Pediatric Surgery: core knowledge for Pediatric residents
Part 2 of 2 [updated June 2016]

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[from RCPSC objectives]
... assess and appropriately refer...

- Last time: Hernias (umbilical, inguinal, incarcerated, and hydroceles).
- Acute abdomen (appendicitis, trauma).
- Abscess (perianal, subcutaneous).
- Acute scrotal pain (testicular torsion and its differential). [Urology lecture]

- This time: Bowel obstruction (pyloric stenosis, malrotation/volvulus, intussusception).
PART 2 OF 2

Discussion topics:
Bowel obstruction:
  - Pyloric stenosis
  - Intussusception
  - Malrotation / volvulus
  - Hirschsprung’s disease

Neonatal surgical emergencies:
  - Intestinal atresia
  - NEC

Not in this slide show:
  - Abdominal wall defects
  - EA/TEF
  - CDH

- We won’t get through everything but the slides will be available.
Case study

- Mother calls you and says 5 week-old infant is vomiting after every feed.
- No blood in vomitus
- No diarrhea
- No fever
What is the most important question to ask the mother?

- A- Is the vomiting projectile?
- B- Is the abdomen tender?
- C- What color is the vomitus?
- D- Are there other family members with similar symptoms?
5 week old male, persistent non-bilious vomiting, weight loss. Most likely cause?

Gastric peristalsis
The differential diagnosis of non-bilious vomiting at this age includes:

- A- Overfeeding
- B- Gastroesophageal reflux
- C- Pyloric stenosis
- D- Congenital adrenal hyperplasia
- E- All of the above
The diagnostic study of choice

- A- Ultrasound
- B- UGI series with Barium
- C- UGI series with soluble contrast
- D- Plain abdo XR
- E- A or B
**Pyloric stenosis - Diagnosis**

- Physical examination: palpable olive

- Ultrasound:
  - 16 mm length
  - 14 mm overall thickness
  - 4 mm one wall
What fluids would you give?

Electrolytes:
- Na: 137
- K: 2.9
- Cl: 80
- HCO3: 38
- BUN: 9
- Cr: 30

Best IV Fluid option?:
- A - RL bolus until cap. Refill normal
- B - D51/2NS + 40 K bolus followed by maintenance
- C - 5% albumin
- D - NS bolus followed by D51/2NS + 40 K
- E - NS bolus followed by NS maintenance
Fluid Resuscitation

- HYPOCHLOREMIC, HYPOKALEMIC METABOLIC ALKALOSIS

- Bolus of NS if required
- Half normal saline with potassium at twice maintenance

- Check electrolytes q6h
- Bicarbonate must be <28 preop, to avoid increased risk of apnea
Most potassium loss occurred in the:

- A - Vomitus
- B - Stool
- C - Urine
- D - No loss, it is intracellular
Pyloric stenosis - surgery

- Pyloromyotomy approaches:
  - RUQ transverse
  - peri-umbilical
  - laparoscopic
Word of caution!

- Mucosal perforation:
  - Rare (1-2%)
  - Approximate mucosa and place omental patch
  - Close myotomy, rotate and re-do on opposite side

- Feed resumed 6 hours post-op

- Discharge 24-48 hours
Case study

HISTORY:
- 18 MONTH GIRL WITH 24 HOUR HISTORY OF INTERMITTENT ABDO. PAIN.
- VOMIT IS YELLOW, NOT FRANK GREEN AND THE BOUTS OF PAIN LAST 10-15 MIN.,
- LOOSE BM 3X IN 24HR, DARK RED SOMETIMES.

EXAM: NORMAL VITALS
- ABDO SLIGHTLY DISTENDED BUT NO REAL TENDERNESS AND NO PERITONEAL SIGNS.
- ON RECTAL EXAM THERE IS BLOOD
An 18 month old presents with vomiting, intermittent colic, lethargy… and blood/mucus per rectum … the cause?

What next?
Plain film of a child with intussusception shows small intestinal obstruction. Notable are a dilated small bowel and the absence of colonic gas. Courtesy of Nancy Fitzgerald, MD and Taylor Chang, MD.
The findings suggest:

- A- Malrotation +/- volvulus
- B- Intussusception
- C- Gastroenteritis
- D- Salmonella food poisoning
- E- Rectal prolapse
Best screening study to confirm your suspicions:

- A- Abdominal U/S
- B- Water soluble contrast enema
- C- Water enema
- D- Air enema
- E- Barium enema
INTUSSUSCEPTION

• Diagnosis:
  • Age 2 months to 2 years
  • Intermittent severe pain
  • Recent viral illness
  • Currant jelly stool
  • Distal bowel obstruction
  • ‘sausage-shaped’ mass
  • Beware young child with lethargy & dehydration

• Ultrasound: target sign

• What next?
If an enema is chosen, which of the following points is INCORRECT?

- **A** - Study is worthless without proper buttock taping and balloon inflation
- **B** - Water soluble contrast is a better choice than barium
- **C** - One should proceed cautiously in the presence of peritoneal signs
- **D** - Air enema, at P up to 120 torr, may be successful more often that liquid
- **E** - It should be preceded by IV fluid administration
Air enema

- Success rate of hydrostatic/pneumatic reduction is 85-90%
- Risk of perforation is 1-2%
- Recurrence is 5-8%
After few min., enema solves problem. Which statement is FALSE?

- **A**- Reduction is not successful until contrast refluxes well up into ileum
- **B**- It is common to have fevers 39-40 in the 24 hours post reduction
- **C**- Recurrent symptoms probably herald recurrent intussusception
- **D**- Chance of reduction may be 85%
- **E**- Recurrent symptoms should be treated with operation
Pathogenesis

- Intussusception most often is ileo-colic due to lymphoid hypertrophy of Peyer’s patches.
- The intussusceptum, a proximal segment of bowel, telescopes into the intussuscipiens, a distal segment, dragging the associated mesentery with it.
- This leads to the development of venous and lymphatic congestion with resulting intestinal edema, which can ultimately lead to ischemia, perforation and peritonitis.
# Pathogenesis

<table>
<thead>
<tr>
<th>Idiopathic (95%)</th>
<th>Lead points (5%)</th>
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<tbody>
<tr>
<td><strong>Hypertrophy of</strong></td>
<td></td>
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<tr>
<td>- Viral</td>
<td>- Meckel’s</td>
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<td>- Rotavirus vaccine</td>
<td>- duplications</td>
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<tr>
<td>- Adenovirus</td>
<td>- Polyps</td>
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<tr>
<td>- Viral prodrome</td>
<td>- lymphoma</td>
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<td></td>
<td>- HSP</td>
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<td></td>
<td>- cystic fibrosis</td>
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<td>- inverted stumps</td>
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</table>
Surgery for intussusception

- If Contrast reduction is not indicated or fails
  - Manual reduction
  - Resection with primary anastomosis

- Some are ileo-ileal, or ileo-ileo-colic, caused by a Meckel’s diverticulum, or other small bowel pathology.
Case study

HISTORY:
A HEALTHY 1 WEEK-OLD PRESENTS WITH 1 DAY HISTORY OF VOMITING AND LETHARGY. HE FED PERFECTLY WELL UNTIL YESTERDAY.

EXAM:
DEHYDRATED, LETHARGIC, ABDOMEN SCAPHOID AND SOFT, NOT TENDER. STOOLS ARE MUCOID AND BLOOD-TINGED.
Beware the baby who vomits bile!!
What to do next?
The most appropriate radiologic test would be:

- A- Doppler U/S of mesenteric vessels
- B- Barium enema
- C- UGI
- D- CT abdomen
What’s the diagnosis?
Beware the baby who vomits bile!!

Midgut volvulus
Normal fetal intestinal rotation occurs:

- A - between 4-10 weeks gestation
- B - under the influence of maternal hormones
- C - within the peritoneal cavity of the fetus
- D - between 10-16 weeks GA
Who knows?

- Normal position of Ligament of Treitz?
- Normal position of IC valve?
- What we mean by base of mesentery?
- Why does malrotation predispose to volvulus?
NORMAL: 270 degree counterclockwise rotation

Small bowel mesentery fixed at Ligament of Treitz and cecum
Why does abnormal rotation lead to the risk of midgut volvulus?

A narrow mesentery predisposes to volvulus
Malrotation and Volvulus

- VOLVULUS is secondary to MALROTATION
- Age: 80% under 12 months old
- Sudden onset of GREEN vomiting
- Exam and X-rays may be normal initially
Operation for malrotation:

- A- is not indicated for asymptomatic patients
- B- should not be undertaken until the diagnosis is confirmed by contrast study
- C- consists of laparotomy, reduction of volvulus, release of Ladd’s bands, appendectomy and cecopexy
- D- may require a second-look procedure
What is the operative procedure to correct malrotation?

Ladd’s procedure:
1. Untwist mesentery counterclockwise
2. Divide Ladd’s bands across duodenum
3. Widen mesentery
4. Replace small bowel on right, colon on left, remove appendix
Clinical presentation of malrotation include:

- A- Acute midgut volvulus
- B- Chronic duodenal obstruction
- C- Failure to thrive with chronic diarrhea
- D- all of the above
Clinical presentation

- **Acute**
  - Bilious vomiting
  - Abdominal pain
  - Rapid progression to shock and sepsis

- **Subacute/chronic**
  - Intermittent vomiting
  - Failure to thrive
  - Early satiety
  - Chronic diarrhea
Doppler Ultrasound to assess relationship of SMA and SMV is a screening test for malrotation – but not 100%
Other causes of newborn bilious vomiting:

**Duodenal atresia**

- Common site of intestinal obstruction
- Incidence 1:6000
- Associated anomalies:
  - Down syndrome: 28%
  - Congenital Heart disease: 23%
  - Malrotation: 20%
- *None: 45%*
DA- Diagnosis

- Majority are now prenatally diagnosed
DA- Diagnosis

- Polyhydramnios in 30-65%
- Prematurity in 50%
- Bilious emesis
- No abdominal distension
DA- Diagnosis
DA - Treatment

- IV fluids
- NG decompression
- Stabilization
- Rule-out associated anomalies
  - Cardiac echocardiogram
DA- Surgery

- Duodeno-duodenostomy
DA- Outcome

- Survival 95%
- Mortality related to associated anomalies
- Take several weeks to “open up”
A 48 HR OLD BABY HAS NOT PASSED MECONIUM. THE ABDOMEN IS DISTENDED AND HE HAS VOMITED BILE THE ANUS IS PATENT.
Newborn with vomiting, abdominal distension, no meconium passed.

Prone lateral xray of rectum

what is the differential diagnosis?
Neonatal distal bowel obstruction: Differential Diagnosis

- Next step: lower GI study

- No Microcolon –
  - Hirschsprung’s
  - Meconium plug
  - Small left colon

- Microcolon –
  - Meconium ileus
  - Ileal atresia

- Contrast enema: look for *Transition Zone*
Hirschsprung’s Disease

- Aganglionosis or Absence of Ganglion cells
- Ganglion cells are part of autonomic nervous system
- Located in submucosa and between muscle layers of bowel wall
- Allow Relaxation of intestinal muscle
Hirschsprung’s Disease

- Functional Intestinal Obstruction
- Sporadic and familial forms
- 90% present with neonatal intestinal obstruction.
How is the diagnosis of Hirschsprung’s Disease confirmed?

Where are ganglion cells normally located?

What are characteristics of the rectal biopsy with Hirschsprung’s?
*How is the diagnosis of Hirschsprung’s Disease confirmed? Rectal biopsy: suction or full thickness.*

**Where are ganglion cells normally located?**
SubMucosal (Meissner) and myenteric (Auerbach’s) plexi.

**What are characteristics of the rectal biopsy with Hirschsprung’s?**
No ganglion cells, nerve hypertrophy, abnormal pseudocholinesterase and calretinin staining
Hirschsprung’s - Treatment

- Rectal Irrigations +/- Antibiotics
- Stoma if not responding to irrigations

- NB Can present with severe sepsis due to Hirschsprung’s Associated EnteroColitis (HAEC)

- Definitive treatment: **Pullthrough**
Hirschsprung’s Disease (congenital aganglionic megacolon): *Which colon segment is normal?*

*What is the operative procedure?*
Hirschsprung’s Disease (congenital aganglionic megacolon): Which colon segment is normal?

Normal is dilated

Aganglionic rectosigmoid is narrow

What is the operative procedure? This is a laparoscopic pullthrough
Pullthrough procedures

Swenson

Duhamel

Soave

External sphincter muscles
Swenson transanal Pullthrough
2 year old with severe constipation: Is it functional or Hirschsprung’s? Describe features of each.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Functional Constipation</th>
<th>Hirschsprung’s</th>
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<tbody>
<tr>
<td><strong>Symptoms</strong></td>
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<tr>
<td><strong>Duration</strong></td>
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<tr>
<td><strong>Diarrhea</strong></td>
<td></td>
<td></td>
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<tr>
<td><strong>Mucus</strong></td>
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<td><strong>Vomiting</strong></td>
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<td><strong>Anemia</strong></td>
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<td><strong>Recurrent Infections</strong></td>
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<tr>
<td><strong>Obstructive Symptoms</strong></td>
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</tbody>
</table>

### Functional Constipation:
- Symptomatology:
- Duration:
- Complete assessment
- Night symptoms
- Anemia:
- Recurrent infections
- Obstructive symptoms

### Hirschsprung’s:
- Symptomatology:
- Duration:
- Complete assessment
- Night symptoms
- Anemia:
- Recurrent infections
- Obstructive symptoms
### 2 year old with severe constipation:

- **Functional Constipation:**
  - Large infrequent stools
  - Soiling (encopresis)
  - Healthy
  - Rectum full on PR
  - Responds to cleanout and laxatives
  - Barium enema shows no transition zone

- **Hirschsprung’s:**
  - Infrequent, sometimes explosive stools
  - Soiling is unusual
  - Looks unwell
  - Rectum empty on PR
  - Poor response to laxatives
  - Transition zone on BE
Neonatal distal bowel obstruction: Differential Diagnosis

- Next step: lower GI study

- No Microcolon –
  - Hirschsprung’s
  - Meconium plug
  - Small left colon

- Microcolon –
  - Meconium ileus
  - Ileal atresia
Meconium ileus

- Inspissated meconium in terminal ileum
- >95% associated with cystic fibrosis
- Prenatally may see echogenic bowel
- May present as simple or complicated
  - In utero perforation, volvulus
  - Meconium peritonitis
Meconium peritonitis
Meconium Ileus - Treatment

- Simple
  - Contrat enema successful in 85%
  - Enterotomy, evacuation inspissated meconium
Meconium Peritonitis - Treatment

- Laparotomy
  - Bowel resection
  - Stomas

Fig. 69-2 Operative options for the surgical treatment of meconium ileus.
Meconium Plug

- Obstruction is in descending colon
- 10-15% associated with CF
- 8-10% associated with Hirschsprung’s disease
- Contract enema is curative
- Sweat test and rectal biopsy may be indicated
Jejuno-ileal Atresia/Stenosis

- Incidence varies from 1:330 in US to 1:1500
- 95% have complete obstruction
- Not frequently diagnosed prenatally
- Known to be a late intrauterine vascular accident
  - Experiment of Louw and Barnard
Jejuno-ileal Atresia – Risk Factors

- Maternal use of pseudoephedrine
- Maternal use of ergotamine to treat migraines
- Maternal use of cocaine
- Tight gastroschisis
Jejunoileal atresia - Presentation

- Maternal polyhydramnios
- Biliary vomiting
- Abdominal distension
- Jaundice
- Failure to pass meconium
### Jejunoileal atresia - Presentation

<table>
<thead>
<tr>
<th>Finding</th>
<th>Jejunal</th>
<th>Ileal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyhydramnios</td>
<td>38%</td>
<td>15%</td>
</tr>
<tr>
<td>Bilious vomiting</td>
<td>84%</td>
<td>81%</td>
</tr>
<tr>
<td>Abdominal Distension</td>
<td>78%</td>
<td>98%</td>
</tr>
<tr>
<td>Failure to pass meconium</td>
<td>65%</td>
<td>71%</td>
</tr>
<tr>
<td>Jaundice</td>
<td>32%</td>
<td>20%</td>
</tr>
</tbody>
</table>
Jejunoileal Atresia - Imaging
Jejunoileal Atresia - Imaging
Jejunoileal Atresia - Classification
Implications

- Types 1 and 2 and 3a likely to have normal bowel length
- Type 3b more likely to have short bowel length
- Type 4 can be familial and often fatal from insufficient intestinal length.
Jejunoileal atresia - Treatment

- Restauration of intestinal continuity
  - Preservation of intestinal length
  - Tapering or resection of excessively dilated segments
  - Ensure patency of entire GI tract
Necrotizing Enterocolitis

Most common surgical emergency in the neonatal period
Merci!