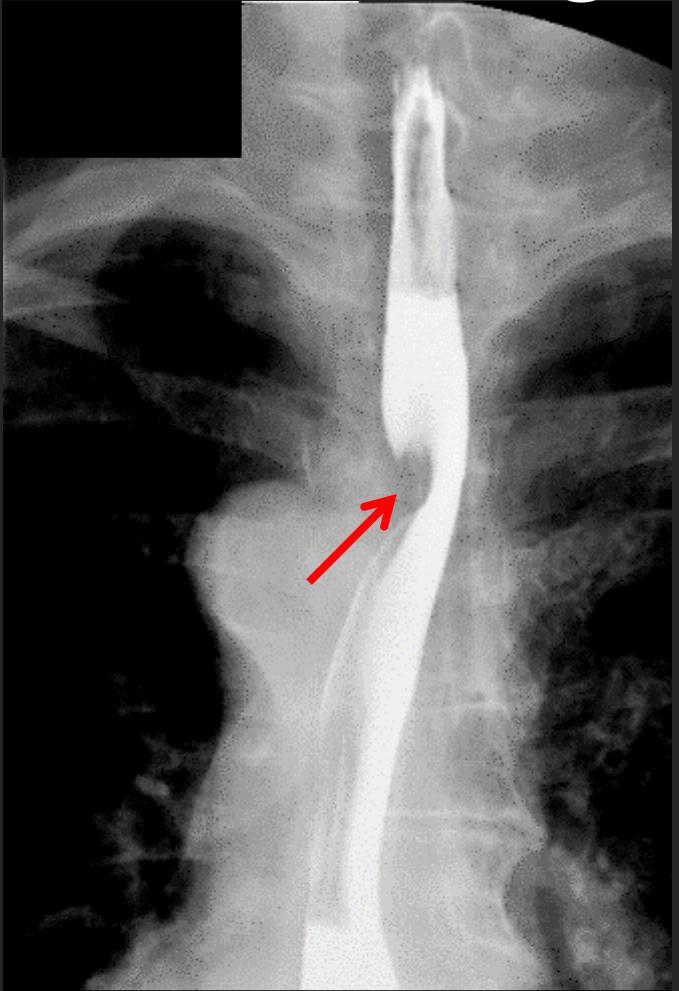


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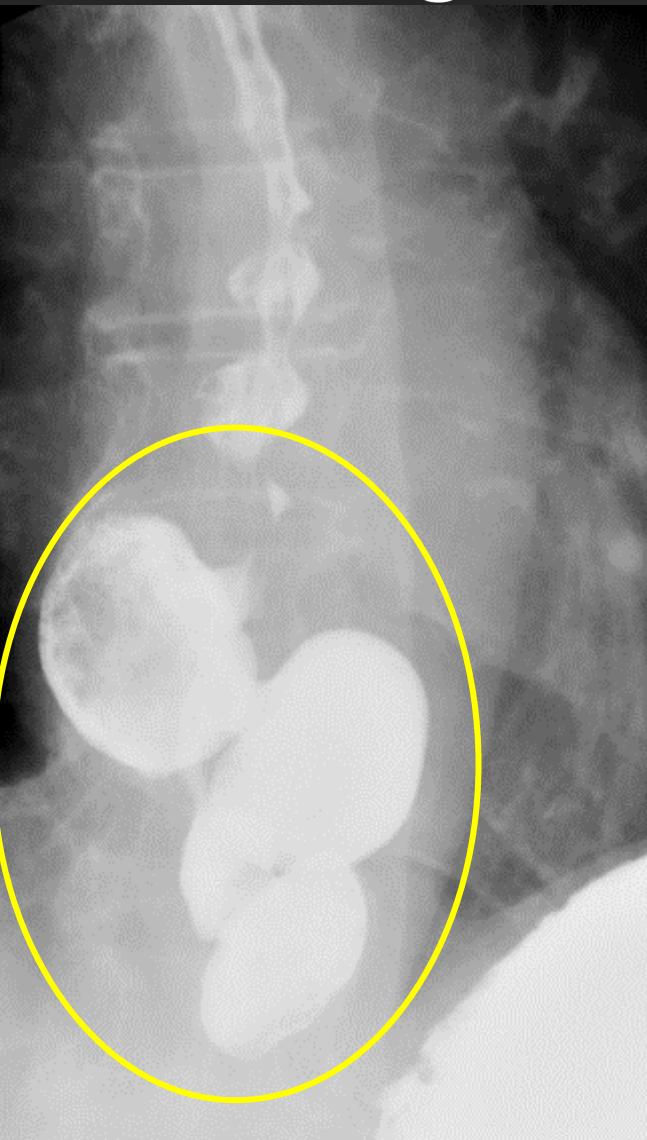


Oblique esophagram shows a scirrhous infiltrative neoplasm (circle) mimicking findings of achalasia.

Other Findings Depicted on Single-Contrast Esophagrams

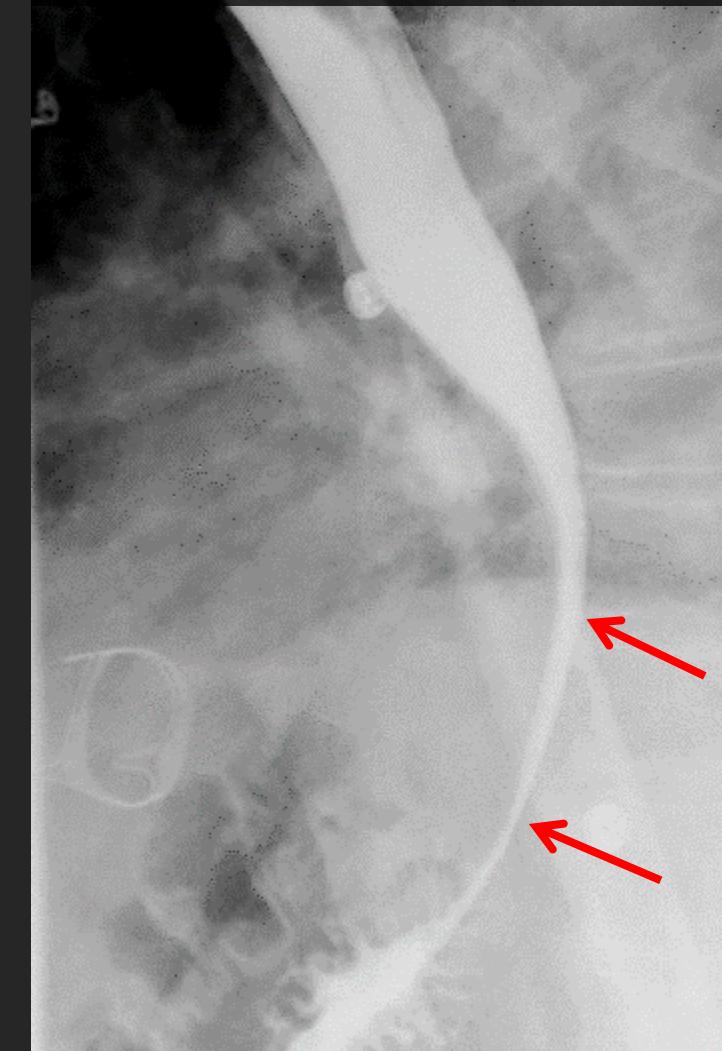


Frontal view: aberrant subclavian artery (arrow) narrowing the esophageal lumen, known as dysphagia lusoria



Frontal view shows multiple diverticula (oval).

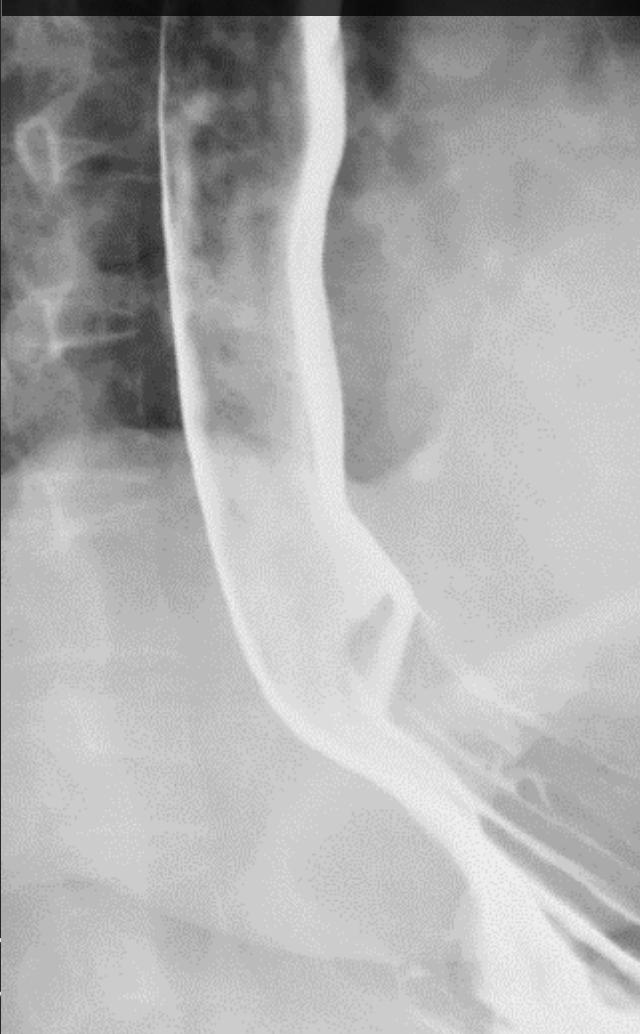
Lateral view reveals impingement by marked left atrial enlargement (arrows)



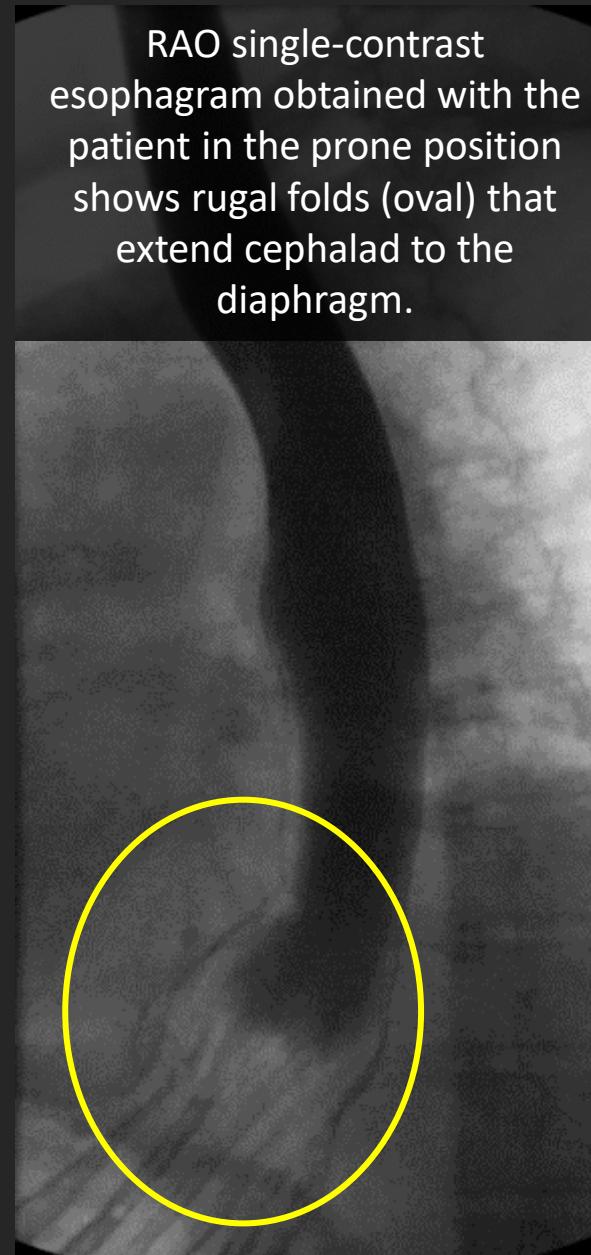
Obtaining prone oblique single-contrast esophagrams is particularly helpful when evaluating the following cases:

Hiatal Hernia Search

LPO double-contrast esophagram obtained with the patient in the upright position shows a normal appearance.



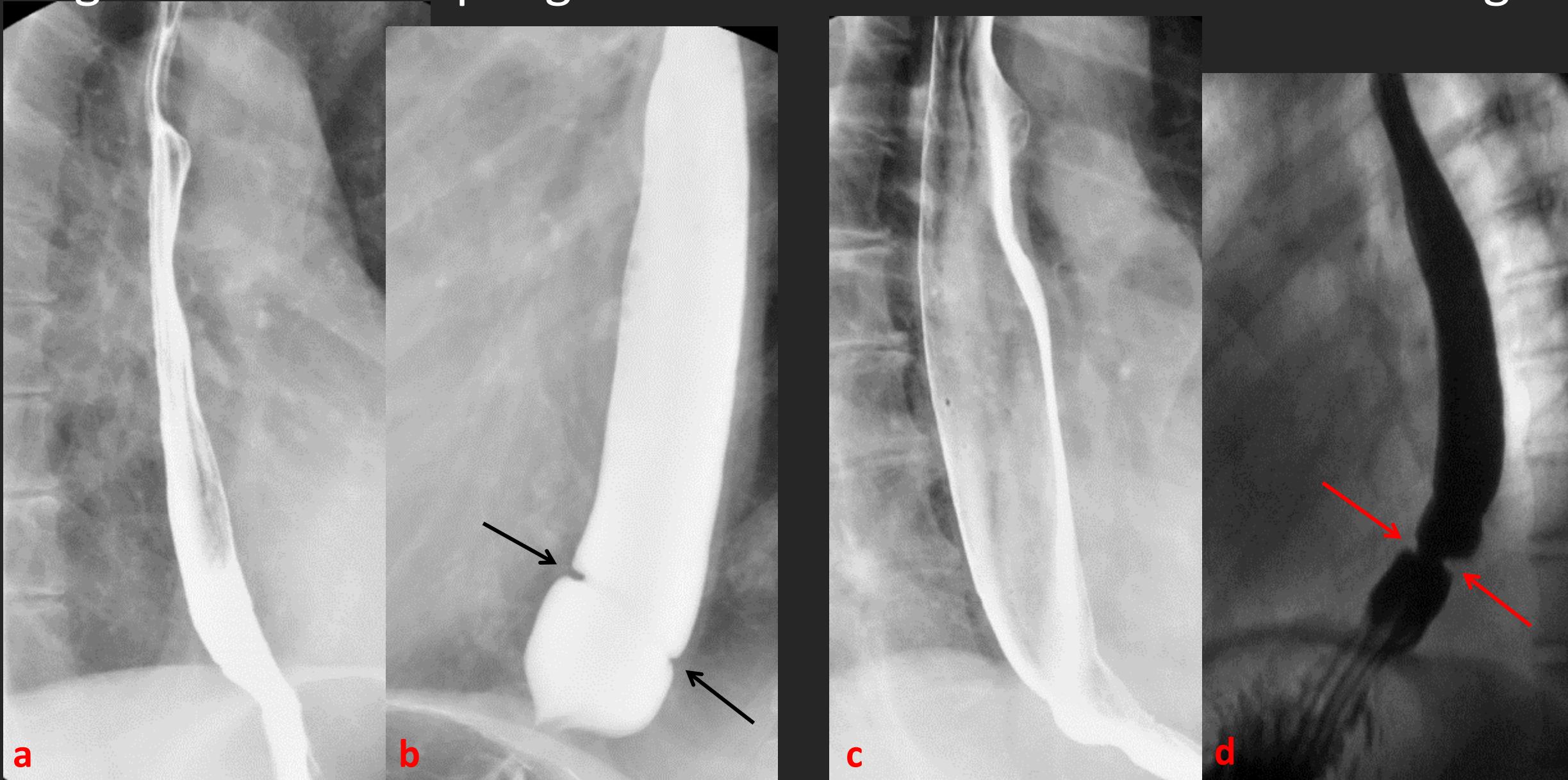
RAO single-contrast esophagram obtained with the patient in the prone position shows rugal folds (oval) that extend cephalad to the diaphragm.



Frontal esophagram obtained with the patient in the supine position shows the hiatal hernia, with spontaneous reflux.



Single-Contrast Esophagrams Can Make You the Lord of the Rings!



Lower esophageal rings (arrows) invisible on upright double-contrast views (a, c),
but easily seen on the prone RAO single-contrast images (b, d).

Checking for Reflux

How “provocative”
should your provocative
maneuvers be?

Trendelenburg?

Cough?

Valsalva?

Water siphon test?

Unfortunately, there is no
consensus.

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When Solid Foods Present Problems

Having the patient ingest the 13-mm barium tablet or marshmallow bolus can be particularly helpful if the patient notes difficulty when eating solids or if the barium swallow study showed a stricture or ring.

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PATIENT STANDING

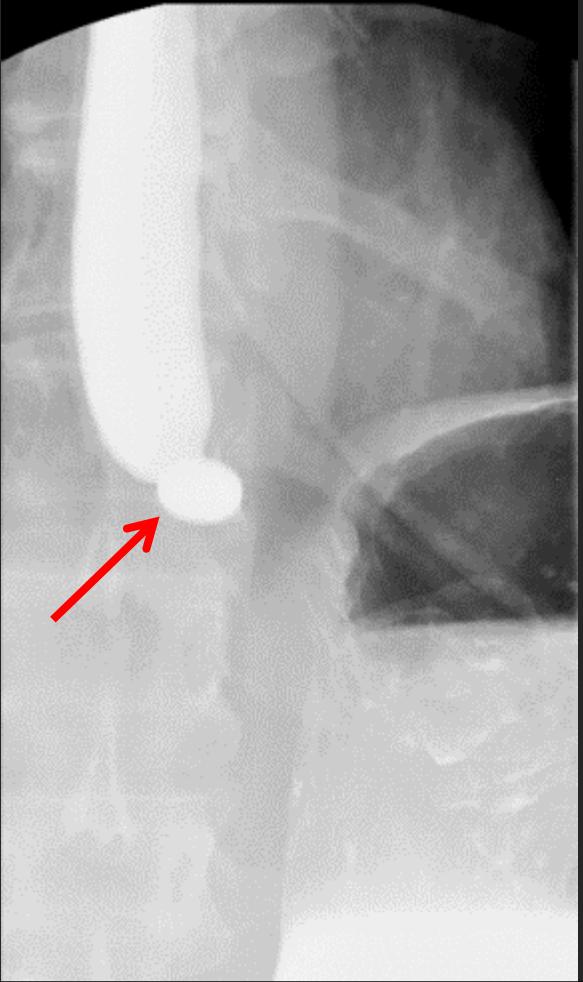
1. **Thick barium.** Lateral and frontal phonation views of pharynx ("Say the letter E like you're singing it: EEEEEEEE")
2. Effervescent crystals and *small* amount of water
3. Thick barium. Left posterior oblique position. ("One gulp after another.") Take several (about 3-4) air contrast views of the thoracic esophagus and GE junction.
4. **Thin barium.** Lateral and frontal rapid sequence images or stored fluoro of pharynx and cervical esophagus during a swallow

PATIENT IN PRONE RIGHT ANTERIOR OBLIQUE POSITION

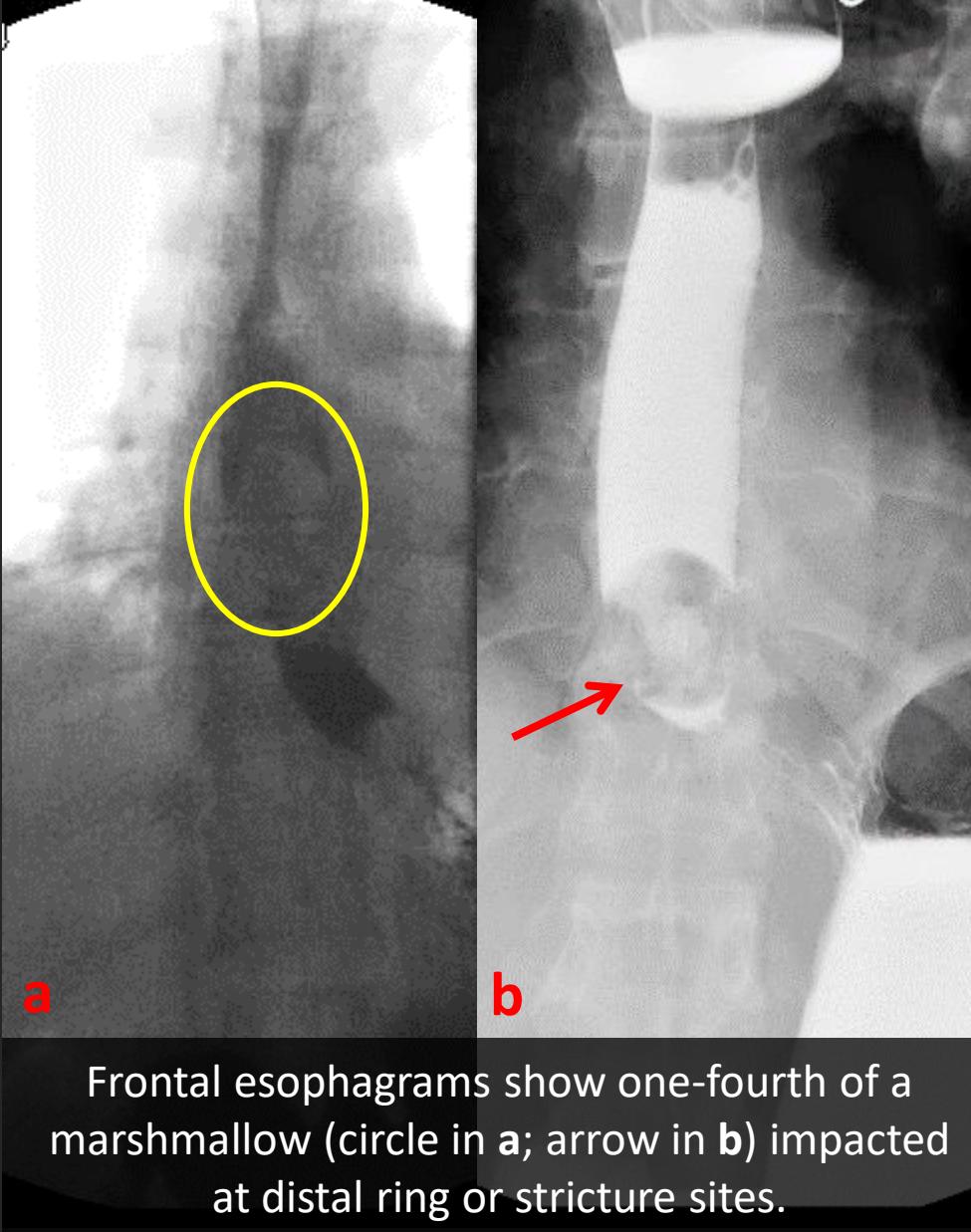
1. **Thin Barium.** A few single swallows to assess peristalsis.
2. Distended views ("chug it like you love it") of each segment of the barium filled esophagus and GE junction.
3. Reflux check: Patient supine, RPO, right lateral
4. For solid dysphagia, stand the patient and give barium tablet or 1/4-1/3 marshmallow. ("Swallow it as whole as you can") washed down with thin barium.



Evaluating Objects that Become Stuck



Frontal esophagram shows a 13-mm barium tablet (arrow) lodged at a distal esophageal ring.

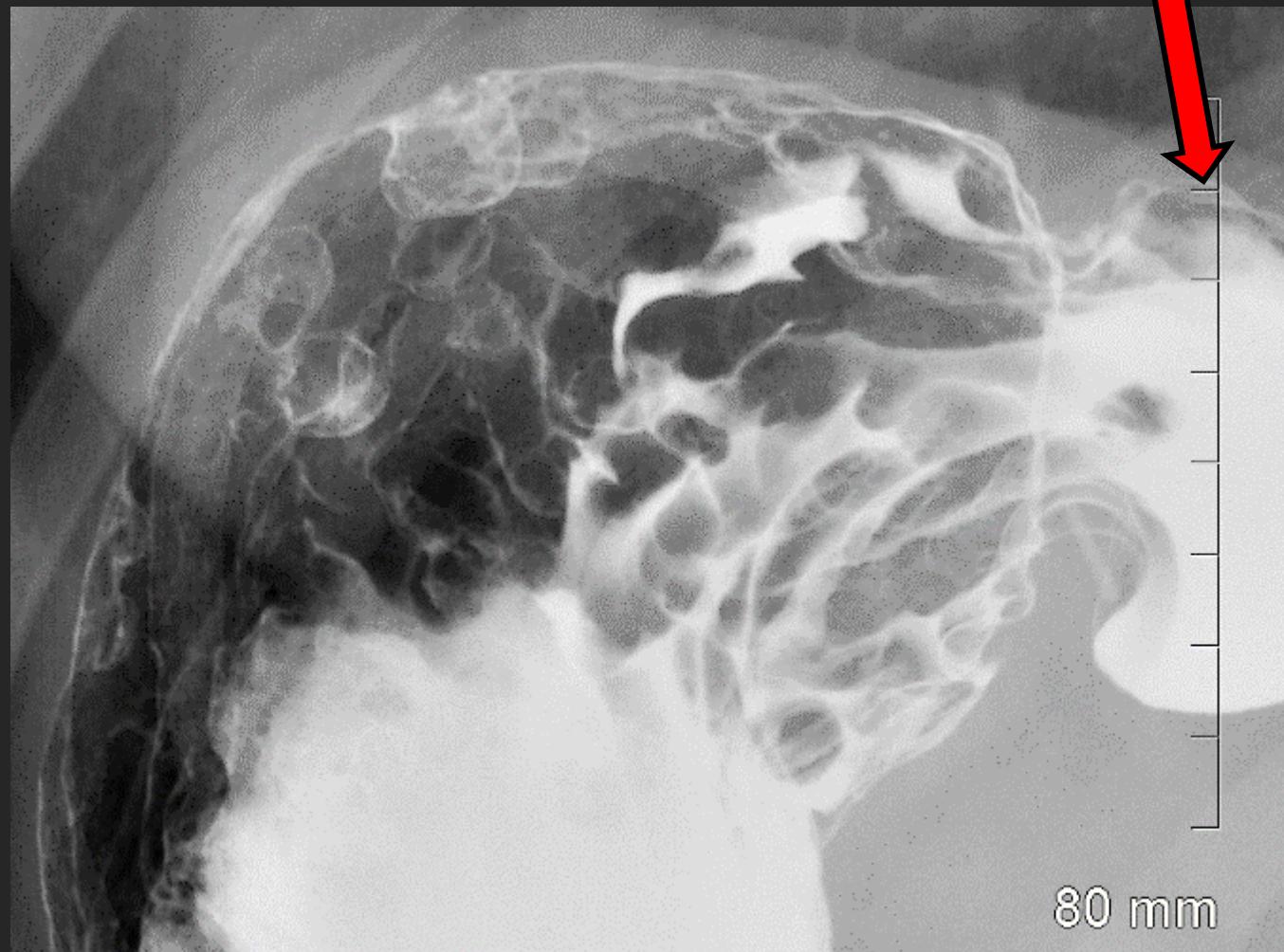


Frontal esophagrams show one-fourth of a marshmallow (circle in a; arrow in b) impacted at distal ring or stricture sites.

Final Thought: Don't Forget to Evaluate the Gastric Cardia



Frontal view shows fundic gland polyps (circle).

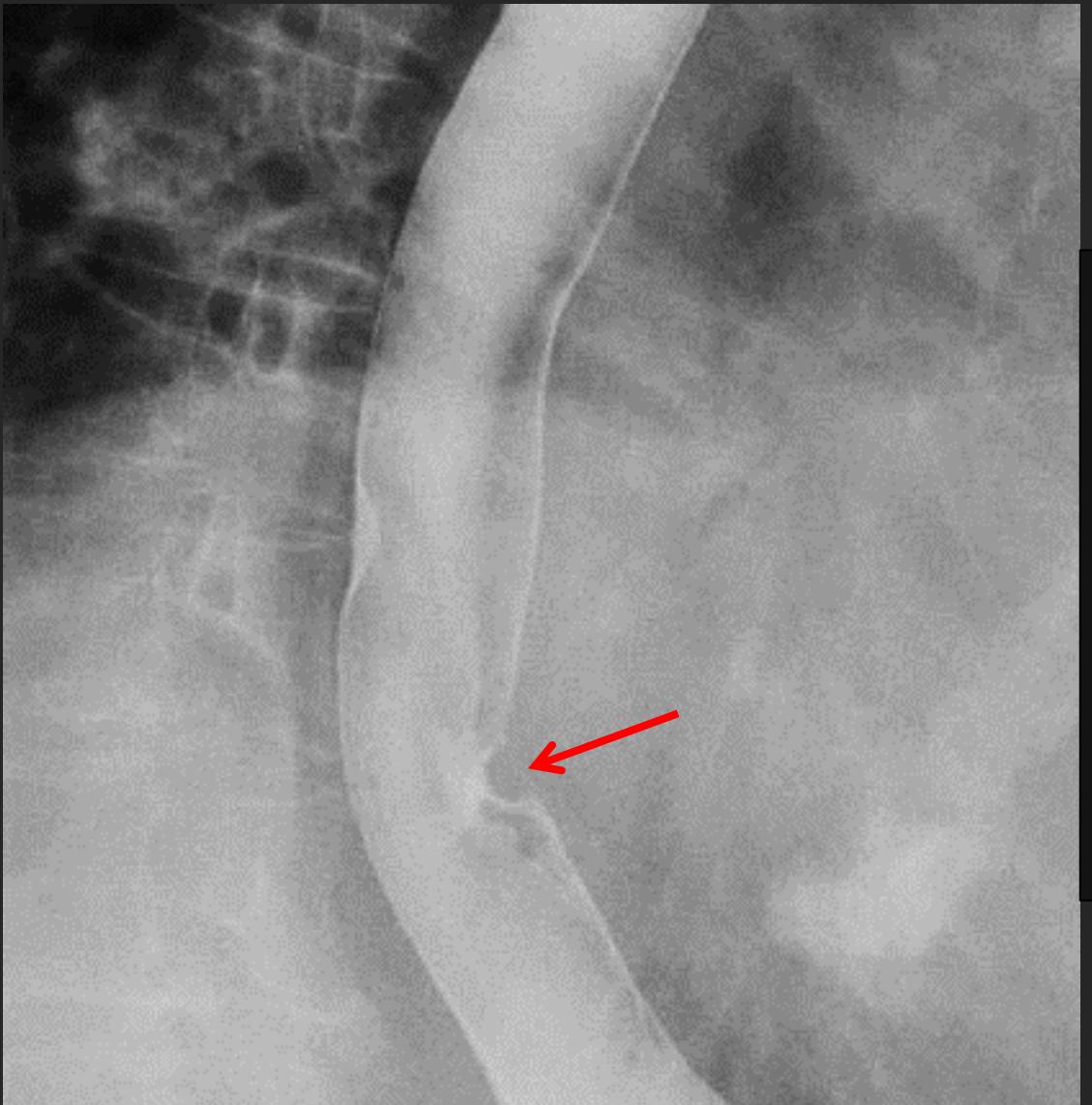


Lateral view reveals a congenital gastric diverticulum (arrow).

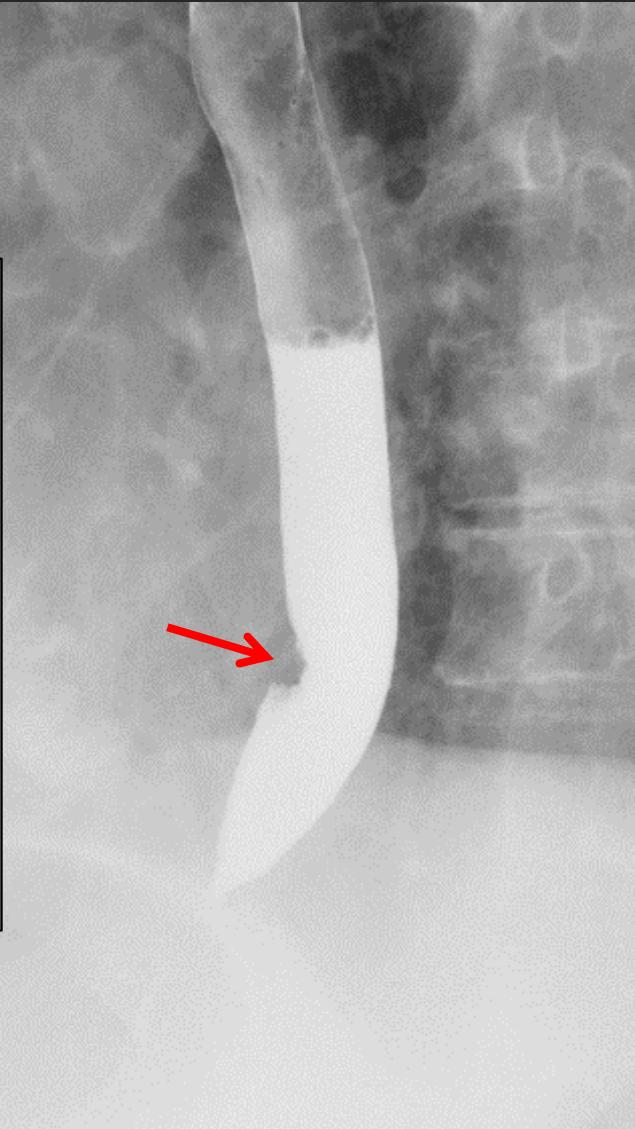
Take-Home Message

We radiologists still perform a lot of esophagrams, so let's do them well.

It CAN Be Done



Oblique views show a tiny esophageal carcinoma (arrow). The diagnosis was made on the basis of the esophagram findings.



Mini guide or “recipe card” to use in the fluoroscopy suite

Standard Dual Phase Barium Esophagogram outline

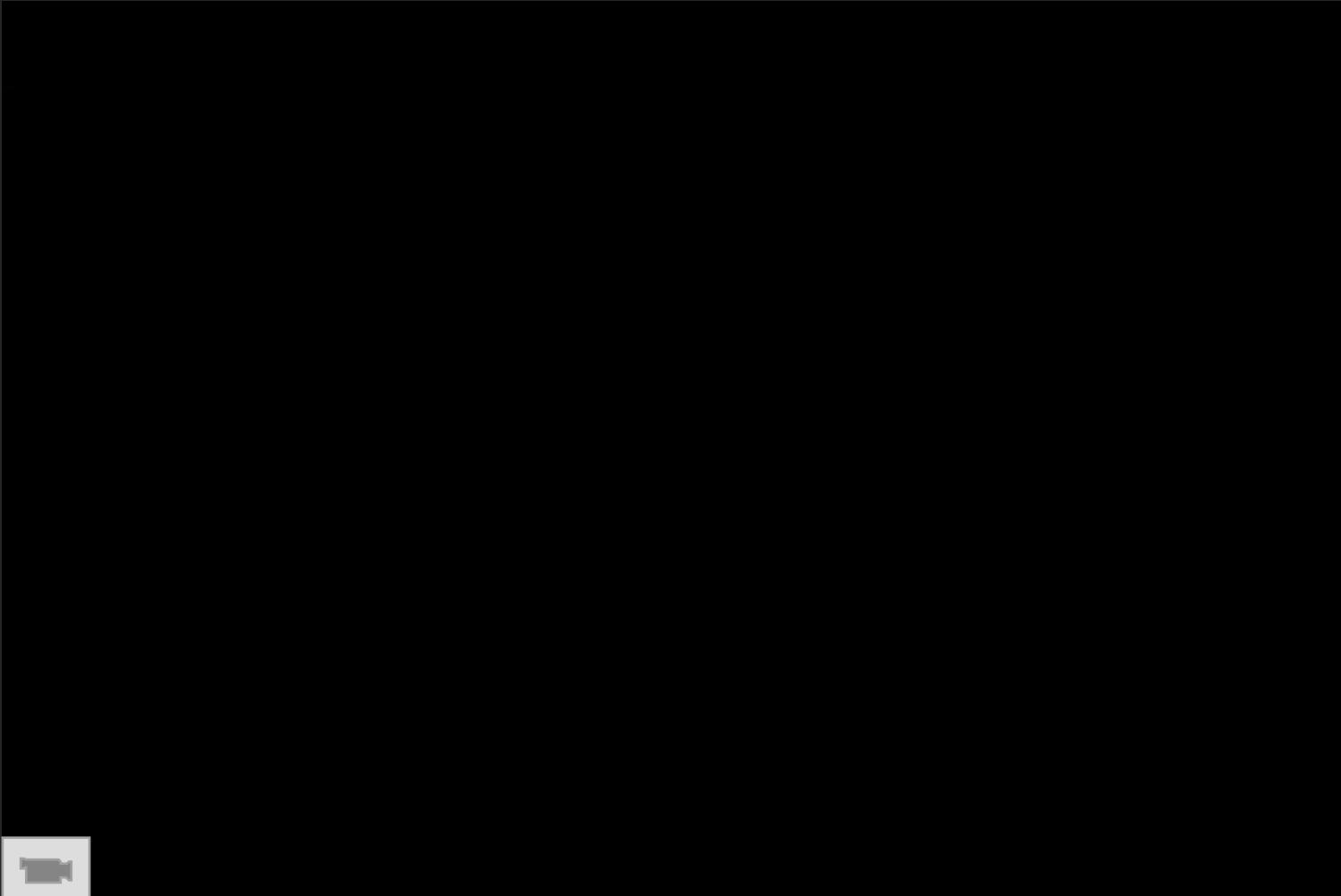
PATIENT STANDING

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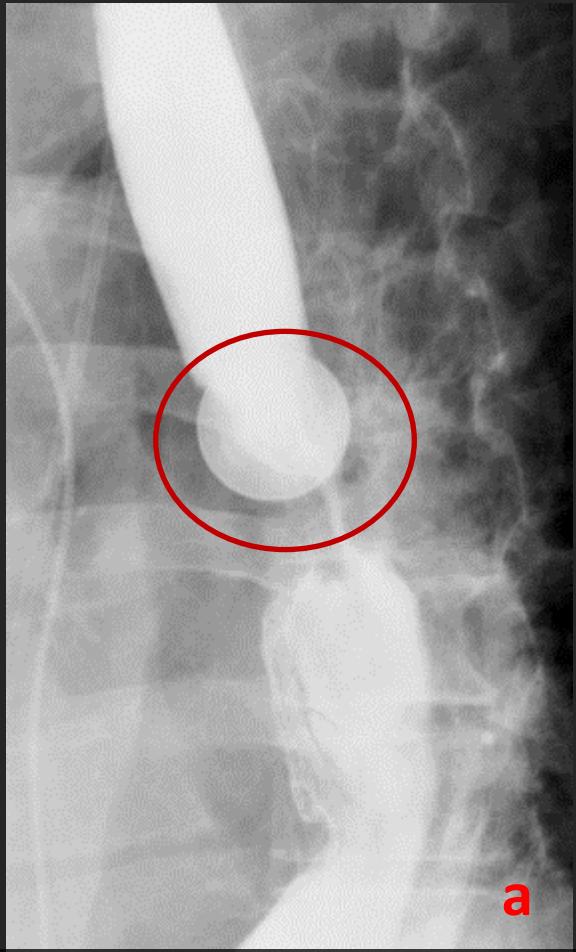
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Tying It All Together: A Video Walk-through for Performing a Dual-Phase Esophagram



Now You're the “Master” of the Esophagus!



a



b



(c) Endoscopic view of the souvenir from
Augusta National Golf Club.

Oblique and frontal views (a, b) show a golf ball marker (oval) lodged in the midesophagus.

Don't Forget! Limit Radiation Dose

Keys for Radiation Dose Reduction

LIMIT fluoroscopy time!

Always keep the image intensifier as CLOSE to the patient as possible.

REDUCE the pulsed fluoroscopy frame rate, when possible.

Use the “SAVE IMAGE” feature to obtain a still frame when you do not need a spot fluoroscopic image.

Always wear a RADIATION BADGE to track exposure.

Conclusion

- The barium esophagram remains a useful and frequently performed examination in contemporary radiology practice.
- Proper esophagram technique is essential for obtaining an optimal study.
- Employing that proper technique, a wide array of structural and functional abnormalities can be diagnosed with barium esophagography.

Suggested Readings

Koehler RE, Weyman PJ, Oakley HF. Single- and double-contrast techniques in esophagitis. *AJR Am J Roentgenol* 1980;135(1):15–19.

Levine MS, Carucci LR, DiSantis DJ, et al. Consensus Statement of Society of Abdominal Radiology Disease-Focused Panel on Barium Esophagography in Gastroesophageal Reflux Disease. *AJR Am J Roentgenol* 2016;207(5):1009–1015.

Levine MS, Rubesin SE. Diseases of the esophagus: a pattern approach. *Abdom Radiol* 2017;42(9):2199–2218.

Rubesin SE, Jessurun J, Robertson D, Jones B, Bosma JF, Donner MW. Lines of the pharynx. *RadioGraphics* 1987;7(2):217–237.

Tao TY, Menias CO, Herman TE, McAlister WH, Balfe DM. Easier to swallow: pictorial review of structural findings of the pharynx at barium pharyngography. *RadioGraphics* 2013;33(7):e189–e208.