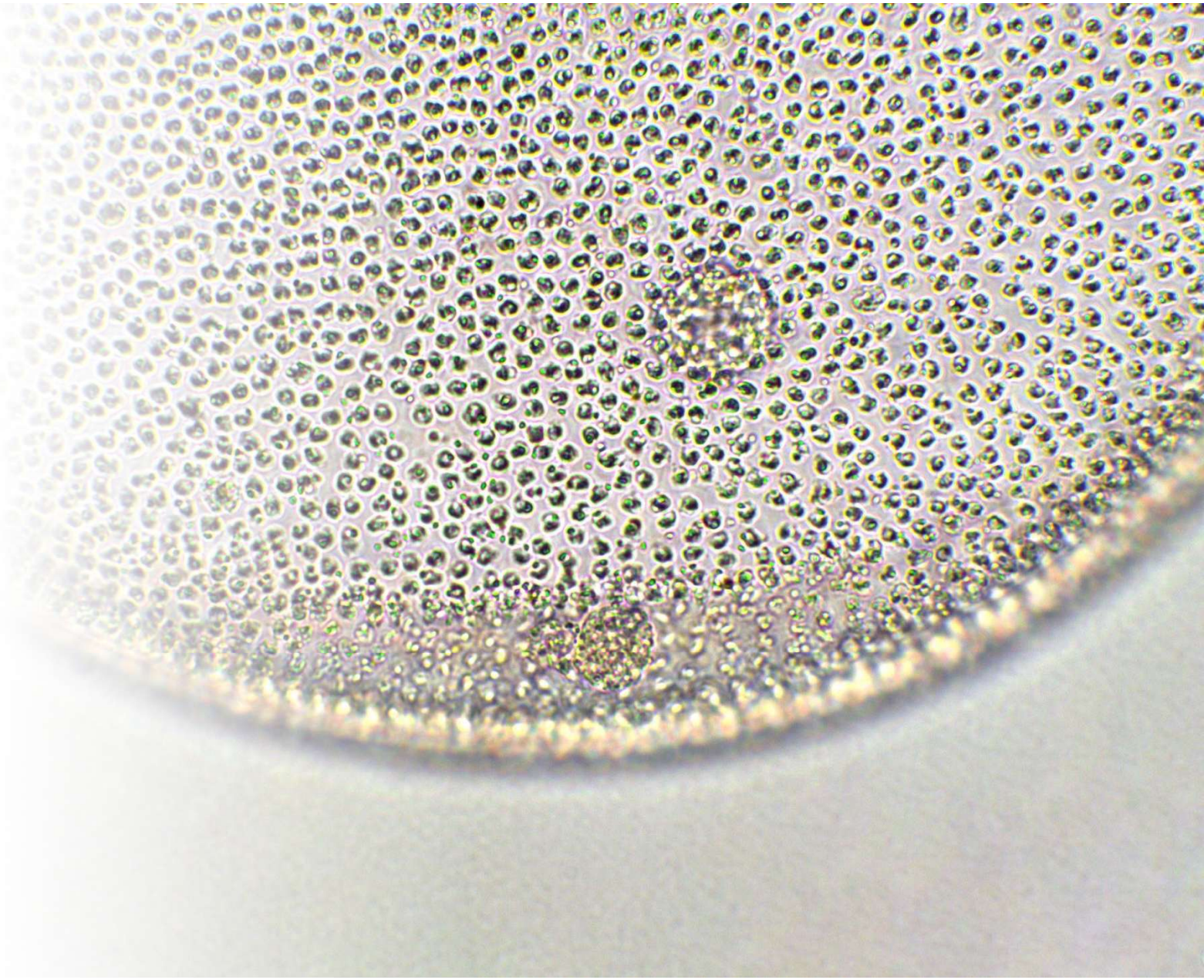
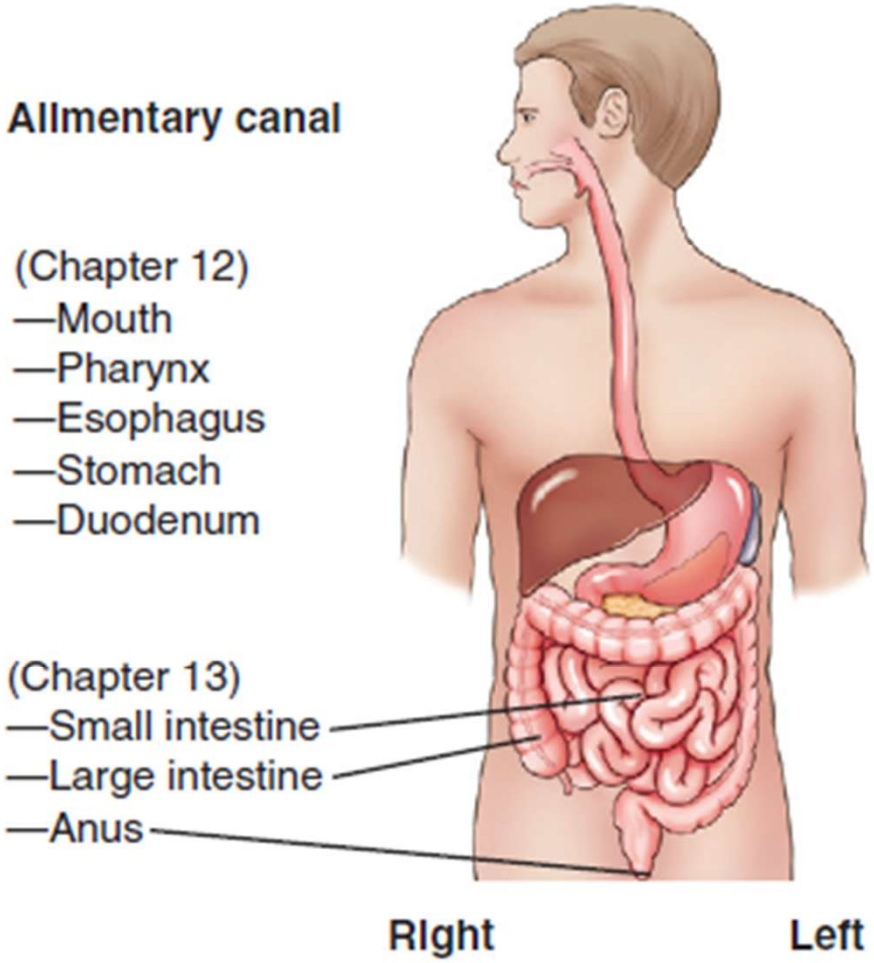
Lower GI System




Alimentary canal
(Chapter 12)
—Mouth
—Pharynx
—Esophagus
—Stomach
—Duodenum
(Chapter 13)
—Small intestine
—Large intestine
—Anus
Right
Left

1. Small Bowel Series

- Radiographic examination specifically of the small intestine
- This examination is often combined with an upper GI series and under these conditions,
- May be termed a *small bowel follow-through*

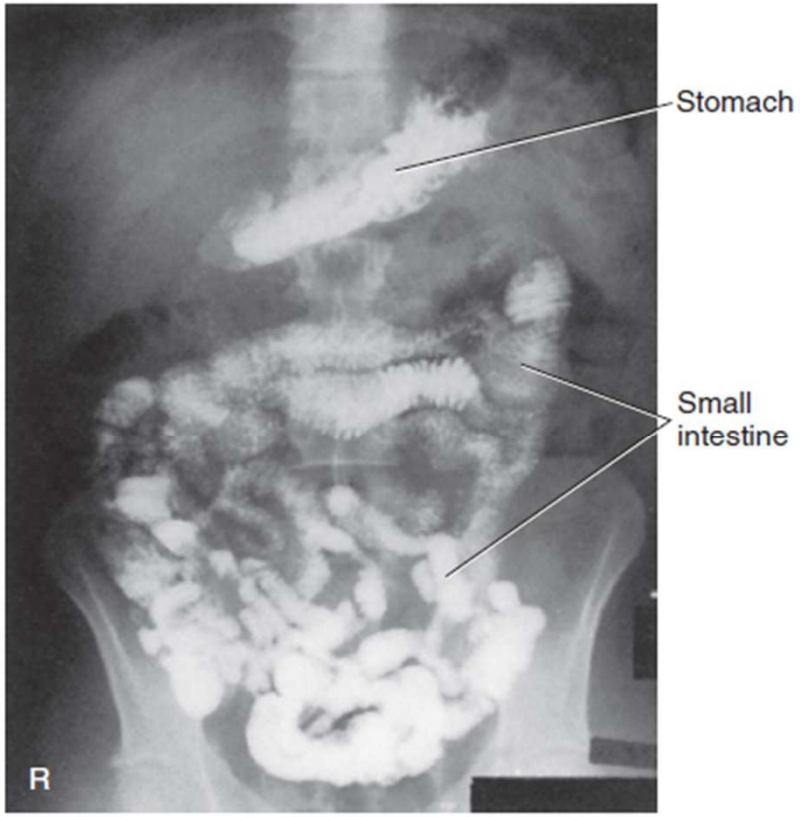


Fig. 13-2 Small bowel series—PA.

2. Barium Enema (Lower GI Series, Colon): Study of the Large Intestine

- The radiographic procedure designed to study the large intestine is most commonly termed a barium enema.
- Alternative designations include *BE, BaE,* and *lower GI series.*
- The figure shows a large bowel or colon filled with a combination of air and barium

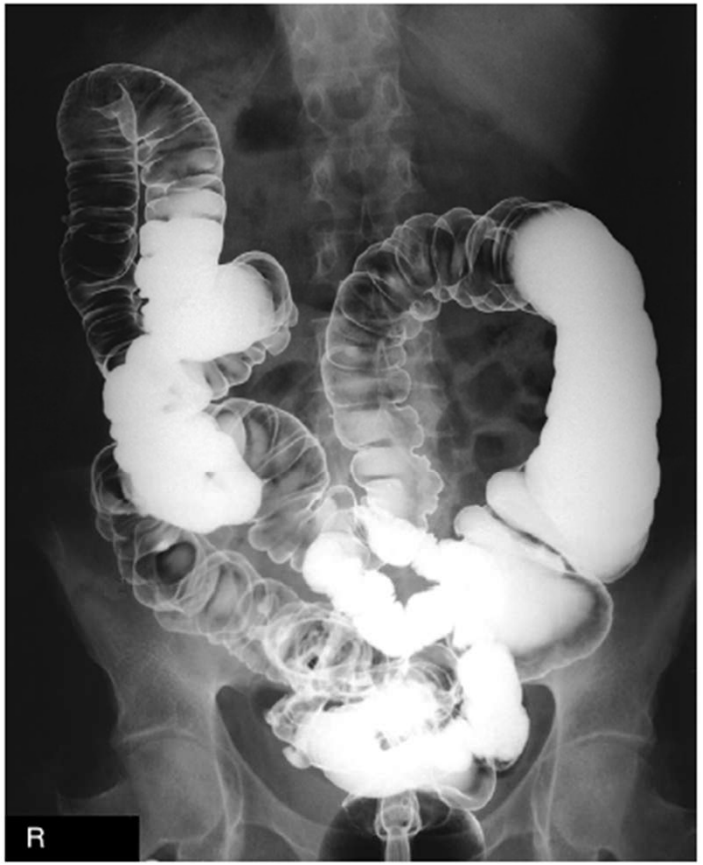
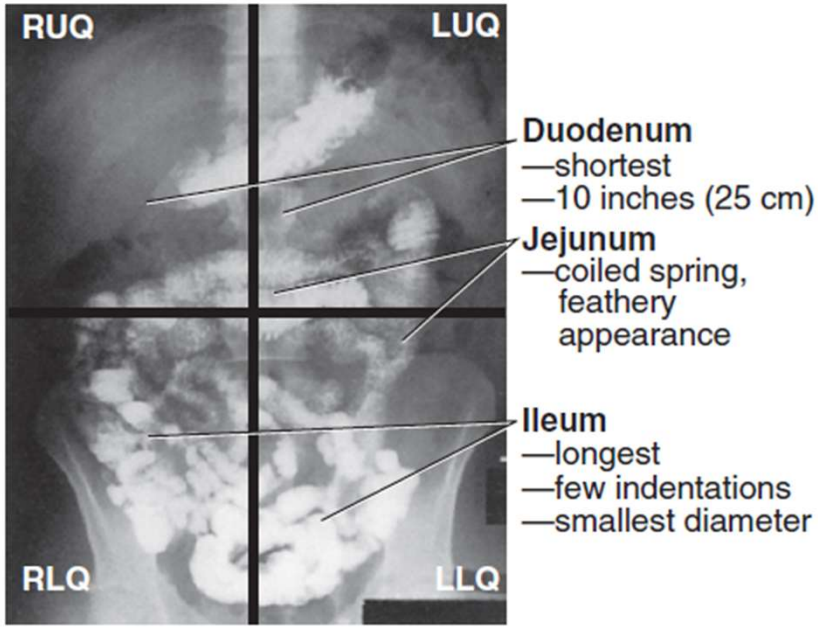
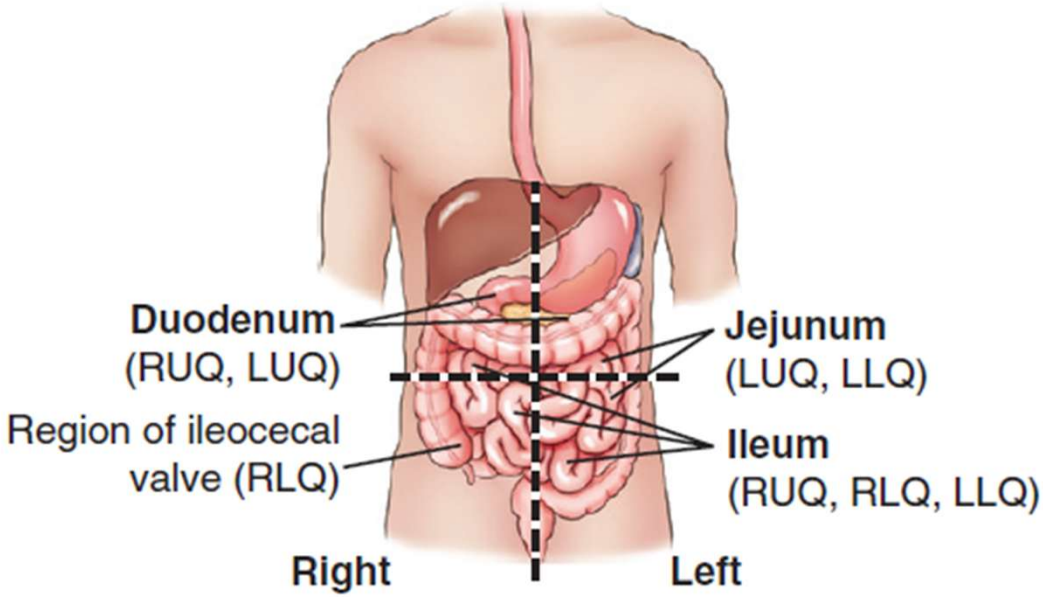


Fig. 13-3 Double-contrast barium enema—AP: patient with situs inversus.

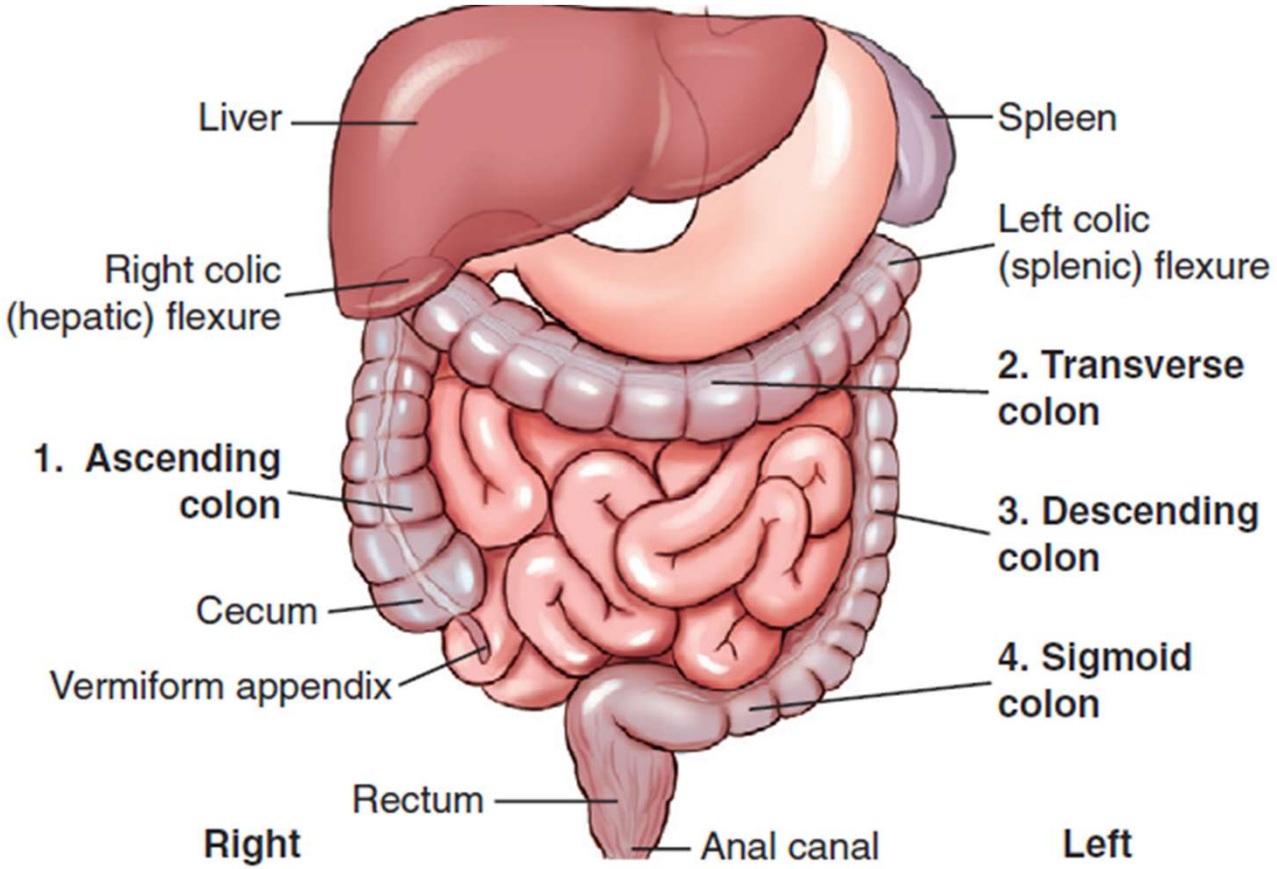
Lower GI Anatomy

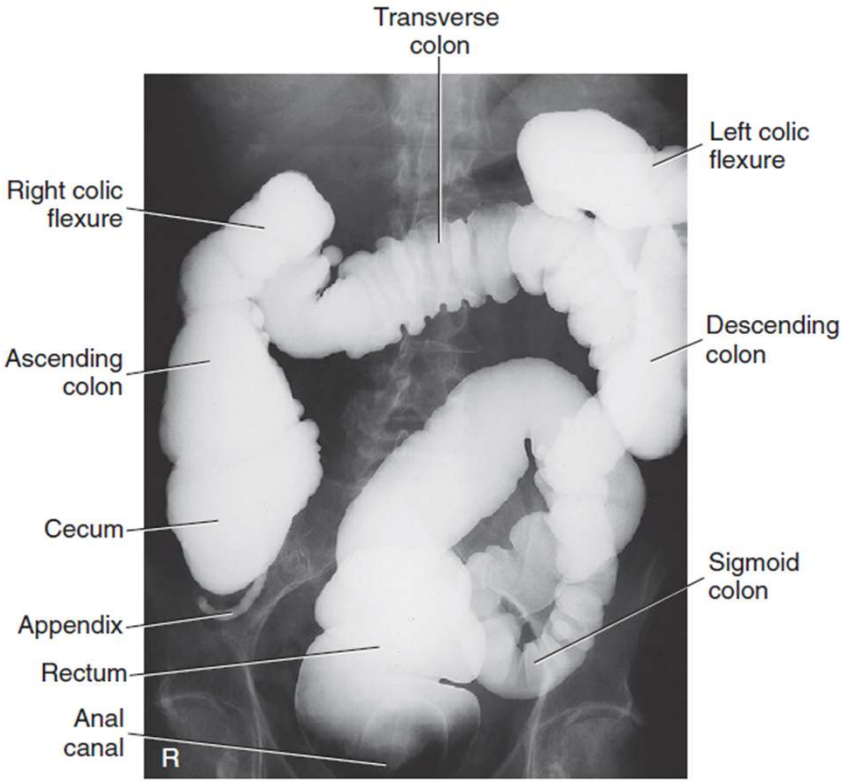


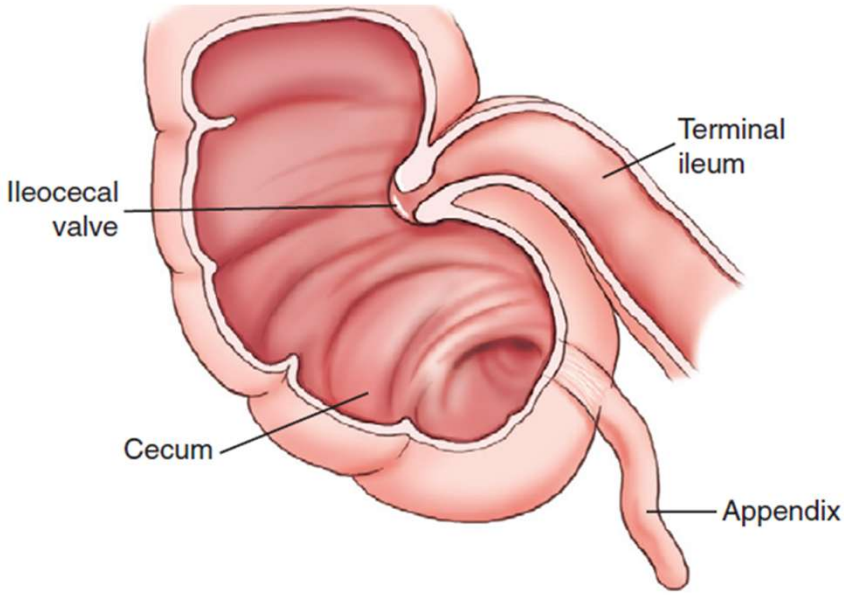


Lower Intestine

- Cecum
- Colon
- Rectum
- Anus

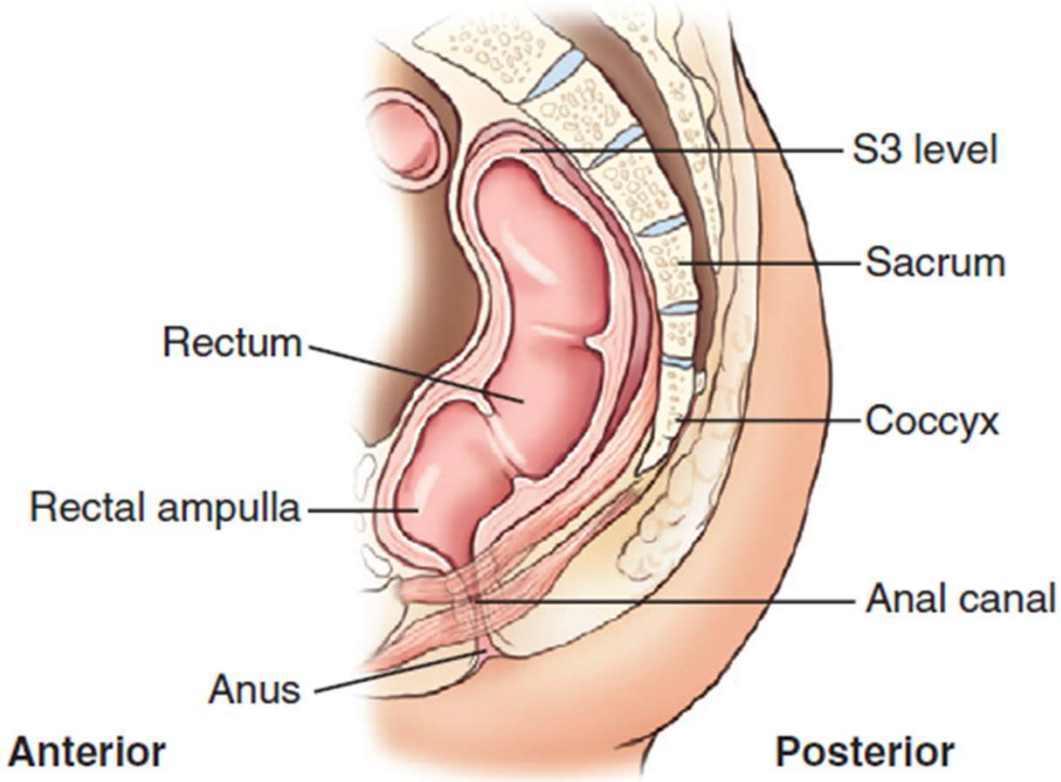



Transverse colon
Left colic flexure
Right colic flexure
Descending colon
Ascending colon
Cecum
Sigmoid colon
Appendix
Rectum
Anal canal
R


Terminal ileum
Ileocecal valve
Cecum
Appendix

LOCATION OF LARGE INTESTINE STRUCTURES IN RELATION TO PERITONEUM

STRUCTURE	LOCATION
Cecum	Intraperitoneal
Ascending colon	Retroperitoneal
Transverse colon	Intraperitoneal
Descending colon	Retroperitoneal
Sigmoid colon	Intraperitoneal
Upper rectum	Retroperitoneal
Lower rectum	Infraperitoneal


S3 level
Sacrum
Rectum
Coccyx
Rectal ampulla
Anal canal
Anus
Anterior
Posterior

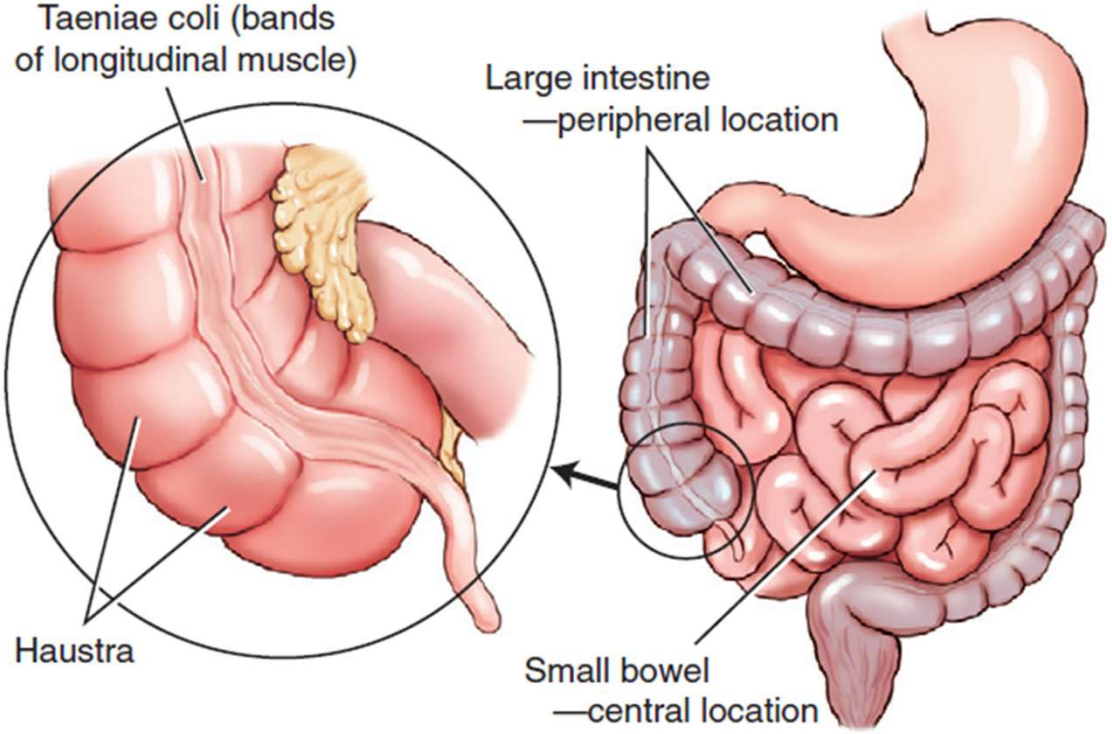


Fig. 13-12 Intestinal differences—large vs. small intestine.

- three bands of muscle called taeniae coli
- pull the large intestine into pouches
- Each of these pouches, or sacculations, is termed a haustrum

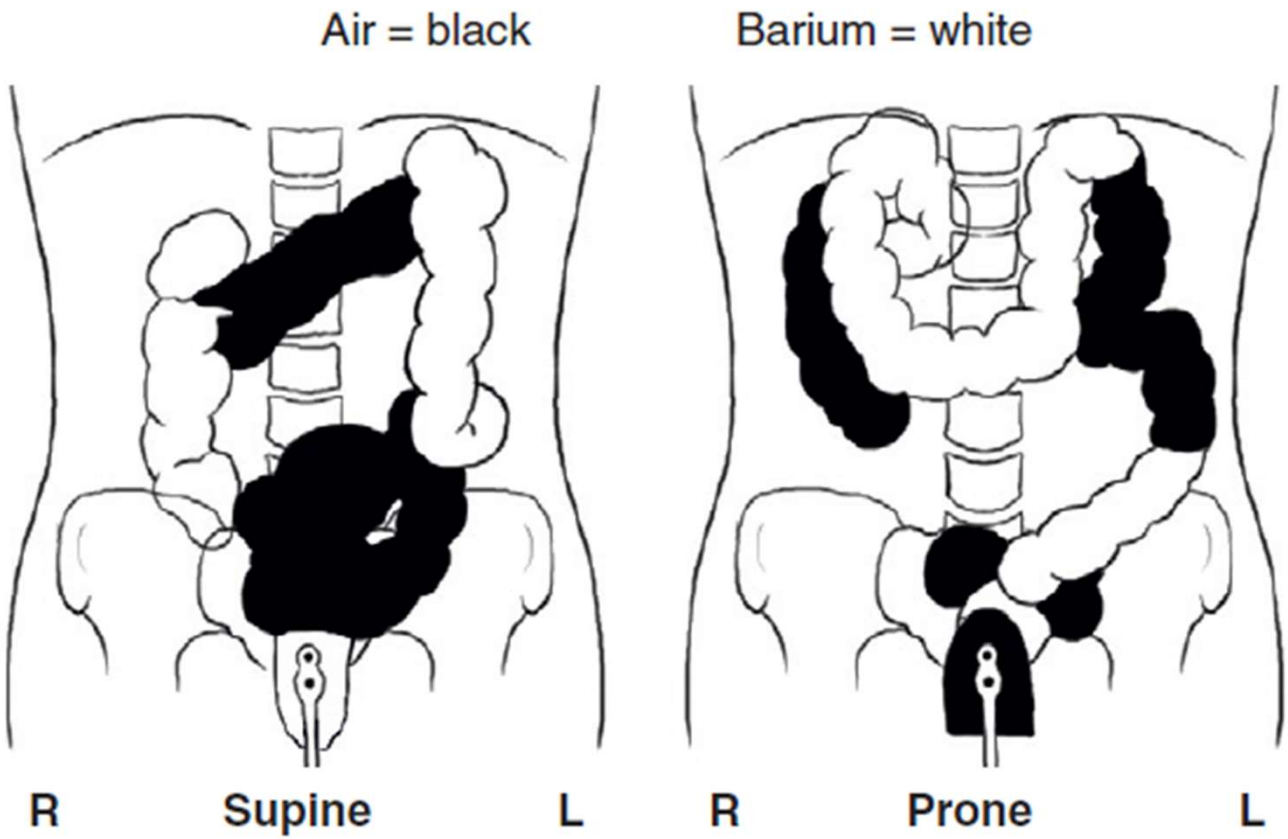


Fig. 13-13 Barium vs. air in the large intestine.

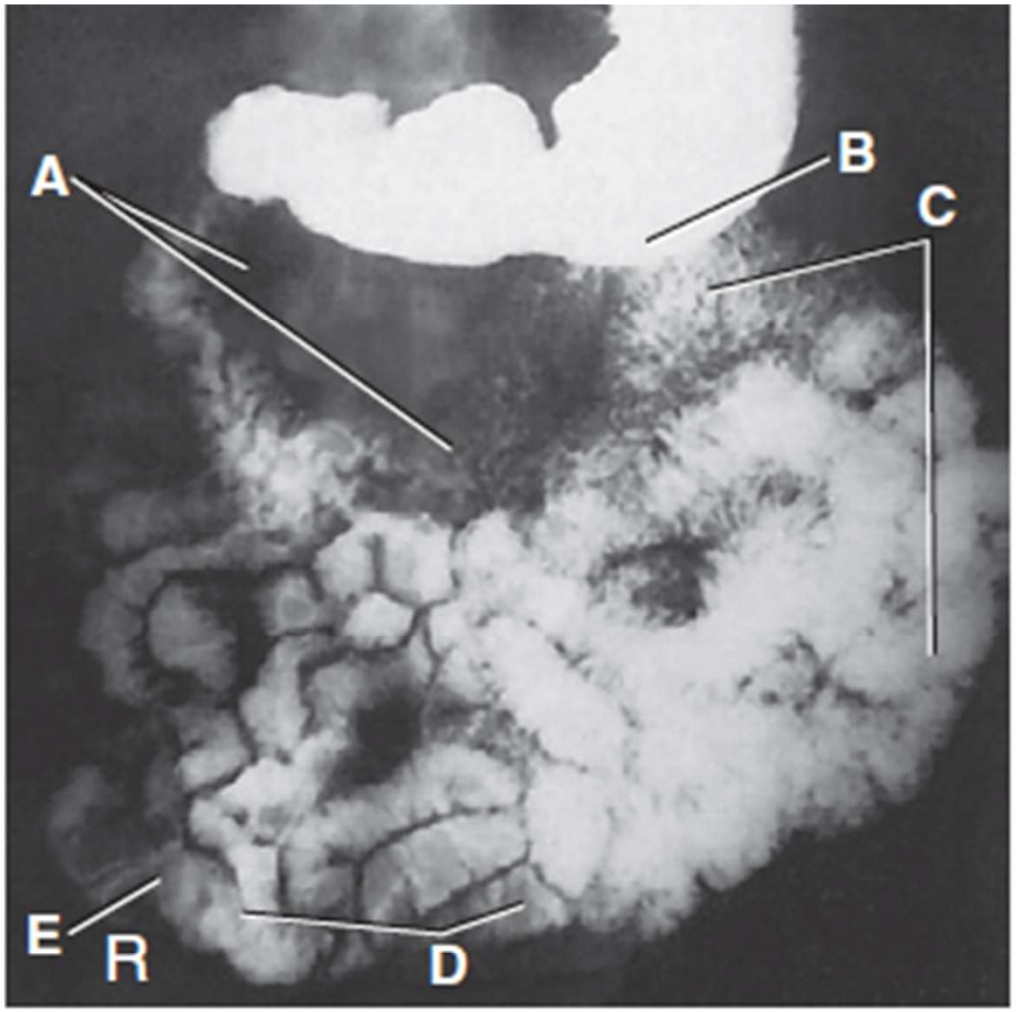


Fig. 13-14 PA, 30-minute small bowel.

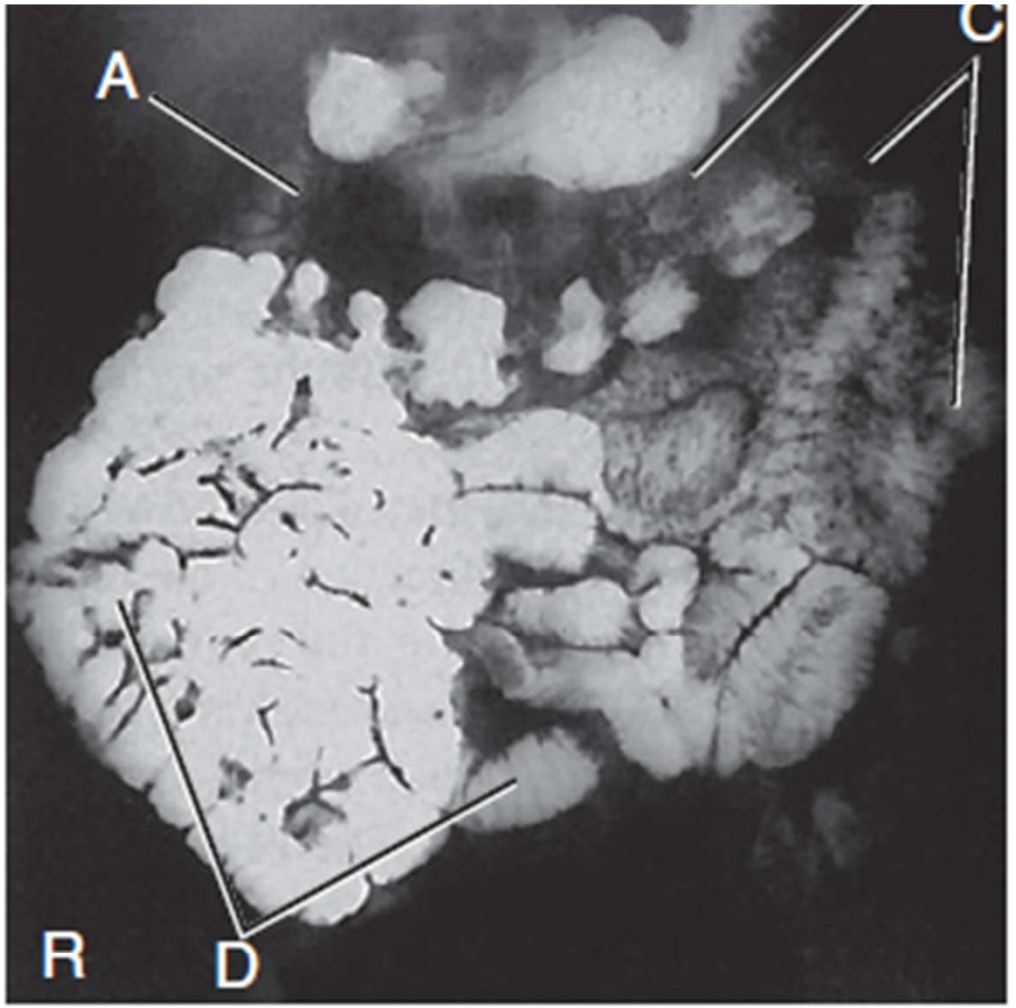
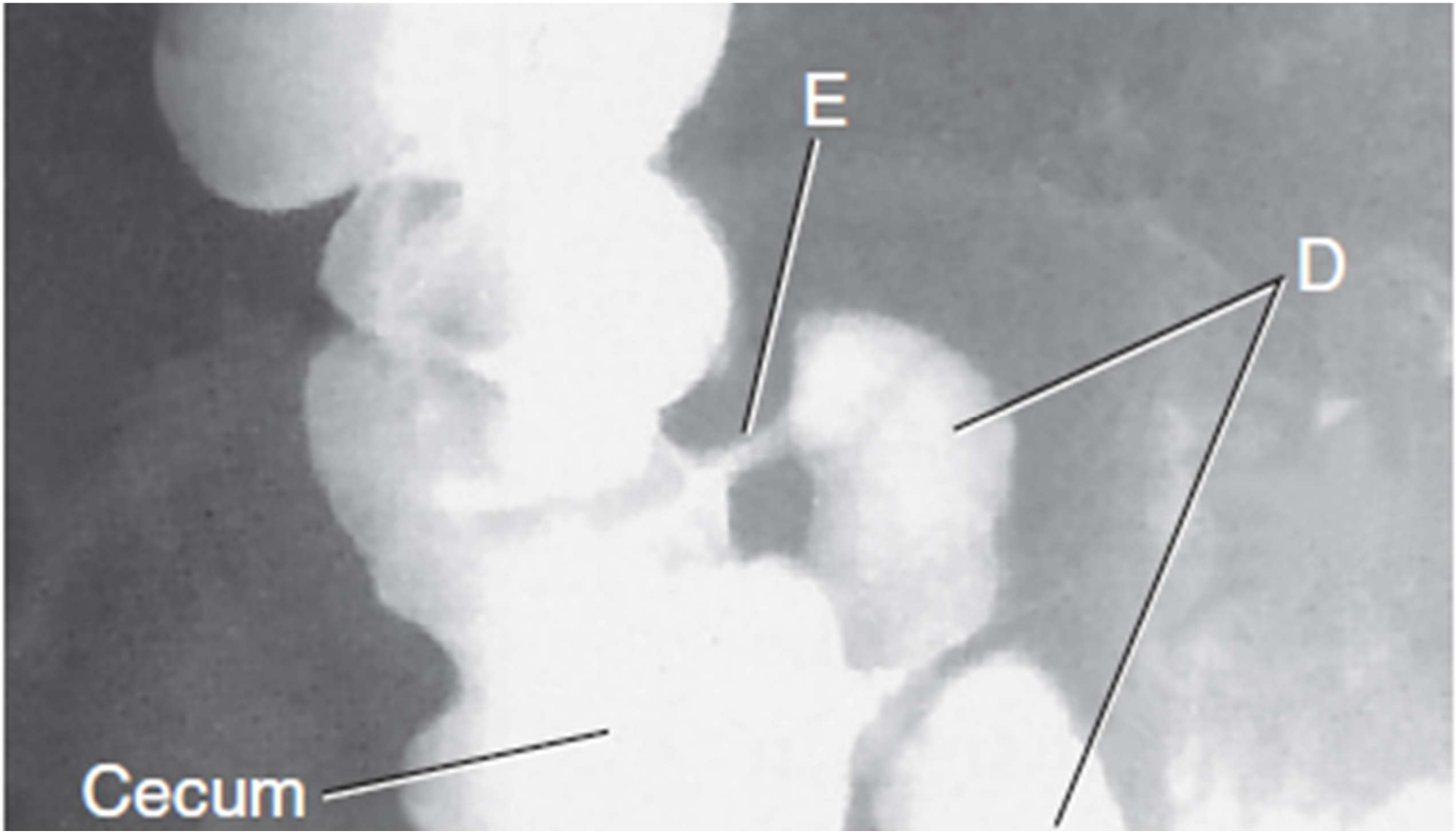


Fig. 13-15 PA, 2-hour small bowel.


E
D
Cecum

Barium Enema

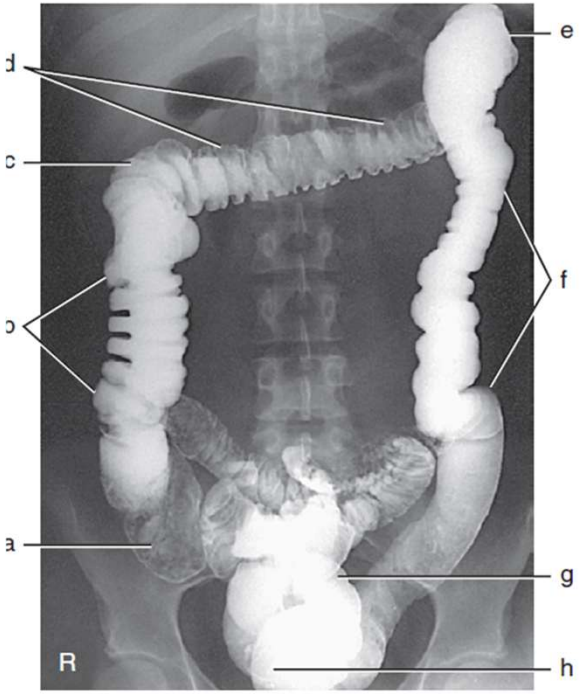


Fig. 13-17 AP, barium enema.

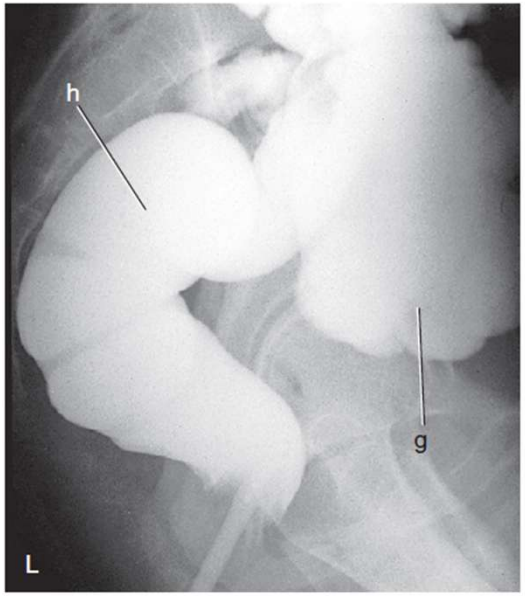


Fig. 13-18 Lateral rectum, barium enema.

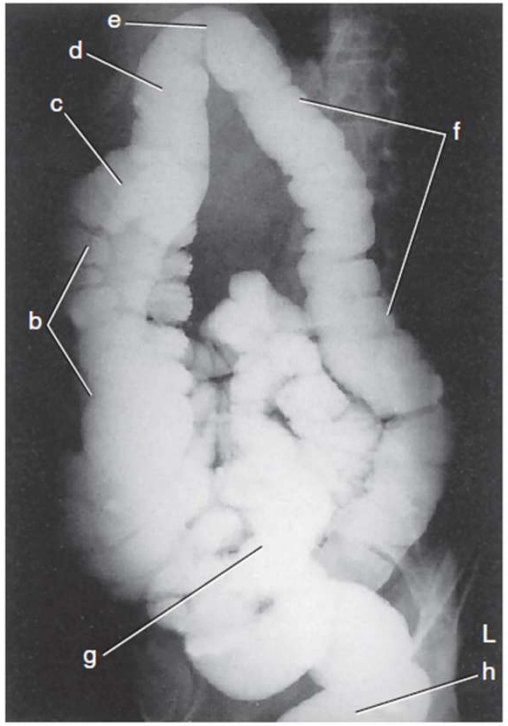


Fig. 13-19 LAO, barium enema (single-contrast study).

SUMMARY OF LOWER DIGESTIVE SYSTEM FUNCTIONS

RESPONSIBLE COMPONENT OF INTESTINE	FUNCTION	
Small intestine	1. **Digestion:** Chemical and mechanical	
Duodenum and jejunum (primarily)	2. **Absorption:** Nutrients, H_2O, salts, and proteins	
	3. **Reabsorption:** H_2O and salts	
Large intestine	Some reabsorption of H_2O and inorganic salts; vitamins B and K; amino acids	Produced by bacterial action; release of gases (flatus)
	4. Elimination **(defecation)**	

Contraindications of SBS

❑ Perforated hollow viscus (intestine or organ):

- should *not* receive barium sulfate.
- Water-soluble, iodinated contrast media should be
- used instead

❑ Large bowel obstruction :

- Barium sulfate by mouth is contraindicated
- An obstructed large bowel should be ruled out first with an acute abdominal series and a barium enema

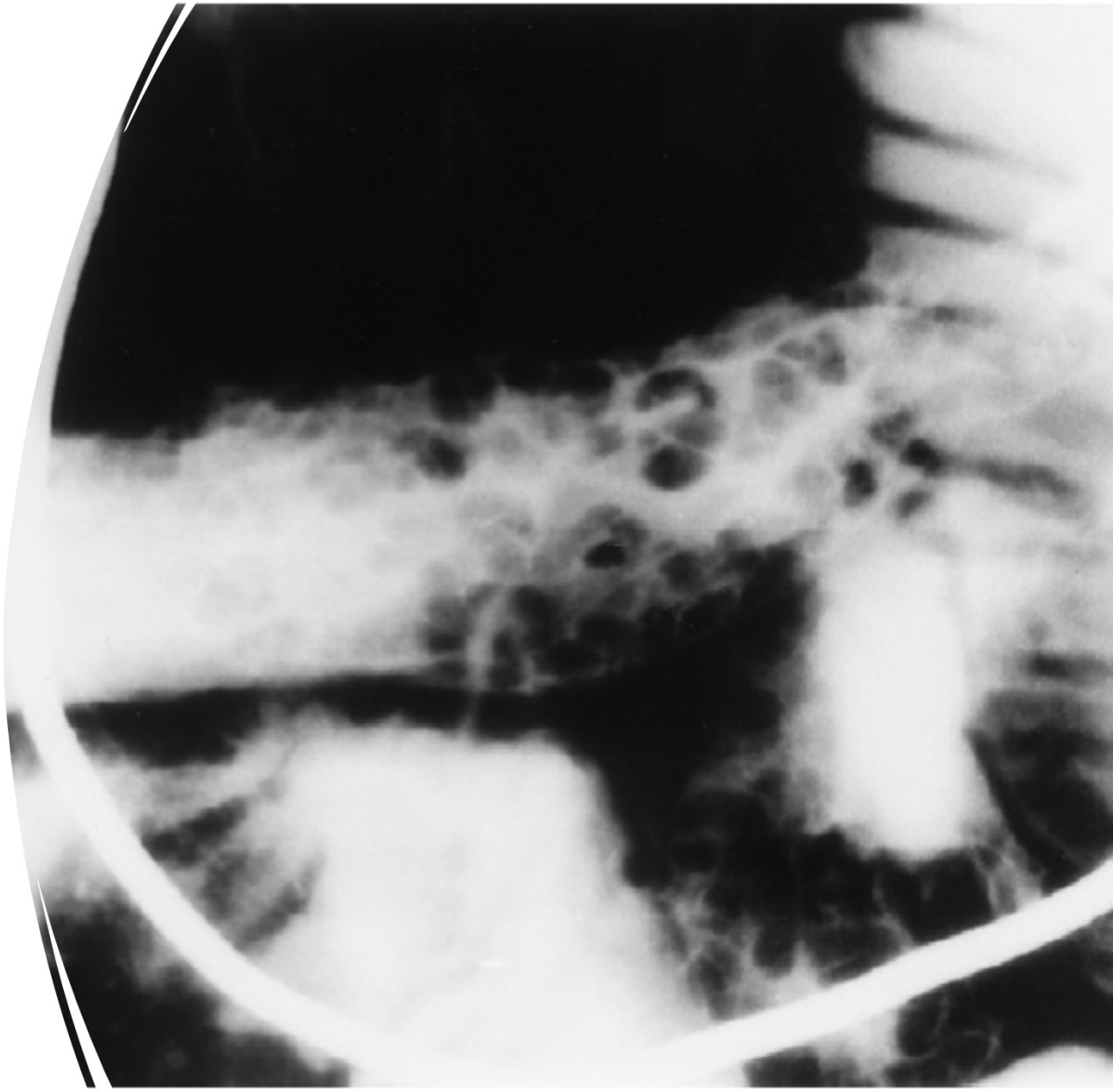
SMALL INTESTINE—SUMMARY OF CLINICAL INDICATIONS

CONDITION OR DISEASE	MOST COMMON RADIOGRAPHIC EXAMINATION	POSSIBLE RADIOGRAPHIC APPEARANCE	EXPOSURE FACTOR ADJUSTMENT*
Enteritis	Small bowel series, enteroclysis	Thickening of mucosal folds and poor definition of circular folds	None
Regional enteritis (Crohn's disease)	Small bowel series, enteroclysis	Segments of lumen narrowed and irregular; "cobblestone" appearance and "string sign" common	None
Giardiasis	Small bowel series, enteroclysis	Dilation of intestine, with thickening of circular folds	None
Ileus (obstruction)	Acute abdomen series, small bowel series, enteroclysis	Abnormal gas patterns, dilated loops of bowel, "circular staircase" or "herringbone" pattern	(–) Decrease if large segments of intestine are gas-filled
Adynamic			
Mechanical			
Malabsorption syndromes (sprue)	Small bowel series, enteroclysis, or CT of abdomen	Thickening of mucosal folds and poor definition of normal "feathery" appearance	None
Meckel's diverticulum	Nuclear medicine scan, small bowel series, enteroclysis	Large diverticulum of ileum, proximal to ileocecal valve; rarely seen on barium studies	None
Neoplasm	Small bowel series, enteroclysis, or CT of abdomen	Narrowed segments of intestine; "apple-core" or "napkin-ring sign"; partial or complete obstruction	None
Whipple's disease	Small bowel series	Dilation and distorted loops of small bowel	None

*Dependent on stage or severity of disease or condition.

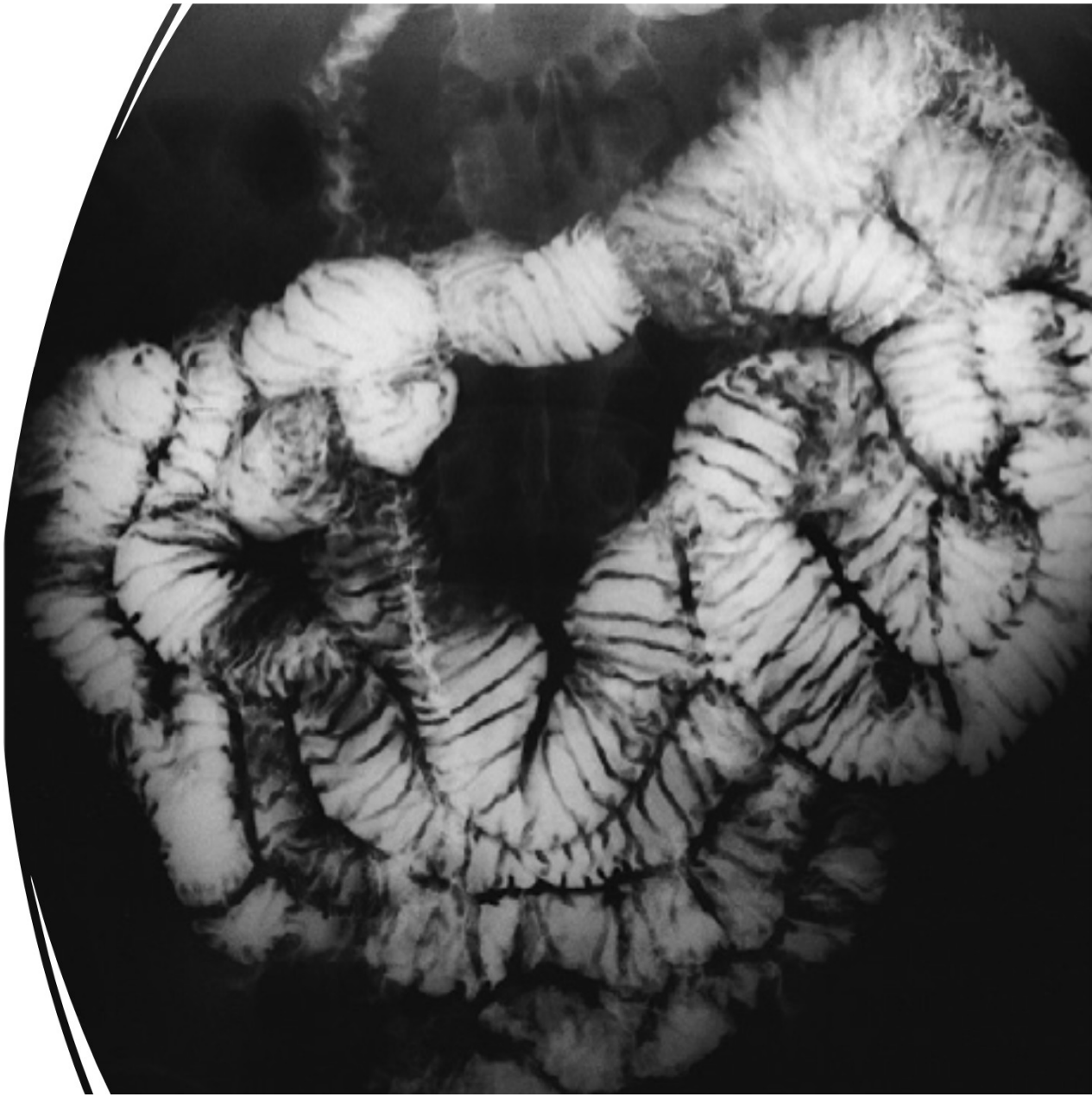
Crohn’s disease

- cobblestone appearance due to scarring and thickening of the bowel wall
- resemble gastric erosions or ulcers seen in barium studies
- Can progress to chronic spasm producing the “string sign” evident during a small bowel series.



Giardiasis of small intestine, jejunum, and ileum.

- Dilation of intestine, with thick circular folds, is visible
- infection of the lumen of the small intestine



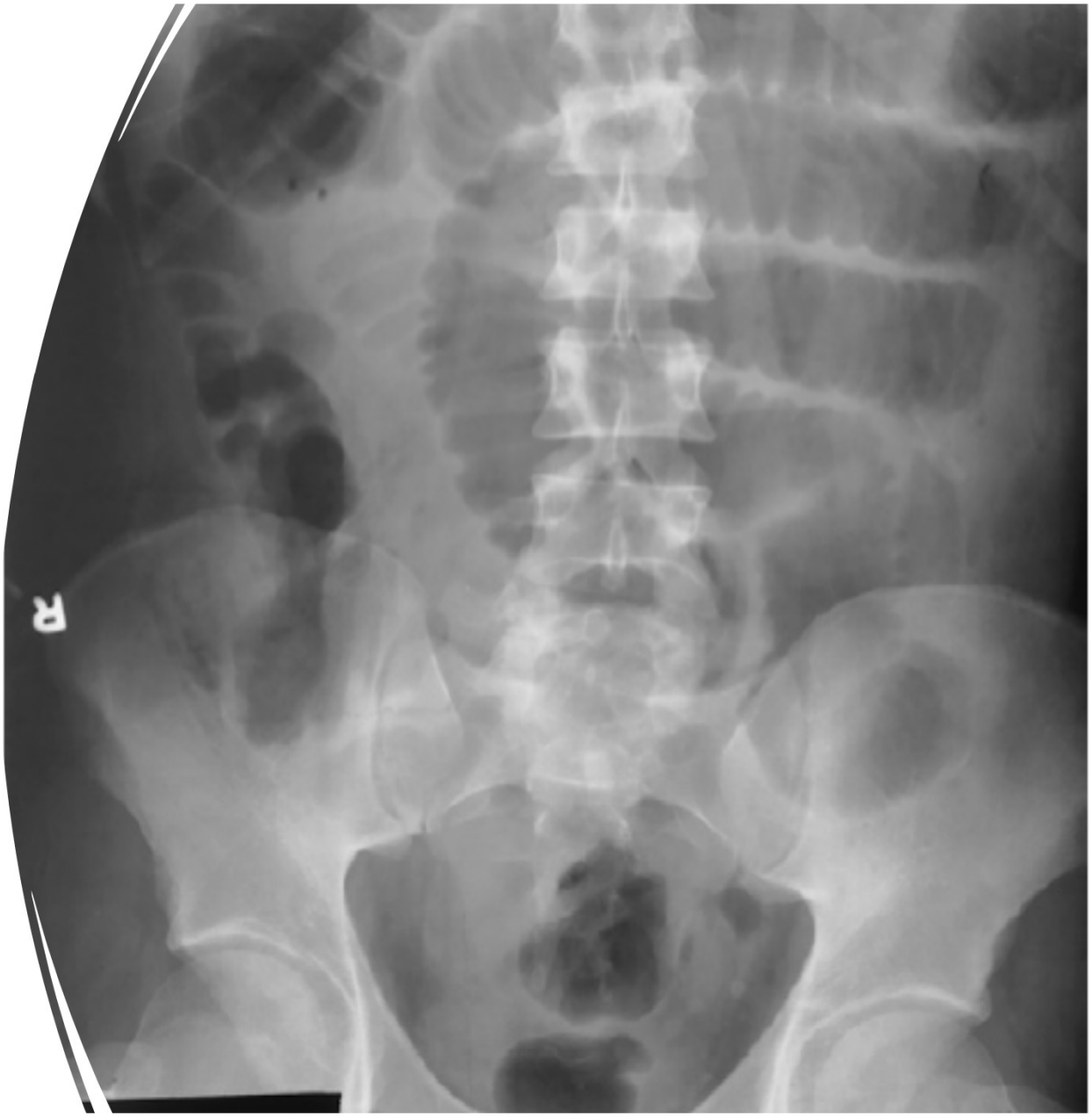
Ileus

- Ileus is an obstruction of the small intestine

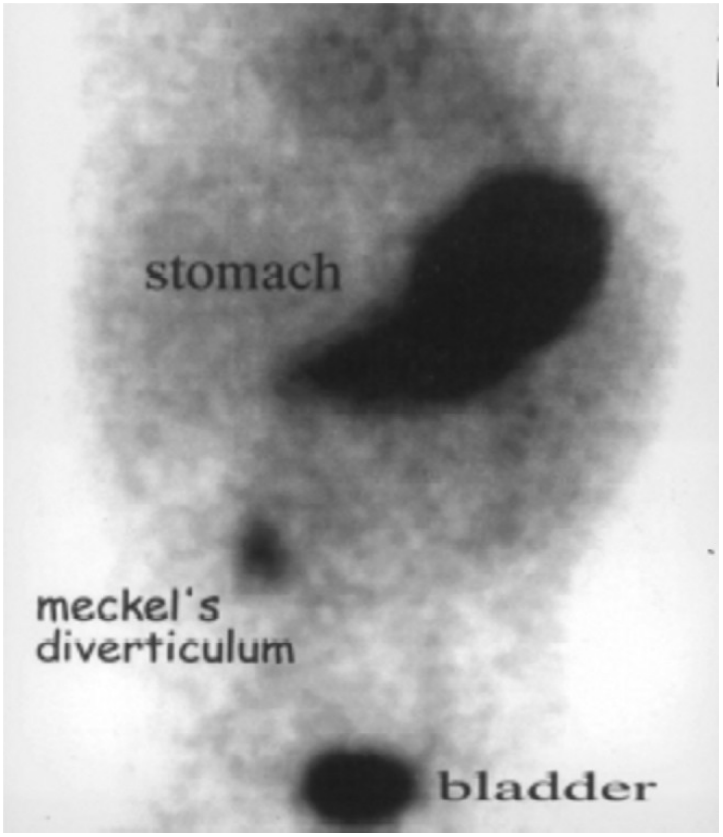
I. Adynamic, or paralytic, ileus is due to the cessation of peristalsis

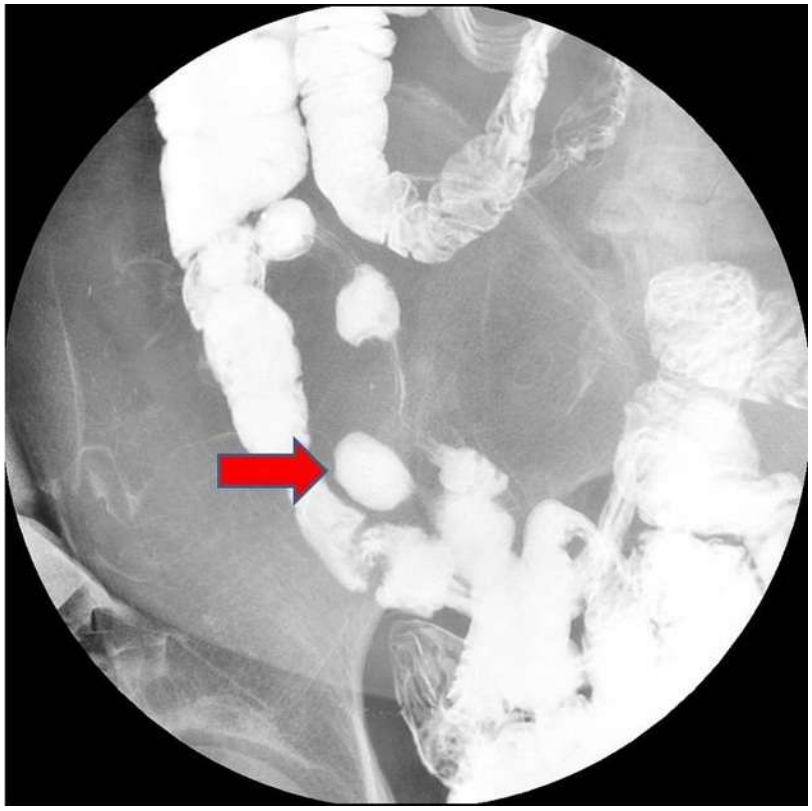
II. A mechanical obstruction is a physical blockage of the bowel

- caused by tumors, adhesions, or hernia
- The loops of intestine proximal to the site of obstruction are markedly dilated with gas



Meckels Diverticulum





Small Bowel Procedures

- Four methods are used to study the small intestine radiographically:

1. Upper GI–small bowel combination
2. Small bowel–only series
3. Enteroclysis
4. Intubation method

CM

- A thin mixture of barium sulfate is used for most small bowel series
- A water-soluble, iodinated contrast may be given (In case of perforated bowel /surgery is scheduled
- water-soluble, iodinated contrast medium can be added to the barium to increase peristalsis and transit time of contrast media through the small intestine.

PROCEDURE SUMMARY

1. UPPER GI–SMALL BOWEL COMBINATION

Routine

- Routine upper GI first
- Notation of time patient ingested first cup (8 oz) of barium
- Ingestion of second cup of barium
- 30-minute PA radiograph (centering high for proximal small bowel)
- Half-hour interval radiographs, centered to iliac crest, until barium reaches large bowel (usually 2 hours)
- 1-hour interval radiographs, if more time is needed after 2 hours

Optional

- Fluoroscopy and spot imaging of ileocecal valve and terminal ileum (compression cone may be used)

PROCEDURE SUMMARY

2. SMALL BOWEL–ONLY SERIES

Routine

- Plain abdomen radiograph (scout)
- 2 cups (16 oz) of barium ingested (noting time)
- 15- to 30-minute radiograph (centered high for proximal small bowel)
- Half-hour interval radiographs (centered to crest) until barium reaches large bowel (usually 2 hours)
- 1-hour interval radiographs, if more time is needed (some routines including continuous half-hour intervals)

Optional

- Fluoroscopy with compression sometimes required

PROCEDURE SUMMARY

3. ENTEROCLYSIS (DOUBLE-CONTRAST SMALL BOWEL SERIES)

Procedure

- Special catheter advanced to duodenojejunal junction
- Thin mixture of barium sulfate instilled
- Air or methylcellulose instilled
- Fluoroscopic spot images and conventional radiographs taken

Optional

- Patient may have CT scan of gastrointestinal tract
- On successful completion of examination, intubation tube removed

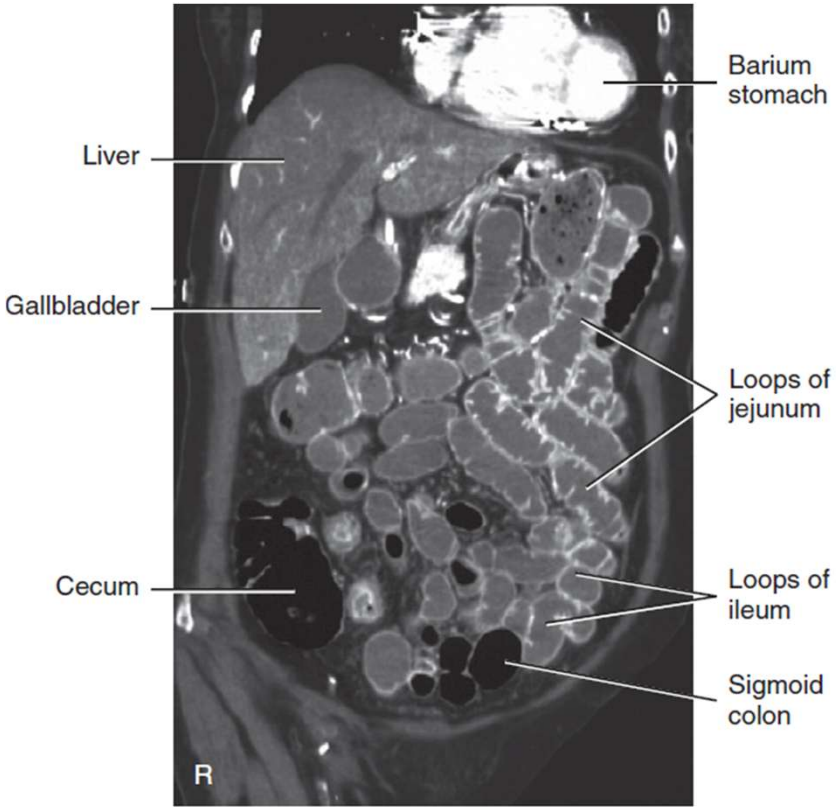


Fig. 13-27 CT enteroclysis.

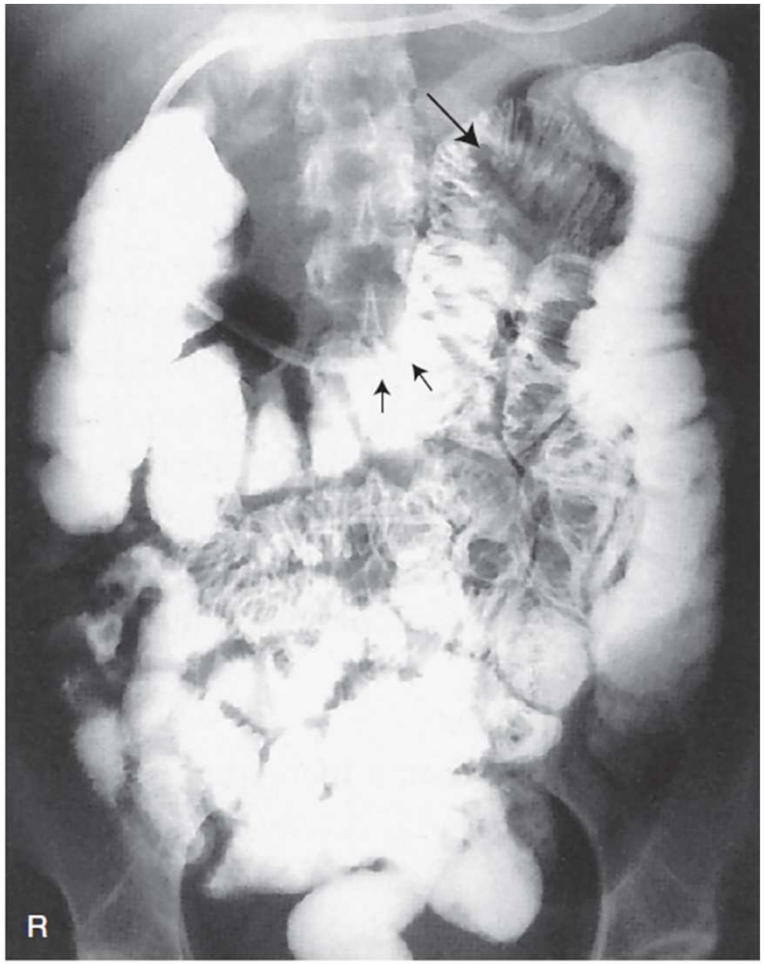


Fig. 13-26 PA radiograph—enteroclysis.

PROCEDURE SUMMARY

4. INTUBATION METHOD (SINGLE-CONTRAST SMALL BOWEL SERIES)

Procedure

- Single-lumen catheter advanced to proximal jejunum (double-lumen catheter used for therapeutic intubation)
- Water-soluble iodinated agent or thin mixture of barium sulfate instilled
- Time at which contrast medium is instilled noted
- Conventional radiographs or optional fluoroscopic spot films taken at specific time intervals

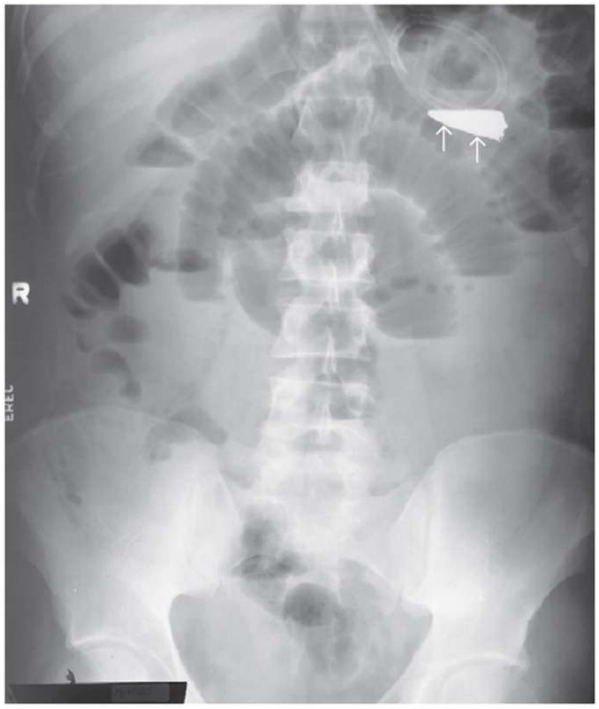


Fig. 13-28 AP erect abdomen—intubation method.

- A nasogastric tube is passed through the patient's nose, through the esophagus, stomach, and duodenum, and into the jejunum

PP

- The goal of patient preparation is an empty stomach.
- Food and fluid must be withheld for at least 8 hours before these examinations
- Ideally, the patient should be on a low-residue diet 48 hours before the small bowel series is conducted.
- The patient should not smoke cigarettes or chew gum during the NPO period.
- Before the procedure is performed, the patient should be asked to void, so as not to cause displacement of the ileum secondary to a distended bladder.
- The prone position is most appropriate for a small bowel series
- Approximately three-fourths of the IR should extend above the iliac crest
- A high-kV technique should be used on this initial radiograph
- For the 1-hour and later radiographs, standard kV settings may be used
- All radiographs after the initial 30-minute exposure should be centered on the iliac crest

PA PROJECTION: SMALL BOWEL SERIES

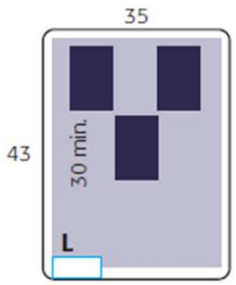
Clinical Indications

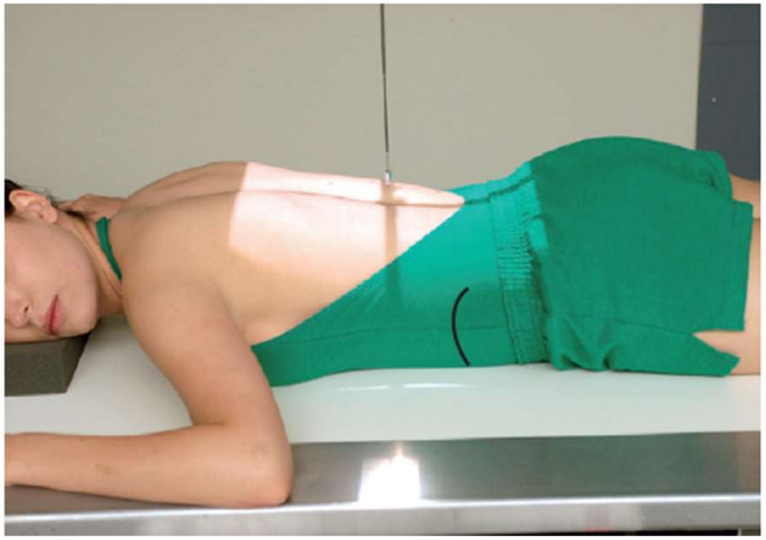
- Inflammatory processes, neoplasms, and obstructions of the small intestine
- **Upper GI-small bowel combination:** Commonly performed; additional barium is ingested after completion of the upper GI (see p. 497)
- **Small bowel–only series:** Includes a scout abdomen radiograph followed by ingestion of barium and timed-interval radiographs (see p. 498)
- **Enteroclysis and intubation procedures:** See descriptions on pp. 498 and 499.

Small Bowel Series

ROUTINE

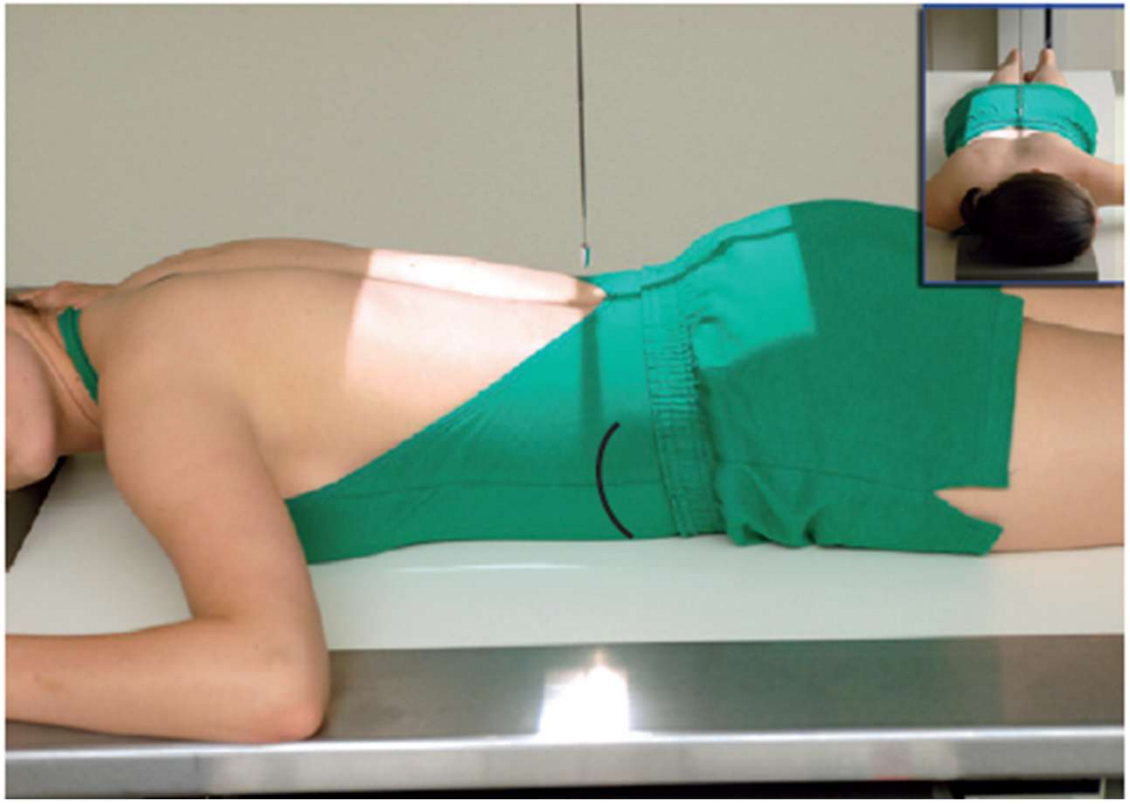
- PA (every 15 to 30 minutes) enteroclysis and intubation





PA, 15 or 30 minutes—centered approximately 2 inches (5 cm) above iliac crest.

PA, hourly……centered to iliac crest



Technical Factors

- Minimum SID—40 inches (102 cm)
- IR size—35 × 43 cm (14 × 17 inches), lengthwise
- Grid
- Analog and digital systems—100 to 125 kV range
- Time markers to be used

Shielding Shield all radiosensitive tissues outside region of interest.

Patient Position Patient is prone (or supine if patient cannot lie in prone position) with a pillow for the head.

Part Position 

- Align MSP to midline of table/grid or CR.
- Place arms up beside head with legs extended and support provided under the ankles.
- Ensure that **no rotation** occurs.

CR

- CR is **perpendicular** to IR.
  1. **15 or 30 minutes:** Center to about 2 inches (5 cm) above iliac crest (see *Note*).
  2. **Hourly:** Center CR and midpoint of IR to iliac crest.
- Center IR to CR.

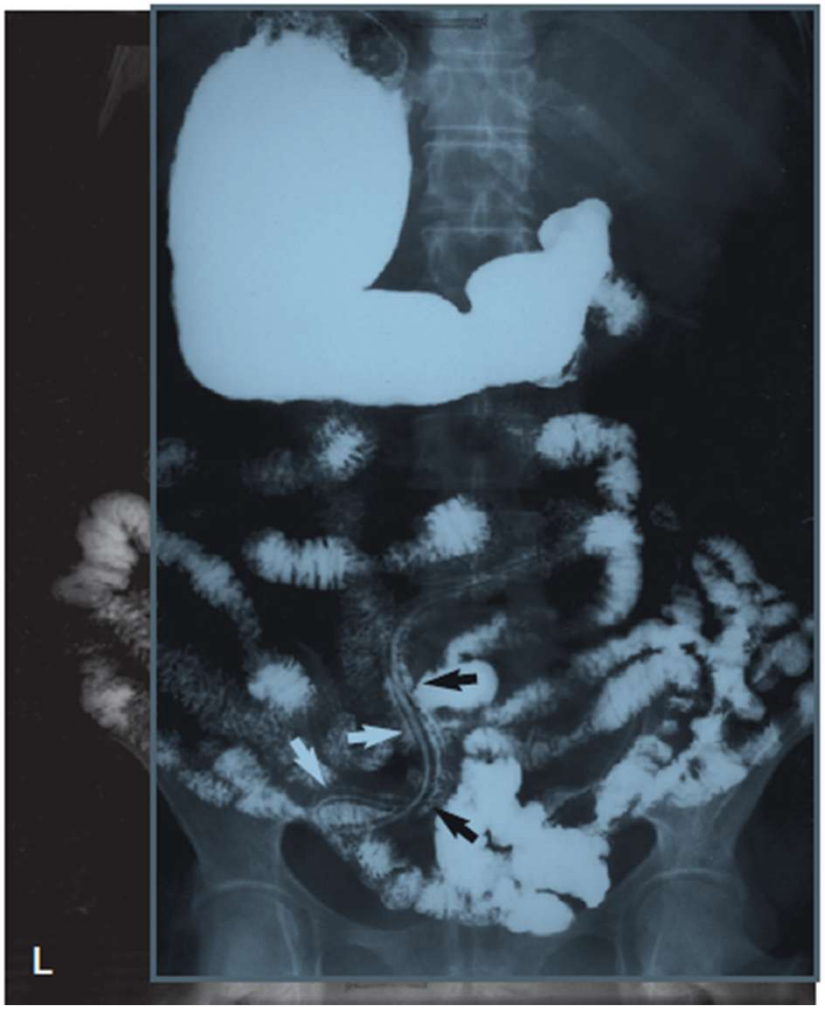
Recommended Collimation Collimate on four sides to anatomy of interest.

Respiration Suspend respiration and expose on expiration.

NOTES: Timing begins with ingestion of barium. Timed intervals of radiographs depend on transit time of the specific barium preparation used and on department protocol. **For the first 30-minute radiograph,** center high to include the entire stomach.

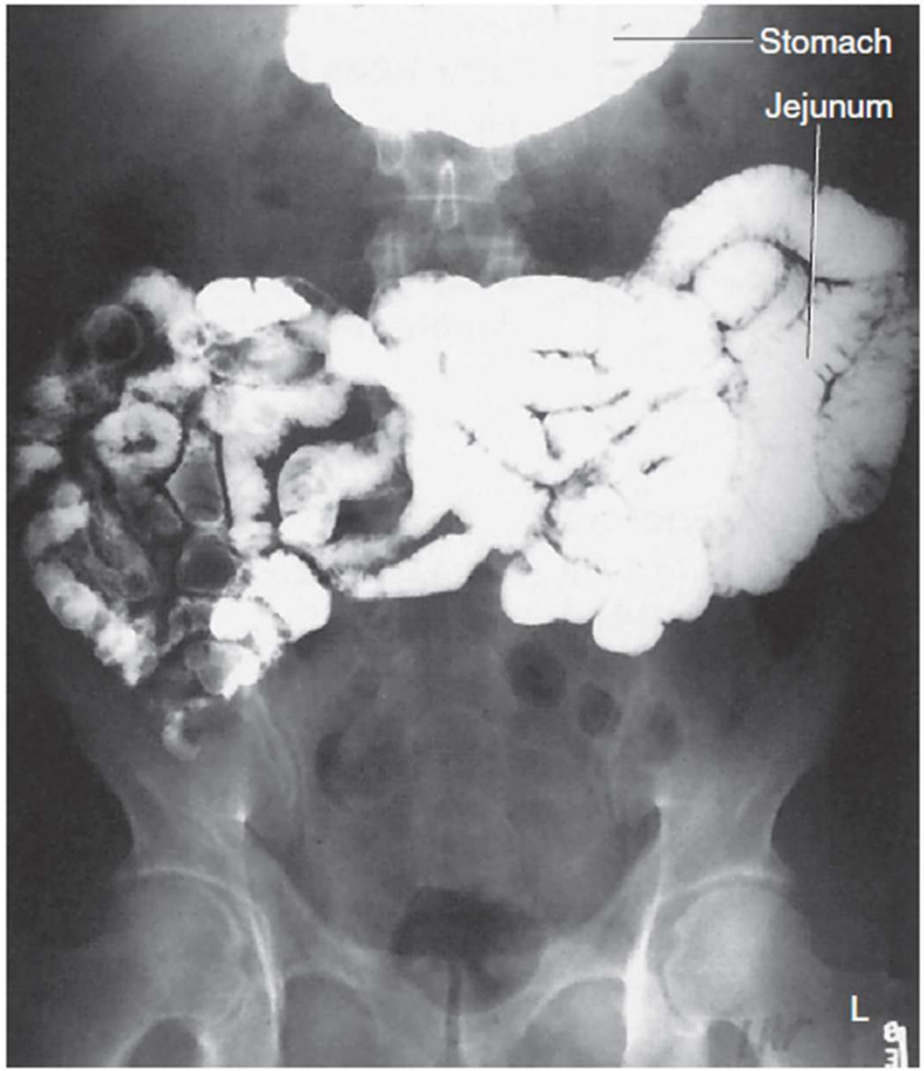
Subsequent 30-minute interval radiographs are taken until barium reaches the large bowel (usually 2 hours). The study is generally completed when the contrast medium reaches the cecum or the ascending colon.

Fluoroscopy and spot imaging of the **ileocecal valve** and terminal ileum after barium reaches this area are commonly included in the routine small bowel series. This procedure is determined by the radiologist's preference and by department protocols.

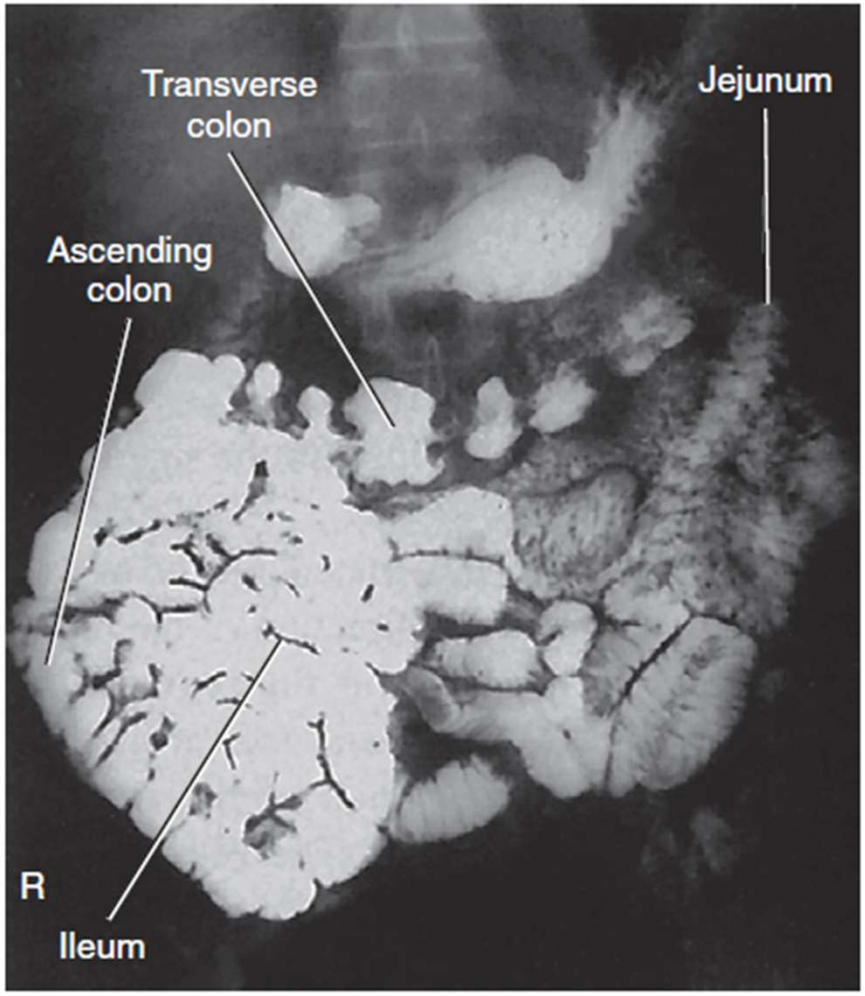


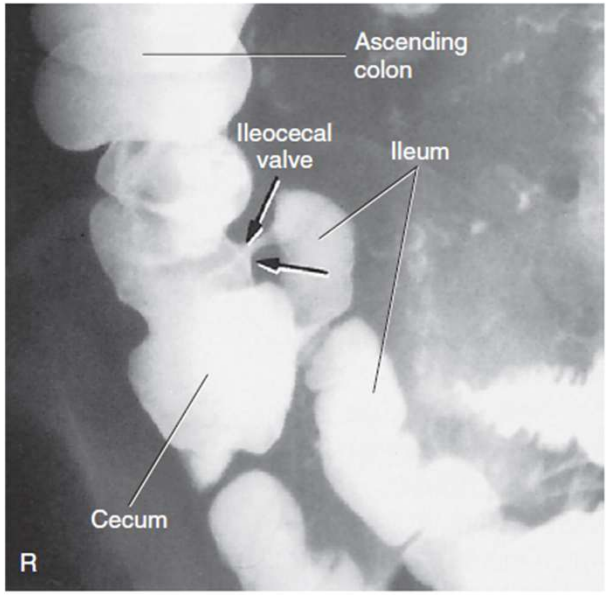
PA small bowel series—30 minutes
(most barium located
in stomach and jejunum).

Note: Large (12-inch) ascariasis
(parasitic roundworm) in jejunum.



- PA small bowel series
- 1 hour -most barium located in jejunum


Transverse colon
Jejunum
Ascending colon
R
Ileum


Ascending colon
Ileocecal valve
Ileum
Cecum
R

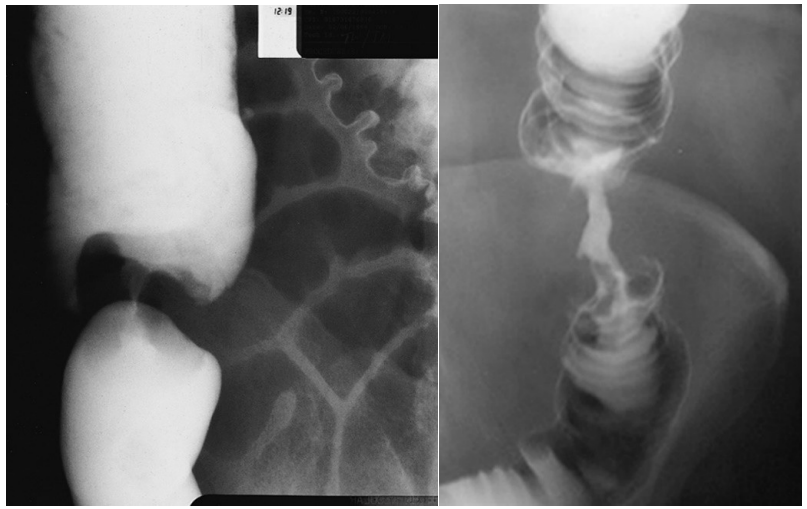
To evaluate

- Entire small intestine is demonstrated on each radiograph, with the stomach included on the first 15-minute or 30-minute radiograph.
- No rotation is present.
- Proper collimation is applied.
- Appropriate technique is employed to visualize the contrast-filled small intestine
- Sharp structural margins indicate no motion

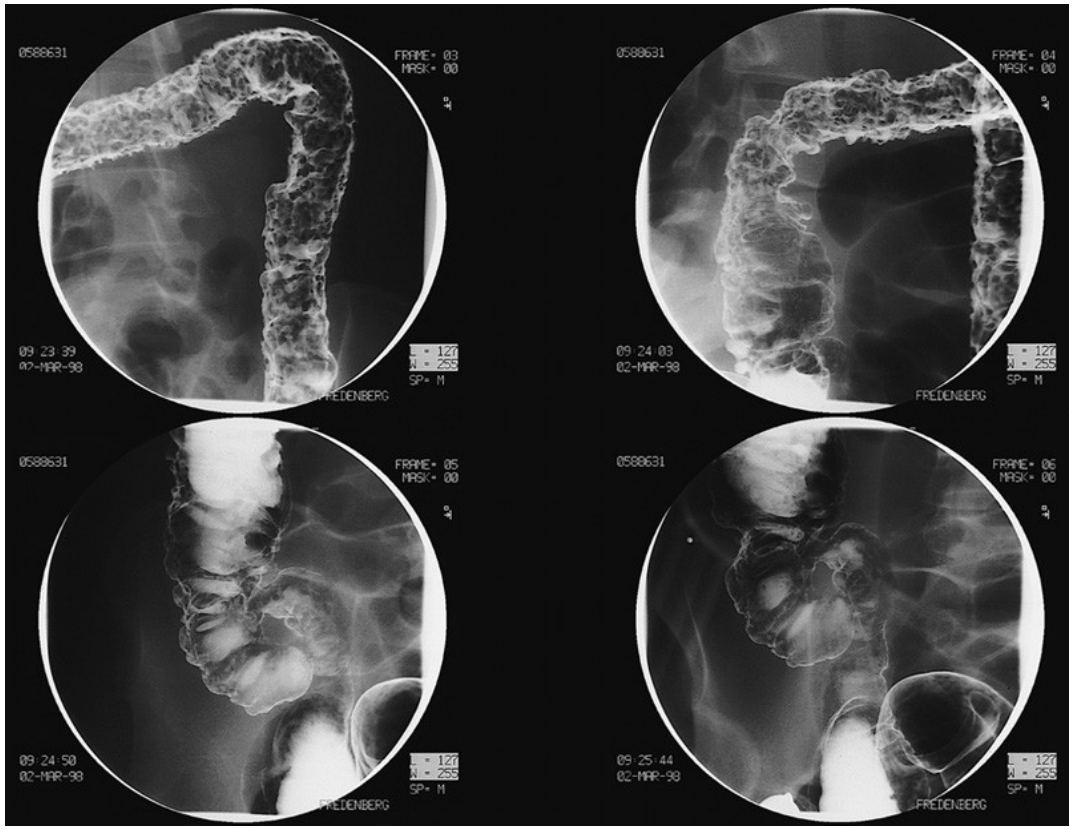
Barium Enema
Clinical Indications

- Colitis (ulcerative)
- Diverticulosis/ diverticulitis
- Neoplasms (apple core or napkin ring lesions)
- Volvulus (can lead to necrosis)
- Intussusception

Advanced carcinoma of colon

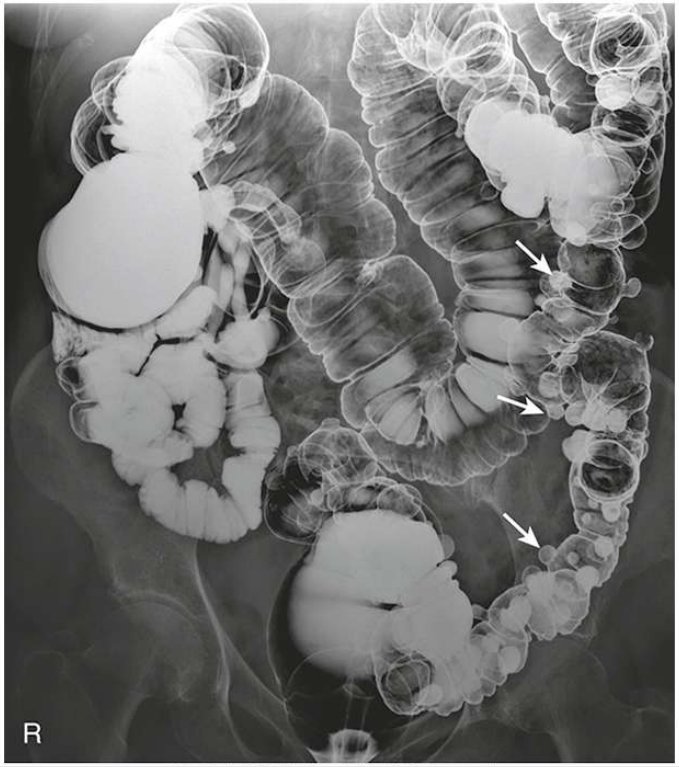


Ulcerative Colitis



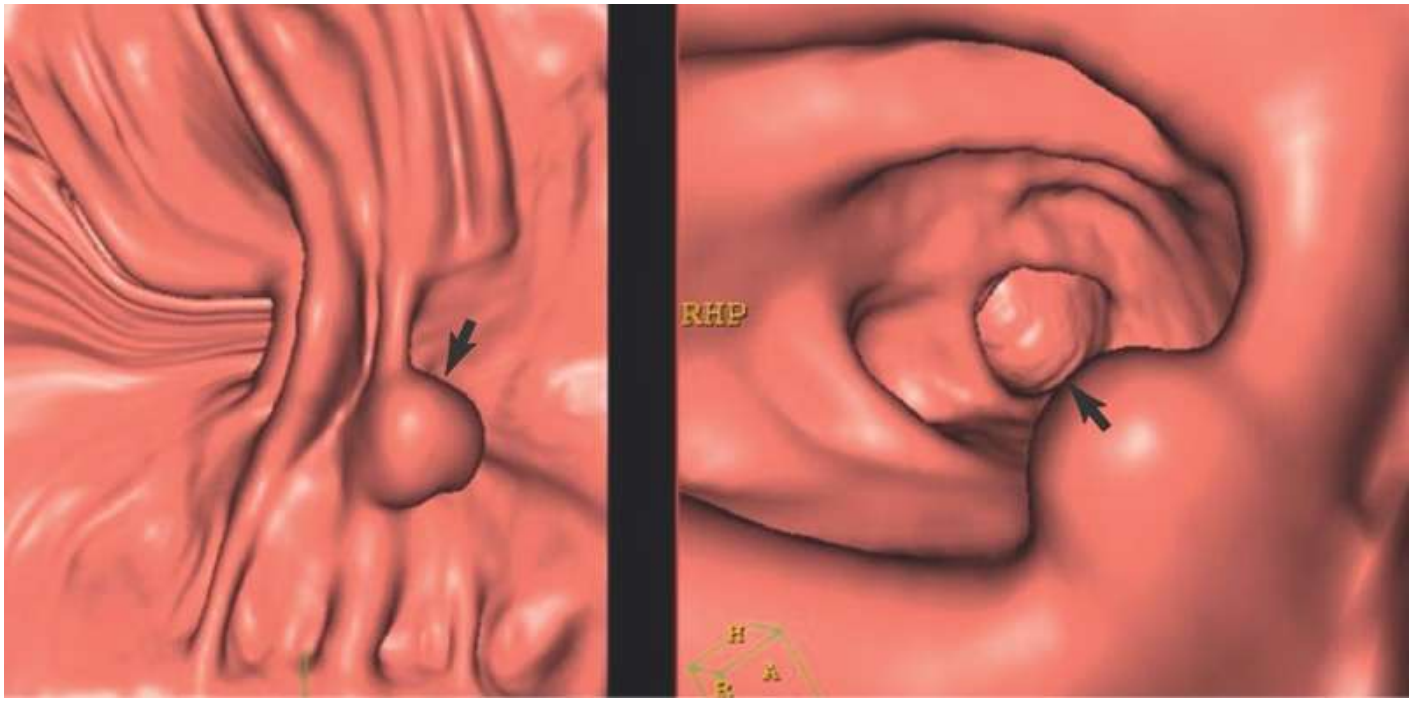
Diverticulosis of Large Intestine

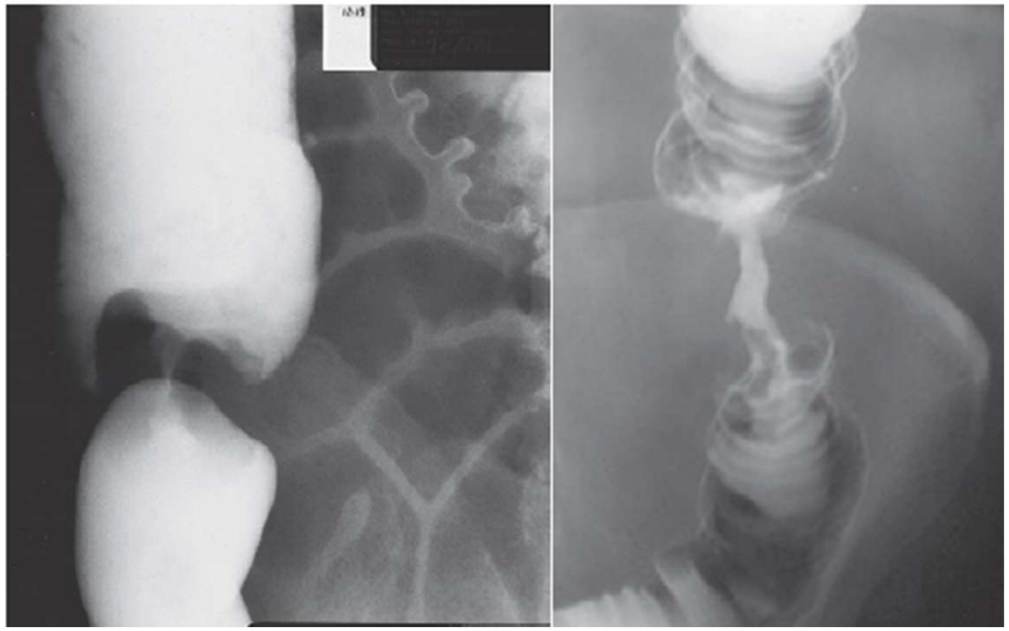
- What is the difference between a diverticulum and a polyp?



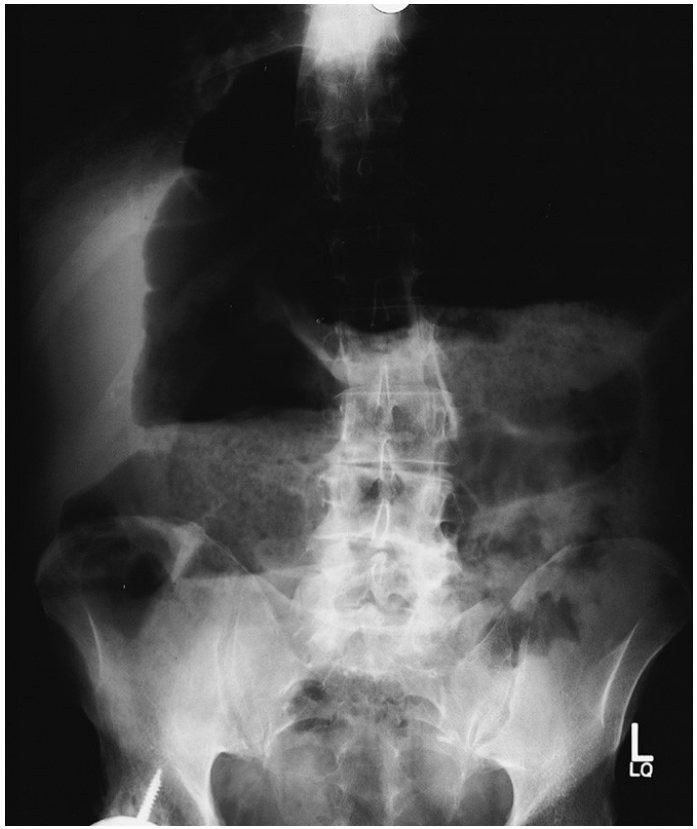
CT Colonography

- Arrows indicate presence of small polyp
- Large intestine filled with air or gas





Cecal Volvulus



Barium Enema Procedure

Barium Enema—Patient Preparation

- Light evening meal prior to exam
- Bowel-cleansing cathartics
- NPO after midnight (8 hours minimum)
- No gum chewing
- No smoking
- Enema morning of exam

Barium Enema—Cathartics

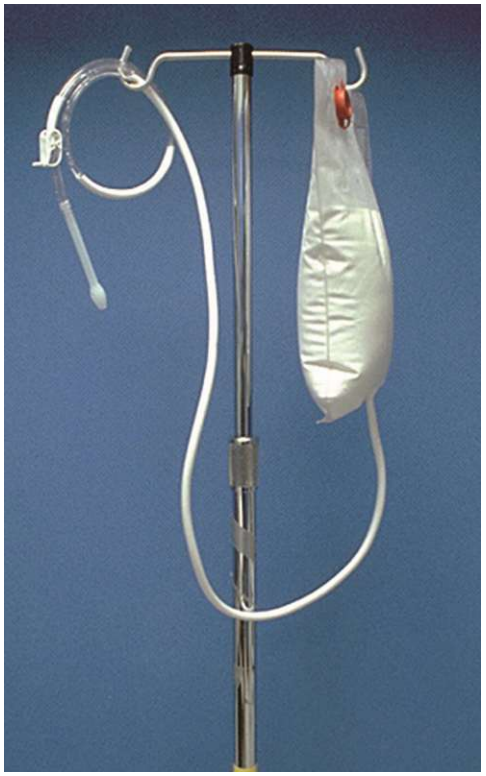
- Cathartics substance that produces frequent, soft, or liquid bowel movements
- Two types
  - Irritant (rarely used)
  - Saline
- Contraindications to cathartics
  - Gross bleeding
  - Severe diarrhea
  - Obstruction
  - Inflammatory lesions

Room Preparation

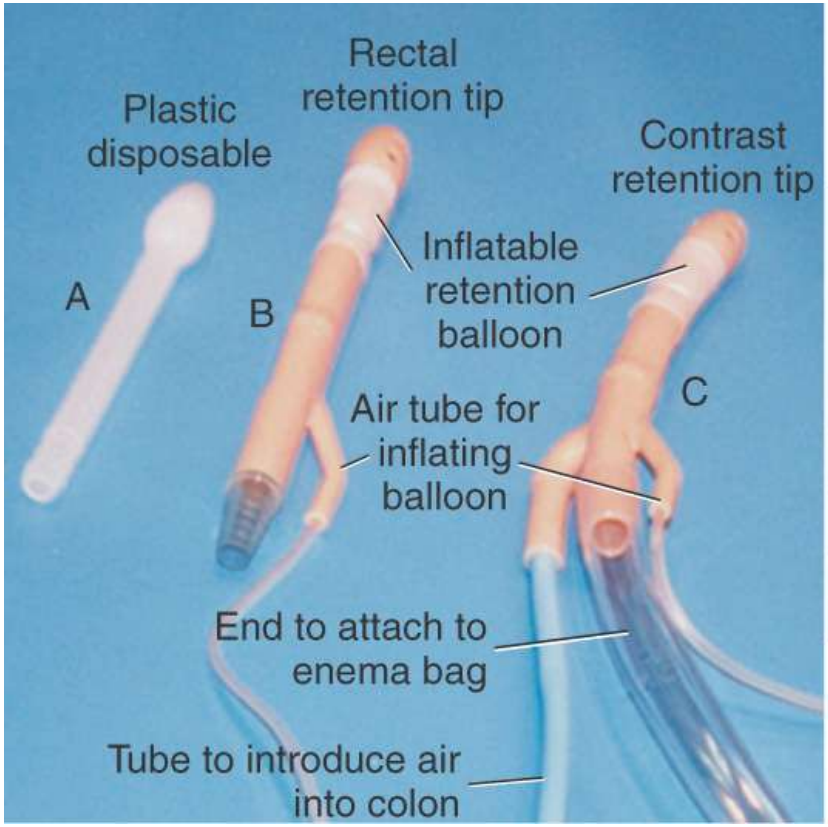
- Fluoroscopy room setup
- Table horizontal
- Cassettes available
- Contrast media prepared
- Towels and linen available

Contrast Media for Barium Enema

- Single-use, closed-system kit
- Cold versus room temperature water
- Colloidal suspension—mix well before use
- Glucagon optional (if spasm occurs)
- Topical anesthetic may be added to contrast media

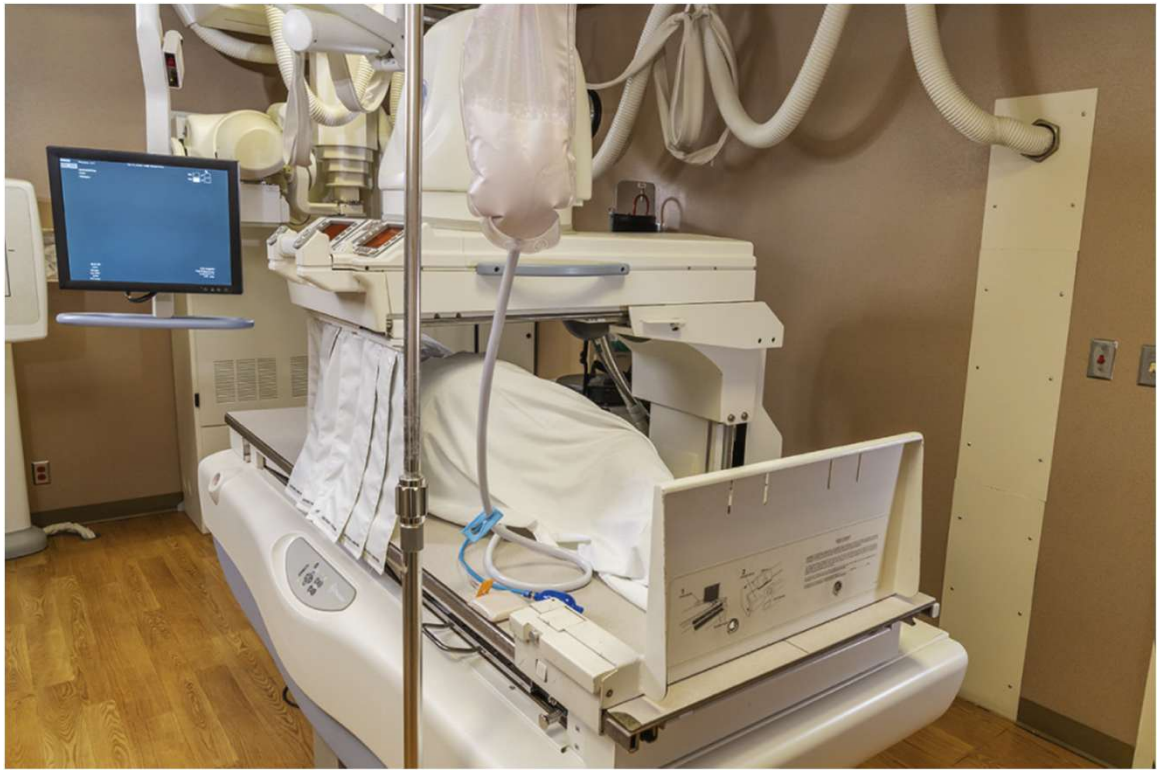


Enema Tips



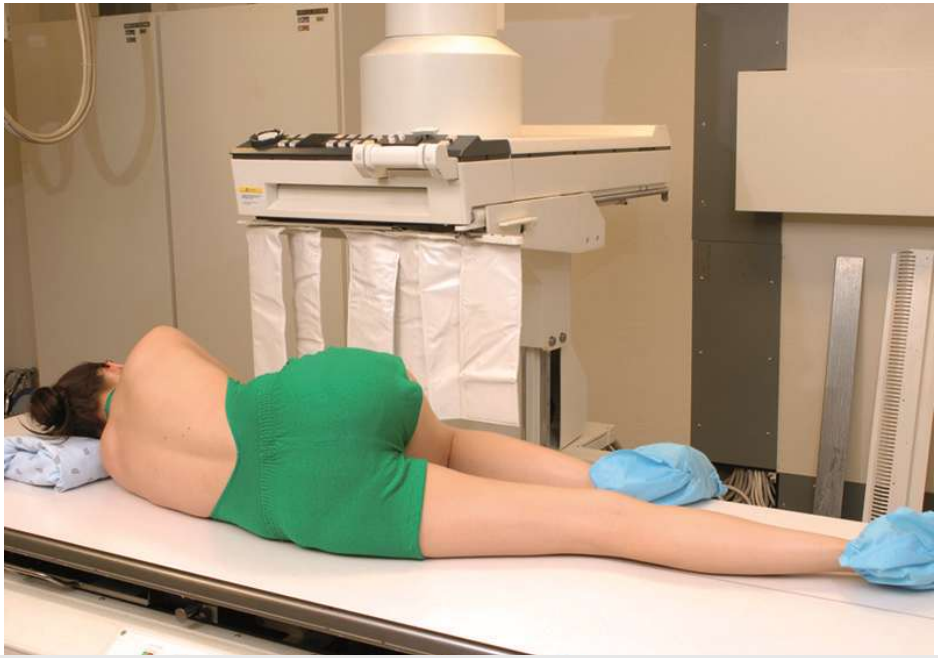
Inflated and un-inflated retention enema tips.

Barium Enema Preparation



Procedure

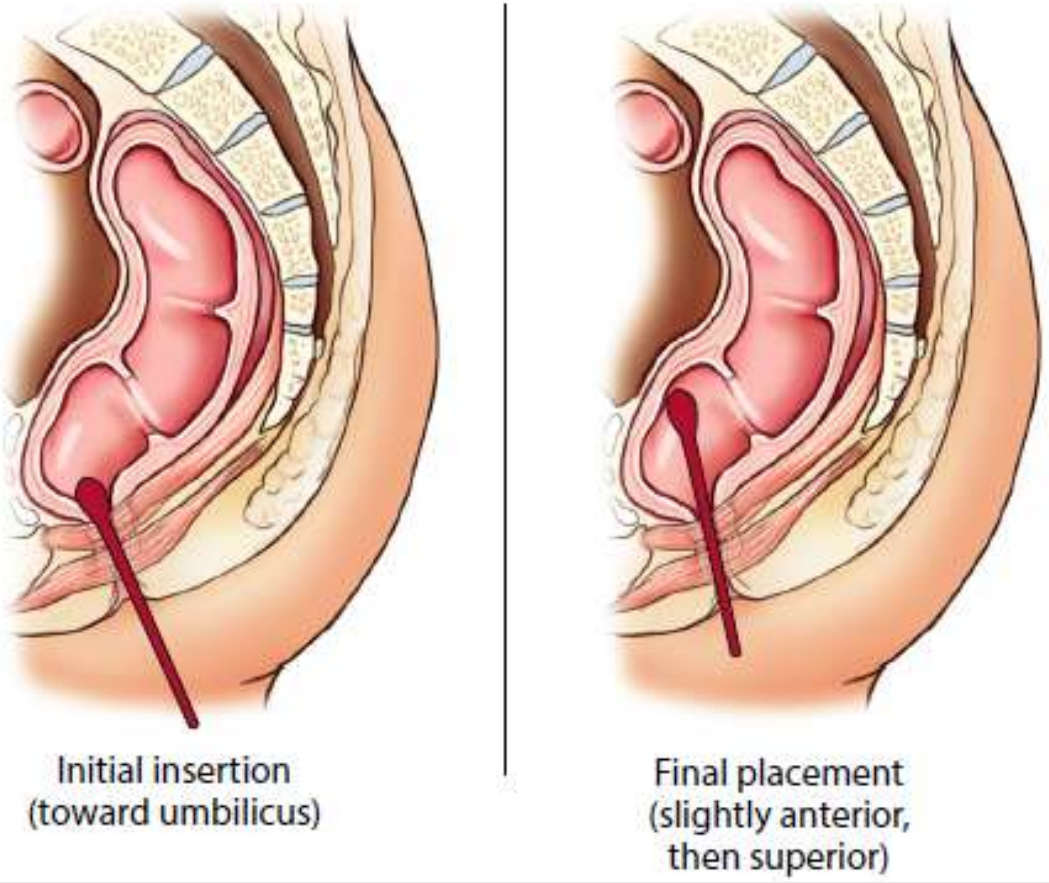
- Sim’s Position
  - Left side
  - Right leg flexed



Enema Tip Insertion

1. Communicate with patient.
2. Wear gloves.
3. Drain air from enema tubing.
4. Lubricate enema tip.

Enema Tip Insertion



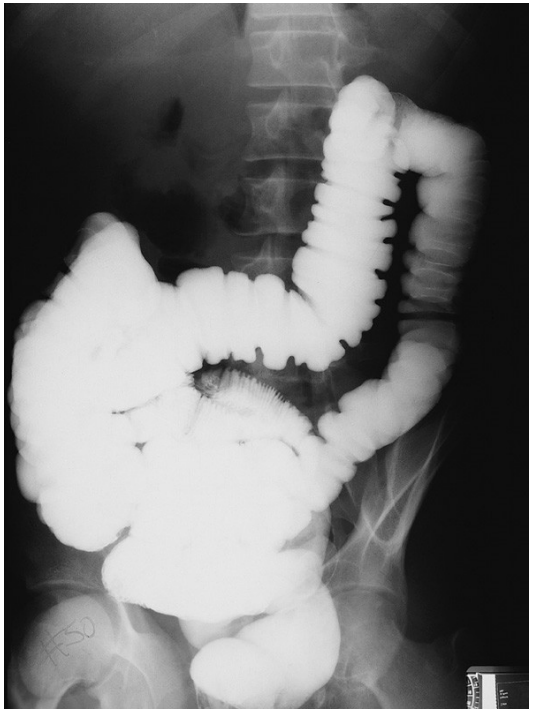
Initial insertion
(toward umbilicus)

Final placement
(slightly anterior,
then superior)

Lower GI Procedures (1 of 3)

1. Single-contrast barium enema
2. Double-contrast barium enema
3. Evacuative proctography (defecogram)

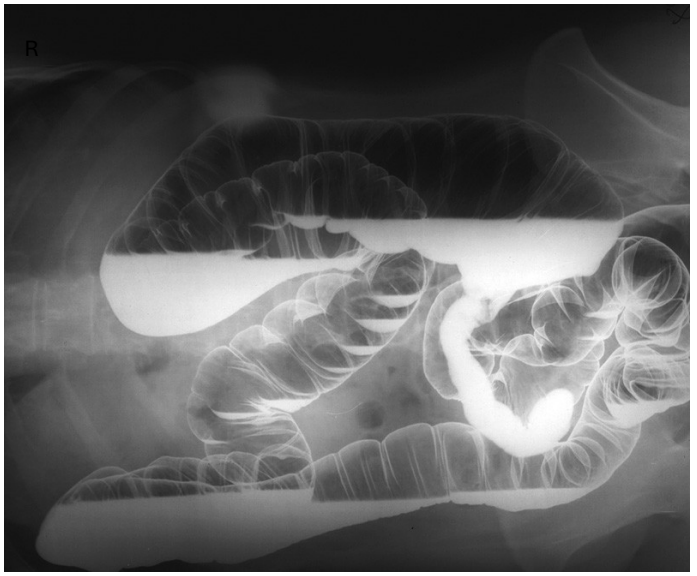
Single-contrast BE



Lower GI Procedures (2 of 3)

- Single-contrast barium enema
- Double-contrast barium enema
  - $BaSO_4$ and room air
  - Thicker barium used
- Two- vs. one-stage procedure

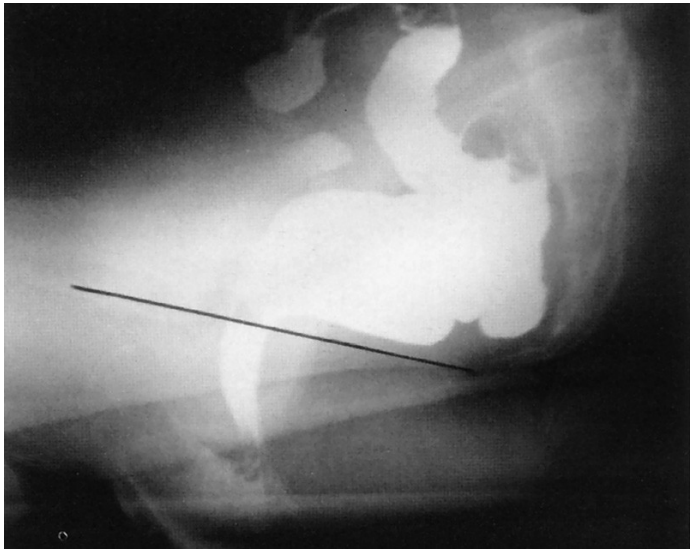
Double-contrast BE



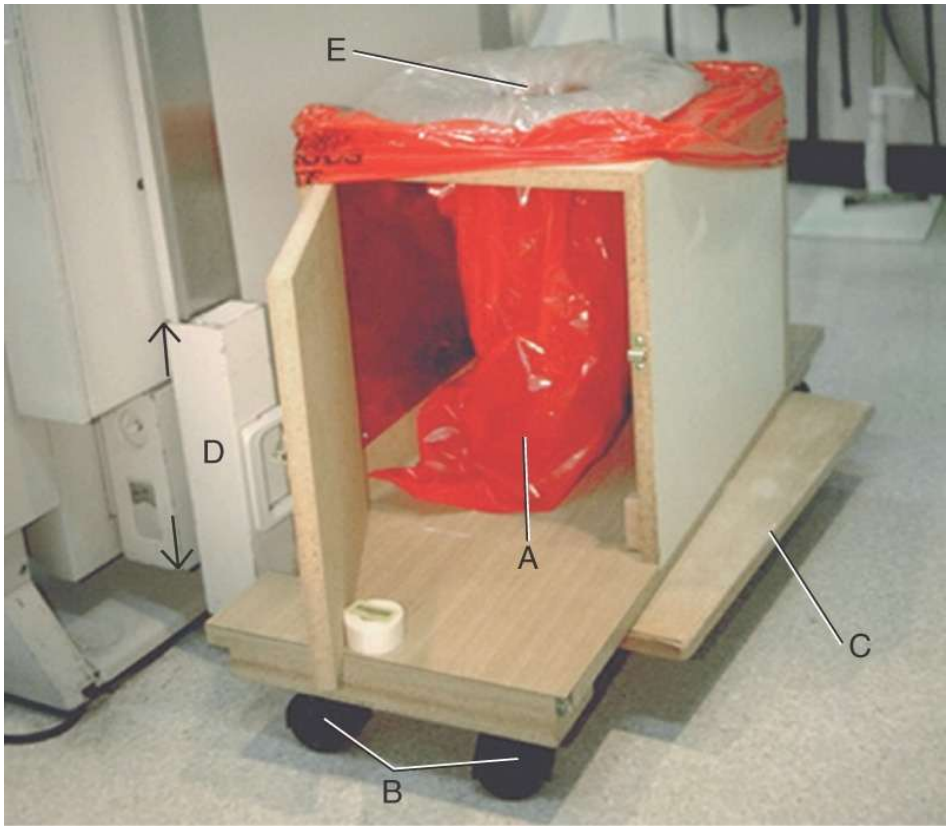
Lower GI Procedures (3 of 3)

- Evacuative proctogram (defecogram)
  - Functional study of the anus and rectum during the evacuation and rest phases of defecation
- Clinical indications
  - 1. Rectoceles
  - 2. Rectal intussusception
  - 3. Prolapse of rectum

Lateral defecogram

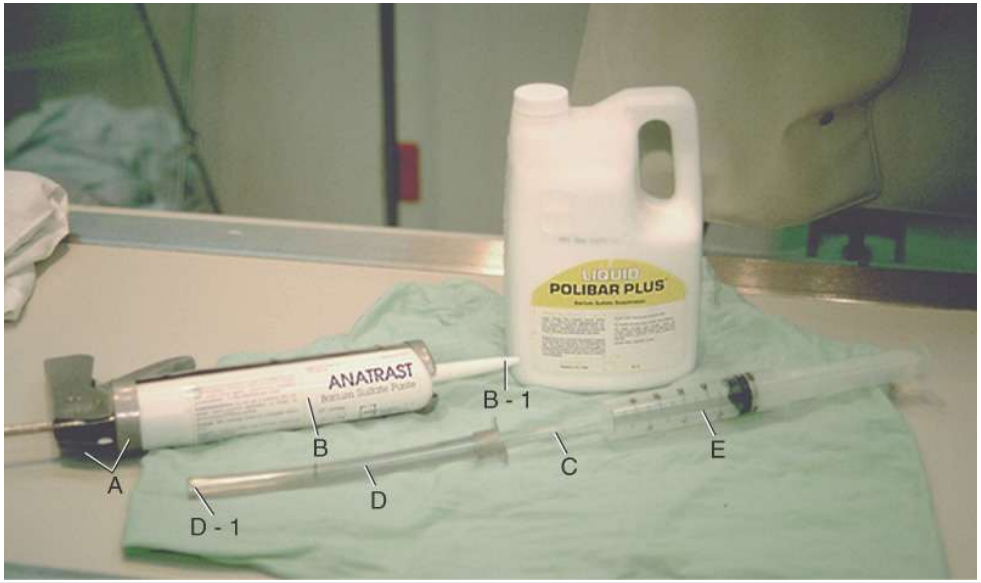


Mobile Imaging Commode with Disposable Waste Receptacle



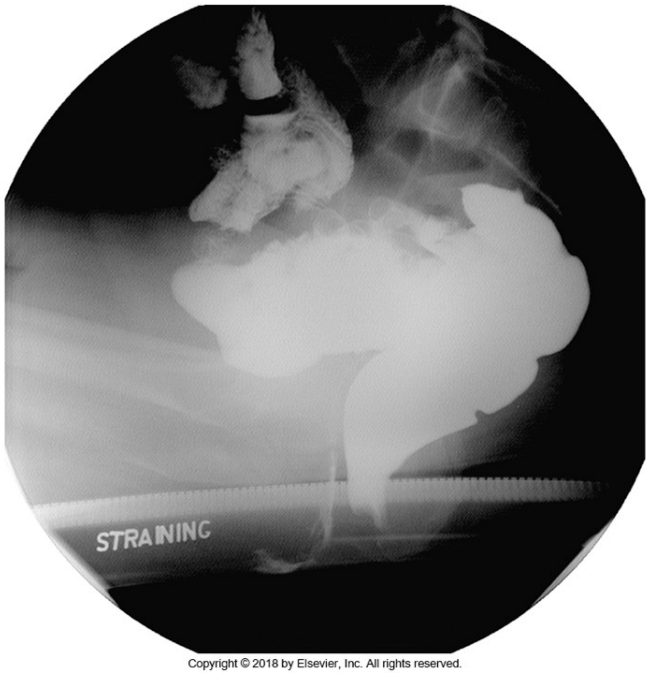
Evacuative Proctogram (Defecogram) Contrast Media

- High-density barium
- Mechanical applicator
- Rectal tubing and tip

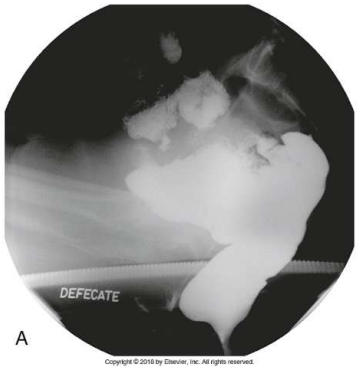


Evacuative Proctogram
Two-Phase Study

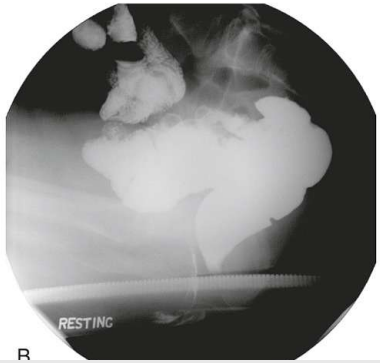
During strain or evacuation



Defecation and resting phases



A



B

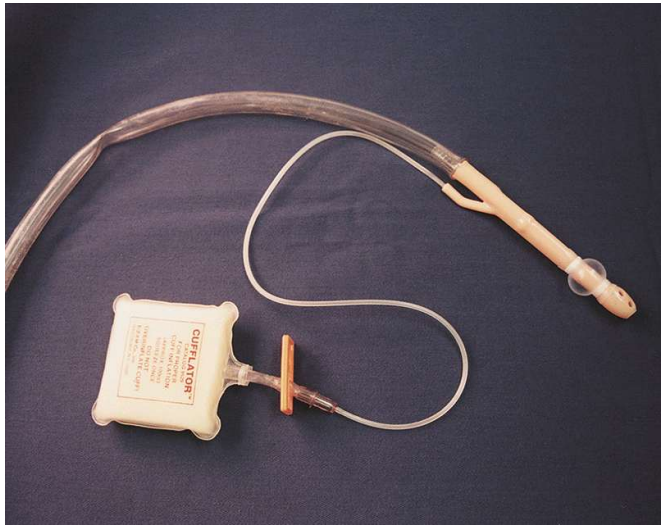
Summary of Safety Concerns (Barium Enema Procedure)

1. Review chart.
2. Never force enema tip.
3. Height of enema bag should be no higher than 24 inches above the table.
4. Verify the water temperature of the contrast media.
5. Escort patient to the restroom.

Colostomy Barium Enema

Colostomy enema bag

Colostomy tip



Special Patient Considerations

- Pediatric applications
  - Small bowel series and barium enema
- Geriatric applications
  - Clear, complete instructions
- Bariatric Patient Considerations

Digital Imaging Considerations

- Collimation filed size
- Accurate centering
- Exposure factors

Alternative Modalities and Procedures

- Computed Tomography (CT)
- CT Enteroclysis
- CT Colongraphy (CTC)
  - Patient preparation
  - Procedure
  - Advantages and Disadvantages
- Nuclear Medicine
- Magnetic Resonance (MR)
- Diagnostic Medical Sonography (DMS)

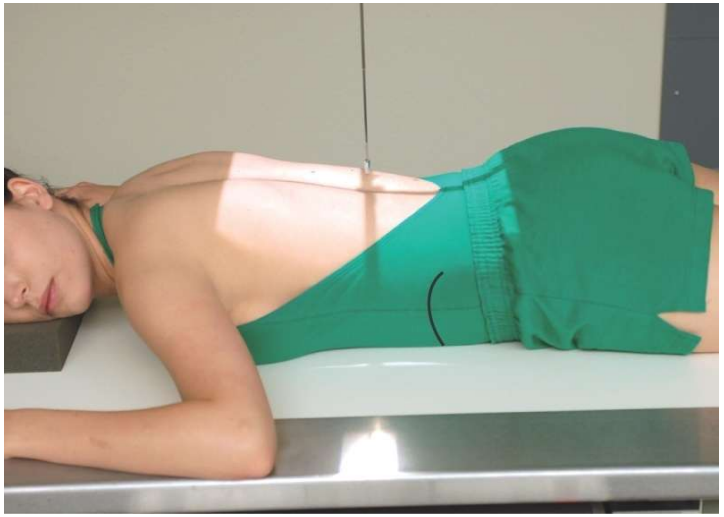
Small Bowel Series

- Routine
  - PA

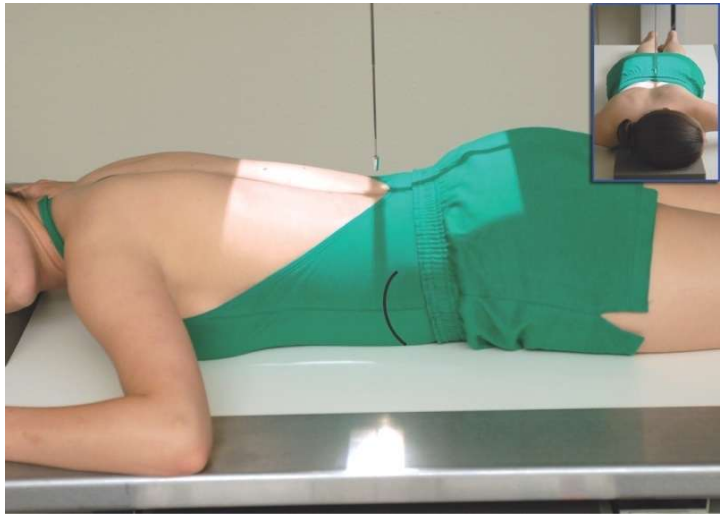
- Special
  - Enteroclysis
  - Intubation

PA Projection-Small Bowel Series

- 15- to 30-minute images
- CR 2 inches (5 cm) above iliac crest



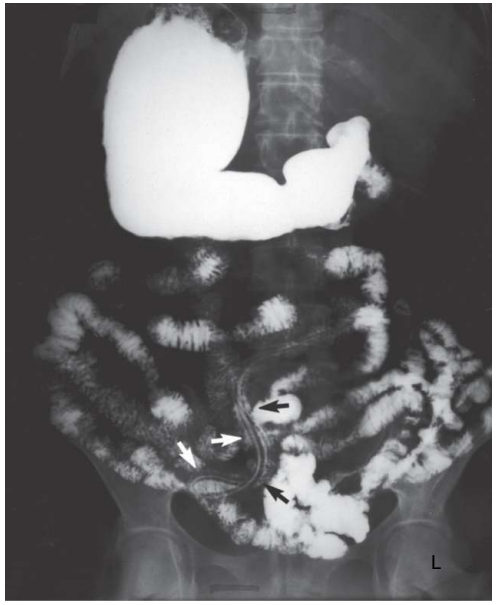
- Hourly images
- CR to iliac crest



Evaluation Criteria
PA projection

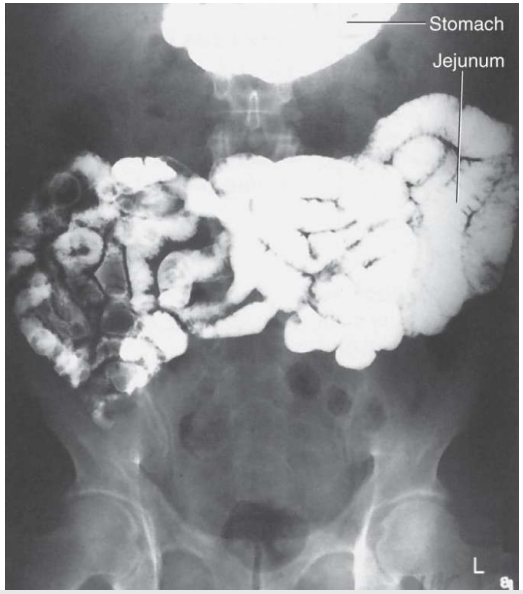
30 minutes

- Entire small intestine demonstrated
- Note intestinal parasite



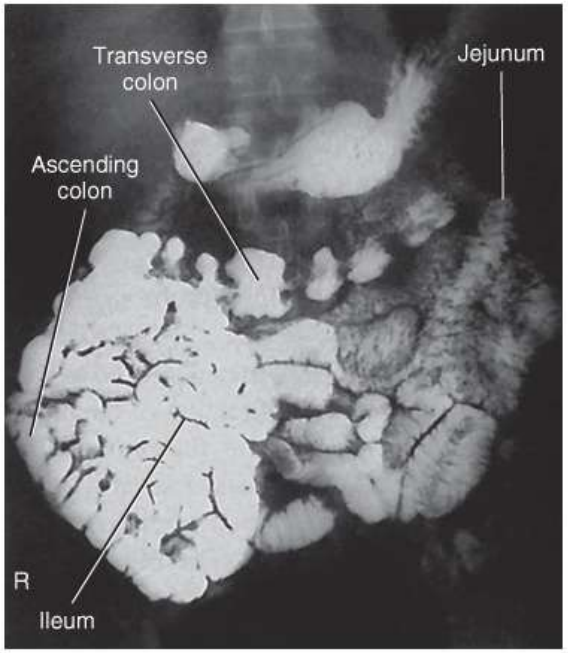
1 hour

- Time interval markers visible
- Optimal exposure factors

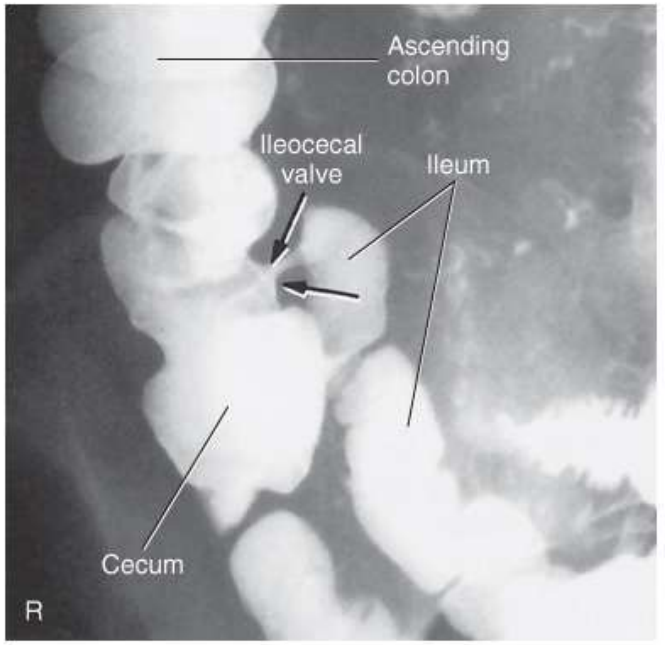


PA Projection-Small Bowel Series

PA—2 hr



PA—ileocecal spot



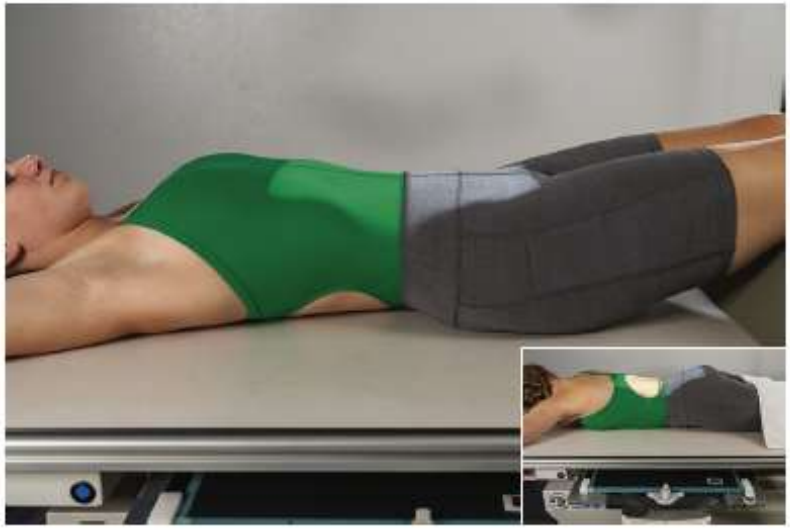
Barium Enema Series

- Routine
  - PA and/or AP
  - RAO and LAO
  - LPO and/or RPO
  - Lateral rectum
  - R and L lat decub (double-contrast)
  - PA postevac

- Special
  - AP axial or AP axial oblique
  - PA axial or PA axial oblique

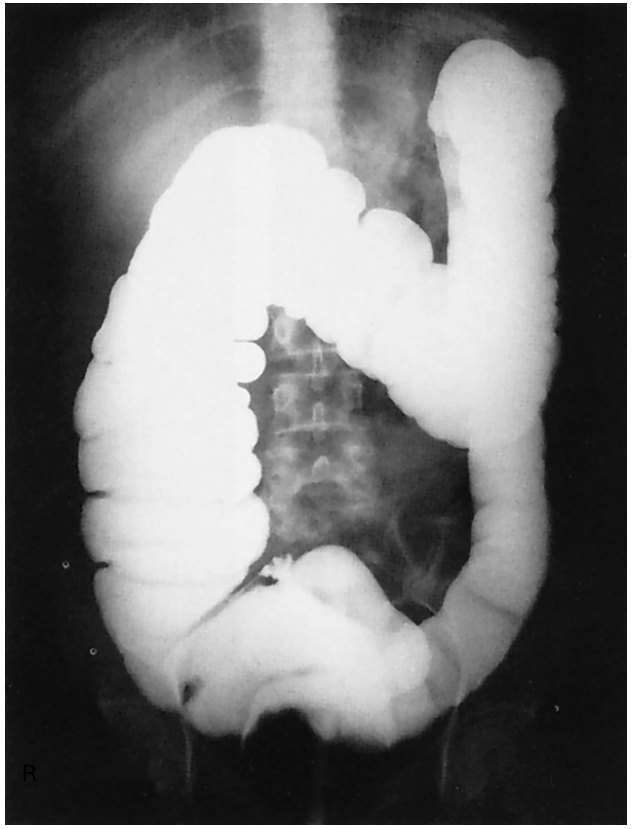
PA or AP Projection-Barium Enema

- No body rotation
- CR to iliac crest



Evaluation Criteria
PA or AP Barium Enema

- Entire large intestine demonstrated
- Transverse colon filled with barium
- No rotation
- Optimal exposure factors

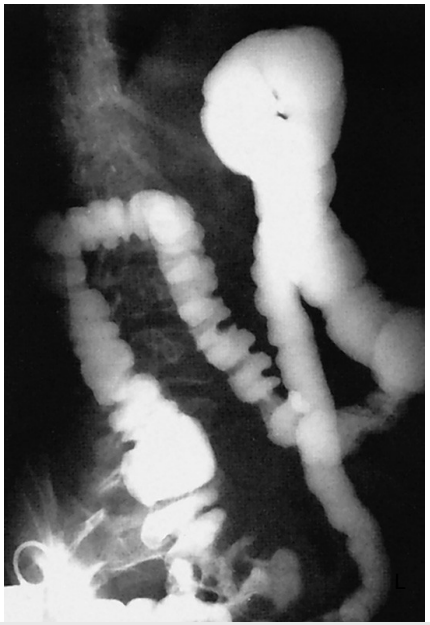


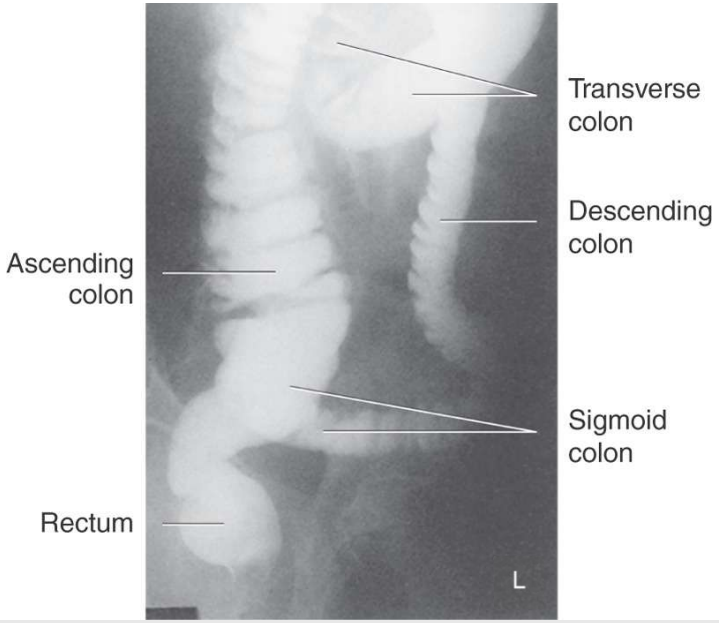
RAO Position-Barium Enema

- 35° to 45° oblique
- CR to iliac crest and 1 inch (2.5 cm) to left of MSP

Evaluation Criteria
RAO Barium Enema

- Right colic flexure, ascending and sigmoid colon are open
- Entire large intestine demonstrated
- Optimal exposure factors



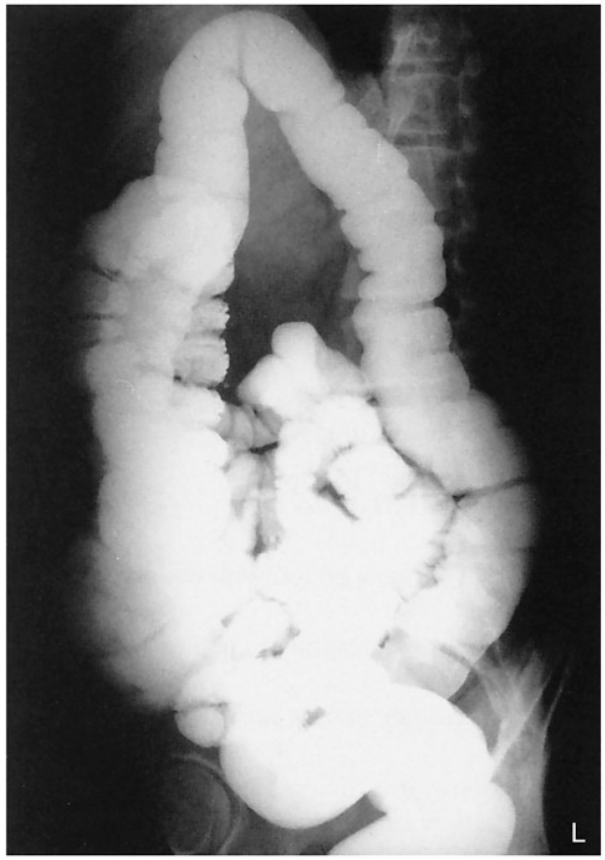


LAO Position-Barium Enema

- 35° to 45° oblique
- CR to iliac crest and 1 inch (2.5 cm) to right of MSP

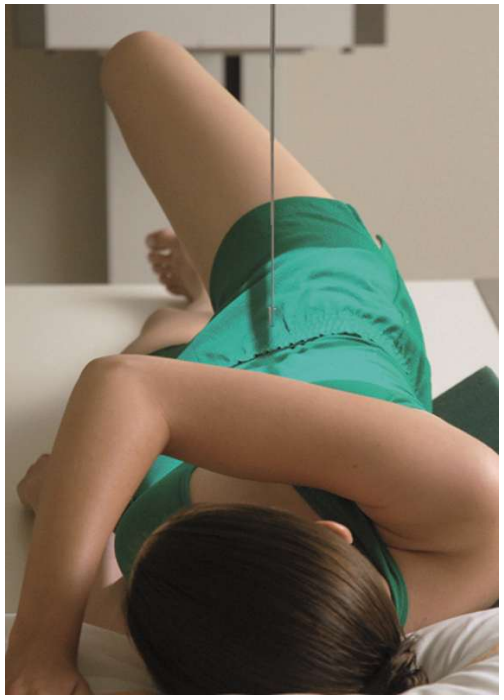
Evaluation Criteria
LAO Barium Enema

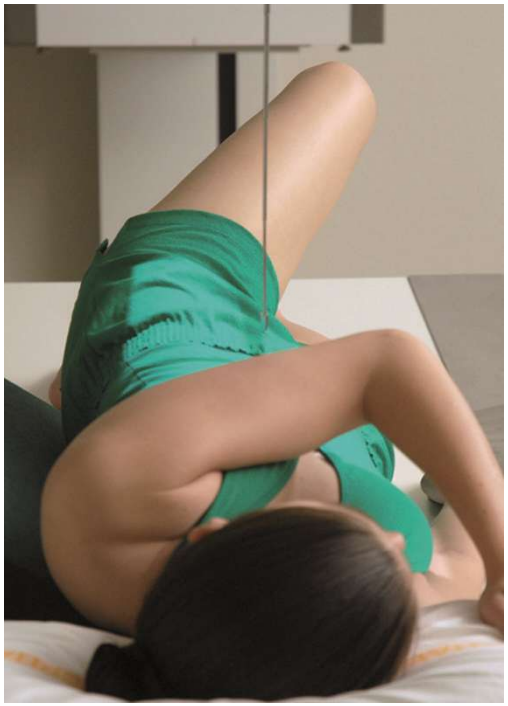
- Left colic flexure and descending colon open
- Entire large intestine demonstrated
- Optimal exposure factors



LPO and RPO Positions-Barium Enema

- 35° to 40° R and L oblique
- CR to iliac crest and 1 inch (2.5 cm) lateral to elevated side of MSP

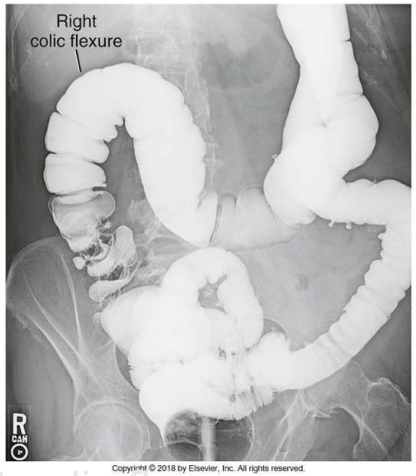




Evaluation Criteria (LPO and RPO)

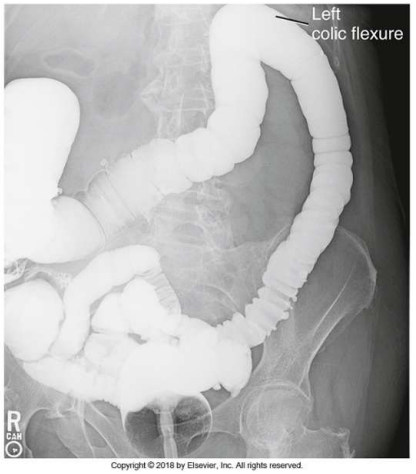
Optimal exposure factors

LPO



- Right colic flexure, ascending, and rectosigmoid colon open
- Entire large intestine demonstrated, including rectal ampulla

RPO

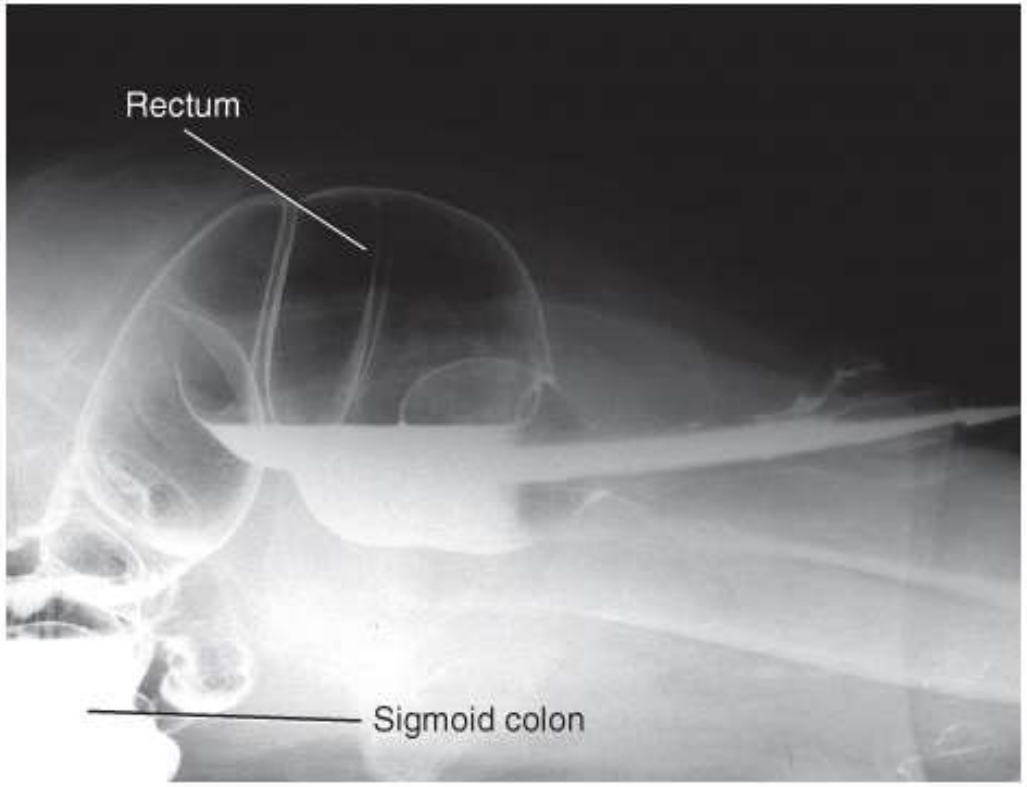


- Left colic flexure and descending colon open
- Entire large intestine demonstrated

Lateral Rectum Position or Ventral Decubitus Lateral-Barium Enema

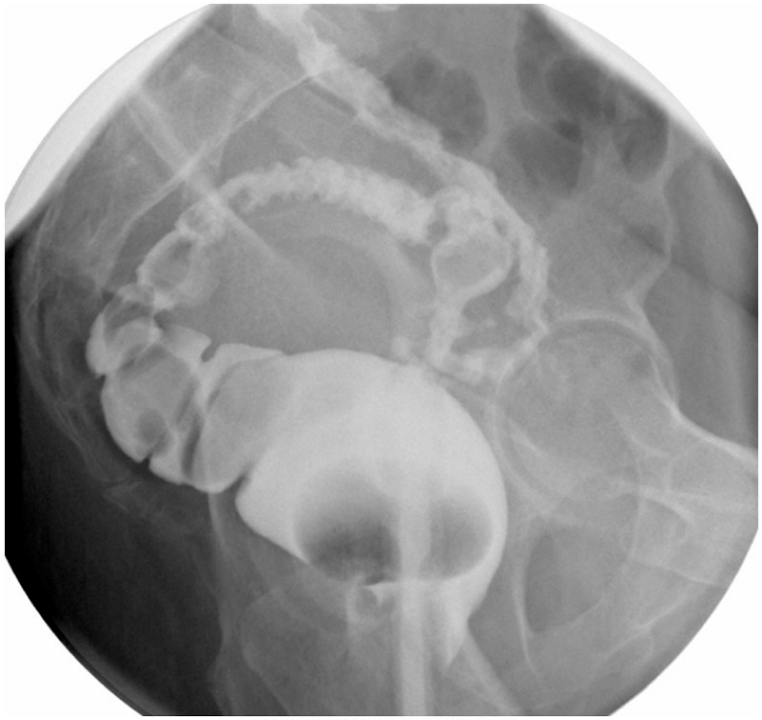
- True lateral
- CR level of ASIS and midaxillary plane
- Prone
- Horizontal beam

Ventral Decubitus—Lateral Rectum



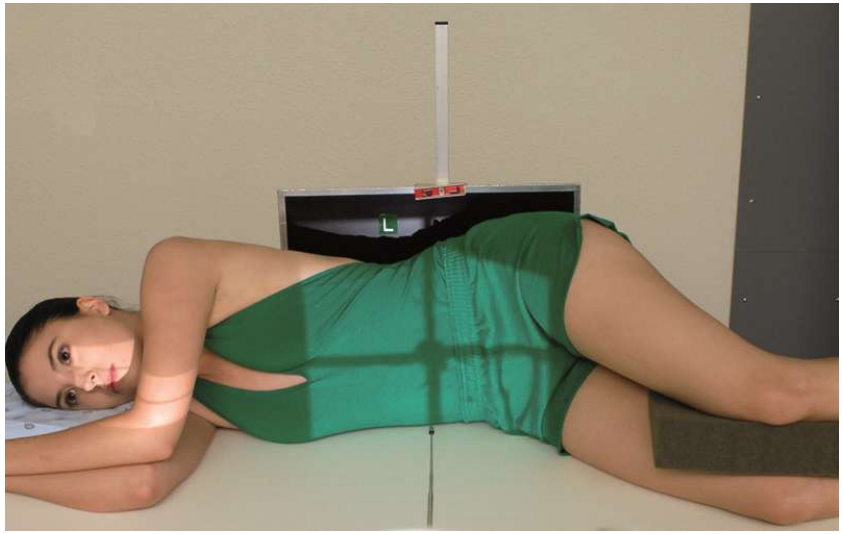
Evaluation Criteria Lateral Rectum

- Rectosigmoid region demonstrated
- No rotation
- Optimal exposure factors



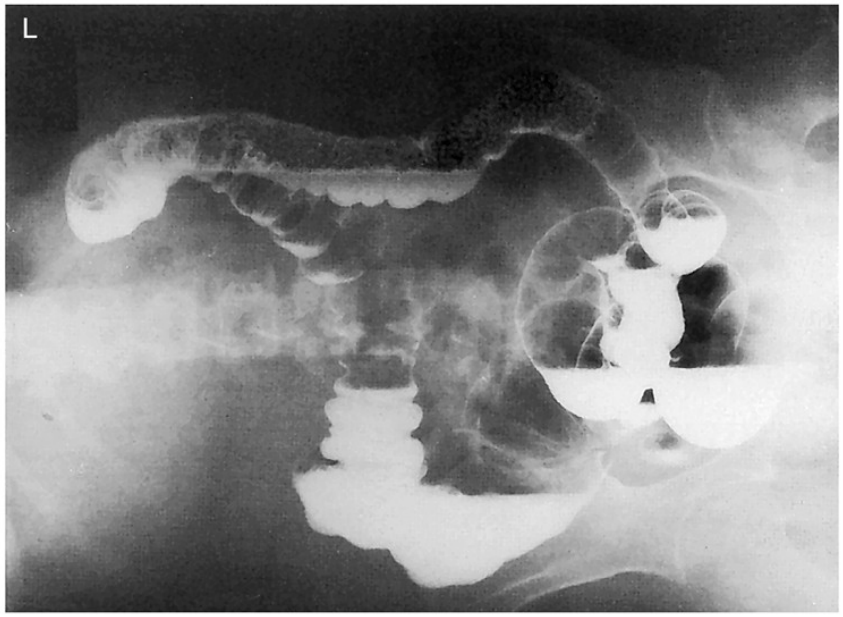
Right Lateral Decubitus Position (AP or PA Projection)-Barium Enema: Double Contrast

- On cart or table
- CR to iliac crest



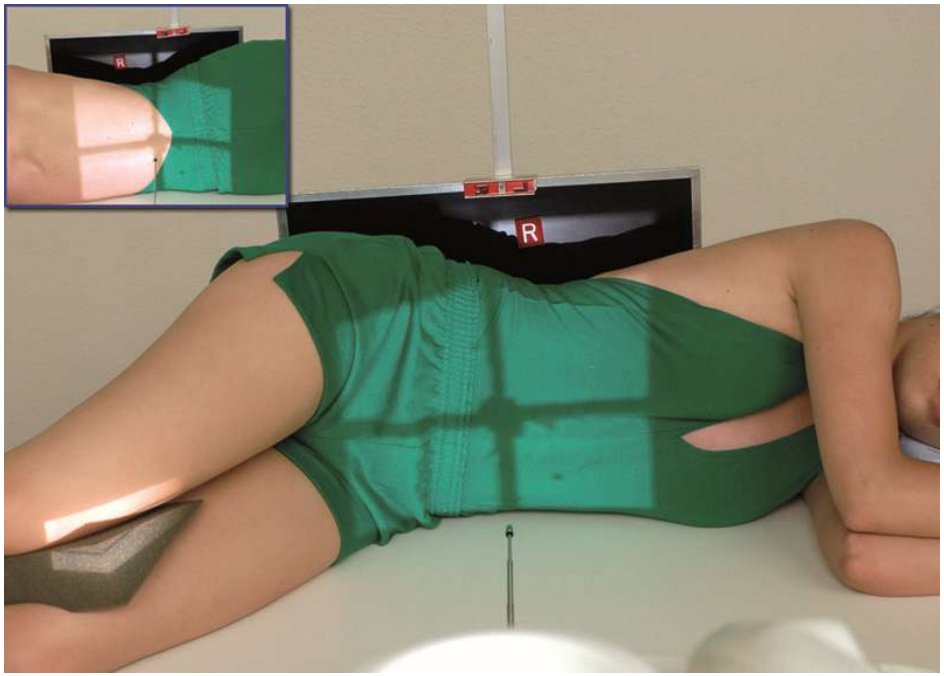
Evaluation Criteria
Right Lateral Decubitus

- Entire large intestine demonstrated
- No rotation
- Optimal exposure factors



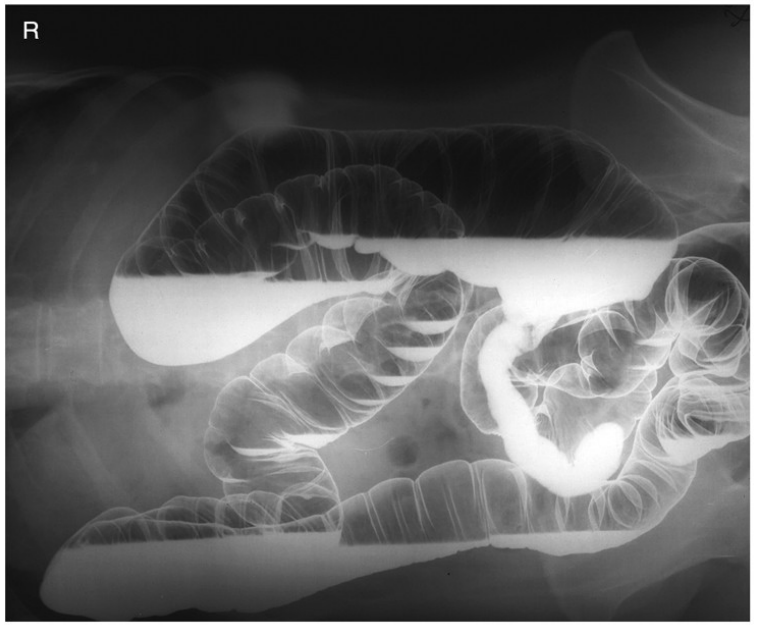
Left Lateral Decubitus Position (AP or PA Projection)-Barium Enema

- On cart or table
- CR to iliac crest and MSP



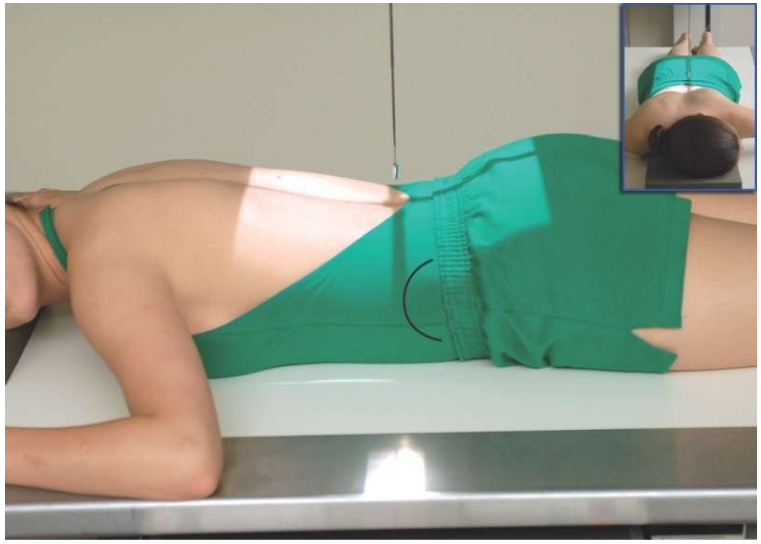
Evaluation Criteria
Left Lateral Decubitus

- Entire large intestine demonstrated
- No rotation
- Optimal exposure factors

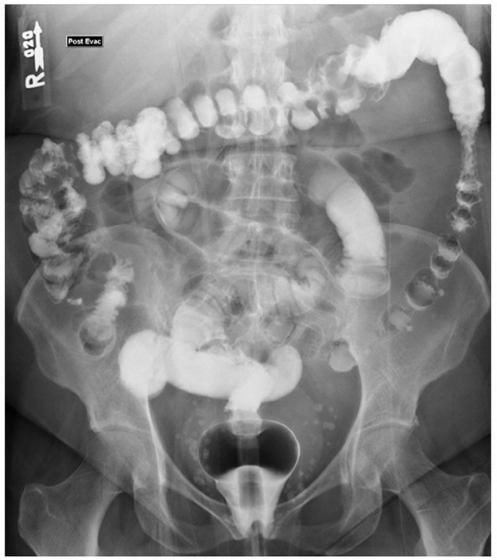


PA (AP) Projection-Postevacuation: Barium Enema

- On cart or table
- CR to iliac crest

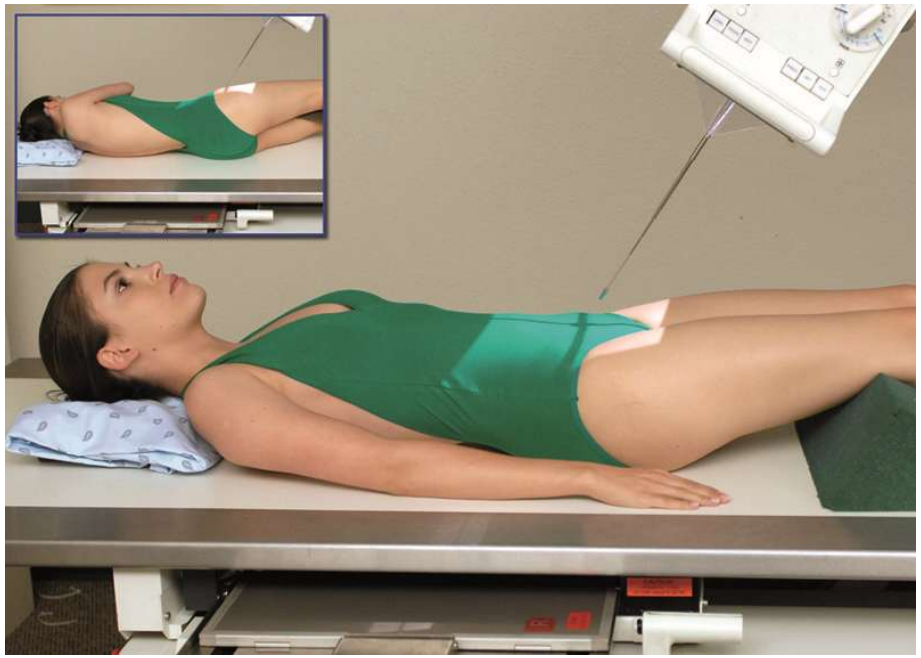


- Entire large intestine included
- No rotation
- Optimal exposure factors



AP Axial and AP Axial Oblique (LPO Projections-Barium Enema

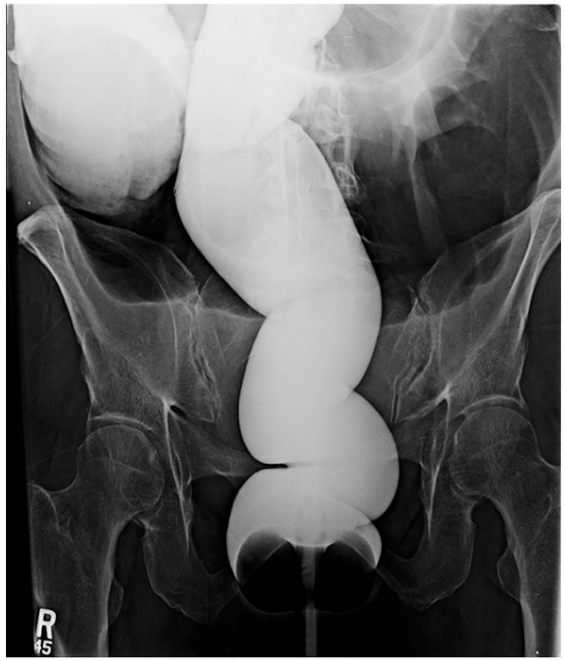
LPO rotate 30˚ to 40˚



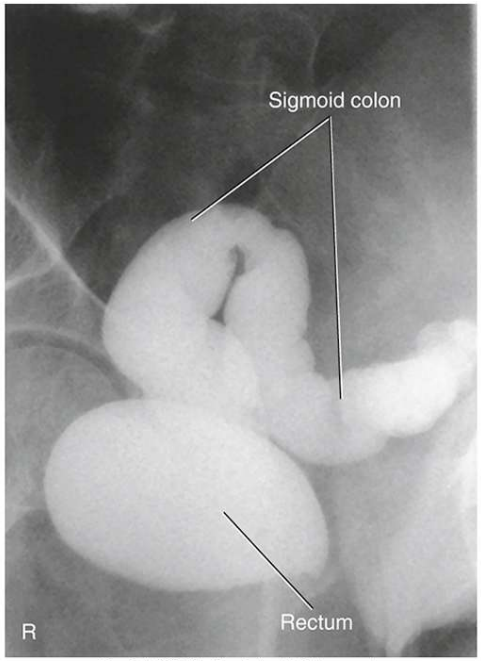
30˚ to 40˚ cephalad CR angle

AP Axial or AP Axial Oblique

AP axial



AP axial oblique (LPO)



PA Axial or PA Axial Oblique (RAO) Projections-Barium Enema

- 30° to 40° caudad
- CR at level of ASIS and MSP
- RAO rotate 35° to 45°

Evaluation Criteria
AP or PA Axial and AP or PA Axial Oblique

- Elongation of rectosigmoid colon
- Optimal exposure factors

PA axial