

SPR 2017 Annual Meeting & Categorical Course

May 16-20, 2017

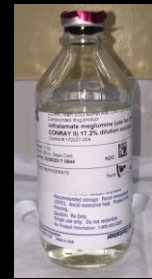
The Westin Bayshore, Vancouver
Vancouver, British Columbia, Canada

“Children’s imaging: Creating change, celebrating success”



OUR DIAMOND ANNIVERSARY
60 Years of Serving Children

General Pediatric Radiology: Abdomen Pediatric Fluoroscopy: Tips & Tricks



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Cincinnati
Children's
changing the outcome together

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Cincinnati Children's Hospital

Associate Professor Radiology & Pediatrics

University of Cincinnati College of Medicine

Cincinnati, Ohio, USA

Tips and Tricks Topics

- Child Life
- Contrast Agents
- Radiation Safety (Low Dose Fluoroscopy)
- Procedural tips & tricks
 - Videofluoroscopic Swallow Studies (VFSS or VSS)
 - Upper GI (UGI)
 - Small Bowel Follow Through (SBFT)
 - Contrast Enema
 - High Pressure Distal Colostogram (for preop Imperforate Anus)
 - Voiding Cystourethrogram (VCUG)
 - Check G-tube or GJ-tube



Child Life Specialists

- Experts
 - growth and development
- Bridge hospital/home gap
- age matched education
- Help cope



Contrast Selection

- Know clinical question – If you don't know, find out!
- Barium vs water soluble
- Water Soluble
 - Osmolality vs opacity
 - Body serum = 275 to 295 mosm/kg



Tips on Contrast Agents

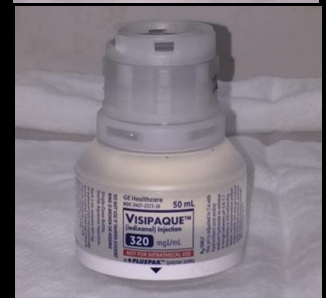
- Oral Contrasts

- Barium

- Most contrast UGIs and SBFTs except to rule out leak
- If patient is eating by mouth or fed by GT/GJT – usually safe

- Water Soluble (OFF LABEL)

- Iodixanol (Visipaque) - Nonionic, **Isosmotic** 320 mg I/mL
 - Rule out bowel leak
 - UGI SBFT in premature infants to evaluate for NEC stricture
 - **NO FLUID SHIFTS**
- Ioversol (Optiray) - Nonionic, slightly hypertonic 160 mg I/mL
 - Tube checks
 - » Malfunction
 - » Replaced

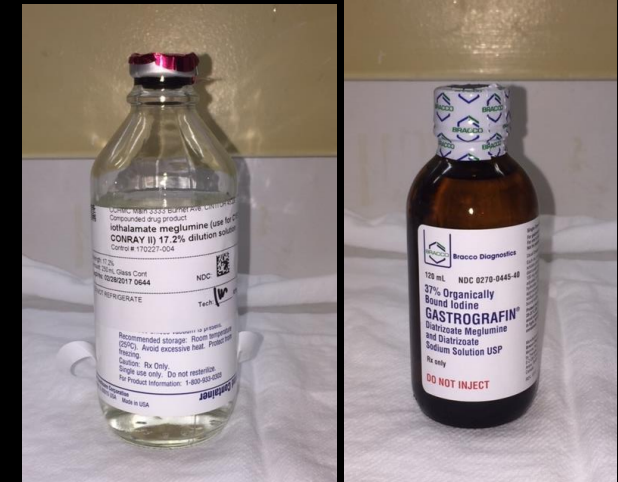


Tips on Contrast Agents

- **Rectal Contrasts**

- **Water Soluble (OFF LABEL)**

- Ionic (Iothalamate Meglumine) Cysto-Conray II
 - Constipation
 - Evaluate for Hirschsprung
 - Ionic (Diatrizoate Meglumine) Gastrografin
 - Treatment for Meconium Ileus
 - Constipation Bowel Mgt pts (potty trained)
 - Nonionic, Isosmotic (Iodixanol) Visipaque
 - Premature Infants
 - » Evaluate for post-NEC stricture
 - » Postop-evaluate for leak




Contrast Selection

Contrast Agent	Osmolality (mosm/kg water)	Iodine (mg/ml)	Cost per 10 mL
E-Z-Paque Barium	0	0	\$0.25
Visipaque 320	290	320	\$13.76
Cysto-Conray 2	400	81	\$1.10
Optiray 320	702	320	\$15.75
Gastrografin	1940	367	\$6.34
Gastroview	2000	367	Not used at CCHMC

Can dilute contrast as needed



Example Contrast Densities

- Cysto-Conray 2  81 ml/mg
- Optiray 160  160 ml/mg
- Optiray 320  320 ml/mg
- Visipaque 320  320 ml/mg
- Thin barium  No iodine



Radiation Safety (Low Dose Fluoroscopy)

Tips on Keeping Radiation Dose ALARA

- Know indications
- Calibrate Fluoroscope
 - Medical Physicist
- Patient size the dose
 - Measure patient
- Pulsed Fluoroscopy
 - Exam dependent
- Remove grid
- Tube lift lowest setting
- Image acquisition
- Magnification setting
- Collimation
- Gel pad management



Known Indications

- ACR appropriateness Criteria
- Know the history
 - Call if you don't know
- If alternative non-rad test better, call clinician
- Lower dose not performing rad exposing exam



Calibrate Fluoroscope

- Medical Physicist
- Lowest doses that maintain diagnostic image quality
- Patient-size the technique



Patient-Sized Technique

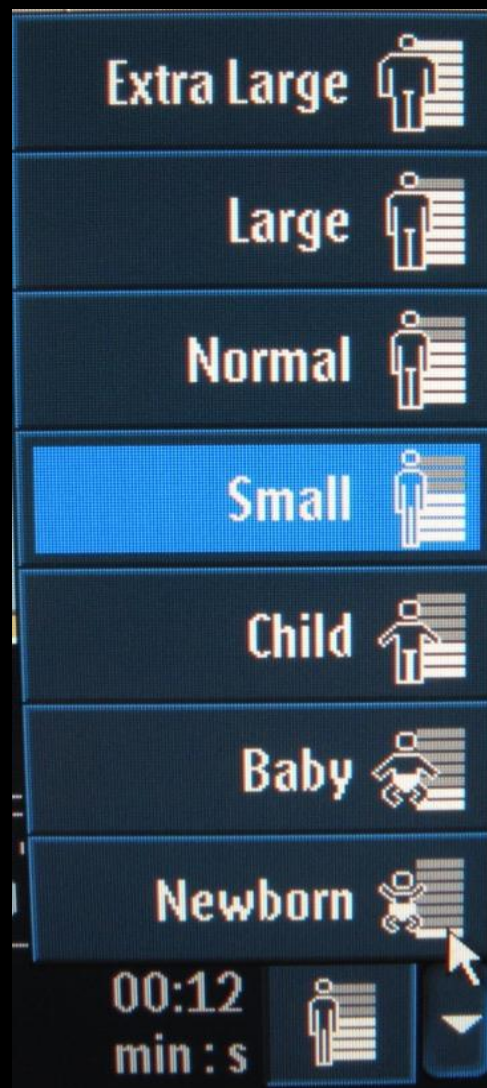
- Measure thickness
 - AP vs Lateral (VSS)
- Medical Physicist
 - Sets dose range for patient thickness



Patient-sized Technique

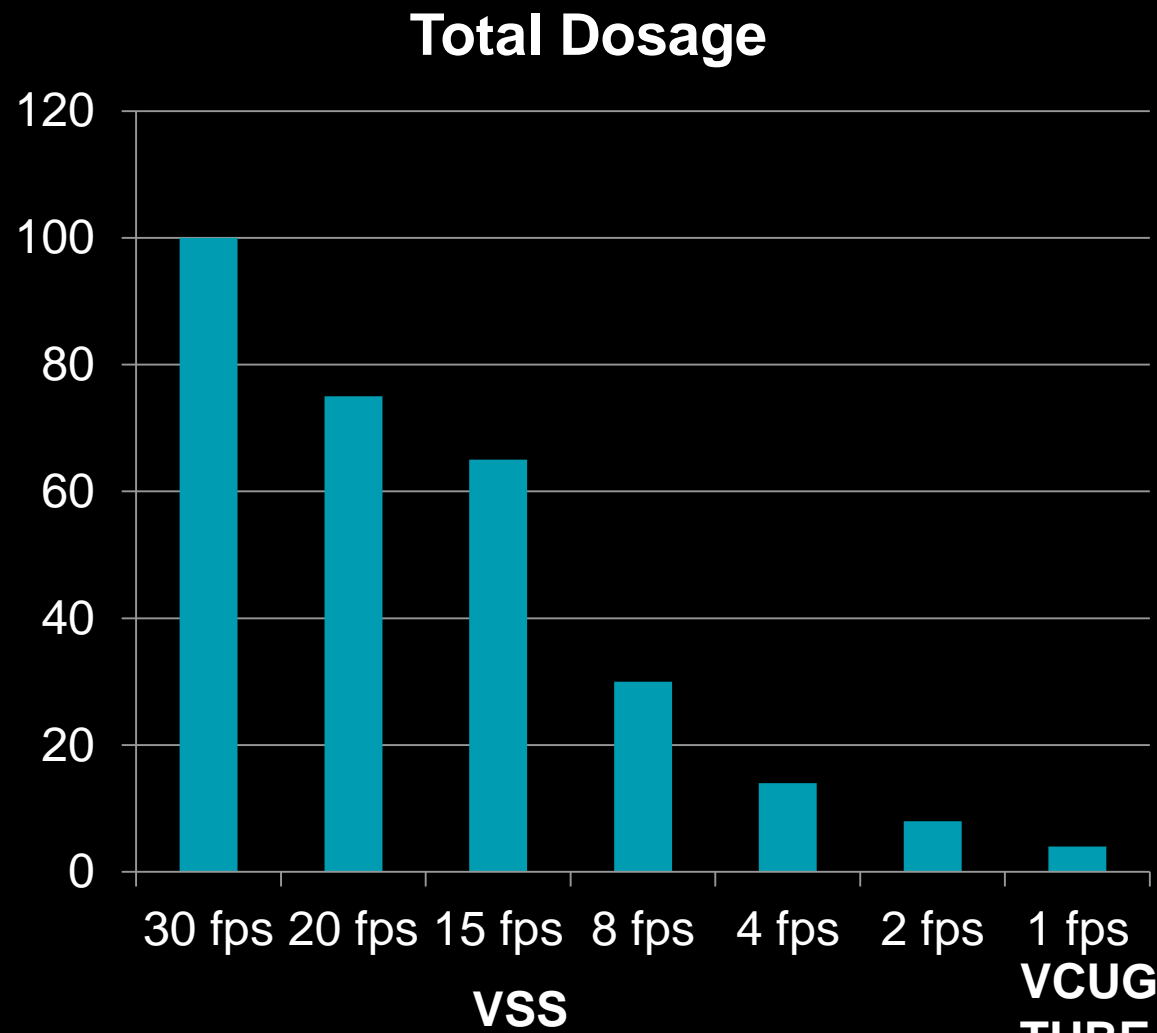
- 24 – 30 cm
- 20 – 24 cm
- 17 – 20 cm
- 14 – 17 cm
- 11 – 14 cm
- 8 – 11 cm
- 5 – 8 cm

Courtesy of Keith Strauss



Pulsed Fluoroscopy - Pulse Rate

Frames (pulses) per second	Dose
30 (continuous)	100%
20	75%
15	65%
8	30%
4	14%
2	8%
1	4%



Fluoroscopy Pulse Rate by Exam

DEFAULT FLUORO PULSE RATES/PER EXAM- PPS (PULSE PER SECOND)

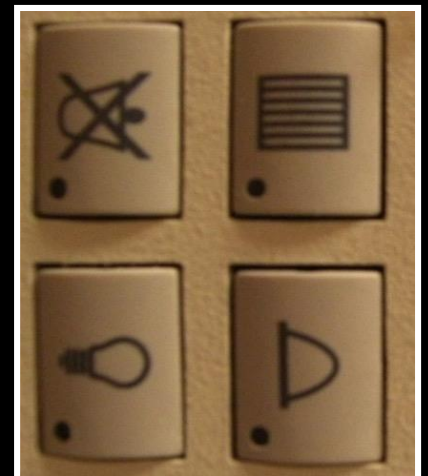
3 SETTINGS PER EXAM

20 / 15 / 10	15 / 4 / 2	4 / 2 / 1'	8 / 4 / 1'
VSS	ESOPHAGRAM	UGI / SBFT	CHEST/ DIAPHRAGM
	UGI	SMALL BOWEL	
		CONTRAST ENEMA	
		COLOSTOGRAM	
		FISTULAGRAM	
		VCUG	
		NEPHROSTOGRAM	
		CLOACAGRAM	
		CYSTOGRAM	
		GENERAL FLUORO	



Remove the Grid

- In vs out of beam
- Out if pt < 12 cm
 - ↓ exposure 30%
 - Loss of contrast



Courtesy of Keith Strauss



Tube Lift

- Off: SSD* 51 cm
- On: SSD* 65 cm
 - Less magnification
 - Increased sharpness
 - Dose reduction of 20%

*SSD = Source Subject Distance
SSD aka SOD (Source Object Distance)

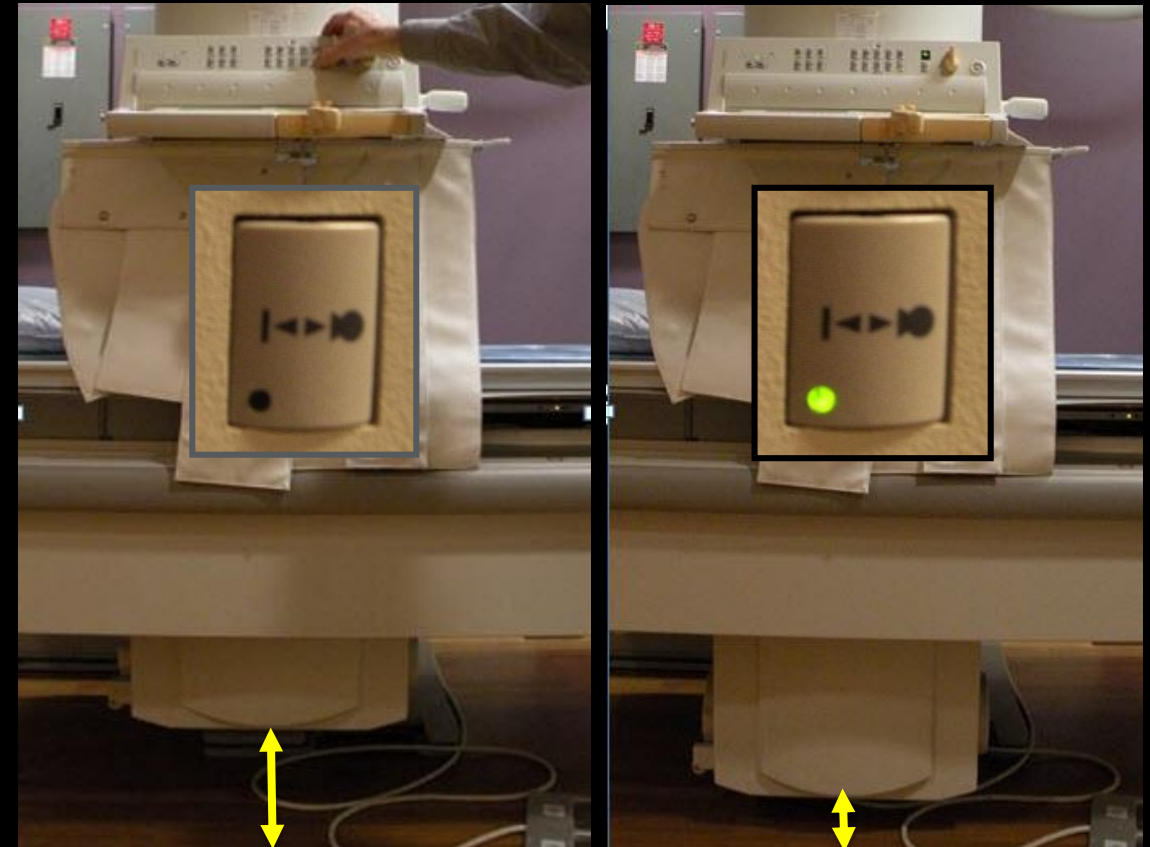


Image Acquisition



Image Capture



Fluorograph



Radiograph



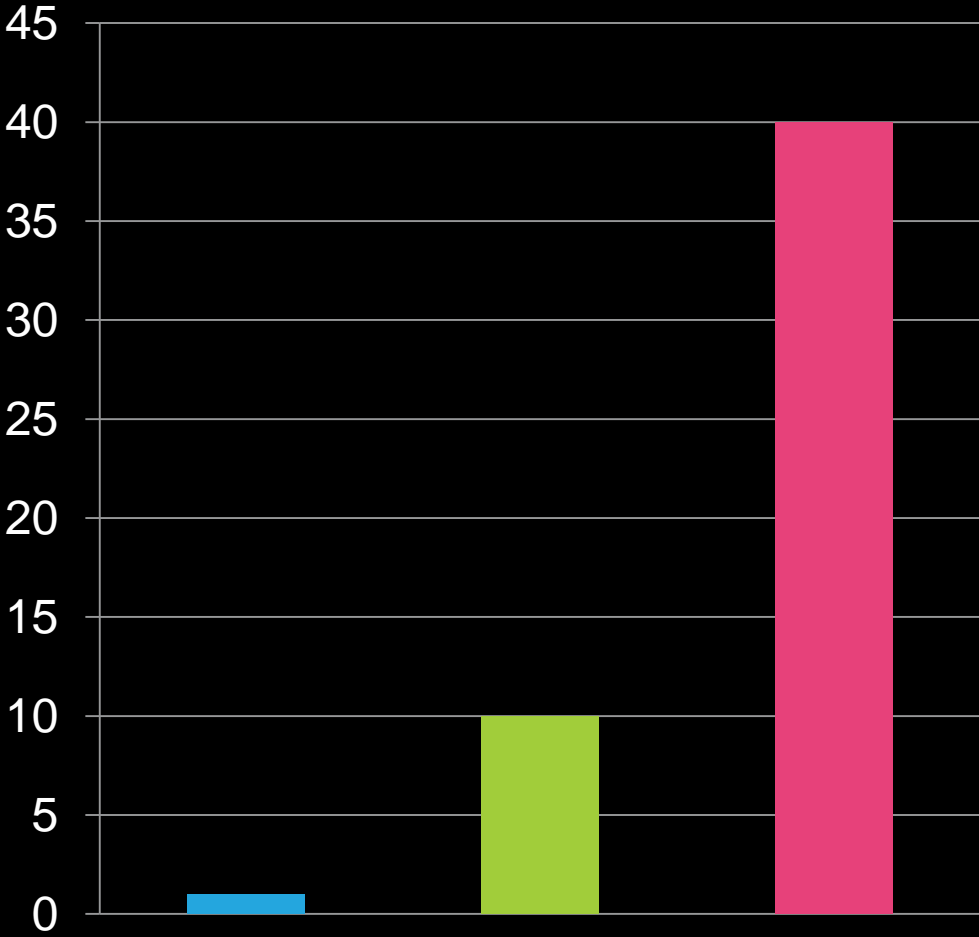
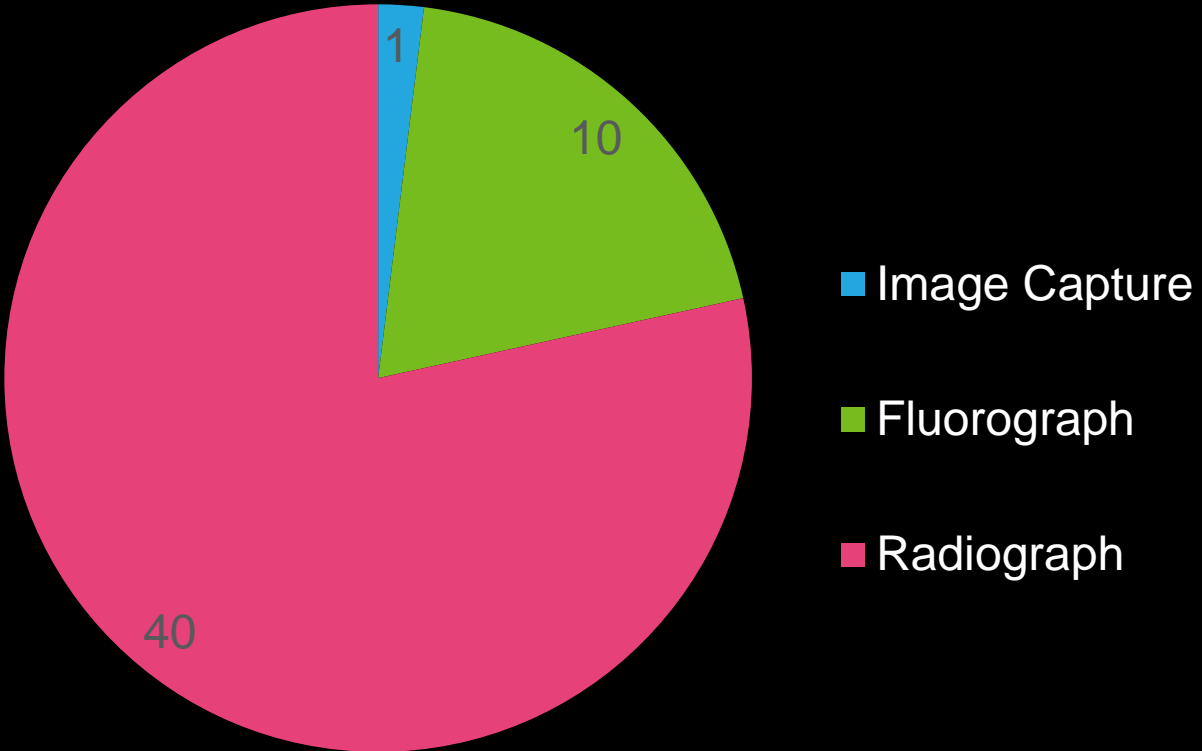
Image Acquisition

- 10 image captures (hold) ~ 1 fluorograph
- 4 fluorographs ~ 1 radiograph
- 1 radiograph ~ 40 image captures (hold)
- Average procedure ~ 6-8 fluorographs
- Radiographs could be $\geq \frac{1}{2}$ the procedure dose!



Image Acquisition

Dose



So, If Taking Scout or Delayed Images.....

- If chest or abdomen fits in field of II
 - Take Fluorographic scout image
- If patient too big too fit in field of II
 - Take Radiographic scout image



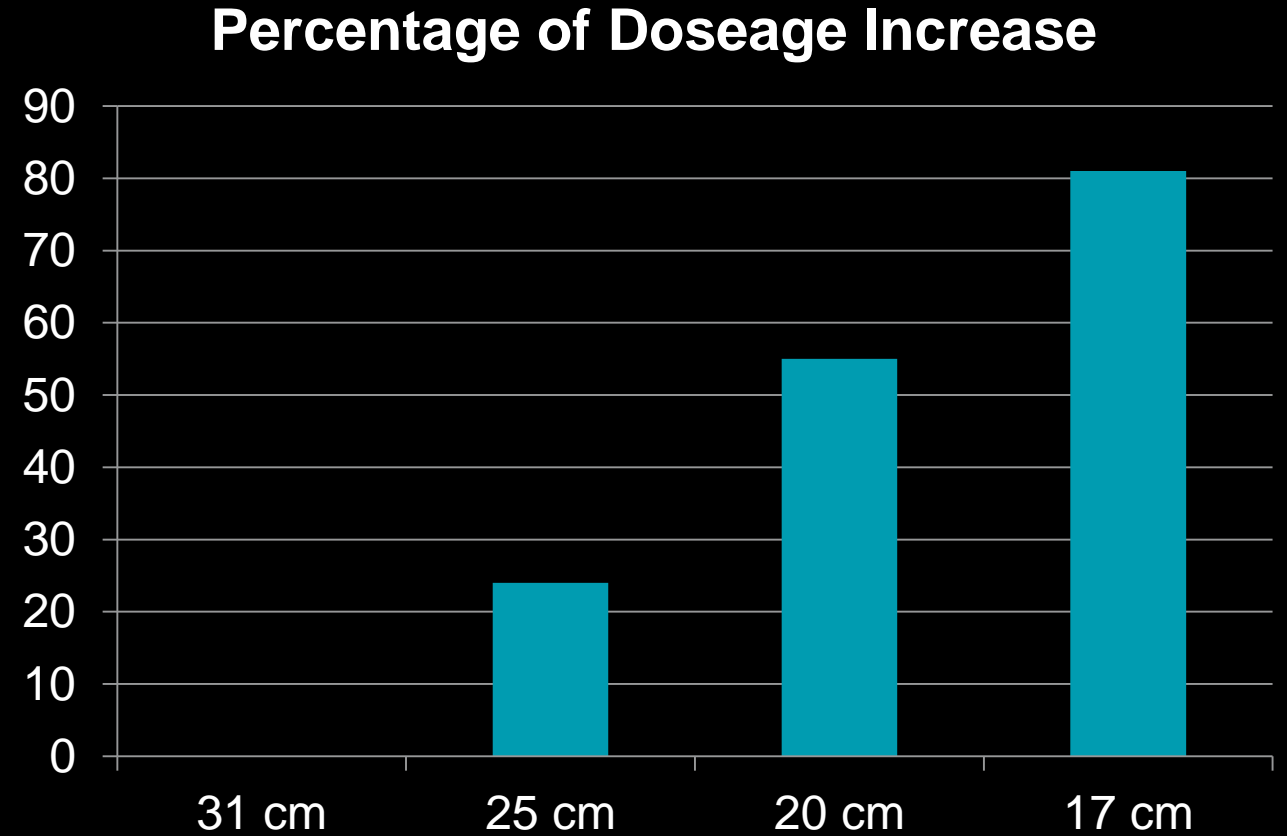
Magnification Mode

- Dose $\propto 1/\text{FoV}$
- Dose \uparrow w mag
- Use sparingly
- Magnify on PACS



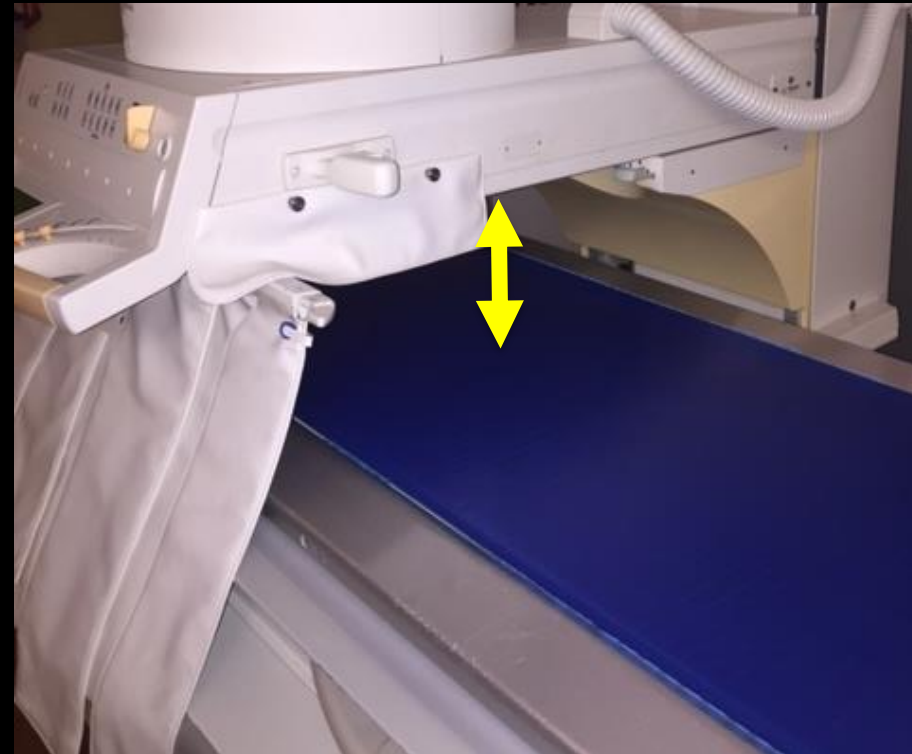
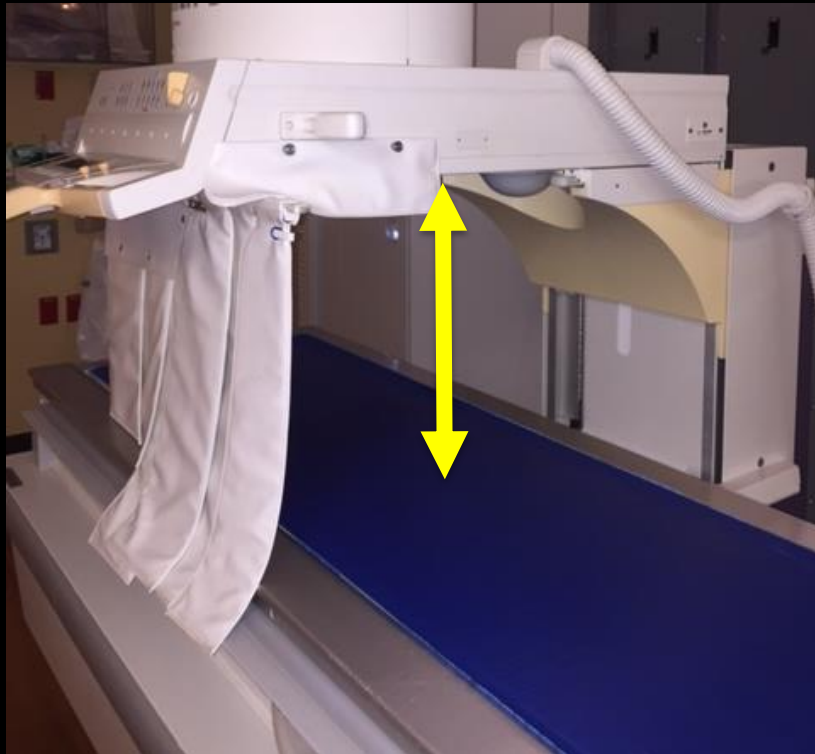
Magnification Mode

FoV Size	Dose Increase
31 cm	0%
25 cm	24%
20 cm	55%
17 cm	81%

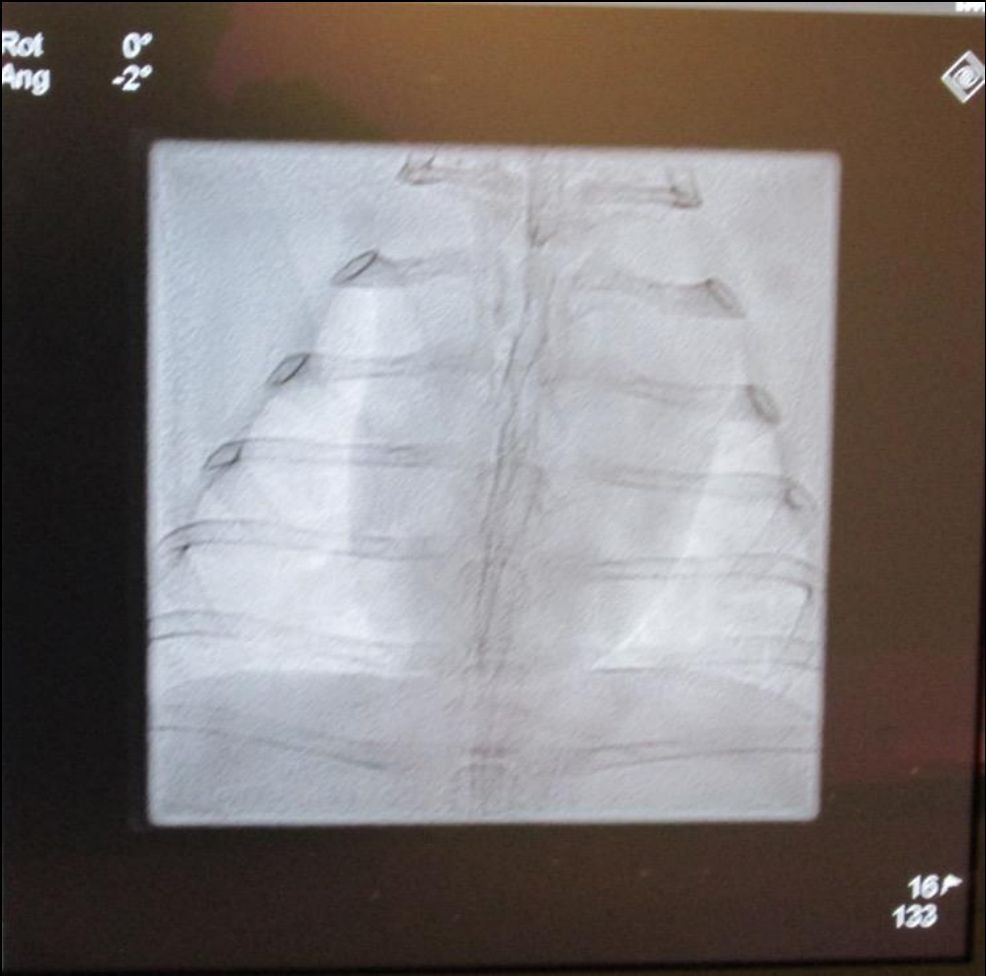
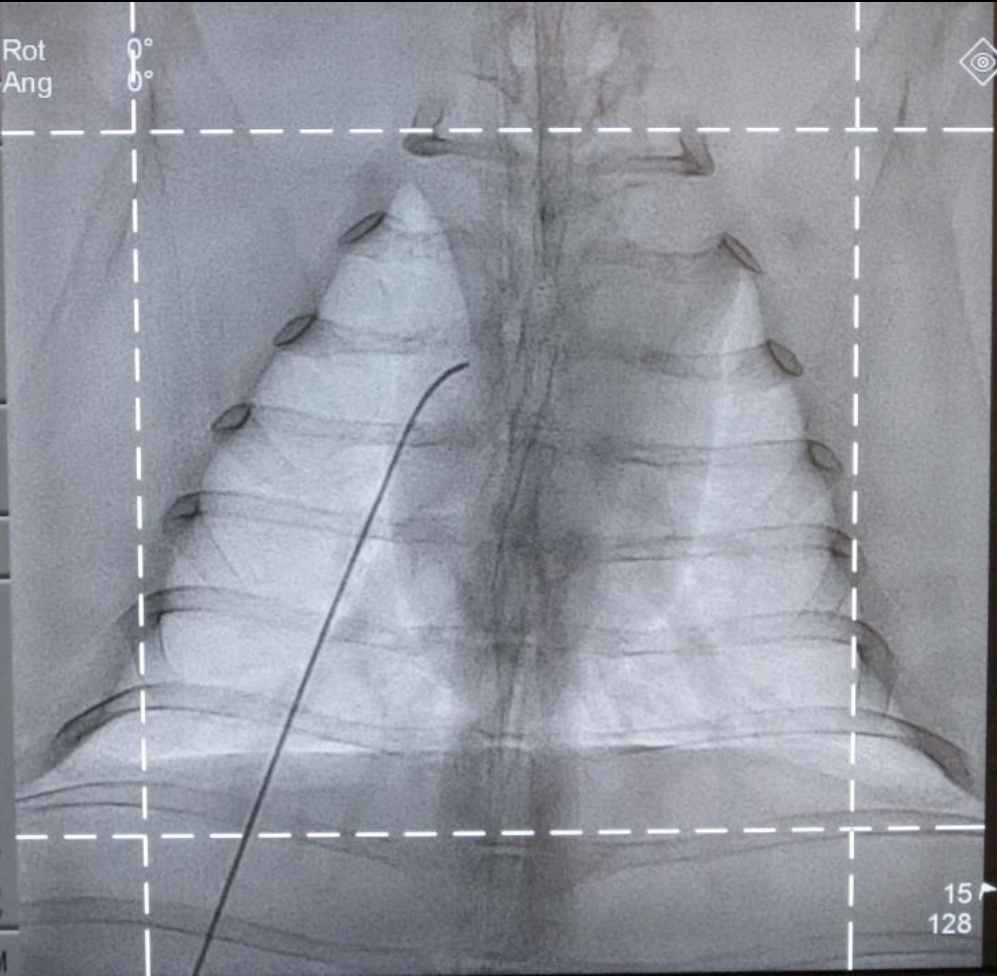


Be Aware of Image Intensifier Position

- Lower position \propto Low Magnification \propto Low Dose



Collimation



Gel Pad

- Increases patient comfort
- ~30 ↑ in dose for overhead radiographs
 - Remove for radiographs
- No ↑ for under-table (fluorographs)



Tips and Tricks: VFSS

- Collimate mouth-pharynx-upper airway
- Pulse rate 30 vs 15 PPS
- Include multiple swallows for each food/liq
- Follow to GEJ at least once
- Incidental esophageal findings
- Rare cricopharyngeal achalasia



Collimate mouth-pharynx-upper airway



Videofluoroscopic Swallowing Study (VSS)

- Controversy: continuous fluoro vs pulsed fluoro for VSS

Can we use pulsed fluoroscopy to decrease the radiation dose during video fluoroscopic feeding studies in children?

M.D. Cohen*

CONCLUSION: Decreasing the fluoroscopic pulse rate cannot be used as a method of decreasing radiation dose during performance of video fluoroscopic studies because it will potentially result in non-detection of episodes of supraglottic penetration of liquid barium.

Theoretical, No supporting clinical evidence



Videofluoroscopic Swallowing Study (VSS)

- Pharyngeal phase duration 500 msec
- At 30 pps – 33 msec between frames
- At 15 pps – 66 msec between frames

Clinical Radiology (2009) 64, 70-73

- Therefore **theoretically** there are multiple frames during which aspiration could be seen
 - **The aspiration itself**
 - **Contrast in the trachea**
- 30 vs 15 cannot be distinguished by human eye



Follow to GEJ at least once



Incidental esophageal findings



Tips on Performing Diagnostic UGI

Tips and Tricks: Esophagram/UGI

- NPO times:
 - Neonates/young infants = 2-3 hours
 - Older infants/children = 4 hours
 - Adolescents = 6-8 hours
- Exceptions for emergent studies

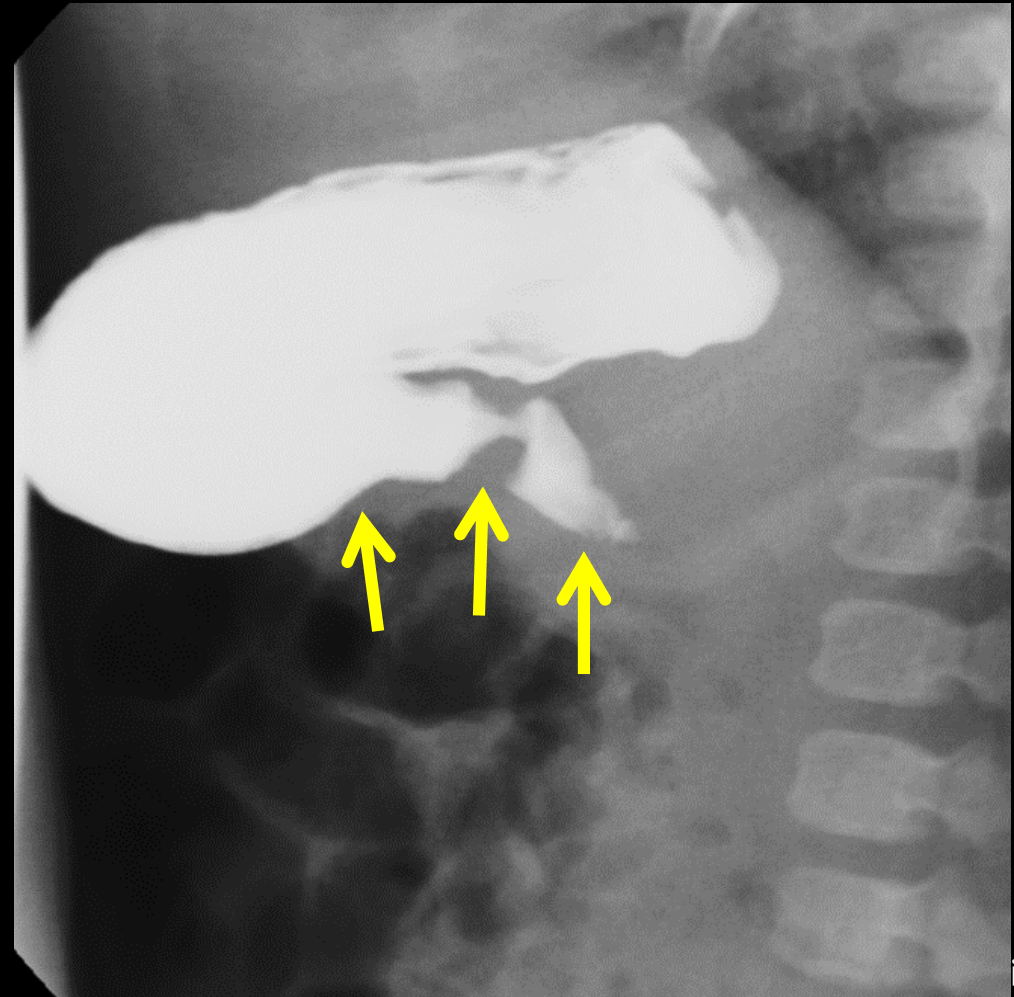
Positioning Controls Bolus

- Left hand tower, right hand patient
- Hold patient at thigh
- Positioning emphasizes control of contrast bolus
- Start Left Lateral and then AP esophagus, mouth to GEJ
- RAO positioning to open up antrum-pylorus-bulb
- **FIRST** lateral passage thru duodenum
- Straight AP DJJ
- LPO DJJ over bulb
- Intermittent pulsed fluoroscopy

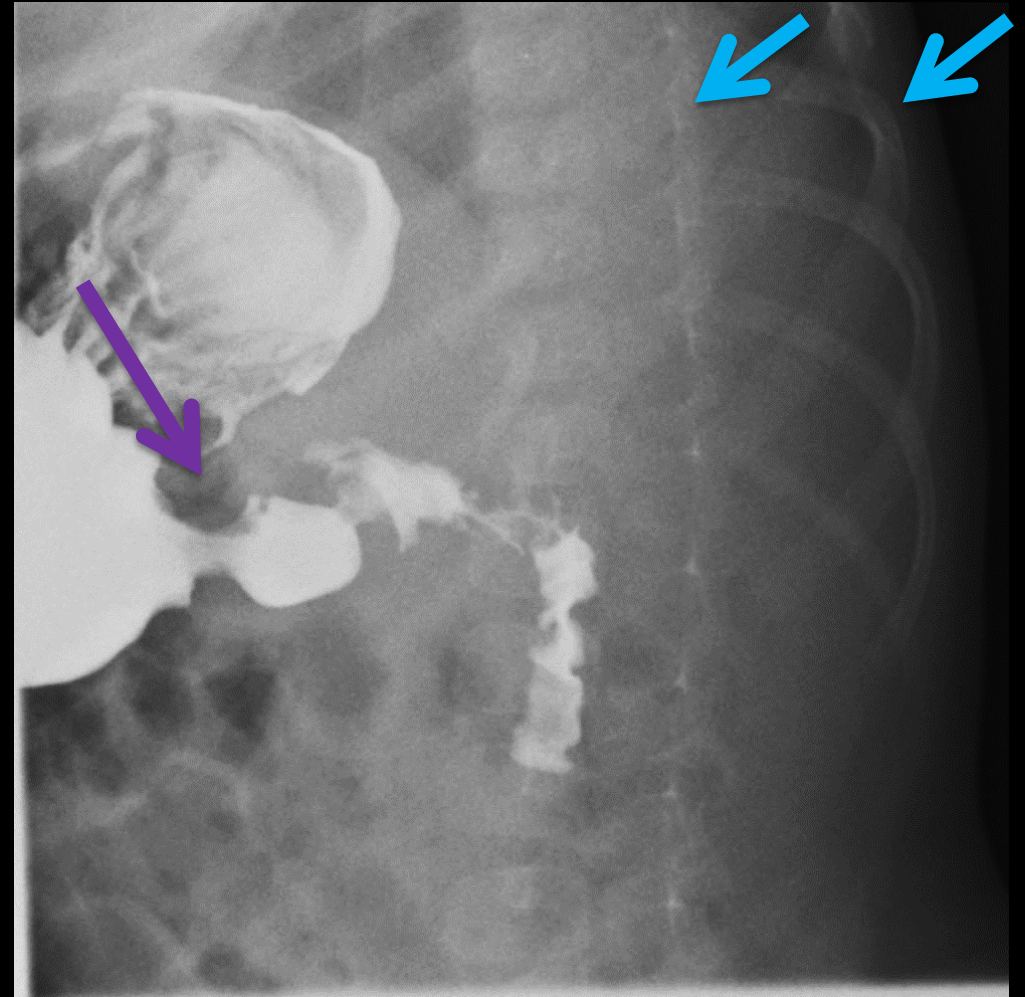
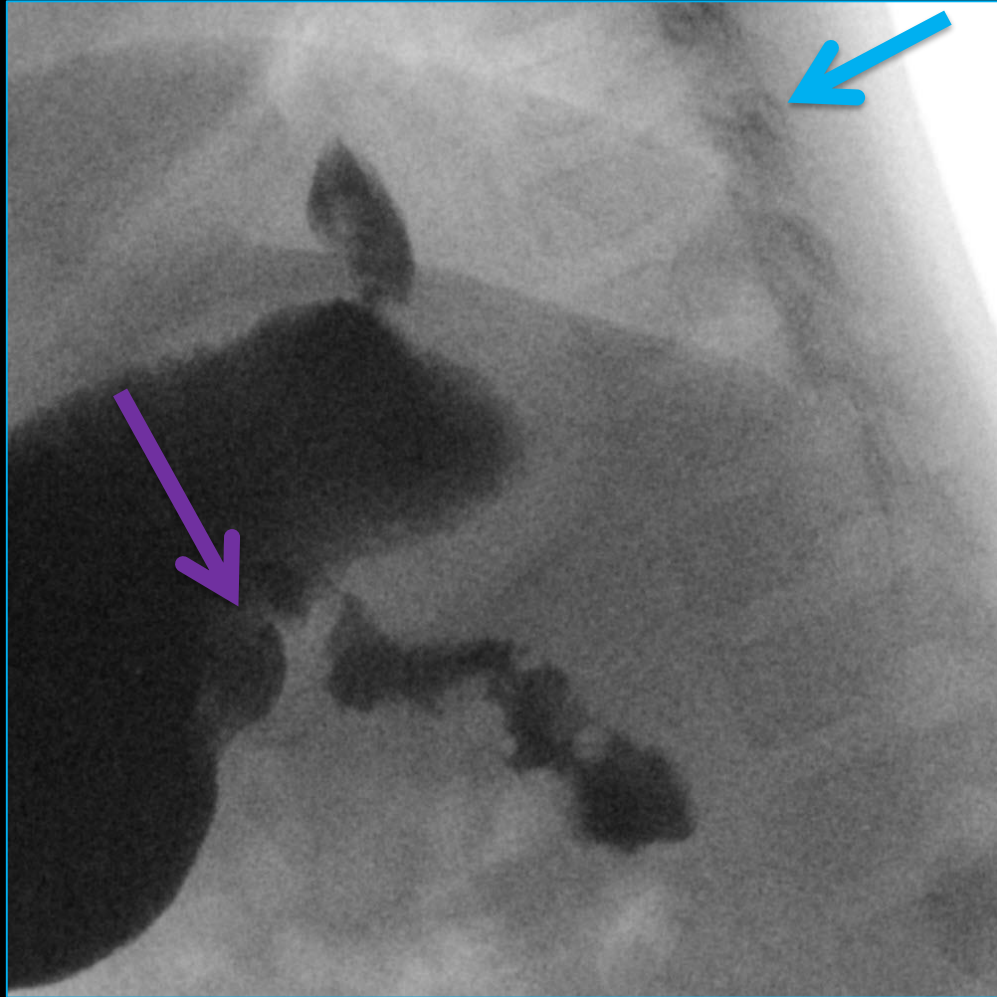
Left Lateral and AP esophagus to GEJ



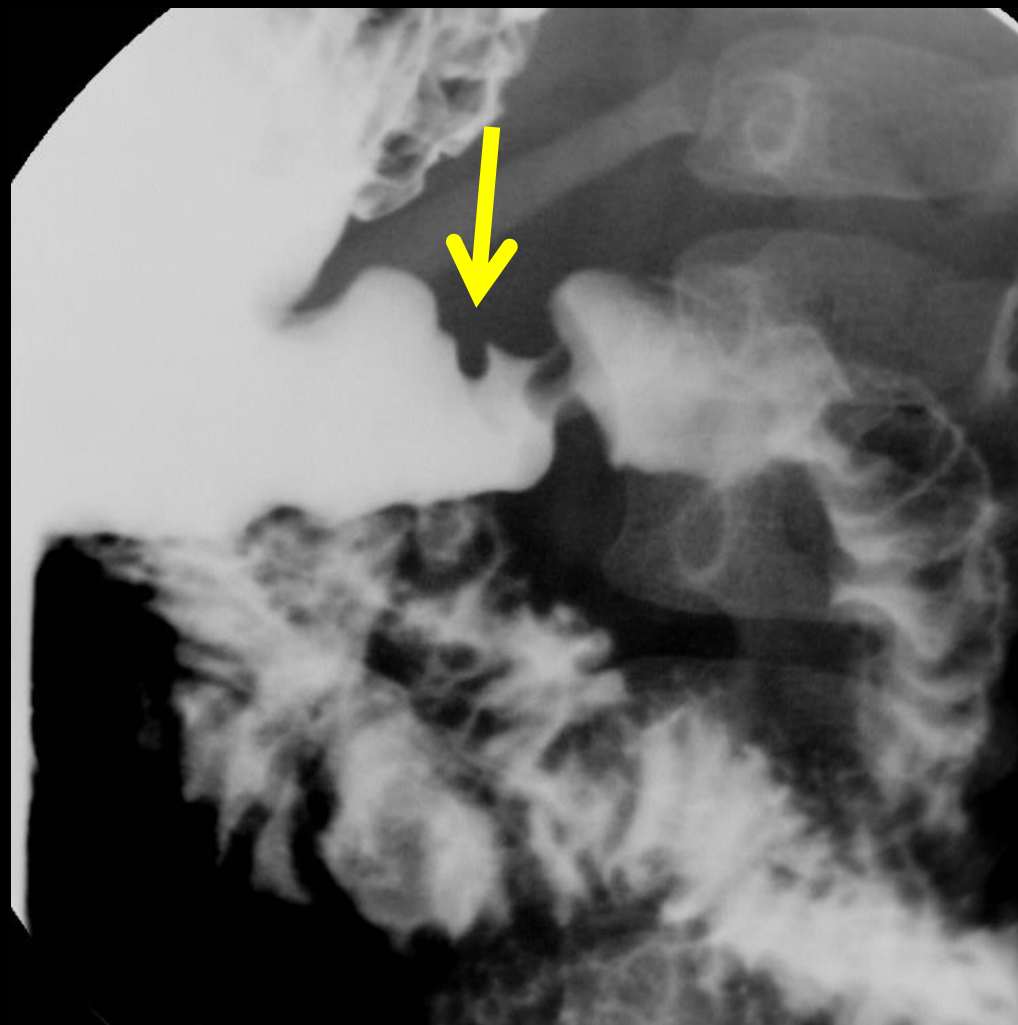
RAO Open Up Antrum-Pylorus-Bulb



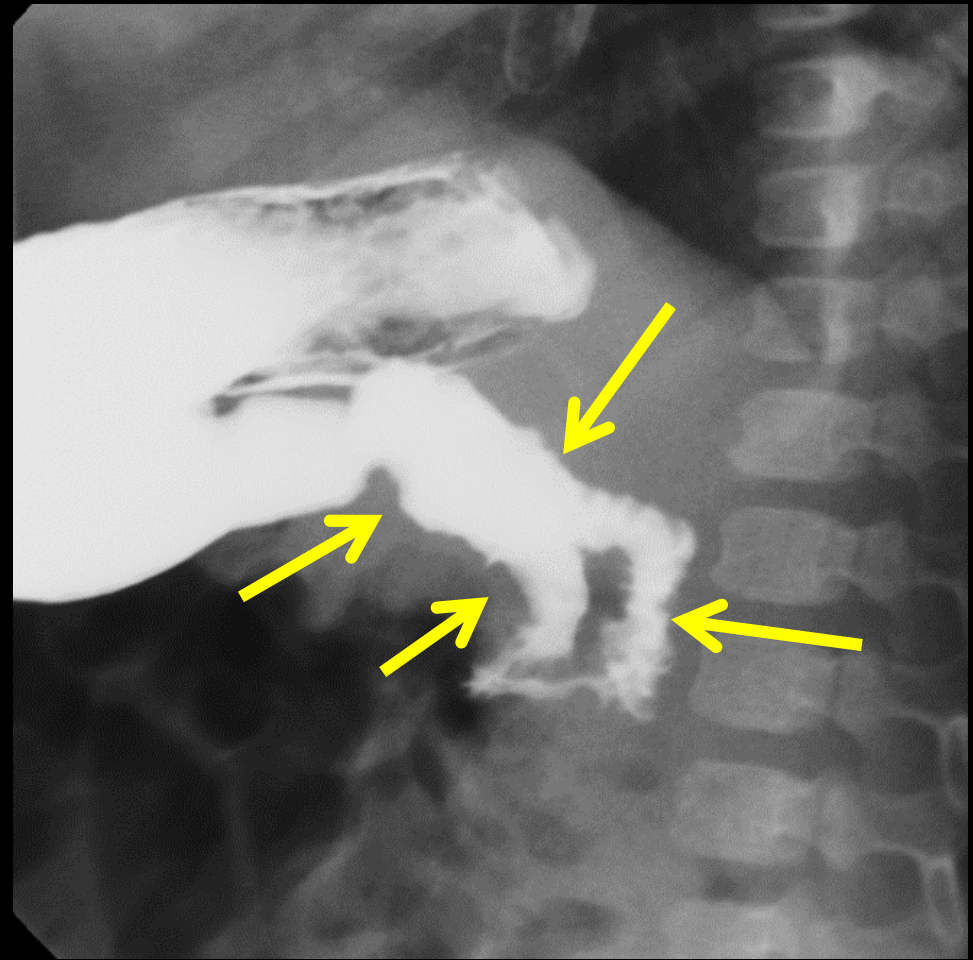
Lateral vs RAO



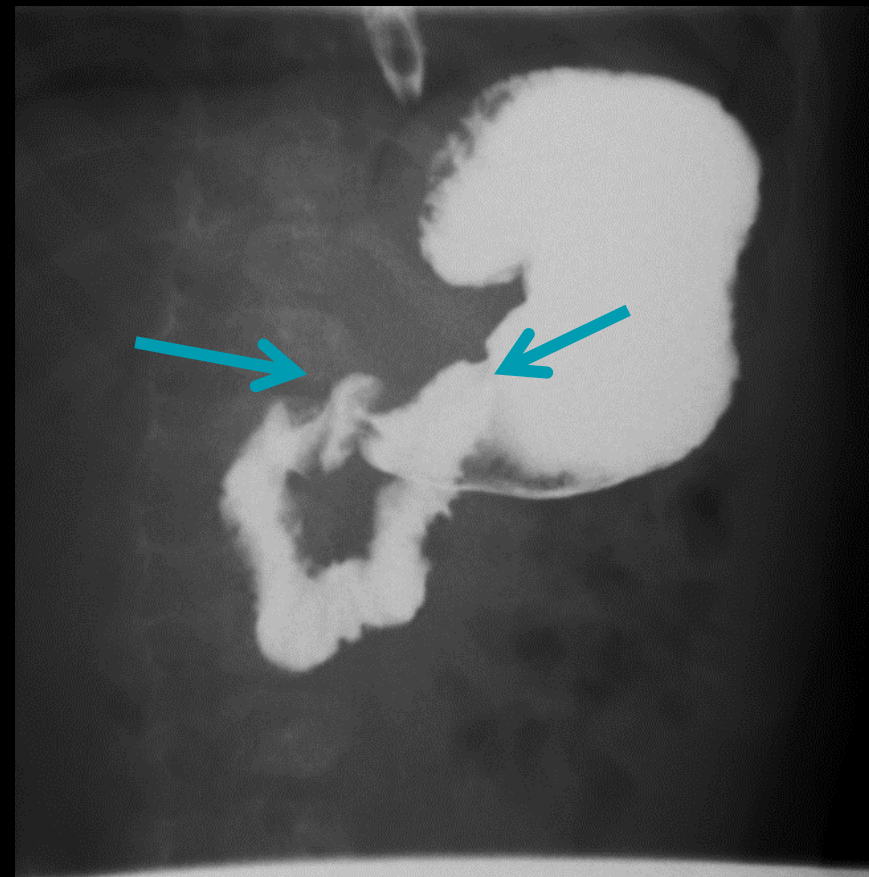
Rare Antral Abnormality - Web



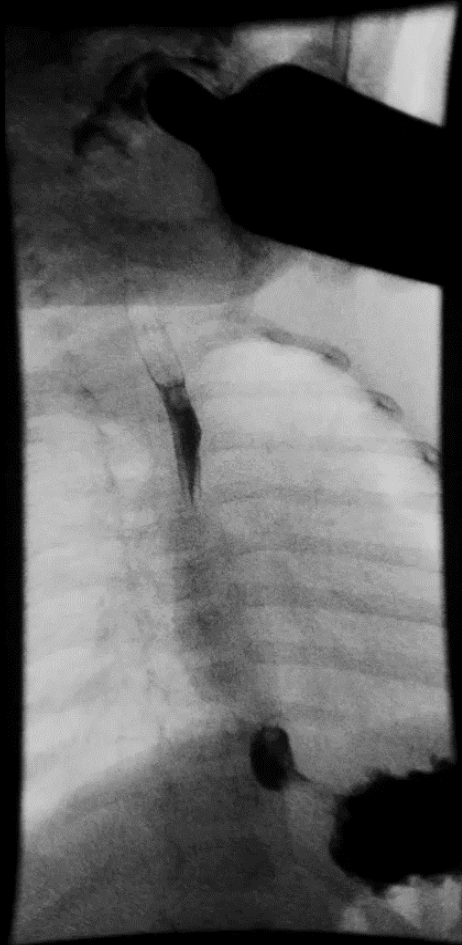
FIRST Lateral Pass Thru Duodenum



LPO DJJ Over Bulb



Clips of Esophagus and Duodenum

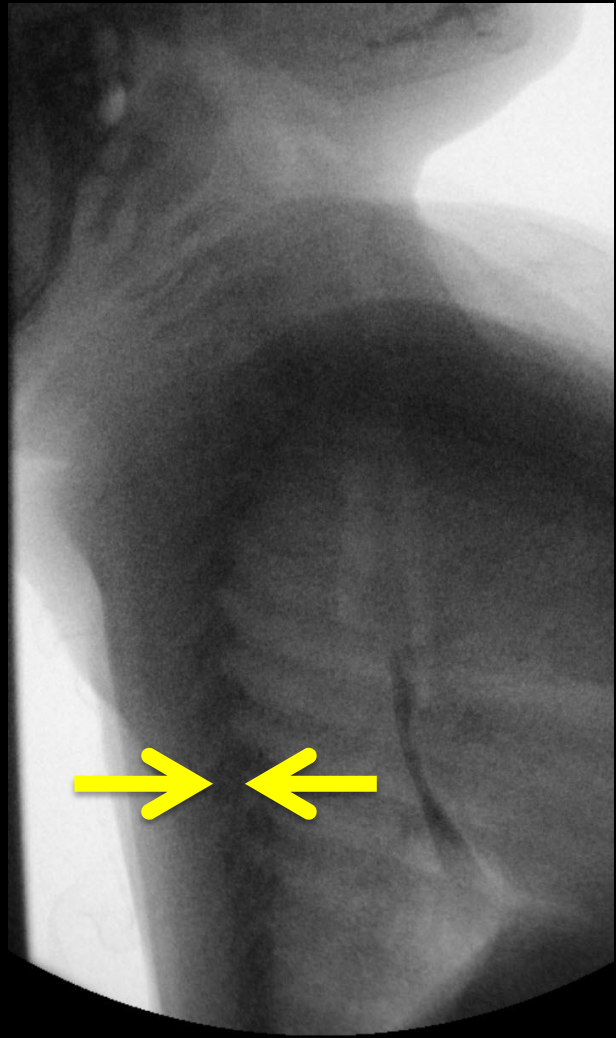
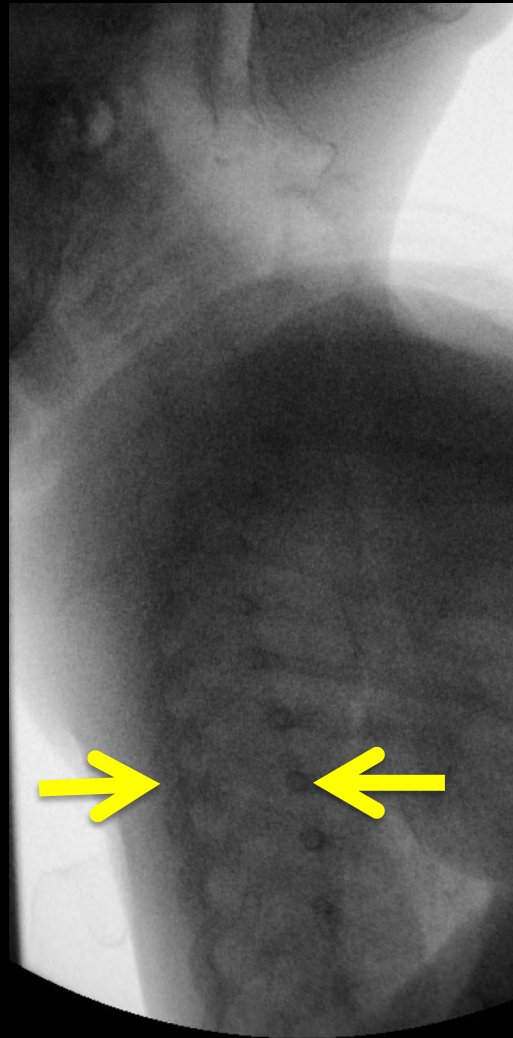


More Tips and Tricks: D_x UGI

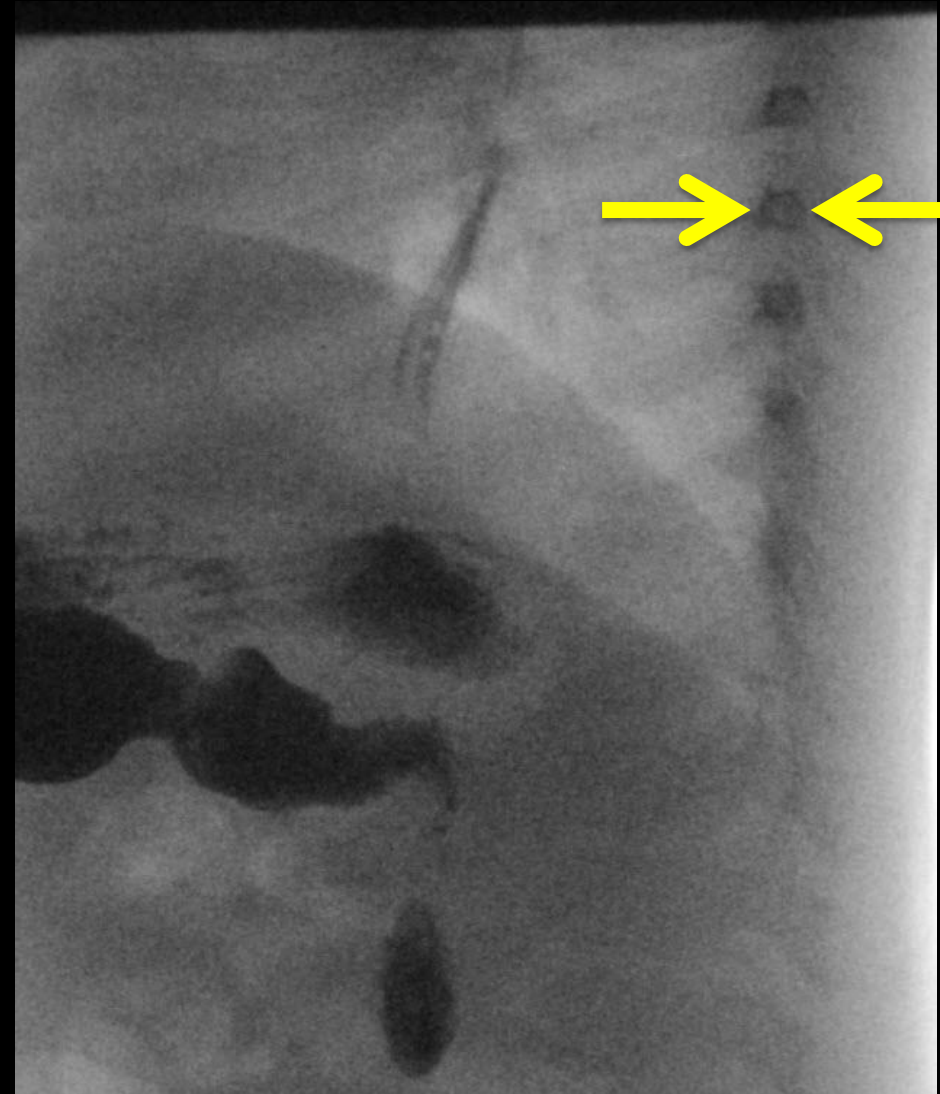
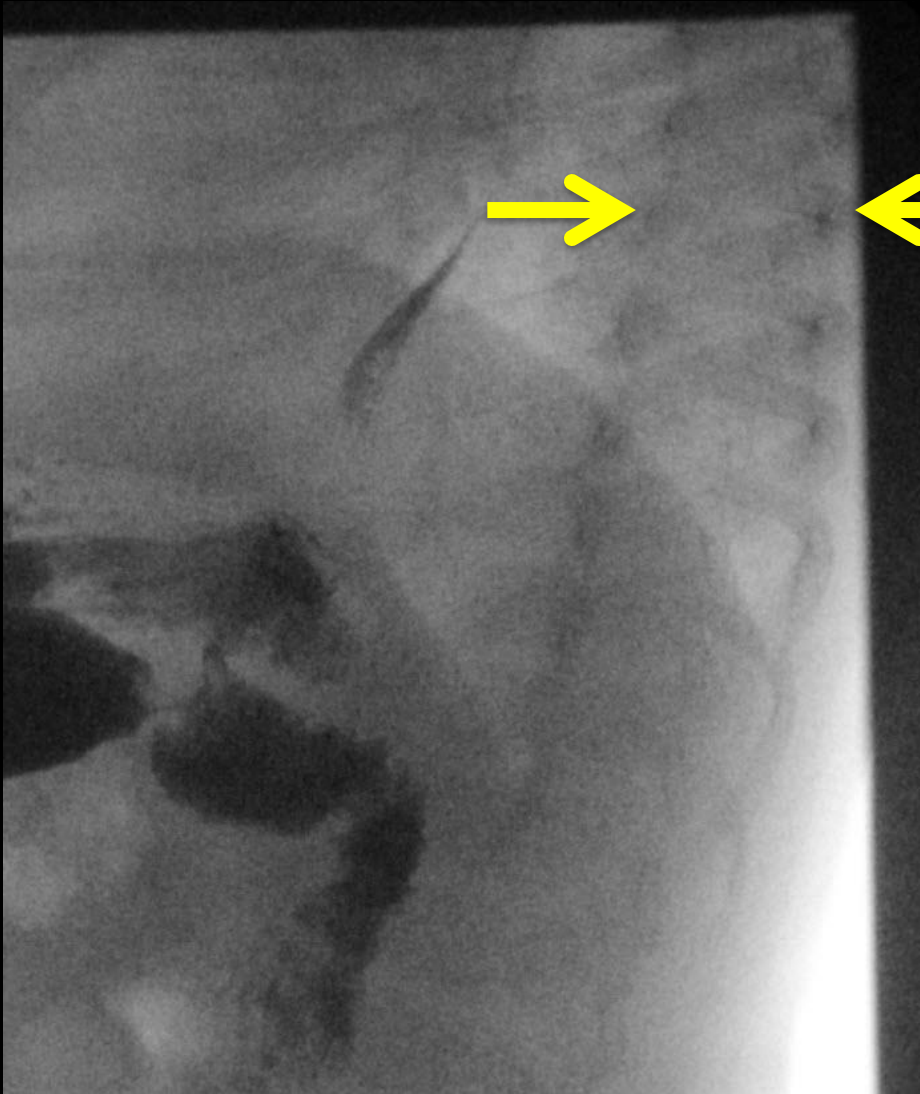
- Knowing you're truly lateral
- Knowing you're truly AP
- Knowing you are RAO



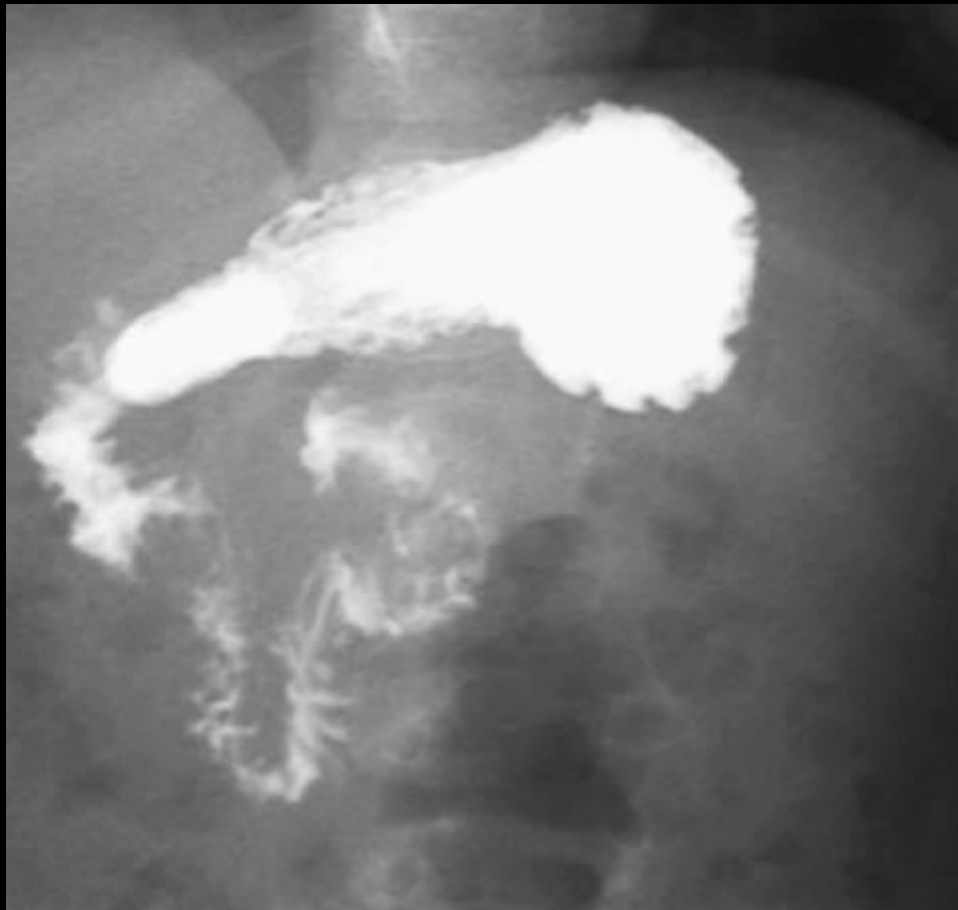
Knowing You're Truly Lateral - Esophagus



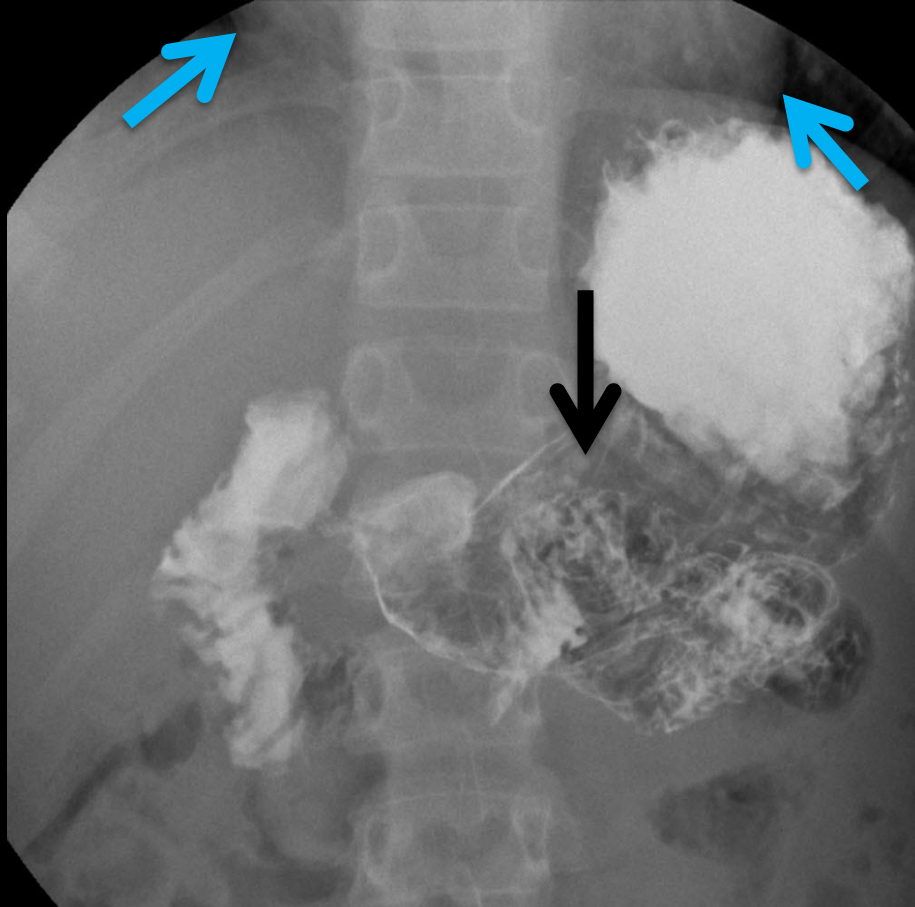
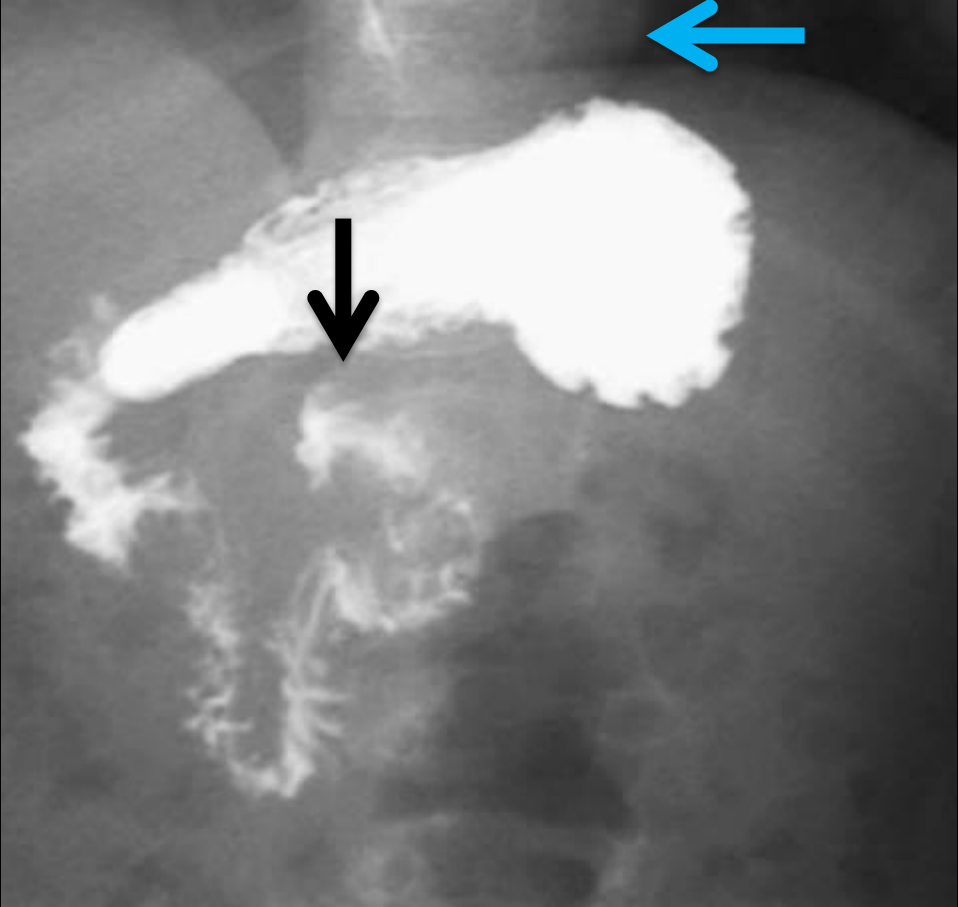
Knowing You're Truly Lateral - Duodenum



Knowing You're Truly AP - DJJ

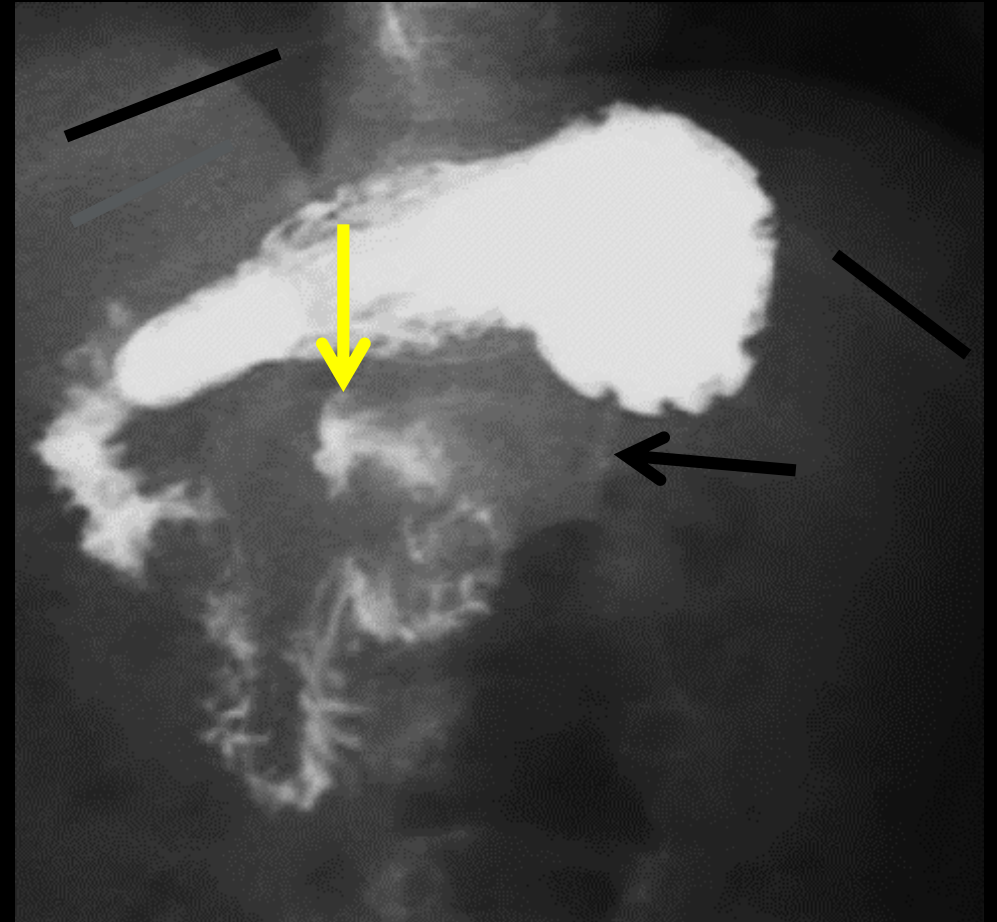


Base of the Heart



Vertebral Pedicles and Ribs

- Ribs not symmetric
- Pedicles not symmetric
- DJJ appears abnormal



Why Positioning So Important

- Biggest pitfalls:
 - Rotation on frontal - Call malrotated
 - Published articles succumb
 - No Lateral entire duodenum
 - Is duodenum retroperitoneal?
 - No RAO - miss antral web due to overlap



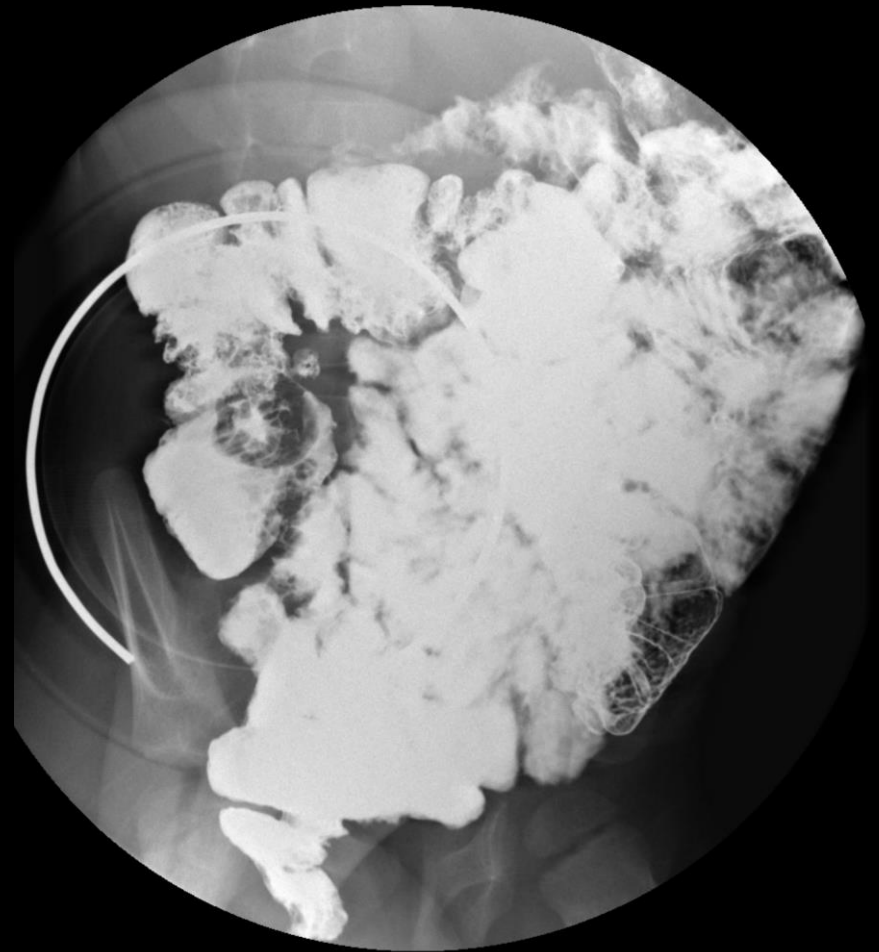
Small Bowel Follow-Through

- Equivocal Malrotation on UGI
 - Evaluate cecal position follow through
- Inflammatory bowel disease
 - Alternate supine and prone overheads
- Small bowel obstruction – post NEC ? Stricture
 - Follow till small bowel evacuated



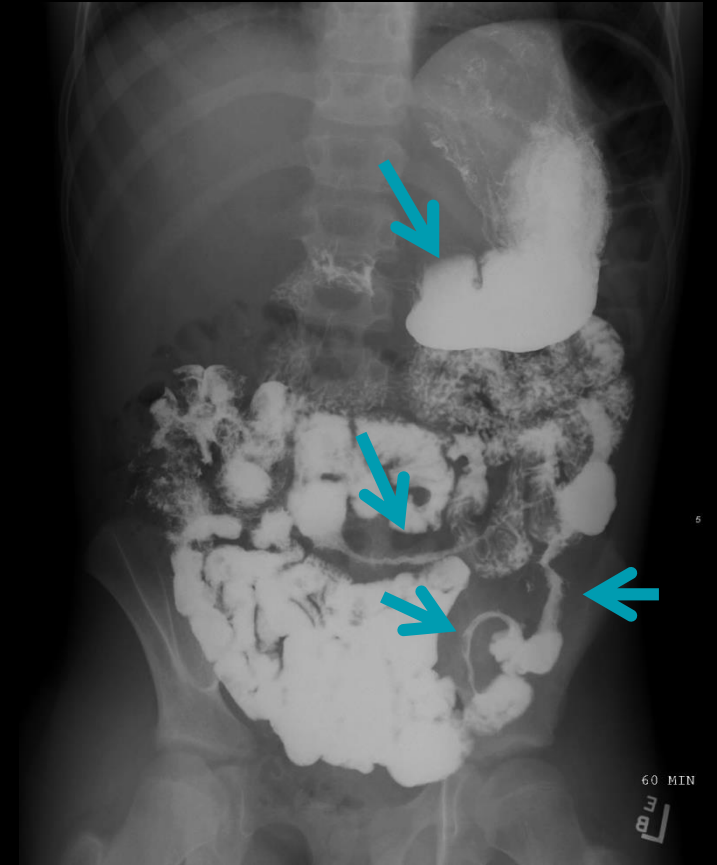
Cecal Position

- Get delayed images
- More delayed the better
- Shouldn't equivocate
- Spot views can help
- Rotate sl left of AP



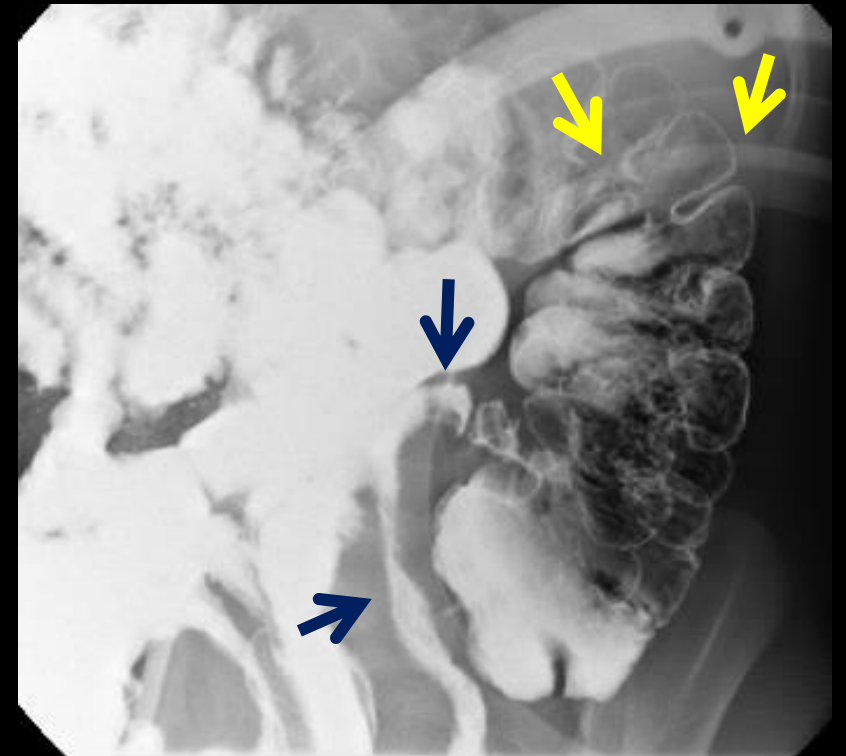
Small Bowel Follow-Through

- Keep stomach filled
 - SB completely filled
 - Compare regions of SB
 - Abnormal areas stick out
- Alternate supine & prone KUB
 - Self compression on prone



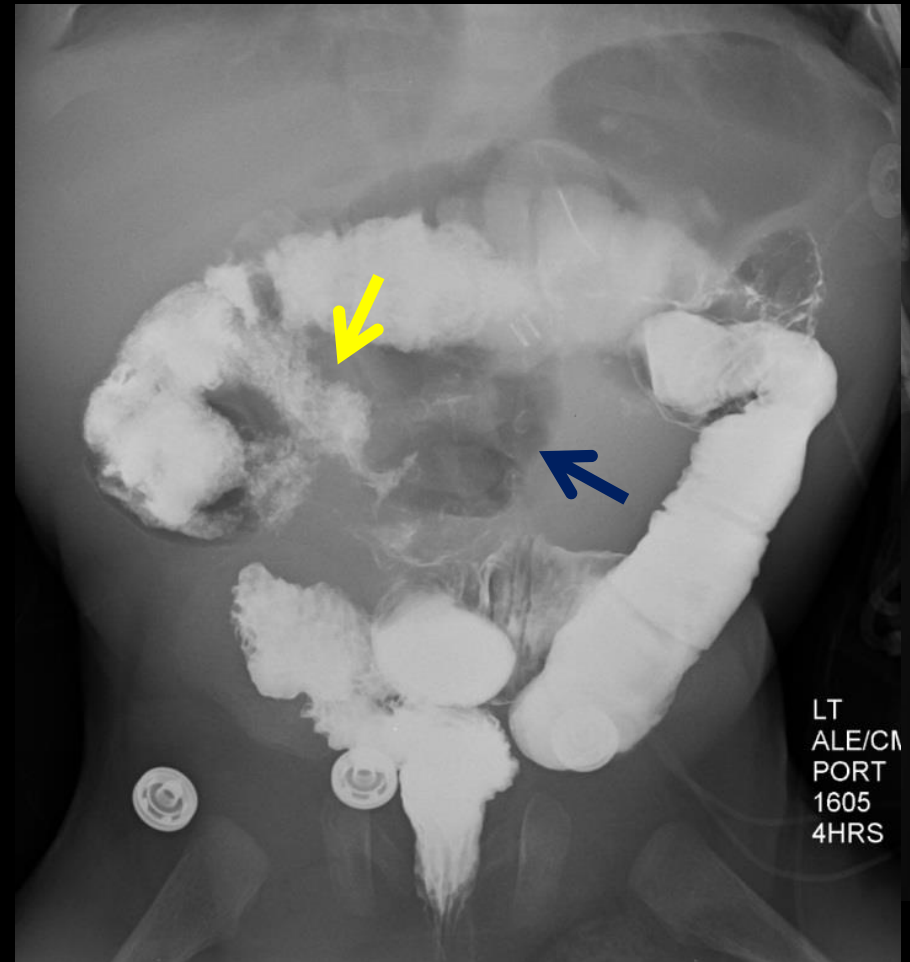
Spot Images TI and Cecum

- Spot images
 - Abnormal areas on overhead KUBs
 - Terminal Ileum
 - Location cecum in equivocal DJJ
 - LPO, prone & lay on balloon



Small Bowel Follow-Through

- Obstruction
 - Fill till obstruction or TI
 - Follow till contrast evacuated from SB
 - Partially obstructed Dilated loops with residual contrast



Tips and Tricks: Contrast Enema

- Contrast selection
- Enema tip selection
- Positioning
- Control the flow
- Foley balloon positioning
- When to reflux into TI

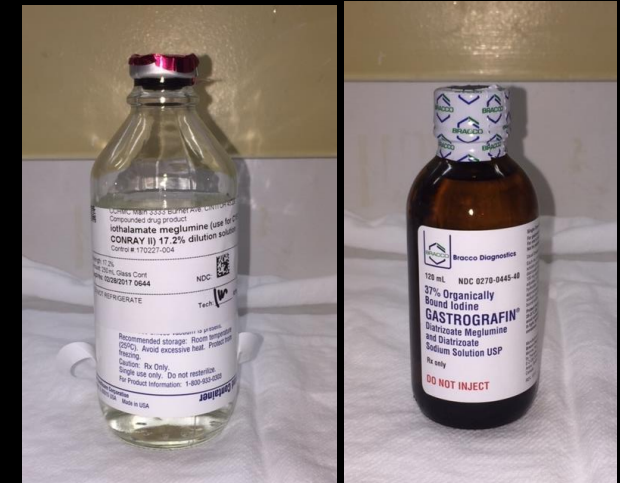


Tips on Contrast Agents

- **Rectal Contrasts**

- **Water Soluble (OFF LABEL)**

- Ionic (Iothalamate Meglumine) Cysto-Conray II
 - Constipation
 - Evaluate for Hirschsprung
 - Ionic (Diatrizoate Meglumine) Gastrografin
 - Treatment for Meconium Ileus
 - Constipation Bowel Mgt pts (potty trained)
 - Nonionic, Isosmotic (Iodixanol) Visipaque
 - Premature Infants
 - » Evaluate for post-NEC stricture
 - » Postop-evaluate for leak



Enema Tip Selection

Green	Blue	Pink	Foley
Preemie	5 months – 2 years	3+ years	0-5 months (balloon out/in)
	Eval for Hirschsprung's Disease	Eval for Hirschsprung's Disease Bowel Mgt Eval	Neurogenic bowel Bowel Mgt
			Anorectal malformation



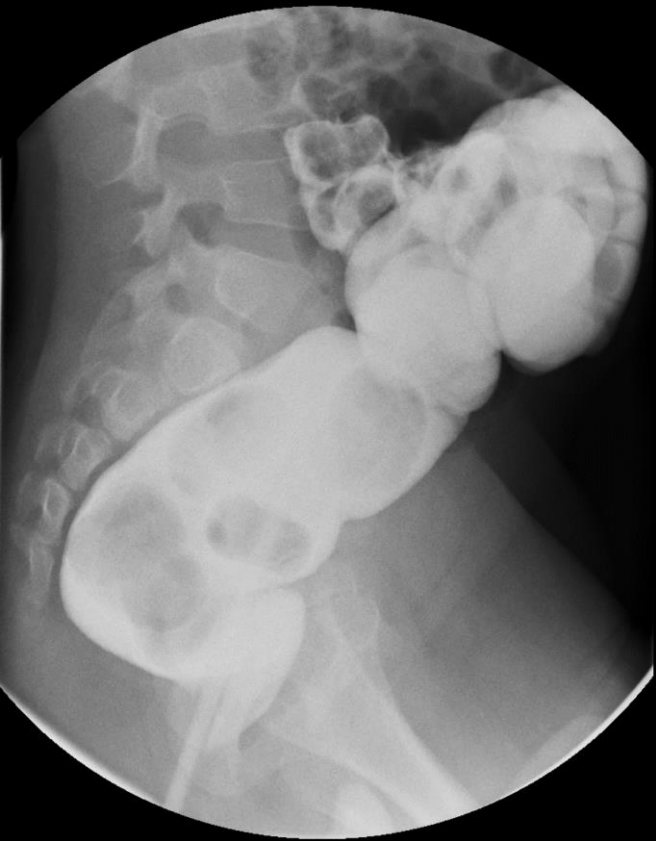
Positioning

- Important images:
 - Lateral/AP recto-sigmoid as far to splenic flexure
 - Contrast flowing when taking images!
 - Turn off when turning patient
 - AP Full colon in constipation/BM cases
 - Post-evac diaper or bathroom (not routine drain)
 - Drain if small pt and no spont evac
 - To avoid fluid shift induced dehydration/vomiting



Contrast enema - Positioning

Lateral



AP



Full

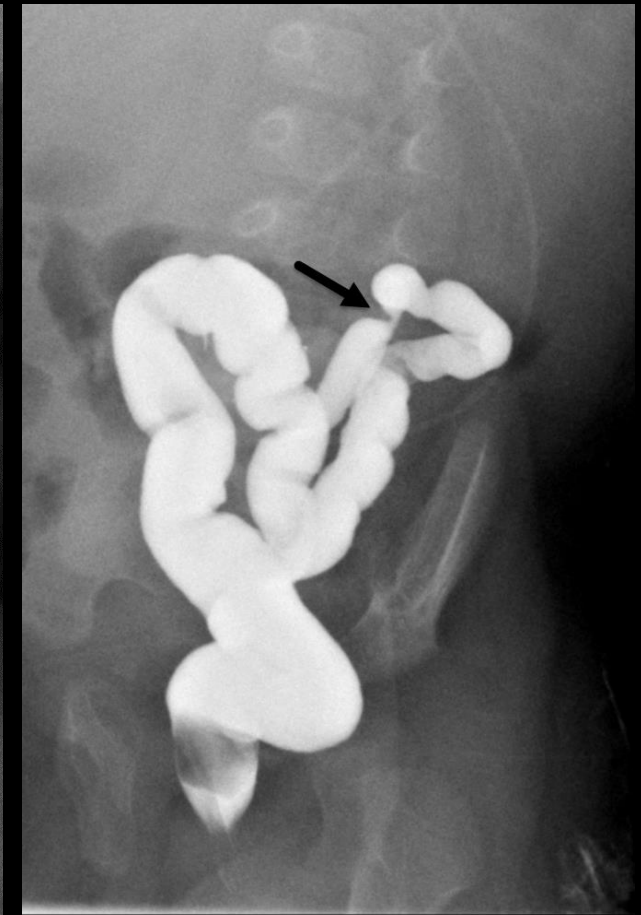
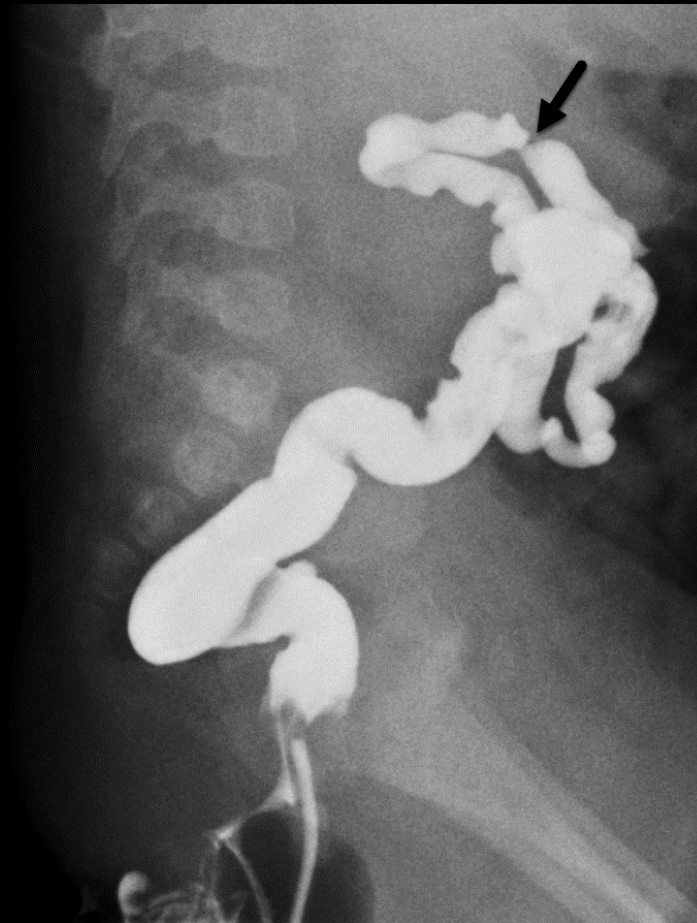


Post-Evac



Contrast Enema - Positioning

- Premature
- Post-NEC
- ? Stricture
- Balloon inflate w fluoro
- 50 mL syringe
- Iodixanol

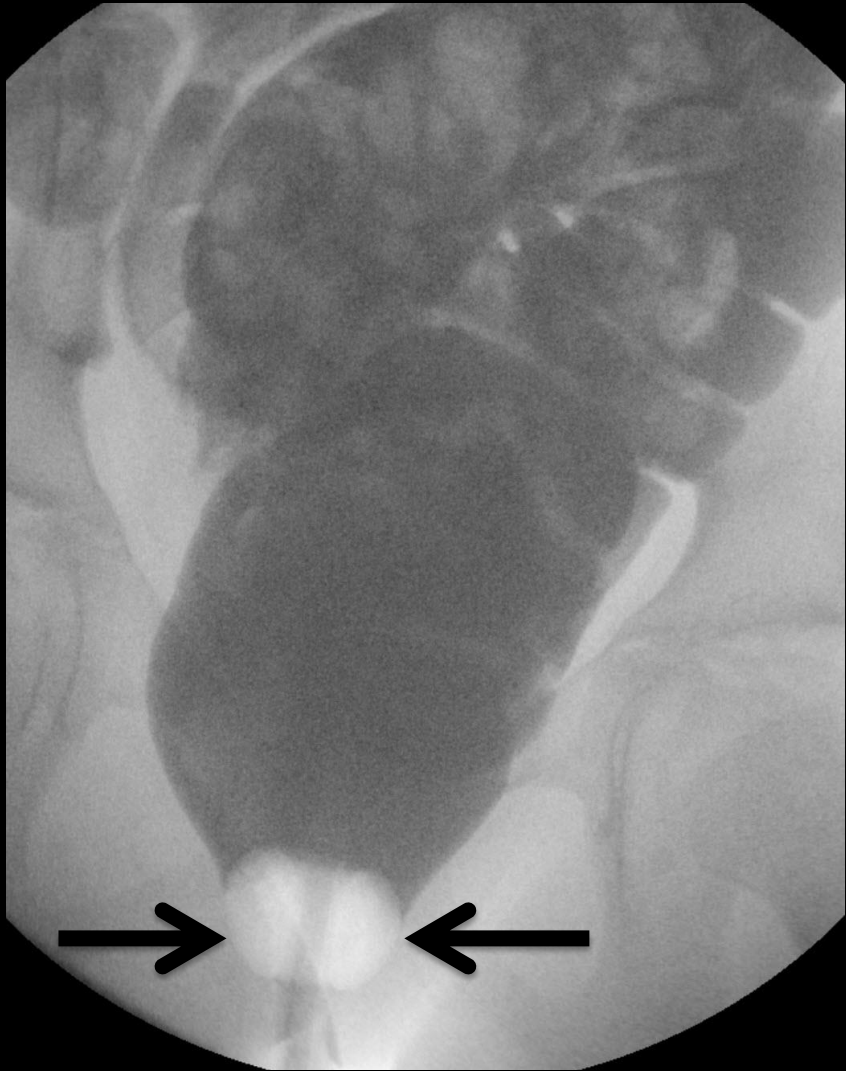


Control flow

- Flowing when taking Images
- Turn off when repositioning patient
- In neonates for bowel obstruction
 - If make Dx Hirschsprung's, STOP
 - If microcolon, Reflux TI to further eval
- Constipation w/u – Fill colon, no TI reflux

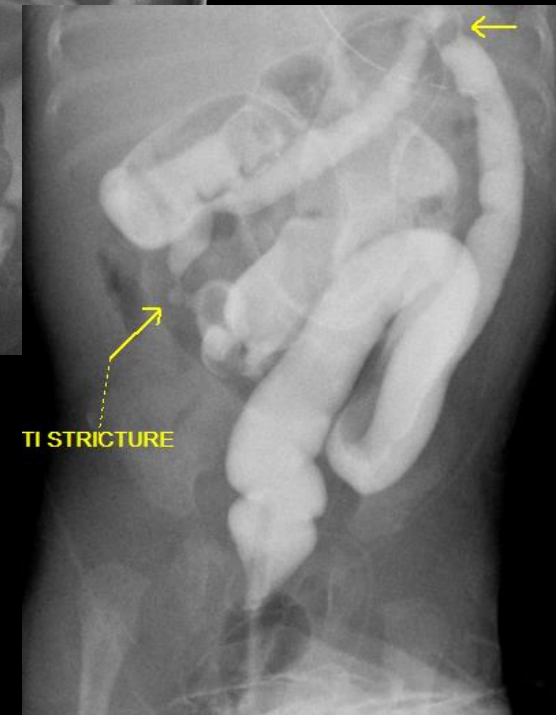
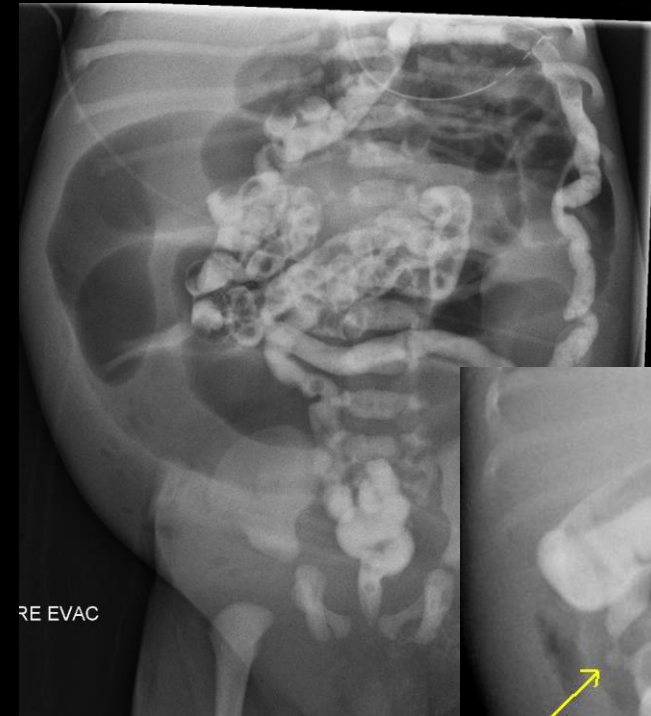


Foley Balloon Positioning



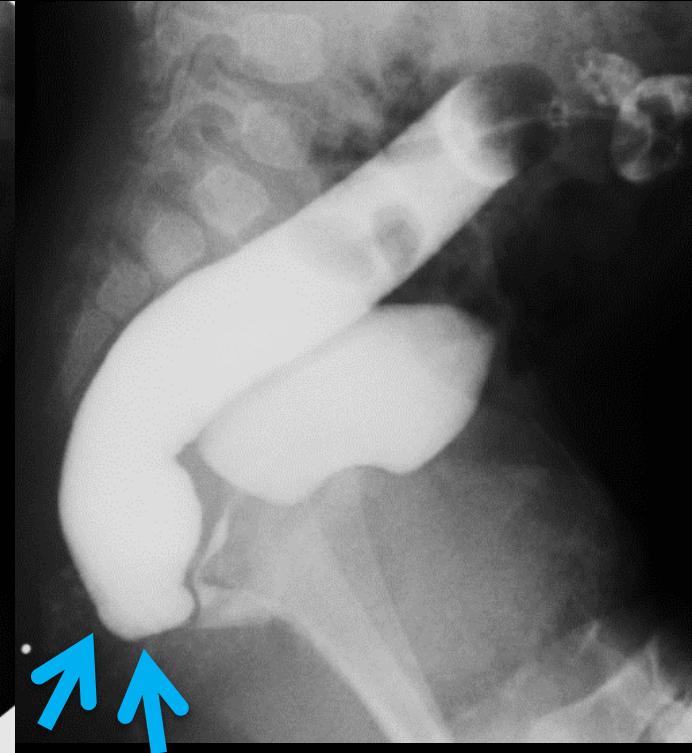
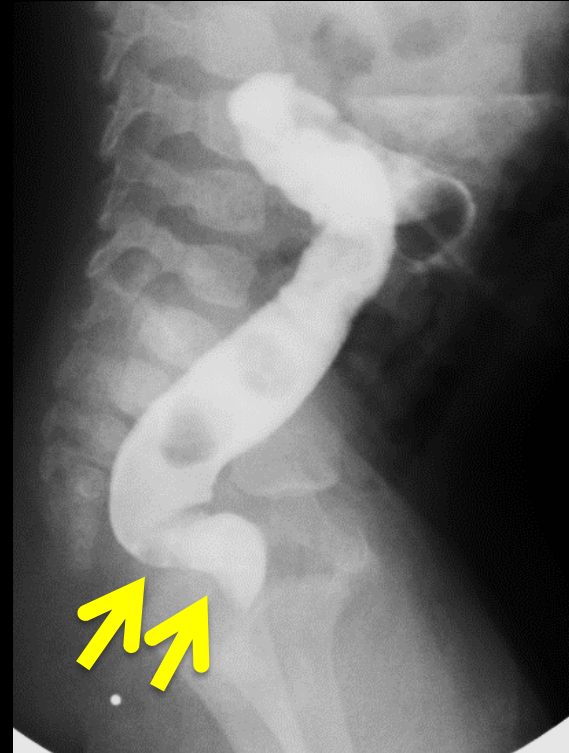
When to Reflux into TI

- Entire colon small in NB
 - MI vs atresia vs Total colonic HD
- NL CE in W/U for SBO
 - Premie with h/o NEC
 - Post-op SBO



High Pressure Distal Colostograms

- Foley catheter inside MF
- Balloon \leq size of bowel
- Pressure to distend rectum
 - Flat rectum – not enough
 - Round rectum - adequate



Tips and Tricks: VCUG

- Review R & B US
- Catheter insertion
- Cyclic studies
- Estimating bladder volume
- Oblique images
- Grading VUR
- Thick bladder wall



Review Renal & Bladder US

- Bladder
 - Ureterocele, stone, thick?
- Kidney
 - Pelvocaliectasis, hydroureter, stone, urothelial thickening, duplication suggested?



Catheter Insertion

- Infants and older = 8 Fr, newborns = 5 Fr
- Lidocaine for boys ≥ 4 years old
- “Down Angle” in ♀
- Gentle forward pressure at sphincter in ♂
- If cath in vagina, leave in and place another



Cyclic Study

- ≥ 2 cycles of filling and voiding
 - Age < 1 year old
 - Febrile UTI (presumed pyelonephritis)
 - US showing dilated IRCS and/or ureter
 - Marked discrepancy in renal size ? scarring
 - VUR on prior study (15% more VUR)



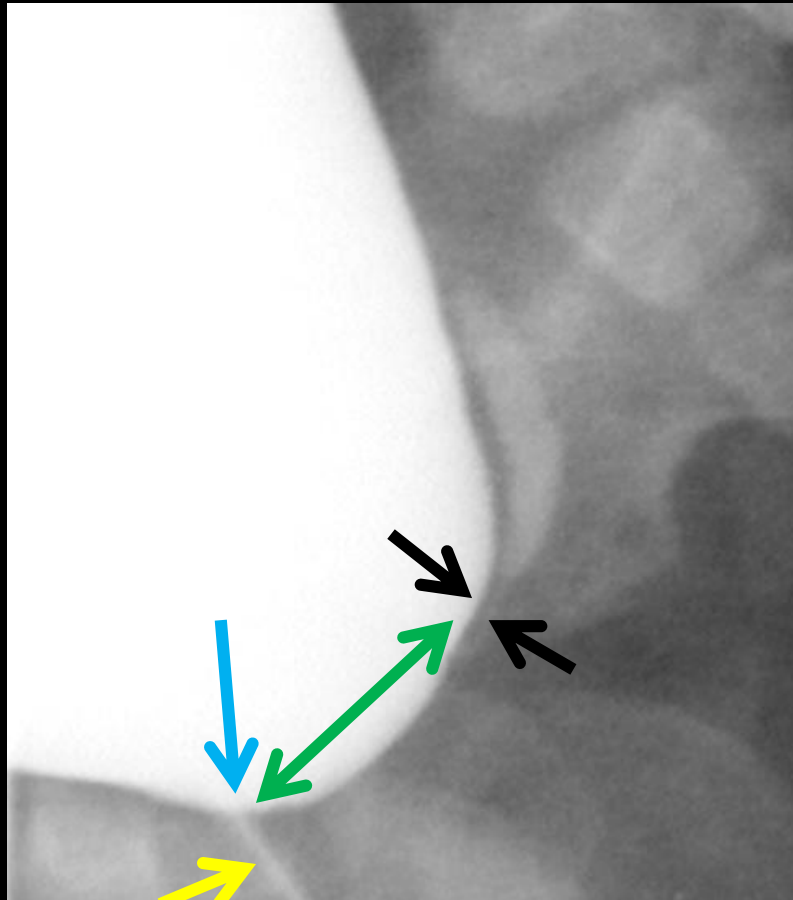
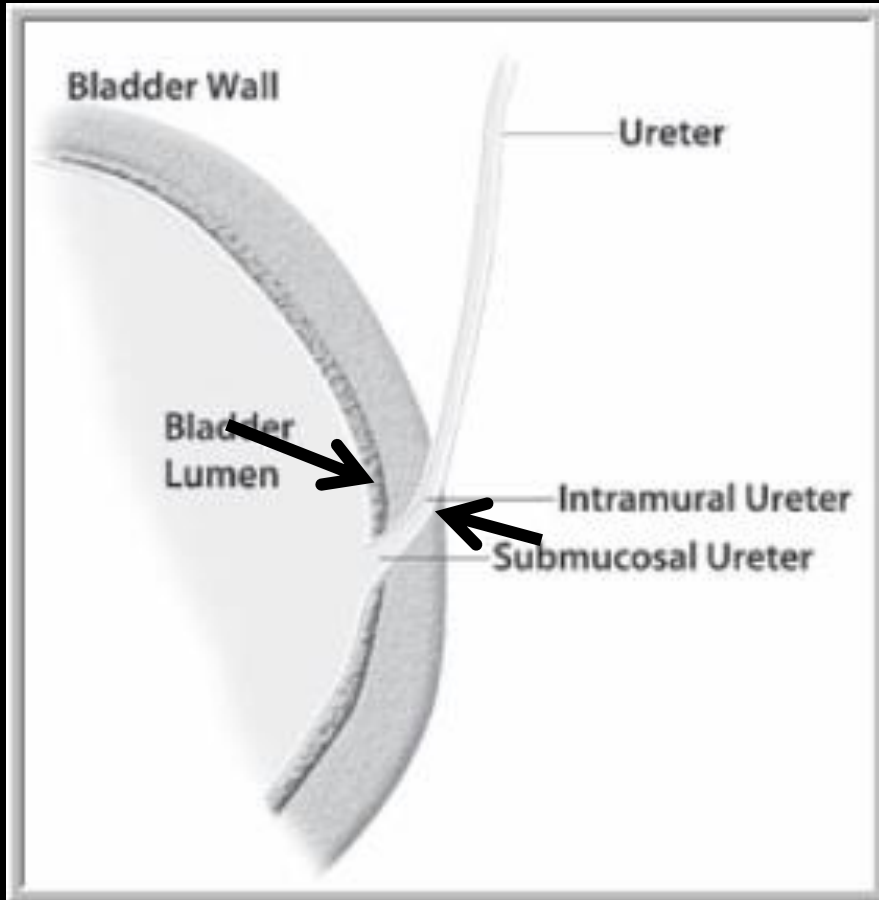
Bladder Volume

- Child < 1 y.o.: weight (in kg) x 7 = ___ mL
- Child > 1 y.o.: (Age + 2) x 30 = ___ mL
- Max limit = 2x calculated volume

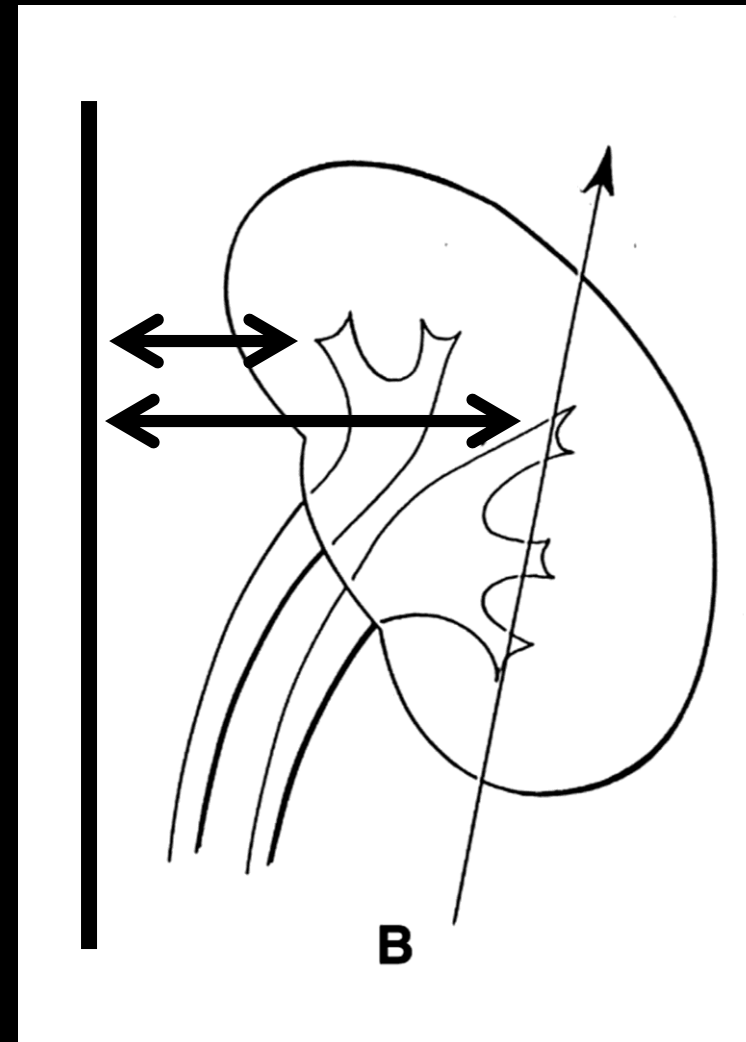
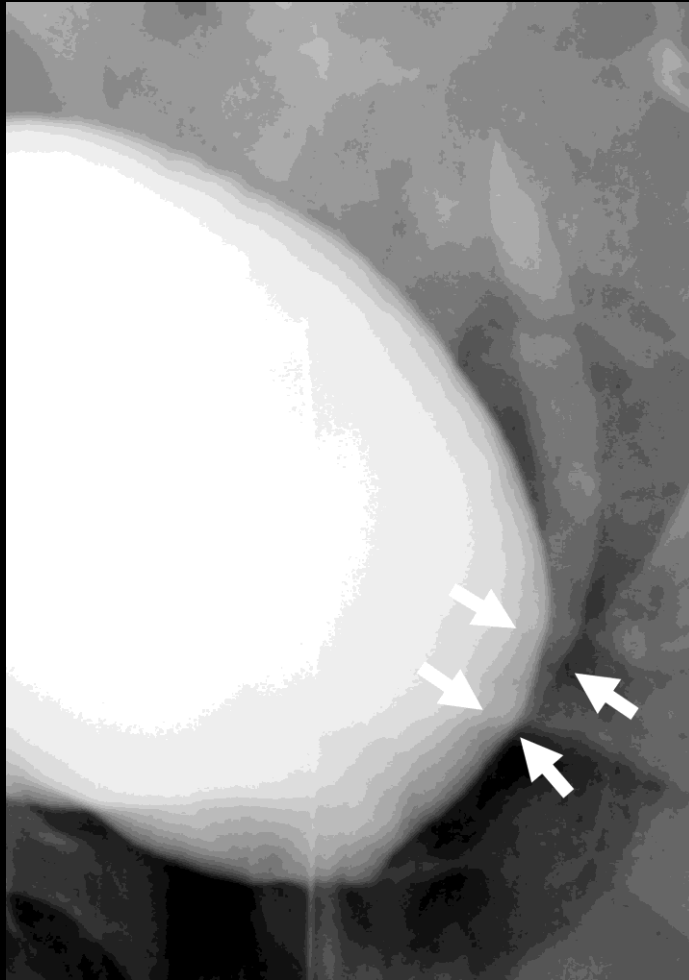
> 2x bladder volume
associated increased
risk urinary retention



Oblique Images



VCUG – Importance of Correct Oblique Views



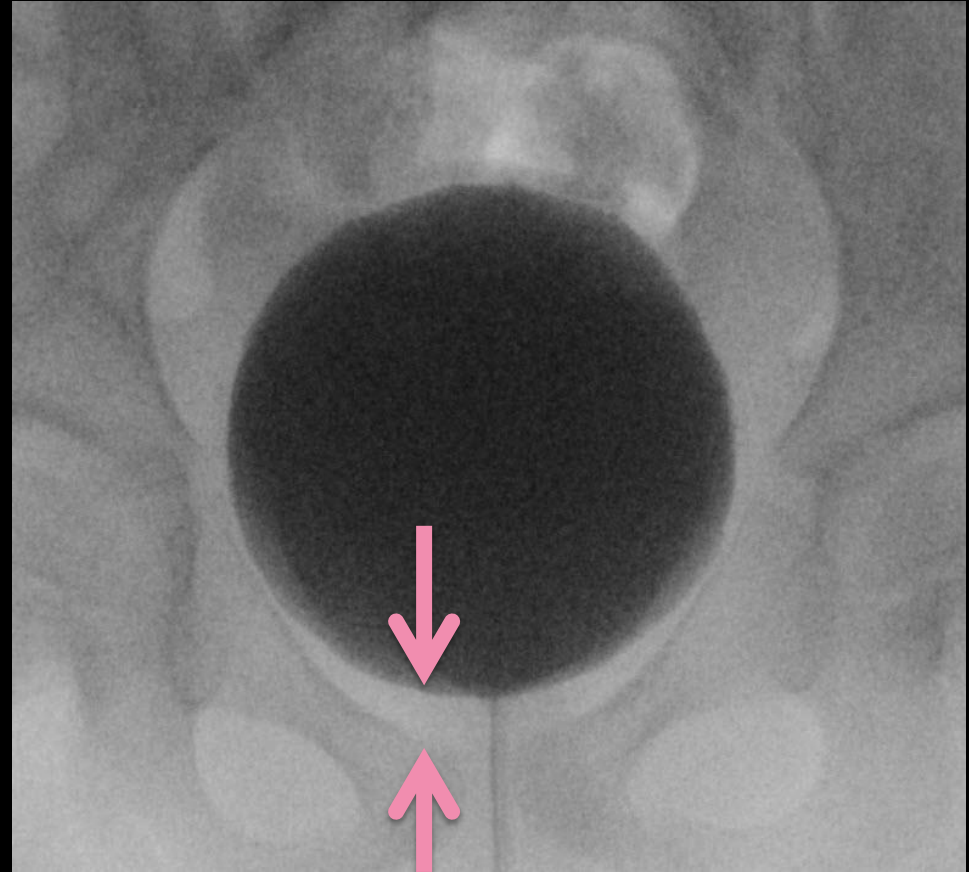
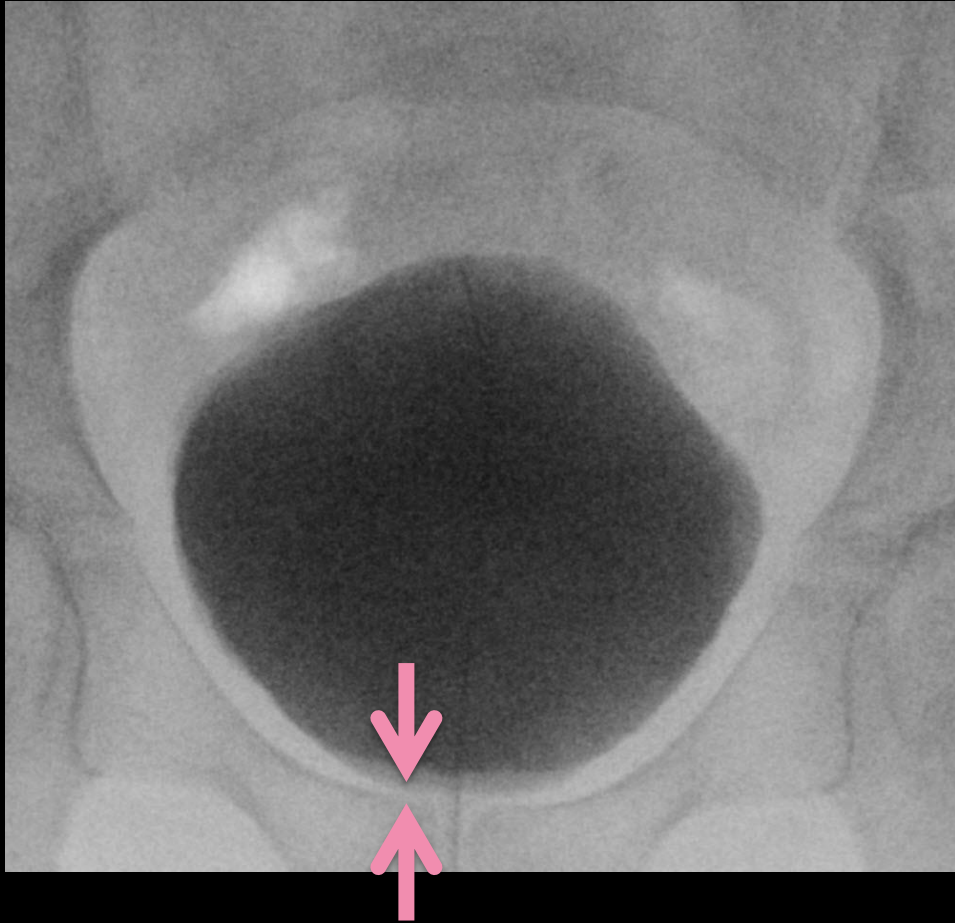
Grading VUR

- Grade 1: ureter only
- Grade 2: renal pelvis
- Grade 3: renal pelvis, mild dilatation
- Grade 4: tortuous ureter
- Grade 5: tortuous ureter, severe dilatation

- IRR is added descriptor to any grade



Thickened Wall



Tips on checking G-Tube placement

- Positioning
- Contrast outline balloon IN stomach
- What if contrast only in duodenum?

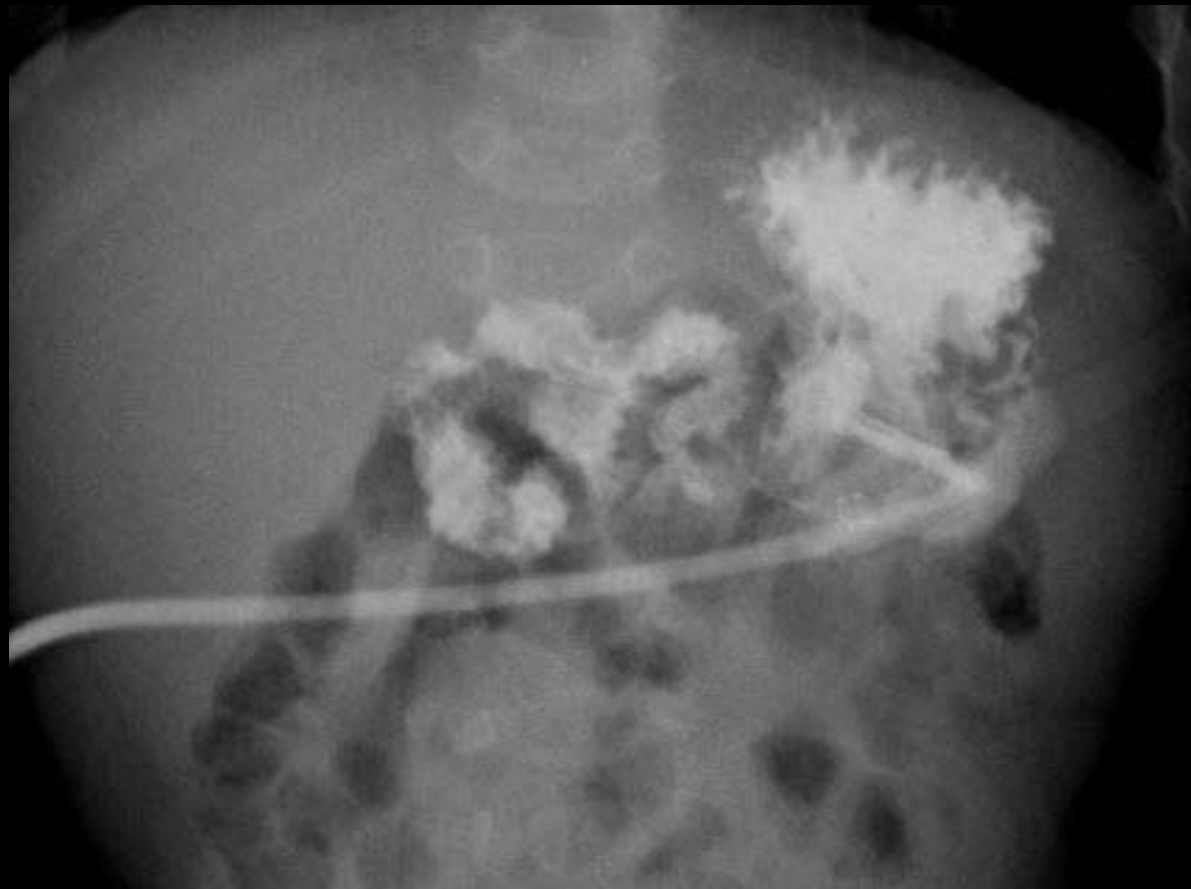


Positioning for G tube check

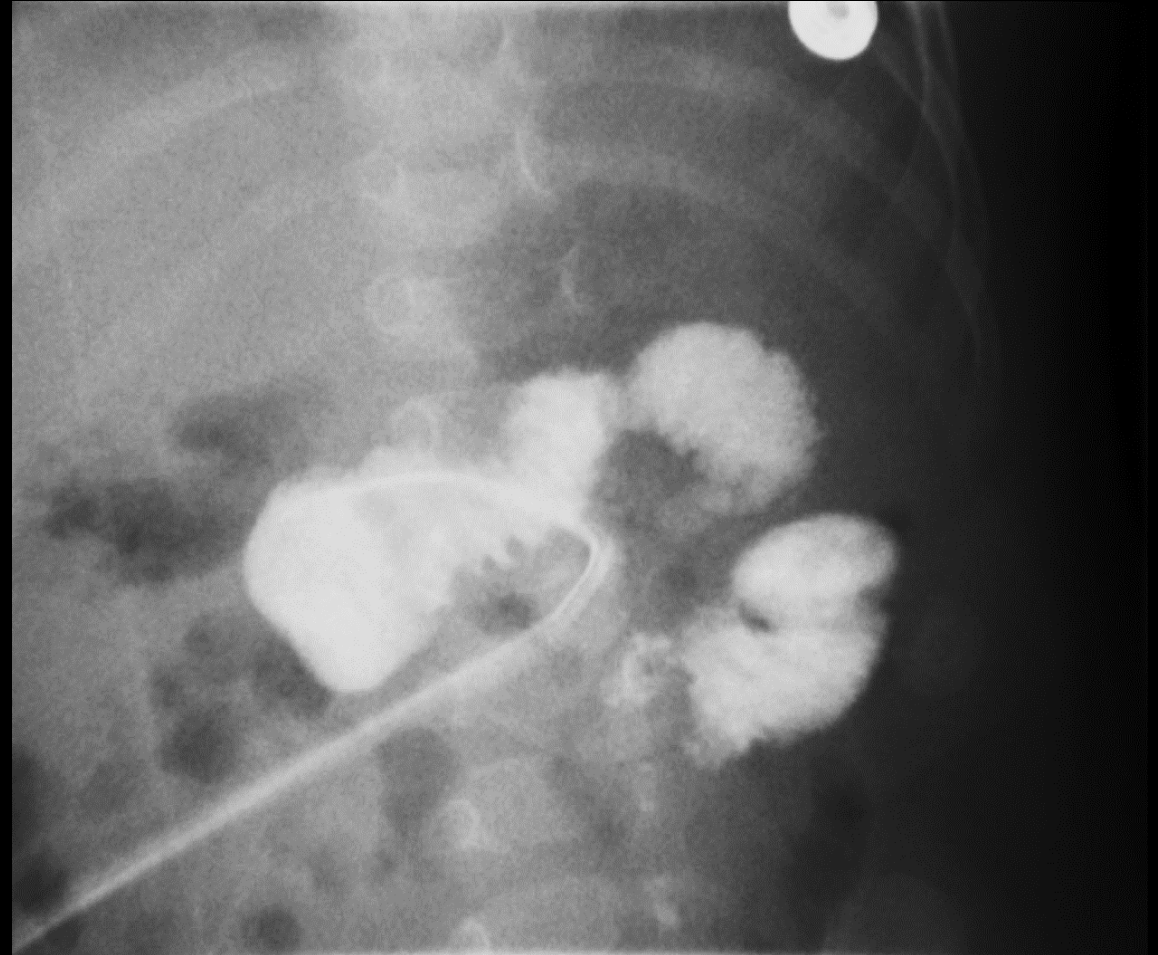
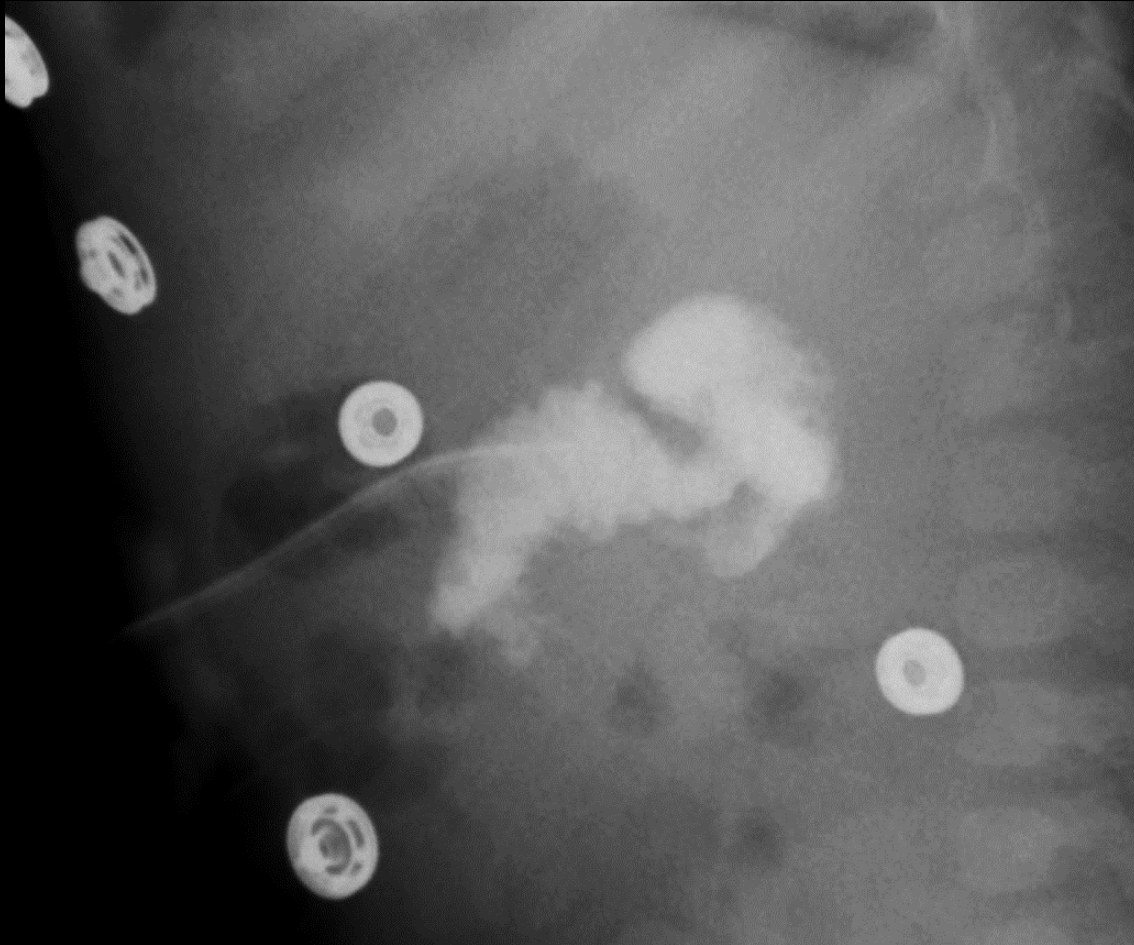
- 2 images
 - \approx R decub positioning
 - Tube parallel to table
 - Supine



Images - Normal



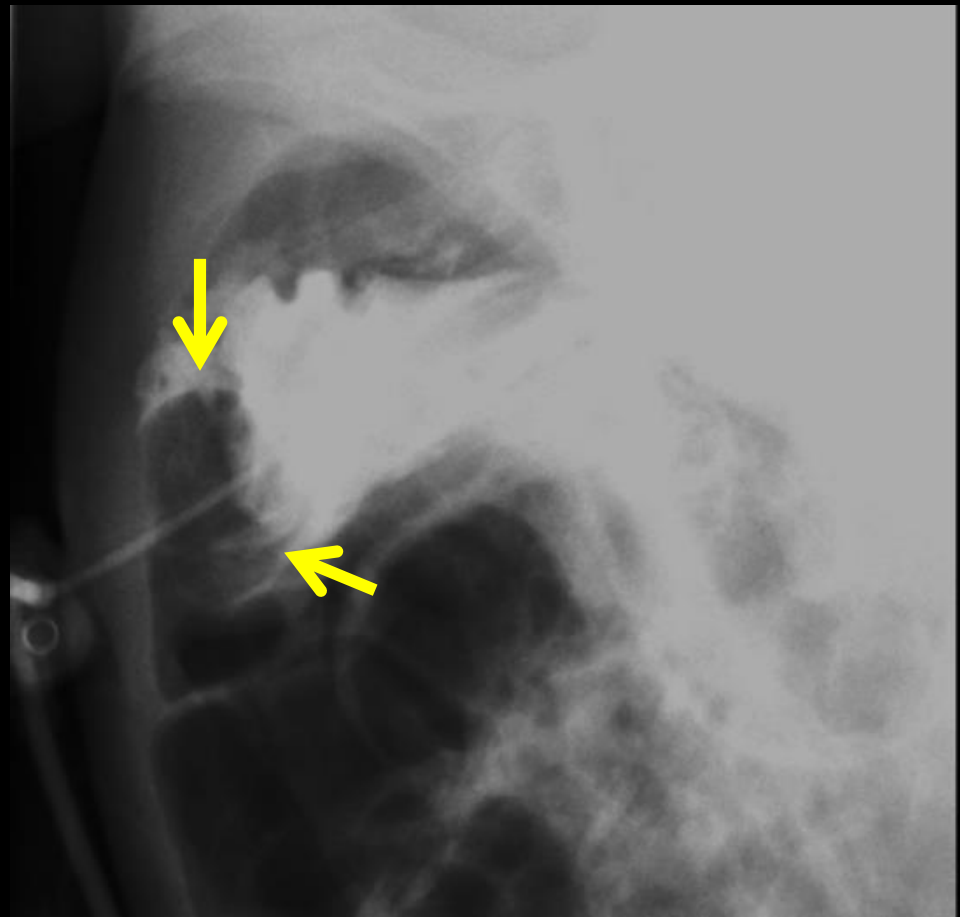
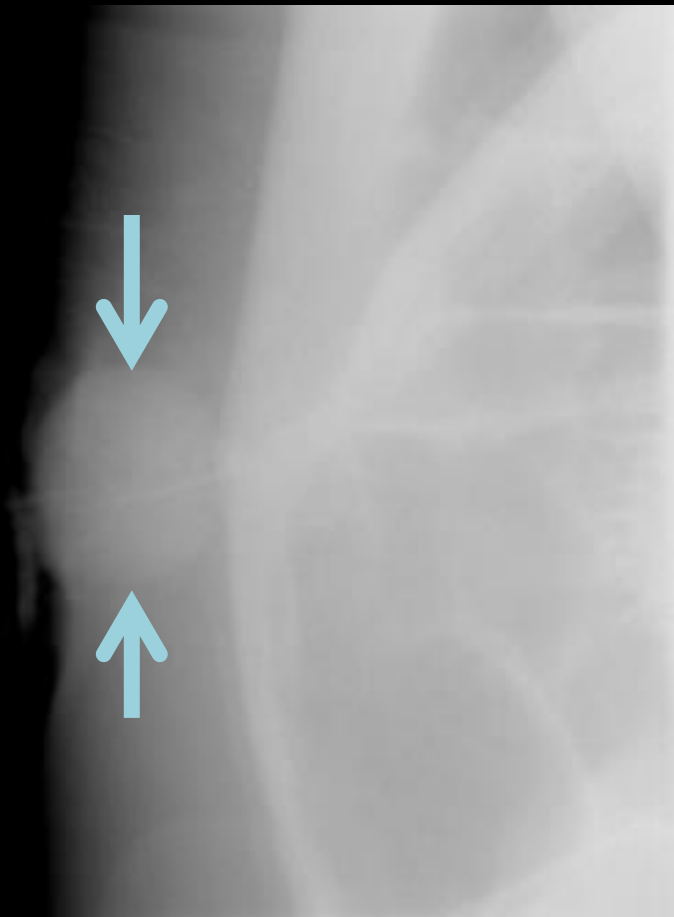
What about this G Tube?



Balloon in Pylorus or duodenal bulb



And This One?



Balloon in Stoma Tract



Tips on checking GJ-Tube Malfunction

- Possible malfunctions
 - Clogged
 - Fell out
 - Broken
 - Leaking from stoma
 - Formula is draining from G-port

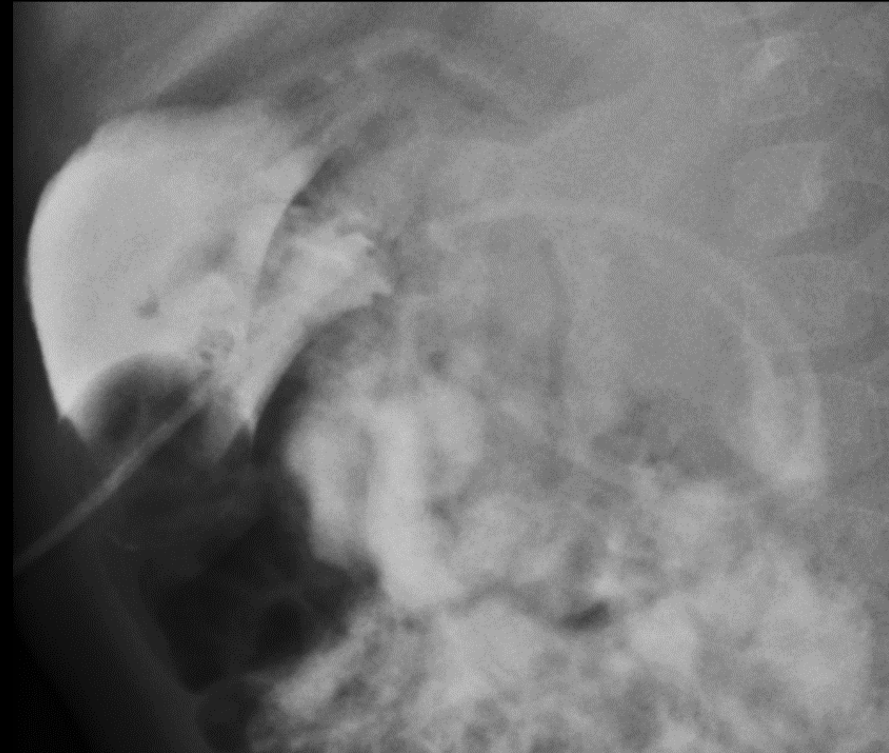
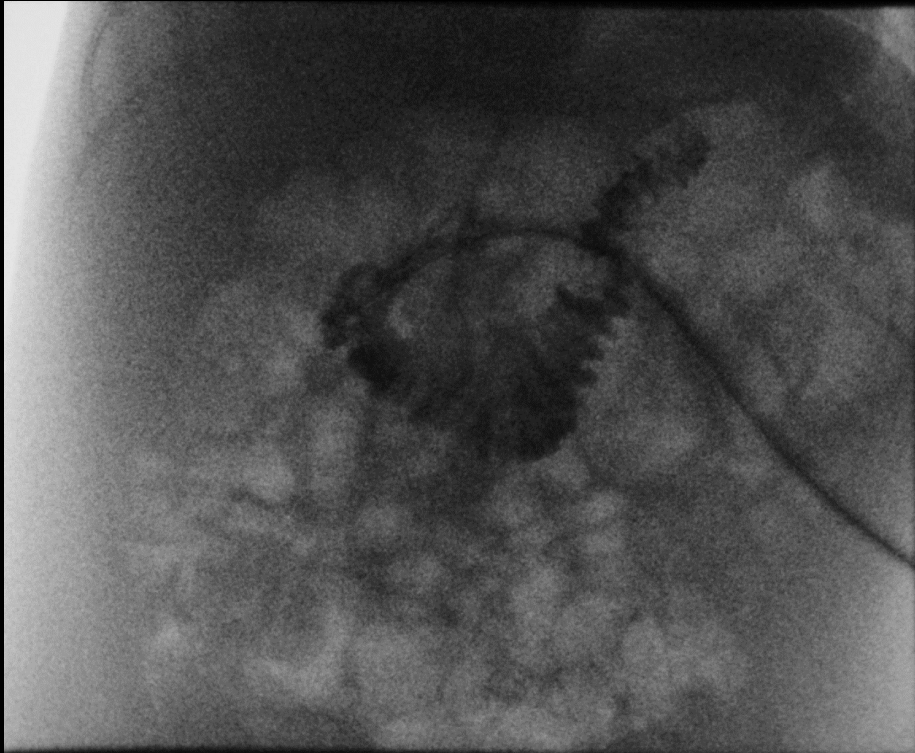


Tips on checking GJ-Tube Malfunction

- Possible malfunctions
 - Clogged
 - Fell out
 - Broken
 - Leaking from stoma
 - Formula is draining from G-port



Fell Out and Replaced



GJ Advanced Too Much, Balloon in Duodenum

Formula is draining from G-port

- Possible etiologies
 - J port migrated into stomach
 - Communication J to G (???)
- What do you do? Inject J port



J Port Injection



Hole between J port and G port

Tips and Tricks Topics

- Child Life
- Contrast Agents
- Radiation Safety (Low Dose Fluoroscopy)
- Procedural tips & tricks
 - Videofluoroscopic Swallow Studies (VFSS or VSS)
 - Upper GI (UGI)
 - Small Bowel Follow Through (SBFT)
 - Contrast Enema
 - High Pressure Distal Colostogram (for preop Imperforate Anus)
 - Voiding Cystourethrogram (VCUG)
 - Check G-tube or GJ-tube