General Pediatric Radiology: Abdomen
Pediatric Fluoroscopy: Tips & Tricks
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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

**Can dilute contrast as needed**

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

<table>
<thead>
<tr>
<th>Frames (pulses) per second</th>
<th>Dose</th>
</tr>
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<tbody>
<tr>
<td>30 (continuous)</td>
<td>100%</td>
</tr>
<tr>
<td>20</td>
<td>75%</td>
</tr>
<tr>
<td>15</td>
<td>65%</td>
</tr>
<tr>
<td>8</td>
<td>30%</td>
</tr>
<tr>
<td>4</td>
<td>14%</td>
</tr>
<tr>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>1</td>
<td>4%</td>
</tr>
</tbody>
</table>

### Total Dosage

![Graph showing total dosage for different pulse rates](chart)
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'     |
| VSS           | ESOPHAGRAM    | UGI / SBFT     |
| UGI           | SMALL BOWEL    | CHEST / DIAPHRAGM |
|               | 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)

http://xrayphysics.com/radio.html

Courtesy of Keith Strauss
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 ≥ ½ the procedure dose!
Image Acquisition

Pie Chart:
- Dose: 40
- Image Capture: 1
- Fluorograph: 10
- Radiograph: 30

Bar Chart:
- Radiograph: 30
- Fluorograph: 10
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 $\alpha \frac{1}{\text{FoV}}$
- Dose ↑ w mag
- Use sparingly
- Magnify on PACS
# Magnification Mode

<table>
<thead>
<tr>
<th>FoV Size</th>
<th>Dose Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>31 cm</td>
<td>0%</td>
</tr>
<tr>
<td>25 cm</td>
<td>24%</td>
</tr>
<tr>
<td>20 cm</td>
<td>55%</td>
</tr>
<tr>
<td>17 cm</td>
<td>81%</td>
</tr>
</tbody>
</table>

![Percentage of Doseage Increase](chart.png)
Be Aware of Image Intensifier Position

- Lower position II α Low Magnification α 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

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
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 slightly 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**

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    - Ionic (iothalamate Meglumine) Cysto-Conray II
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# Enema Tip Selection

<table>
<thead>
<tr>
<th>Green</th>
<th>Blue</th>
<th>Pink</th>
<th>Foley</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preemie</td>
<td>5 months – 2 years</td>
<td>3+ years</td>
<td>0-5 months (balloon out/in)</td>
</tr>
<tr>
<td></td>
<td>Eval for Hirschsprung’s Disease</td>
<td>Eval for Hirschsprung’s Disease Bowel Mgt Eval</td>
<td>Neurogenic bowel Bowel Mgt</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Anorectal malformation</td>
</tr>
</tbody>
</table>
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
  - Pelvocalycectasis, 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
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
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
  ▪ ≈ 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
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