Common Abdominal Emergencies in Pediatrics

Ultrasound Diagnosis

No Conflicts of Interest to Disclose

Infantile Hypertrophic Pyloric Stenosis (IHPS)
Malrotation
Intussusception
Appendicitis

Objectives

At the conclusion of this discussion, attendees will:

- Be able to accurately diagnose IHPS vs normal pylorus
- Understand the role of US vs. UGI in the diagnosis of malrotation and volvulus
- Understand the ultrasound diagnosis of intussusception
- Differentiation of small vs. large bowel, unusual presentations
- Understand the role of US in the evaluation and diagnosis of appendicitis in the pediatric patient

IHPS

Familiar to every pediatric radiologist

2-5: 1000 births

- 500 visits per year
- 40 visits per month
- 4 visits per week

IHPS: anatomy & definition

- Thickened, UNRELAXING pyloric muscle
- Thickening and edema of mucosa

IHPS: historical perspective

- Virtually unknown prior to 1627
- 1627 Fabricius Hildanus
  - First reported case with survival
- 1788 Hezikiah Beardsley
  - First reported case in North America
- 1799 Michael Underwood – postmortem description
- 1841 Thomas Williamson – postmortem description
- 1842 Siemon-Dawosky – postmortem description
  - Includes "hypertrophy of submucous cellular tissue"
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IHPS: historical perspective

- 1887: Pediatric Congress, Wiesbaden, Germany
  - Harald Hirschsprung: 2 infant girls
  - Rigorous postmortem description of two cases

- Published 1888:
  - Falle von angeborener pylorusstenose, beobachtet bei sauglingen; Jahrb der Kinderh 27:61-68

Percent mortality in infants with Pyloric stenosis

- Year vs. Mortality

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IHPS: diagnosis

Palpation
- Accurate?
- Surgeons: Sensitivity: 31-100%; Specificity: 85-99%
- Non-surgeons: Sensitivity: 26 - 47%
- Noninvasive?
  - No need to further distend stomach
  - No radiation exposure
- Rapid?
  - No need to wait until stomach empties
  - No need to empty the stomach
  - No need to have a calm infant

Ultrasound
- Accurate?
- Sensitivity: 97-100%; Specificity: 99 - 100%
- Noninvasive?
- No need to further distend stomach
- No radiation exposure
- Rapid?
- No need to have a calm infant

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IHPS: normal anatomy

- Pyloric antrum = 2.5 cm in length
- Terminates at pyloric sphincter/orifice

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IHPS: abnormal anatomy

- Pyloric antrum is abnormal
  - thickened muscle
  - thickened mucosa

H. Mark, 1903
Bulletin of the History of Medicine

Percent mortality in infants with Pyloric stenosis

- Year vs. Mortality


Pyloric antrum ~ 2.5 cm in length
Terminates at pyloric sphincter/orifice

No need to further distend stomach
No radiation exposure
Rapid?
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**IHPS**

**Ultrasound: technique**
- Warm room
- Warm gel
- Scan infant under blankets
- Pacifier soaked in D5W

**IHPS**

- 6-7 MHz long footprint linear transducer
- Patient positioned to bring pylorus into view
  - begin with patient supine
  - turn to right slowly if need to bring fluid to antrum
  - turn to left slowly if pylorus tucked behind distended stomach

**IHPS: ultrasound characteristics**
- Thickened muscle ≥ 3mm
- Thickened mucosa
- Usually hyperemic
- Dimensions may change during study
- IHPS is NOT a complete obstruction

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**Mucosal hypertrophy:**

**Ultrasound**
- Mucosa fills pyloric channel
- protrudes into antrum: “nipple sign”

**IHPS: ultrasound characteristics**
- Mucosal hypertrophy
  - nipple sign
  - double track sign
**Ultrasound**

Pyloric stenosis: thickened muscle, mucosa

3.6mm; 10.7mm

**Mucosal hypertrophy:**

- Endoscopy
  - Mucosa protrudes through pyloric channel into antral lumen

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**IHPS: pitfalls**

**PROBLEM**
- Failure to visualize the pylorus
  - Overdistended stomach
  - Pylorus tucked behind stomach

**SOLUTION**
- Turn infant to the left, allowing pylorus to rise anteriorly

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**Normal pylorus: ultrasound characteristics**

- Muscle at rest < 2mm
- Dimensions may change during study
  - May need observation
  - Turn patient, Add fluid
  - The stomach may or may not empty during

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**Normal pylorus: pitfalls**

**PROBLEM**
- Borderline measurements
  - empty stomach
  - collapsed antrum

**SOLUTION**
- Turn infant to the right
  - Give fluid (e.g., Pedialyte D5W)

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**Normal pylorus: pitfalls**

**PROBLEM**
- Borderline measurements
- punishable

**SOLUTION**
- Watch ........!
Normal pylorus: pitfalls

- Beware the GE junction

Unsure rate of evolution of pyloric stenosis
- Unknown whether pylorospasm (failure of antropyloric portion of the stomach to relax, with muscle thickness < 3mm)
  - is self-resolving in some
  - develops into pyloric stenosis in others

IHPS - Questions

- 6/145 consecutive patients had borderline muscle thickness ≥ 2 < 3mm
  - 2/6 developed pyloric stenosis two weeks later
- 7/152 with borderline muscle thickness
  - none developed pyloric stenosis
- 1/75 patients developed pyloric stenosis between 2 weeks of age (intermittent opening, 2.8mm) and 7 weeks (no opening, 3.5mm)

IHPS: Questions

- What happens if US is negative?
  - Reflux
    - Document
    - Treat
  - Duodenal stenosis

IHPS: Questions

- 2 wks; 1.7mm
- 4 wks; 2.8mm
- No opening
- 6 wks; 2.8 – 3.5mm
- Intermittent opening

MALROTATION
Malrotation = Incomplete Rotation

Malrotation = Incomplete Rotation
= Spectrum

Malrotation = Incomplete Rotation

Malrotation - Ischemia

Malrotation – Clinical presentation

80% present in the first month of life
90% within the first year

- Acute Obstruction
- Vascular compromise

- Bilious vomiting
- Abdominal distension
- Hematochezia
- Hematemesis

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Duodenojejunal Junction (DJJ)

Normal Rotation

0°
90°
180°
270°

Malrotation

= Incomplete Rotation

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Malrotation = Incomplete Rotation

Cecal Loop

0°
90°
180°
270°

Acute Obstruction
Vascular compromise
Malrotation – Clinical presentation

- Older patients
  - Recurrent vomiting
  - Recurrent abdominal pain
  - Failure to thrive
  - Malabsorption

Malrotation – Diagnosis

Upper GI: Gold Standard (?)
- Detection of Malrotation
  - Sensitivity 93 – 100%
  - Lateral view
  - Sensitivity 96%
- Detection of volvulus
  - Sensitivity 54%
  - Specificity 88%

Meticulous technique:
- First pass
- Gastric emptying is variable
- Duodenal emptying is variable
- Gastric overdistension with contrast

Ultrasound
- Reversal of SMA / SMV relationship
  - Sensitivity: 66 – 71%
  - Specificity: 89 – 92%
- Whirlpool sign: volvulus
  - Twist of duodenum and SMV around SMA
  - Sensitivity: 83 – 92%
  - Specificity: 92 – 100%
- Dao, Beydoun, Youssfi
  - 245 studies; 100% Sensitivity & Specificity
  - SPR 58th annual meeting, April 2015
Malrotation – Diagnosis

Case history:
- 8 year old boy
- long history of failure to thrive
- recent 14 pound weight loss
- recent diagnosis of “sprue”
- on gluten-free diet

Malrotation

INTUSUSCESSION

Intussusception
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**Intussusception**

**ULTRASOUND**
- Diagnosis
- Tailoring management
  - Sensitive – 100%
  - Specific – “89%”
  - BOWEL - WITHIN - BOWEL


**Intussusception**

**ULTRASOUND**
- TECHNIQUE
  - Curvilinear transducer for bird’s eye view
  - Linear transducer for focused evaluation of
    - bowel-within-bowel
    - trapped fluid
    - lead points

**Intussusception**

**ULTRASOUND**
- Increased reduction failure
  - Age < 3 months
  - Duration > 48 hours
  - small bowel obstruction
  - Hematochezia
  - Fluid within the intussusceptum complex
  - Diminished or absent flow to complex

**Intussusception**

- 6 months – 2 years
  - Ileocolic, idiopathic
- Lead points
  - < 2-3 months - duplication cyst, Meckels
  - > 5 years – lymphoma - Burkitt

**Intussusception- lead points**
- Duplication cyst
- Burkitt lymphoma
**Intussusception – small bowel**

**INCONSEQUENTIAL**
- Asymptomatic
- < 3 cm wide
- < 3 cm long
- No obstruction
- Active peristalsis

**APPENDICITIS**

**Most common childhood surgical condition**
- 80% of pediatric surgical emergencies
- Greatest in second decade
- Rare in young children
- Neonates- appendiceal perforation may be a presentation of long-segment Hirschsprung disease

**Appendicitis – Pediatric Challenges**
- Young children unable to verbalize symptoms
- Presentation atypical in 30-45%
- Perforation rates
  - adults 16-39%
  - children 23-73%
  - infants 62- 88%
- as high as 100% in infants < 1 year
Appendicitis – Diagnosis

- Physical examination
  - Typical findings
  - Atypical findings

Appendicitis – Ultrasound

- Sensitivity
  - Approximately 40-100%
- Specificity
  - Approximately 40-95%

How to do it?
- High frequency LINEAR transducer
  - graded compression
    - Gentle and STEADY pressure
    - Upward direction
  - empty bladder
  - visualize psoas
- CALM INFANT
  - Crying prevents successful compression
  - Toys, videos

Visualization is variable
- 5 – 50%
- ENTIRE appendix MUST be visible
  - Base and length may be normal
  - Tip may be hidden by overlying gas

Find liver and right kidney
- Identify ascending colon
  - noncompressible bowel gas?
- Follow ascending colon
  - identify terminal ileum
- Search for appendix
  - cecal tip, retrocecal area, iliac fossa

Normal appendix
Appendicitis – Ultrasound

**Abnormal appendix**
- >6mm outer-wall-to-outer-wall during compression
- Periappendiceal echogenicity
- Increased flow
- May not be present if necrosis has supervened

**False positive**
- Borderline appendix size
- Loop of bowel mistaken for appendix
  - Need to confirm blind-ending structure
  - Origin from cecal tip if possible
  - Identify terminal ileum separately

**False negative**
- No appendix identified
  - Hidden by bowel gas or bone
- Normal appendix identified at cecal pole
  - Inflamed appendiceal tip elsewhere
  - Loop of bowel mistaken for “normal” appendix

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Thank you for your attention