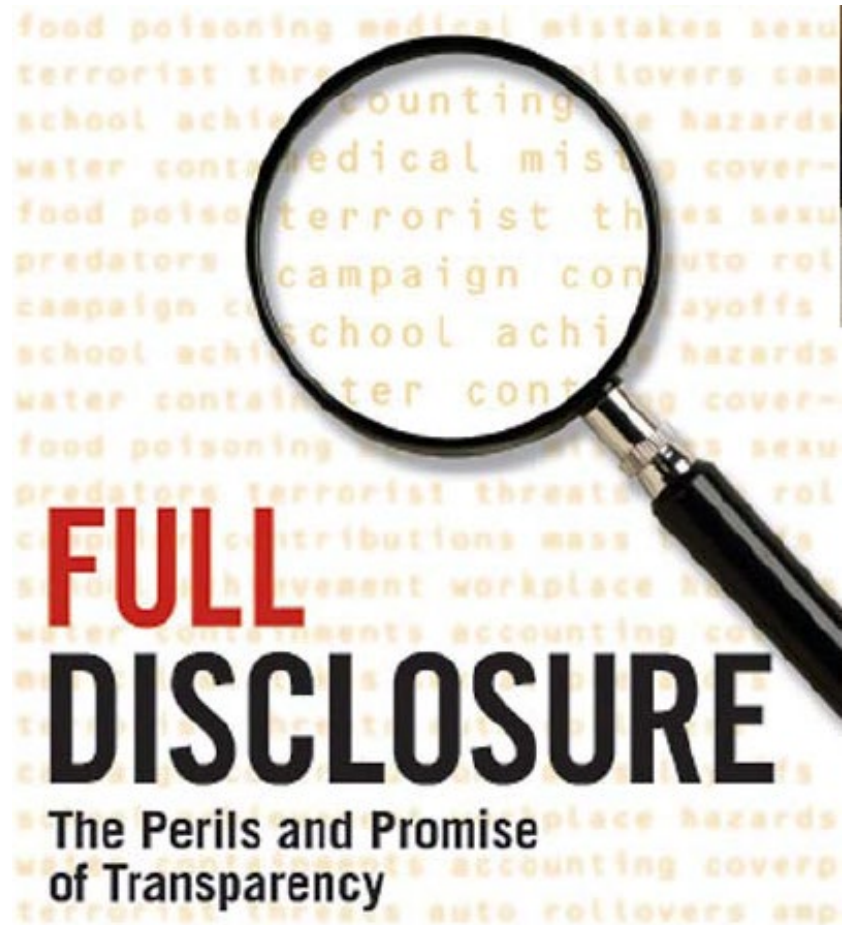


Common Pediatric Surgery Emergencies



Nothing to disclose

No commercial bias

No financial conflicts

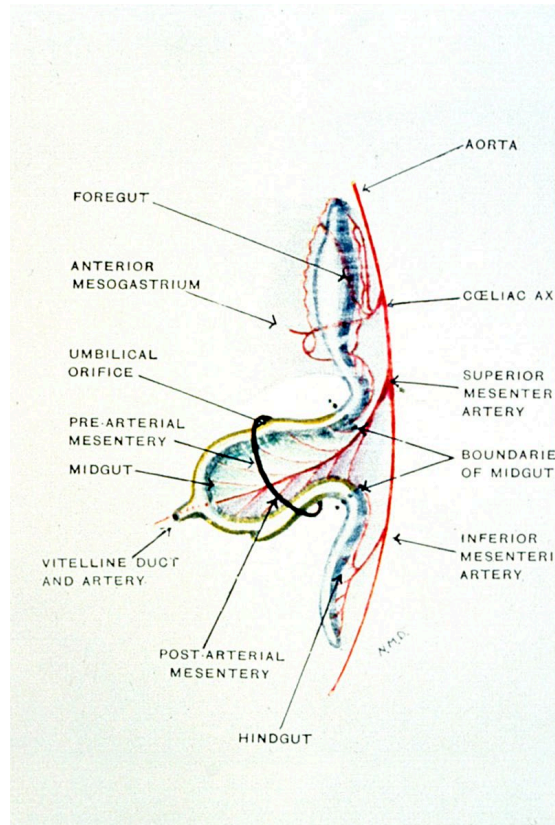
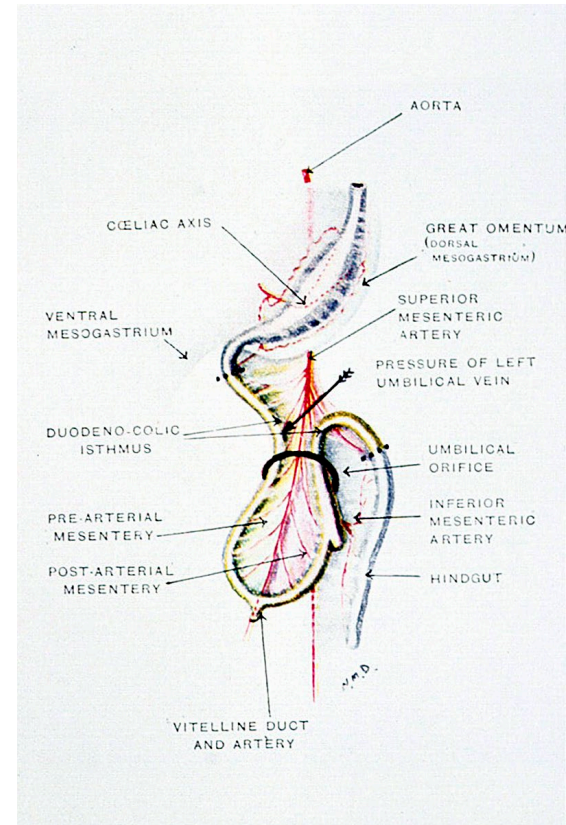
Outline

- Malrotation
- Appendicitis
- Intussusception
- Inguinal Hernia – Hydrocele
- Pyloric Stenosis

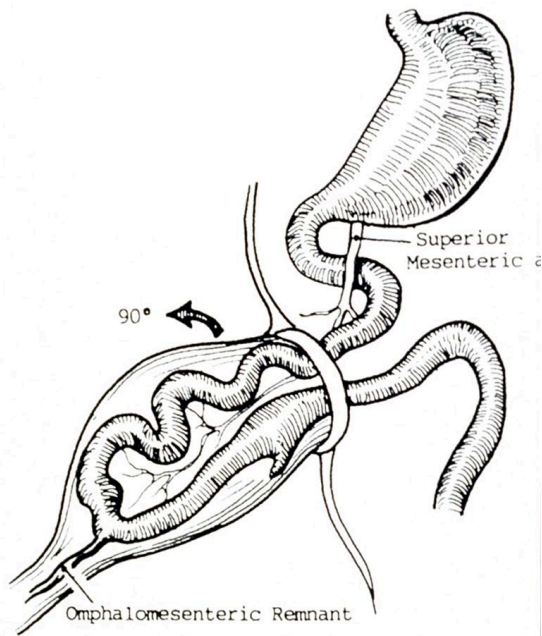
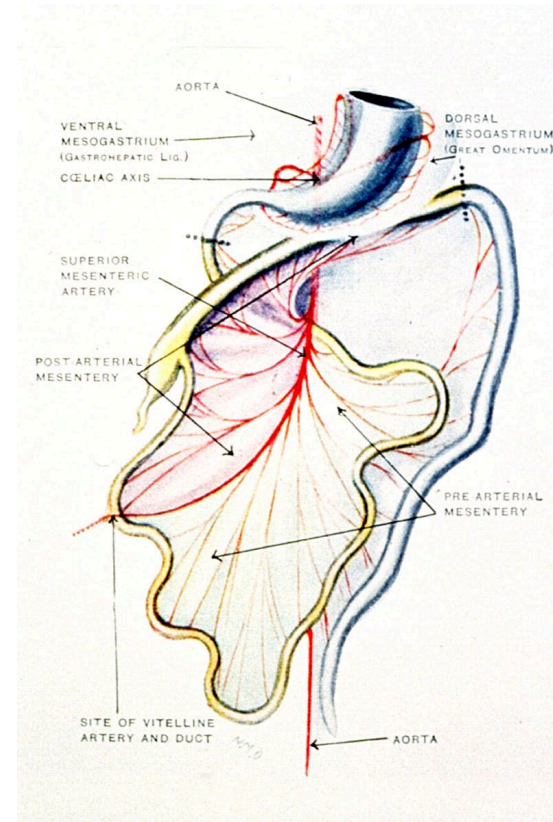
Malrotation

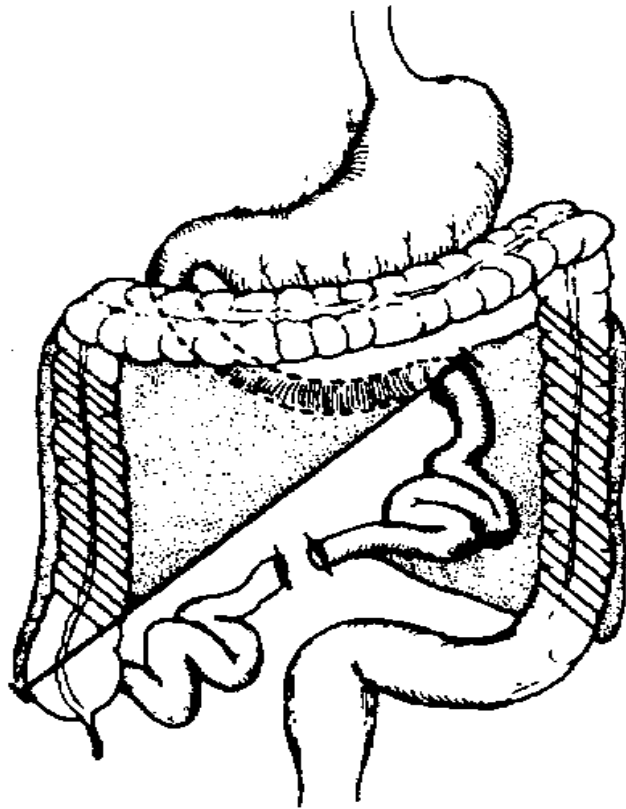
- **Most urgent and potentially catastrophic surgical condition in children**
- Embryology
 - Faulty rotation around superior mesenteric artery
 - Abnormal peritoneal attachments
 - Narrow base of mesentery
 - Potential for volvulus

Malrotation

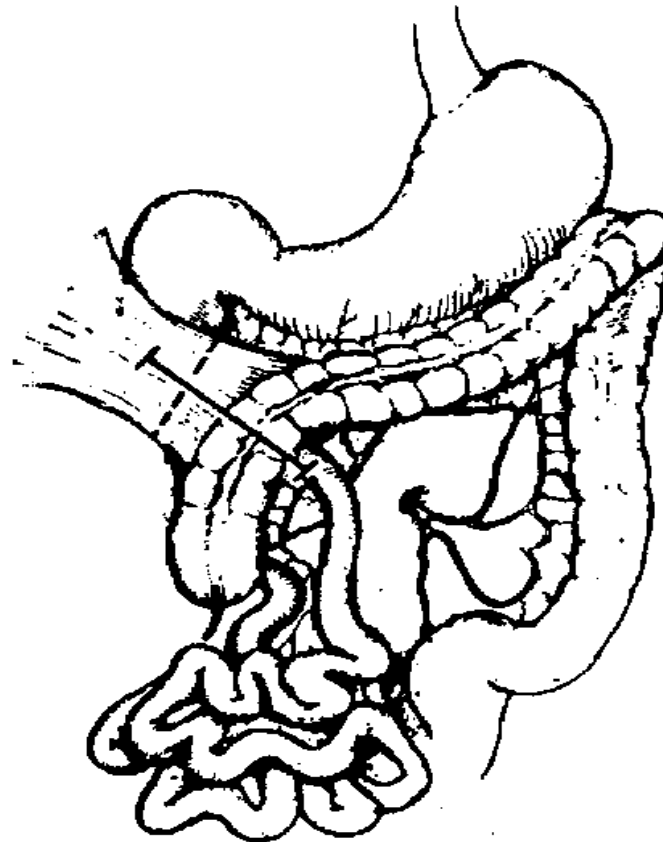


Malrotation



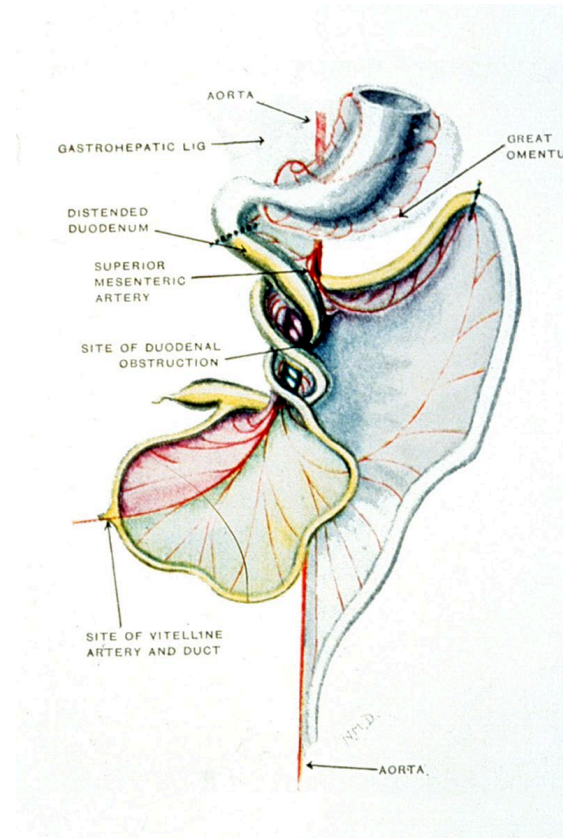


Normal
Wide Base



Malrotation
Narrow Base

Malrotation



Presentation

Bilious vomiting
(can be any age)

Most commonly in infancy (80%)

Usually NOT distended

Surgical emergency

Diagnosis

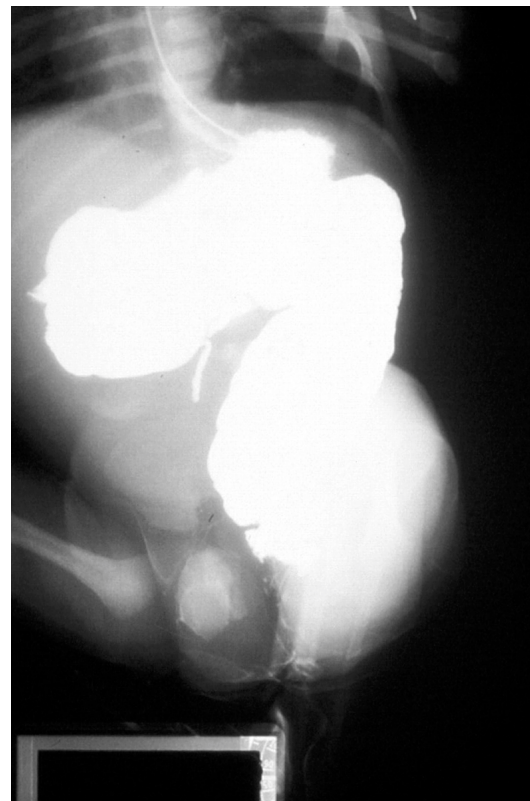
KUB is usually nonspecific

Upper GI series

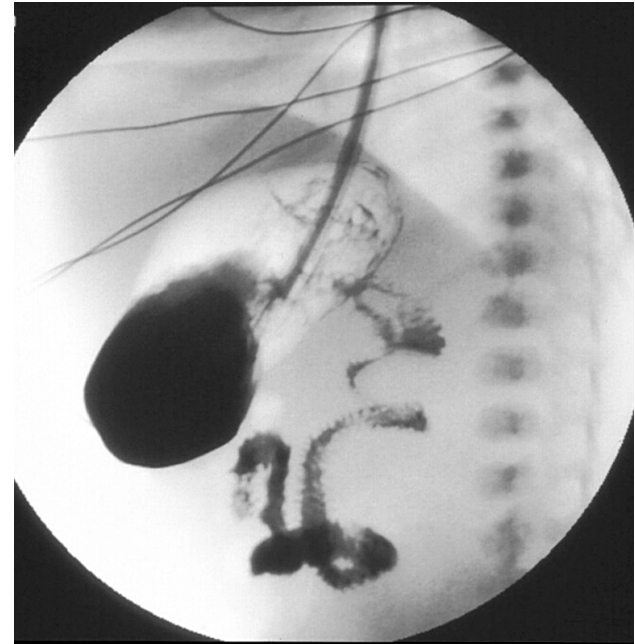
Abnormal duodenum

± Duodenal obstruction

Malrotation



Malrotation - UGI



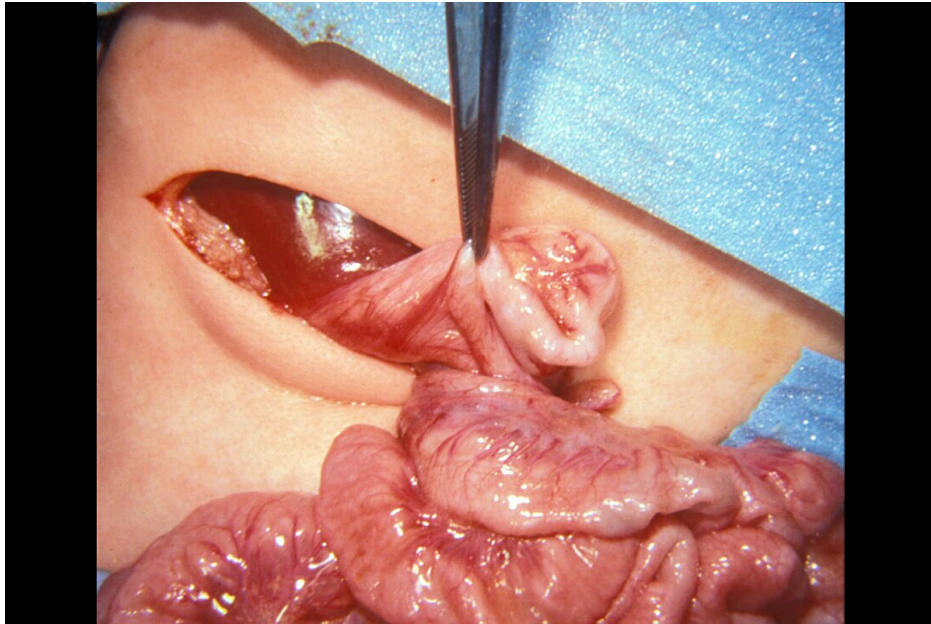
Treatment

Fluids, antibiotics, NG

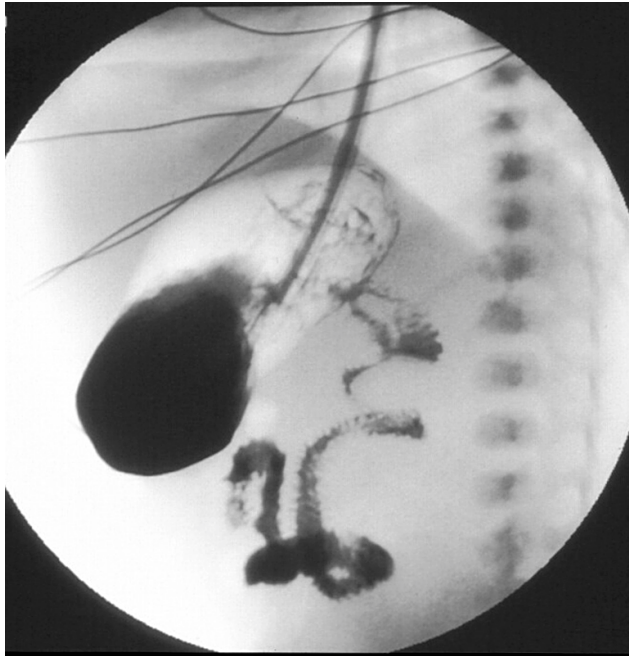
Ladd's procedure —
(Appendectomy)

Second-look, short bowel
syndrome

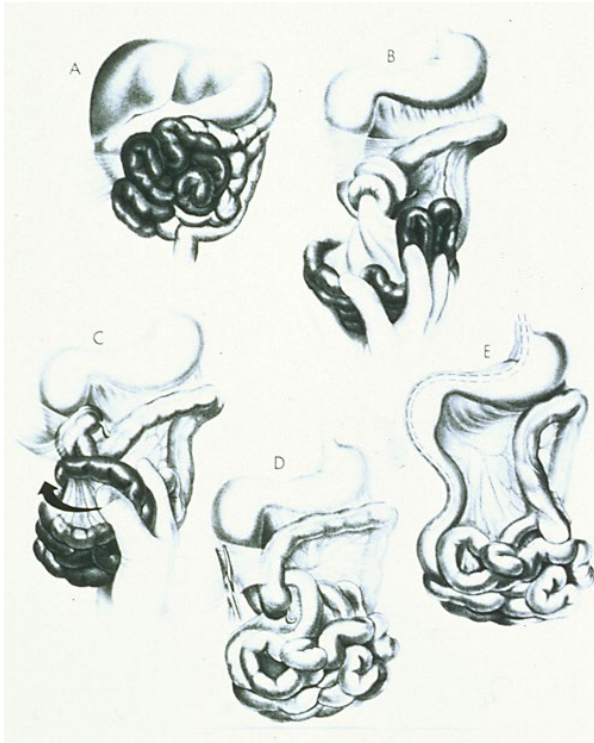
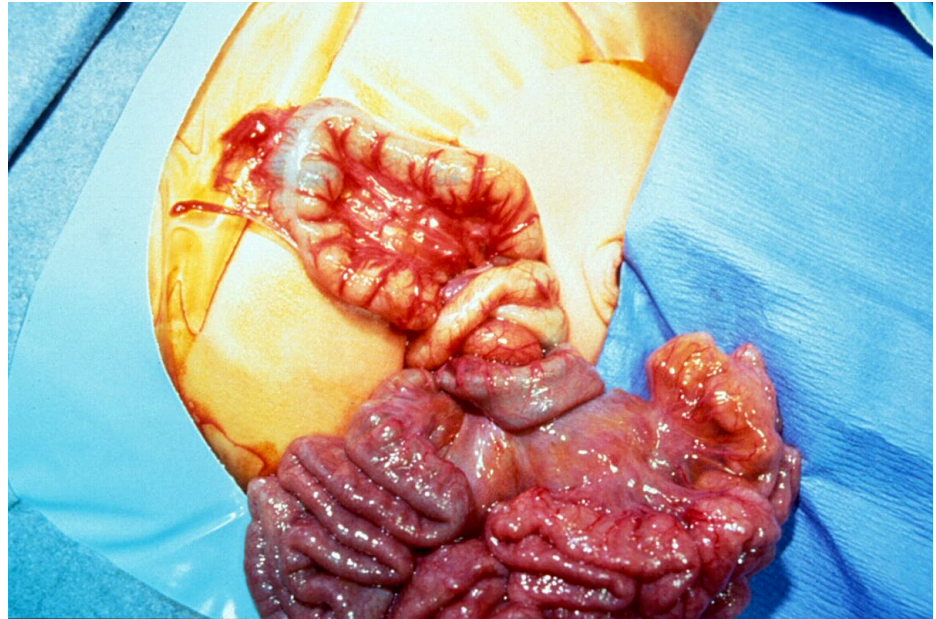
Treatment



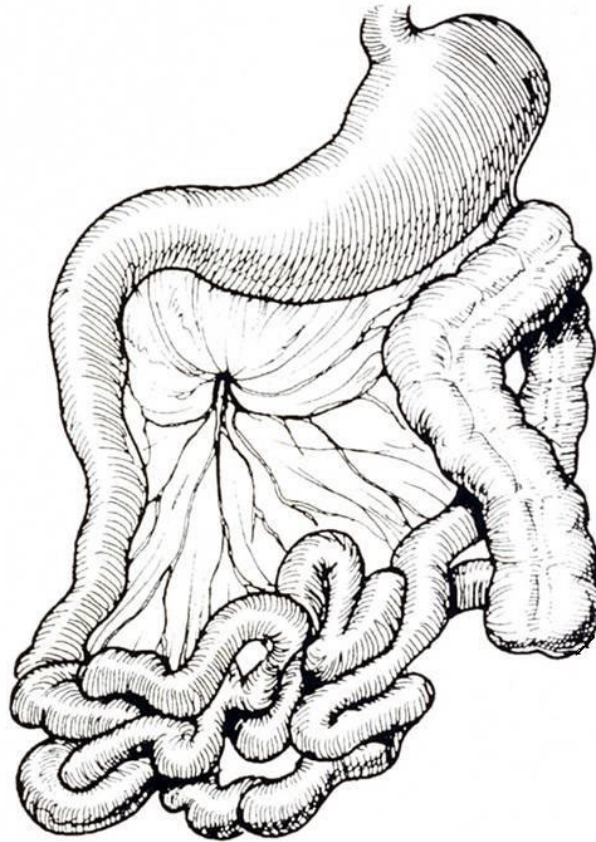
Treatment



Ladd's Procedure



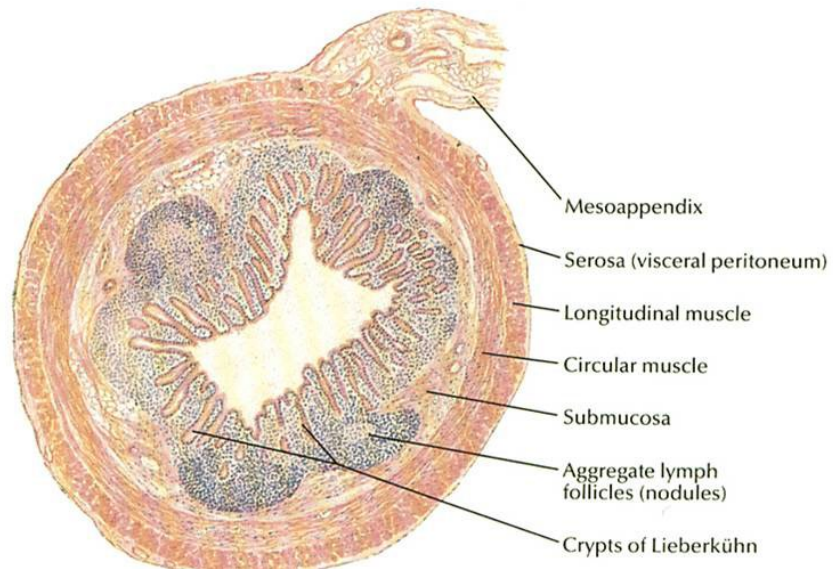
Completed Ladd's



Appendicitis

- **Most common surgical emergency in children**
- Luminal obstruction
- Luminal pressure
- Venous congestion / inflammation
- Infarction
- Perforation

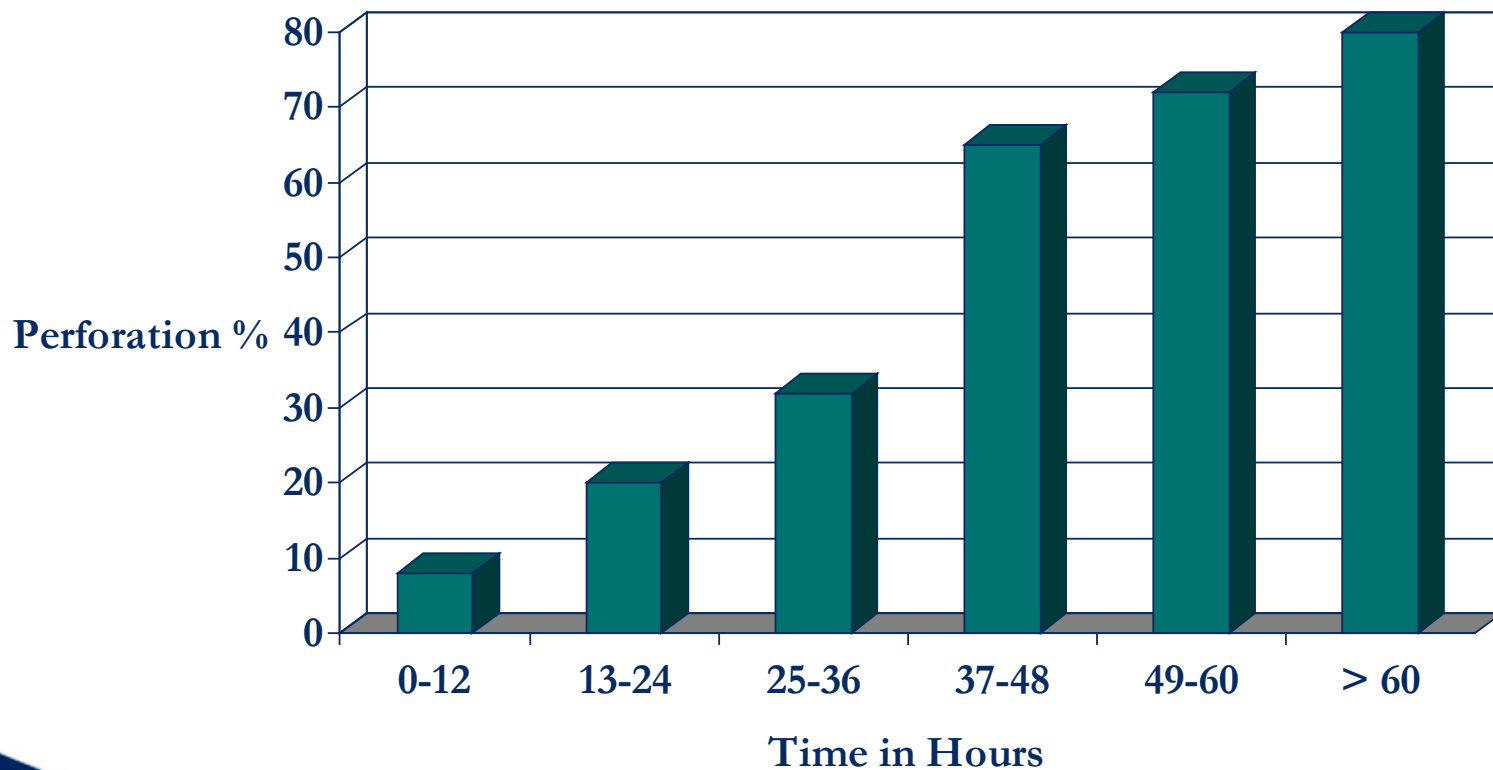
Pathology



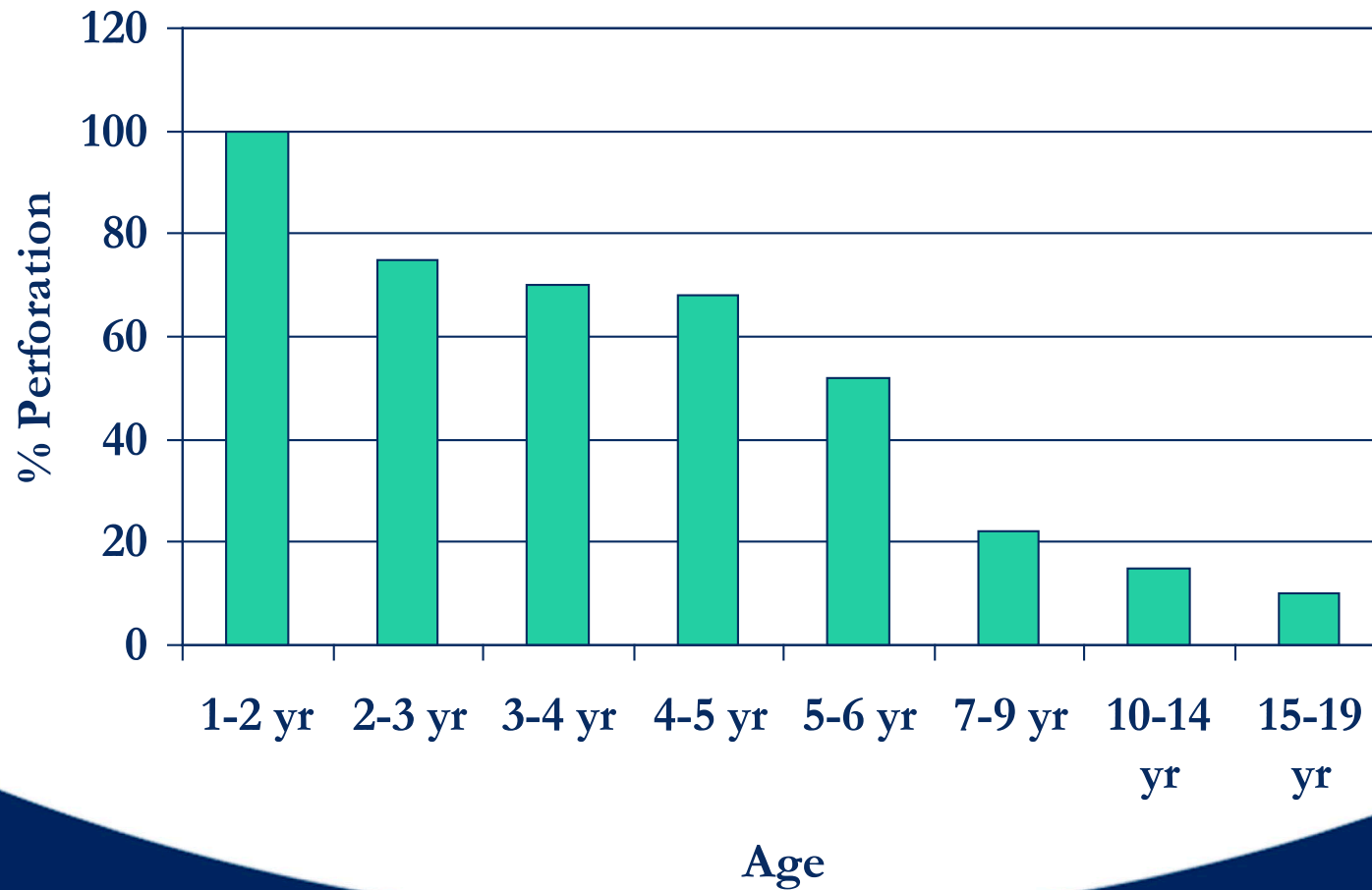
Epidemiology

- More than 250,000 cases/year
- 25-35 % in patients < 20 years old
- Life-time risk of appendicitis
 - 8.6% for males
 - 6.7% for females
- Complications clearly related to delay in treatment

Perforation vs Time

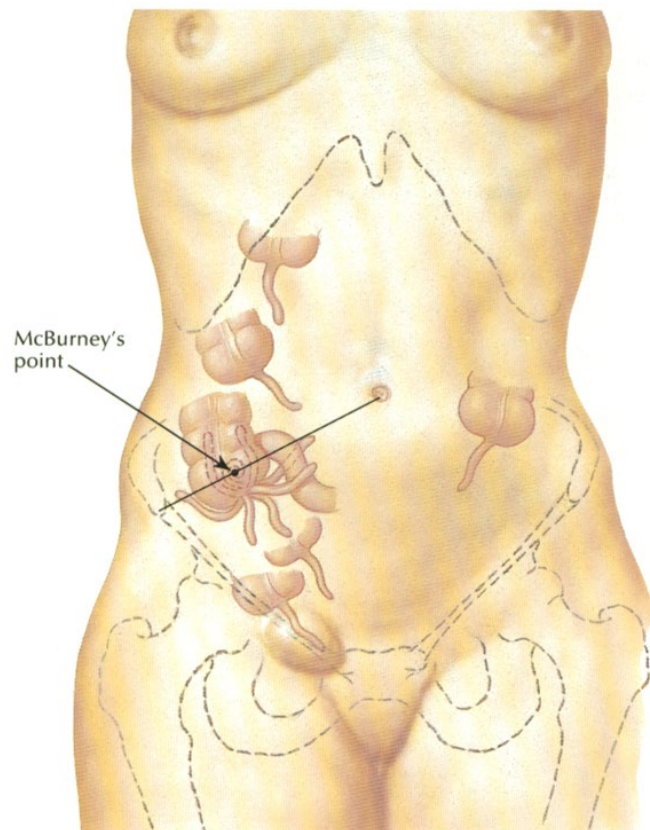


Age and Perforation

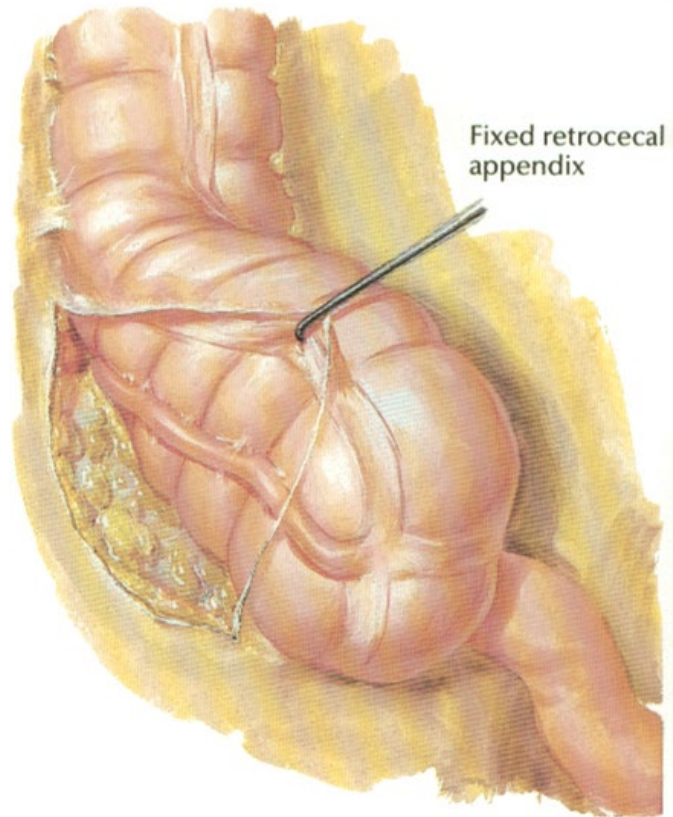


History / Physical

- Luminal obstruction
- Luminal pressure
- Venous congestion / inflammation
- Infarction
- Perforation
- Crampy pain / reflex emesis
- Localization
- Peritoneal irritation
- Local peritonitis
- Generalized peritonitis / abscess



Variations in position of appendix



Physical Exam

- Bowel sounds / Distention
- RLQ tenderness
- Guarding / Rebound
- Rovsing's sign
- Psoas sign
- Obturator sign
- Heel tap
- Rectal exam

Adjuncts

- CBC
- Urinalysis
- Amylase/Lipase/BMP
- KUB
- Additional Imaging
 - US
 - CT
 - MRI?

KUB



Appendicitis



Imaging

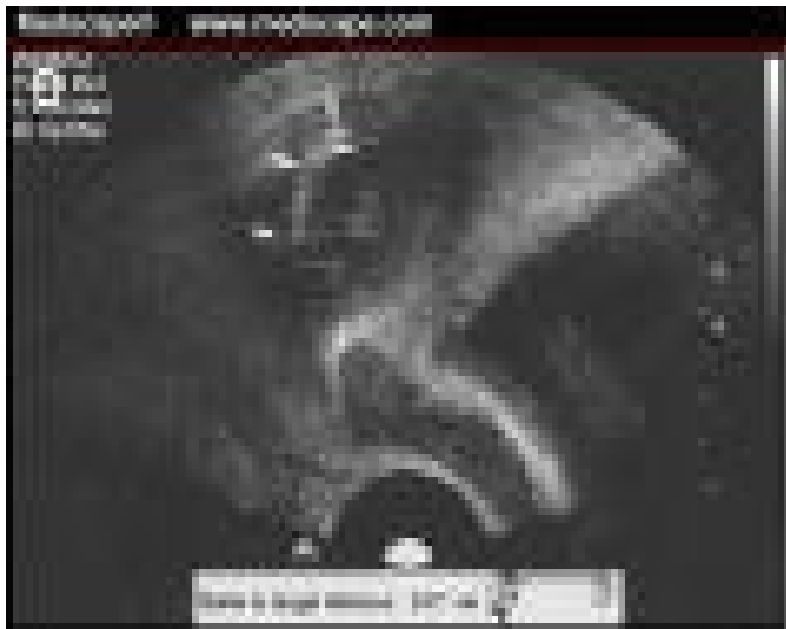
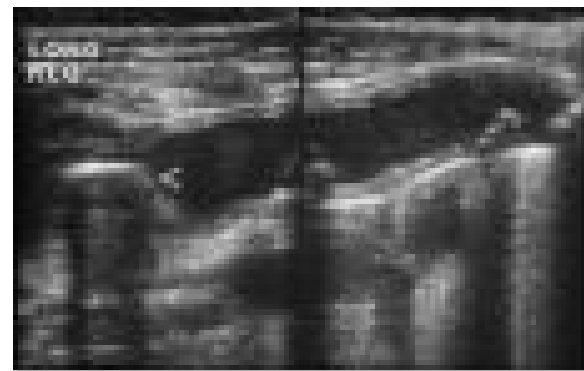
● Ultrasound

- Cheaper
- Portable
- No radiation
- Operator dependent
- Ovarian pathology
- Gallbladder pathology

● CT

- Expensive
- Radiation
- Delay in imaging
- Rectal contrast ?
- Consistency ?
- Accuracy

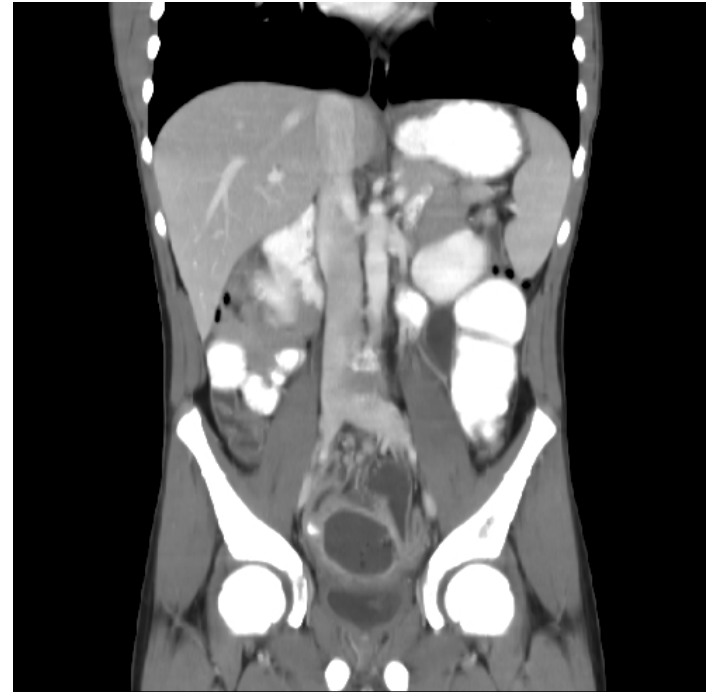
Ultrasound



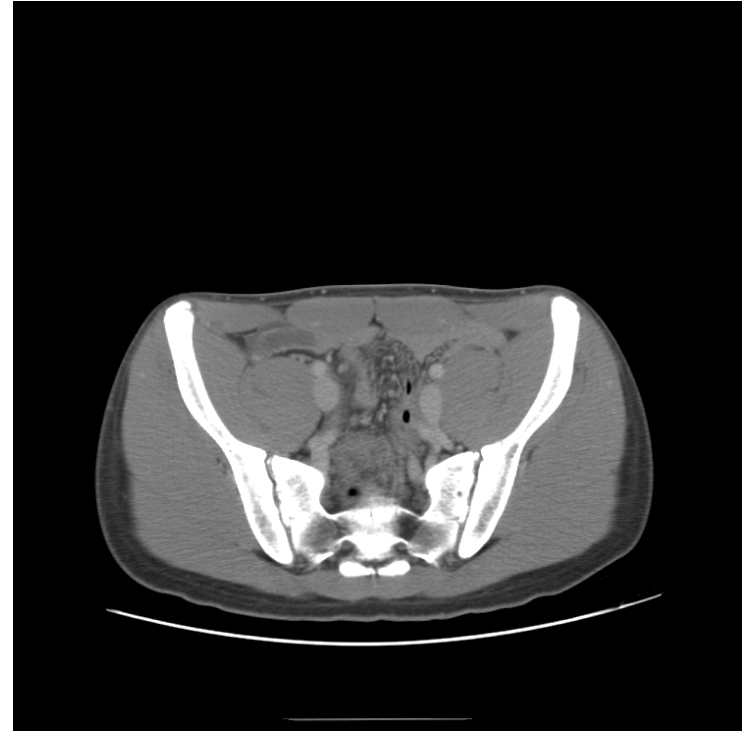
CT



CT



CT



CT



US / CT

- If imaging, usually start with US
- If equivocal or negative CT
- If US and CT discordant: CT correct 85%
- 739 equivocal patients had U/S → CT
 - 62% beneficial change
 - 36% no change
 - 2% detrimental change

Just scan everybody ! ????

- Studies from centers with special interest
 - Results in community hospitals
 - One report: 37% of pts had CT : Sens = 53%
- Radiation exposure and cancer risk
- Costs and resource utilization
- Overuse / Over-reliance on results

One size does not fit all.....

There's no question - CT helps us save kids' lives!

But, when we image, radiation matters.
* Children are more sensitive to radiation
* What we do now, lasts their lifetimes

So, when we image, let's image gently
* More is often not better
* When CT is the right thing to do:
* Child size the kVp and mA
* One scan (single phase) is often enough
* Scan only the indicated area
Let's image gently.....



4D · MONDAY, DECEMBER 21, 2009 · USA TODAY

Look closer at CT scan risks

Recent studies found that patients may receive far more radiation from the common diagnostic tests called CT scans than previously estimated. These scans may cause 29,000 new cancers a year — as well as 14,500 deaths. USA TODAY's **Liz Szabo** asked experts how patients can reduce their risk.

INDUSTRY NEWS March 1, 2010
Congressional hearing: More oversight needed for medical radiation procedures

TOP STORIES

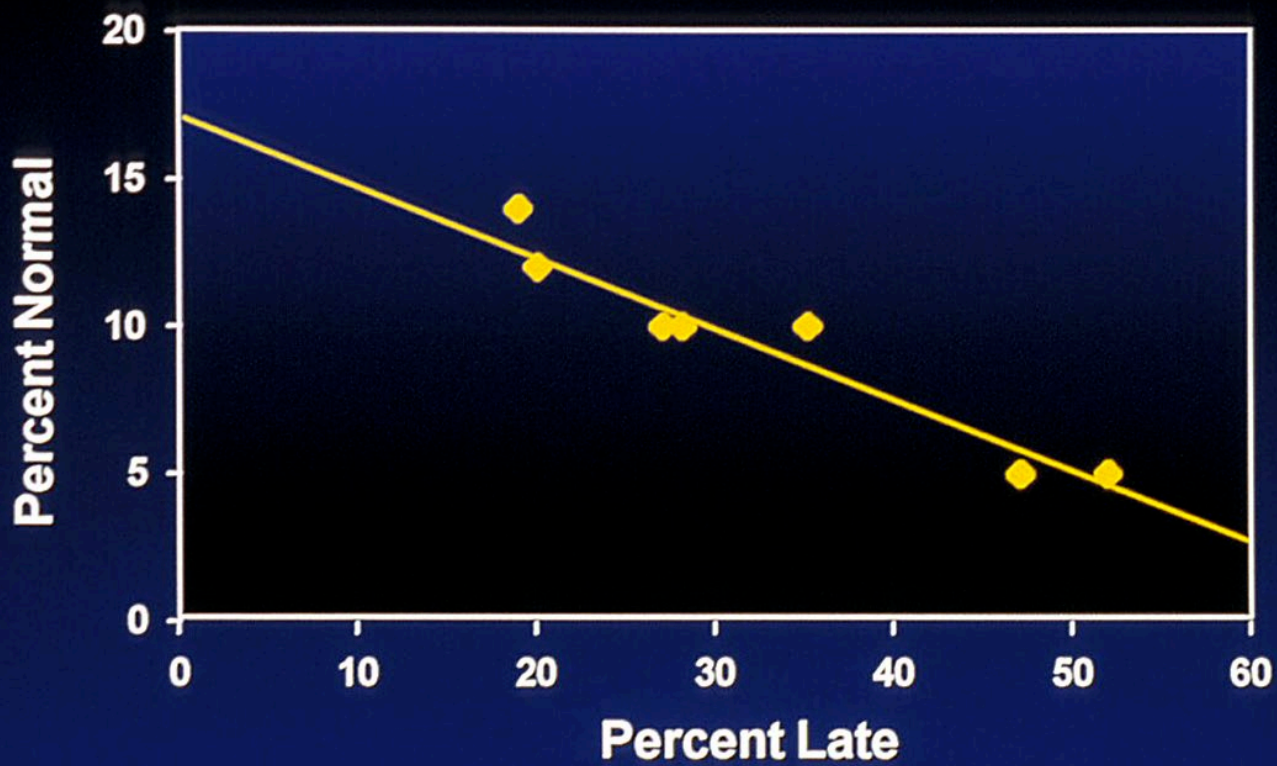
GE sued in Alabama CT excess radiation case

Results 1 - 10 of about 577,000 for ct scan safety. (0.24 seconds

Google™

Cancer Risk

- Based on mortality data from Japanese atomic bomb survivors
- 600,000 abdominal and head CTs in children under 15 → 500 extra cancer deaths
- Estimated lifetime cancer mortality risks due to radiation exposure for a 1-year-old are;
 - 0.18% for abdominal CT (1.8 / 1,000)
 - 0.7% for head CT (7 / 10,000)



Appendectomy

- Open vs Laparoscopic
- Laparoscopy clearly preferred by pt / family
- Laparoscopy allows better evaluation
- Acute appendicitis - neither superior
- Perforated appendicitis – laparoscopy may have higher abscess rate
- Clear cosmetic advantage to laparoscopy

Missed Diagnosis

- Most Pediatric Series : 7 -9%
- One large review of missed cases (7%)
 - Normal appetite, afebrile, diarrhea
 - 50% perforated (vs 28%)
- Young patients
 - ≤ 3 yrs old : high perforation rate in all series
 - One series: 27/27 perforated
 - “abdominal pain, tenderness, vomiting”
 - One-third had diarrhea

Missed Appendicitis

- “ Error ” at initial presentation:
 - Not enough attention to physical findings
 - Inappropriate reliance on imaging (False -)
 - Failure to correlate symptoms with natural history and pathophysiology – duration of illness
 - Variability in disease evolution
 - Variability in location of symptoms

Treatment – Non-Operative

Patients with late appendicitis

- Abscess +/- drainage
- Fluids / IV antibiotics / TPN
- Appendectomy 6-8 weeks later (65-85%)
 - Immediate appendectomy: 20% complications
 - Failed interval appendectomy: 12 % complications
 - Interval appendectomy: 11% complications
- Observation without appendectomy



What Surgeon ?

- Ped Surgeon vs General Surgeon – 2 reviews
 - Statewide review of all patients with appendicitis
 - Pts > 13 : no difference
 - All age groups < 13 : shorter LOS, lower costs
 - Review in one hospital
 - Acute pts : no difference
 - Perforated pts : shorter LOS, lower costs with Ped Surg
 - Complications and reoperations markedly lower

What Surgeon ?

- AAP Guidelines for Surgical Specialty Referral
 - Perforated appendicitis pts < 12 years old

Post-Op Course

- Acute Appendicitis
 - Outpatient: Same day DC or overnight stay
 - 1-2% wound infection rate
- Gangrenous or Perforated
 - 4-7 days post-op
 - IV antibiotics until afebrile X 24h and WBC normal
 - 5% abdominal abscess
 - 2% reoperation rate

Long-Term Complications

- Small Bowel Obstruction

- Negative appendectomy: 1.8%
- Acute appendicitis: < 1%
- Gangrenous: 1%
- Perforated: 3.4%

- Tubal Infertility

- 279 tubal infertility pts vs 957 controls)
- 4.8 relative risk
- 5.1% of females with perforated appy (1.7% norm)

Pathways

- Critical reviews of appendicitis treatment
 - Only 35% of studies had any control group
 - Only 3% of studies randomized
- Evidence-based pathways improve outcome
 - Lower perforation rate
 - Lower mis-diagnosis rate
 - Lower costs / LOS
- Difficult compliance

Pathways

- Recent review emphasizing early assessment by attending pediatric surgeon
- All patients seen by staff surgeon before any imaging
 - 5% negative appendectomy
 - 33% late
 - 62% of pts seen → appendectomy (89% early)
 - Sensitivity: 99%
- Labor intensive

APPENDICITIS EVALUATION

Inclusion Criteria

- Any child 0-18 years of age with history or exam findings concerning for appendicitis

Exclusion Criteria

- Known inflammatory bowel disease
- Prior appendectomy

Index of Suspicion / Pediatric Appendicitis Score (PAS)

PEDIATRIC APPENDICITIS SCORE (PAS)	
RLQ tenderness	2
RLQ pain with cough, percussion, hopping	2
Fever	1
Nausea/vomiting	1
Anorexia	1
Migration of pain to RLQ	1
Leukocytosis (WBC > 10,000)	1
Neutrophilia (ANC > 7500)	1

Mod-High Suspicion or PAS ≥ 4

MALES

- US Abdomen – Limited
- IV access, CBC, CMP, CRP
- Consider UA
- Analgesia, IVF as indicated

FEMALES

- US Abdomen – Limited
- US Pelvis, non-OB
- IV access, CBC, CMP, CRP, UA
- Serum/urine HCG, consider STI testing (if age appropriate)
- Analgesia, IVF as indicated

Low Suspicion or PAS ≤ 3

Consider alternative diagnosis and/or discharge home with PCP follow up in < 24 hours with strict return precautions OR continued observation with serial exams

Appendix Normal

- Disposition options:
- Discharge home after PO trial once pain well controlled
 - Consider alternative diagnoses, and/or admit to Pediatrics for serial exams

Appendix Not Seen

- Consult Surgery for recommendations regarding disposition and/or additional imaging (eg, MRI abdomen/pelvis)

Appendicitis or Perforation

- Consult Surgery for admission/OR
- Start antibiotics:
 - Metronidazole 10 mg/kg IV (max 500 mg)
 - Ceftriaxone 50 mg/kg IV (max 2 g)
 - OR, if severe PCN allergy
 - Metronidazole 10 mg/kg IV (max 500 mg)
 - Ciprofloxacin 10 mg/kg IV (max 400 mg)
- NPO, start MIVF with D5 NS + 20KCl
- Continue appropriate pain management

No surgical admission or intervention anticipated

- Admit to Surgery for serial abdominal exams
- NPO, start MIVF
- NO antibiotics

Additional Imaging

No appendicitis

Appendicitis

* REFERRING FACILITIES *

- If a CT abdomen-pelvis is performed at a referring facility **AND** is **positive**, please contact **OMC Pediatric Surgery** for consultation / direct admission.
- If a CT abdomen-pelvis is performed at a referring facility **AND** is **negative**, please contact **OMC Pediatric ED** for consultation / ED-to-ED transfer.

APPENDICITIS EVALUATION

Inclusion Criteria

- Any child 0-18 years of age with history or exam findings concerning for appendicitis

Exclusion Criteria

- Known inflammatory bowel disease
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Index of Suspicion / Pediatric Appendicitis Score (PAS)

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MALES

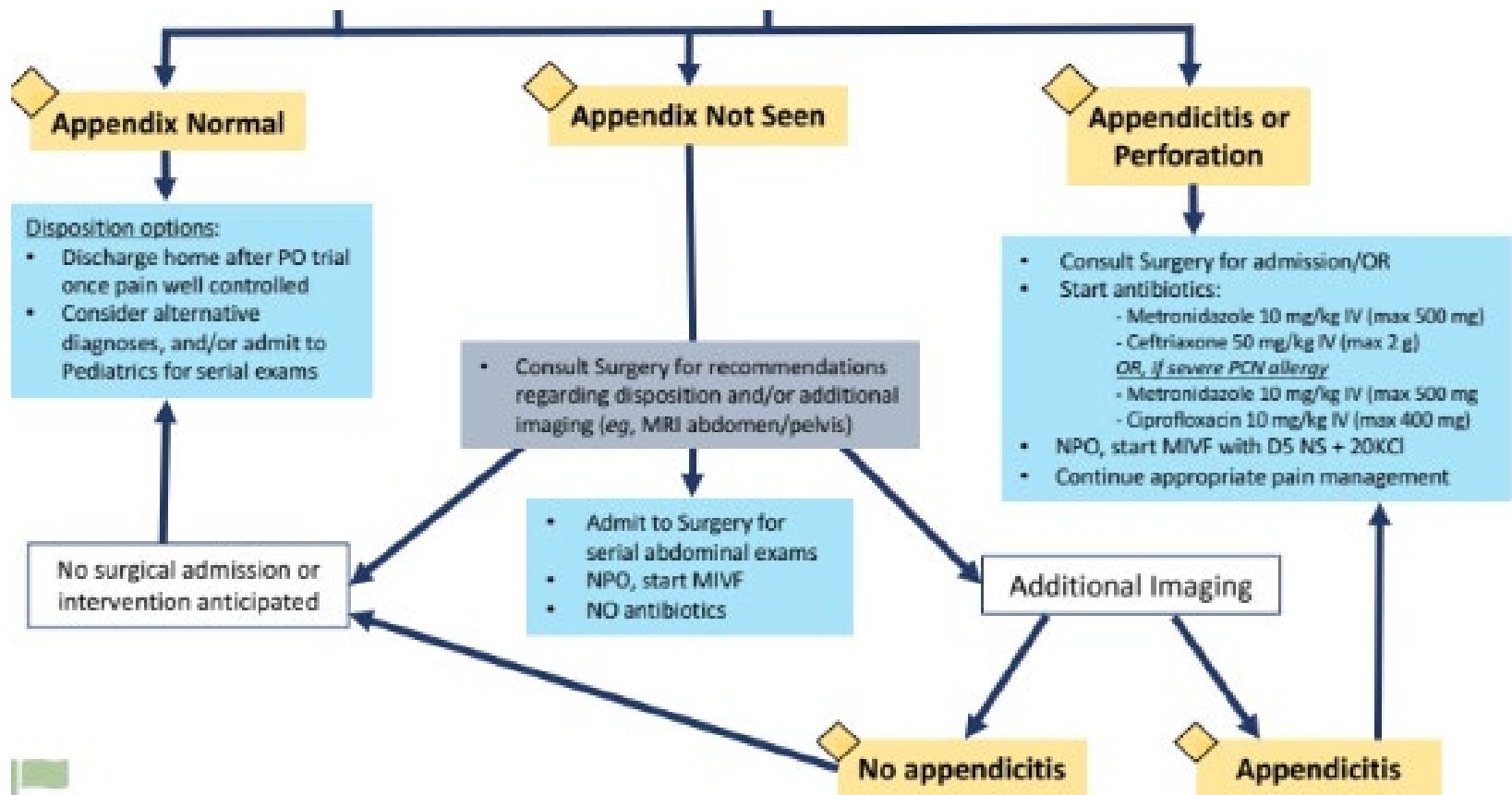
- US Abdomen – Limited
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FEMALES

- US Abdomen – Limited
- US Pelvis, non-OB
- IV access, CBC, CMP, CRP, UA
- Serum/urine HCG, consider STI testing (if age appropriate)
- Analgesia, IVF as indicated

Low Suspicion or PAS ≤ 3

Consider alternative diagnosis and/or discharge home with PCP follow up in < 24 hours with strict return precautions OR continued observation with serial exams



Appendicitis - Summary

- One of the most common conditions requiring prompt recognition and surgical referral
- Early appendicitis has extremely low rate of complications and significantly lower costs
- Perforated appendicitis has significant short-term and long-term costs
- Selective imaging (after early surgical referral) will reduce negative appendectomies and lower perforation rate

Intussusception

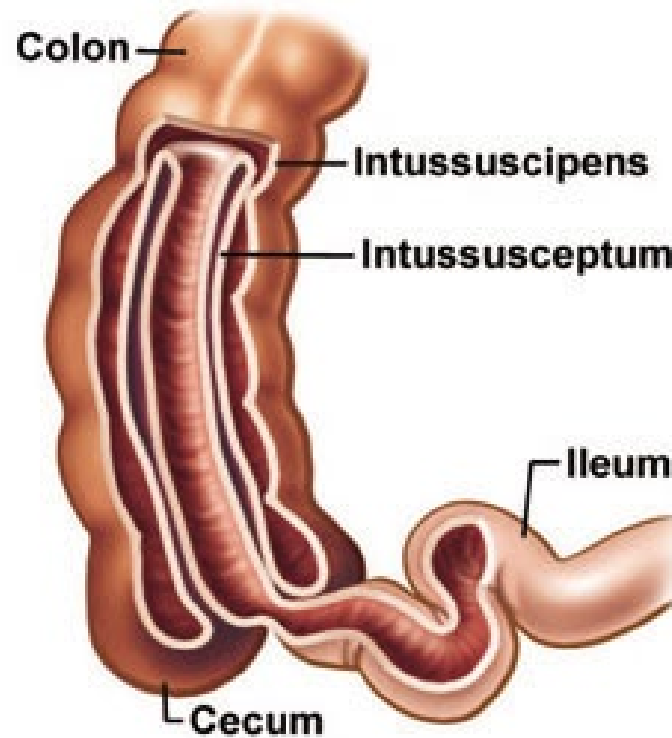
- Anatomy

Invagination of bowel into
distal bowel

Usually ileo-cecal

Progression to obstruction,
gangrene

Anatomy



Lead point (<5%)

Increases with patient age

Meckel's in younger patients

Polyps and lymphoma in older patients

Presentation

Classic: 9-11 months
(3 months to 3 years)

Intermittent, crampy
abdominal pain

Abdominal mass
(sausage-shaped)

Currant jelly or bloody stools

Currant Jelly



Prolapse of Intussusceptum



Diagnosis/Treatment

Fluids, NG, antibiotics

Contrast enema for diagnosis

Will treat (reduce) in 80%

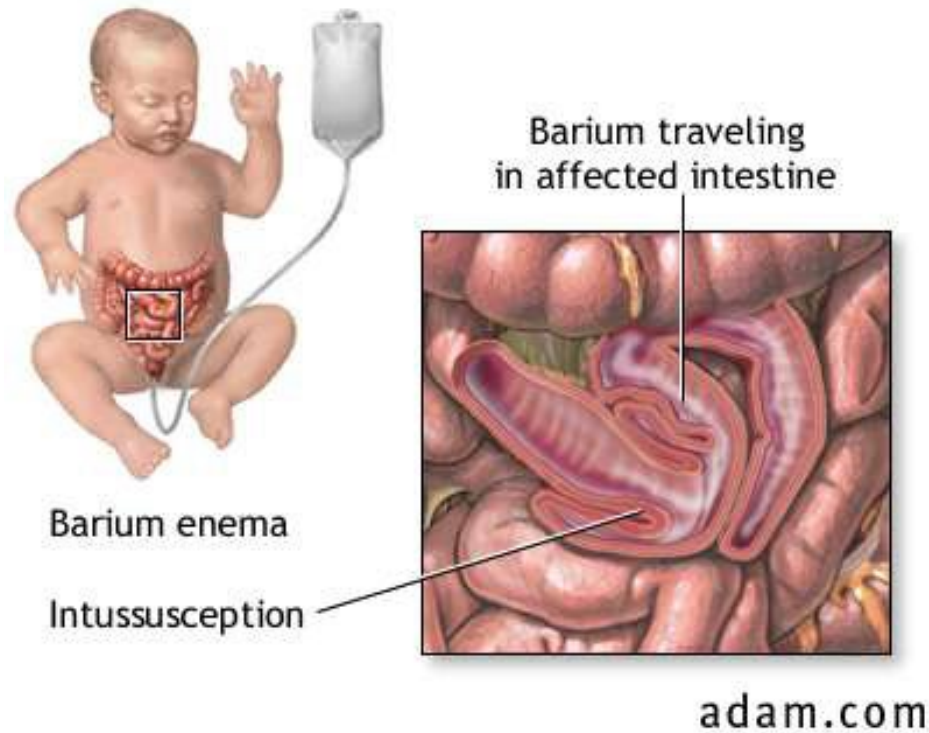
Ultrasound Dx: “Target,” pseudo-kidney signs

Air reduction used in some centers

If not reduced:

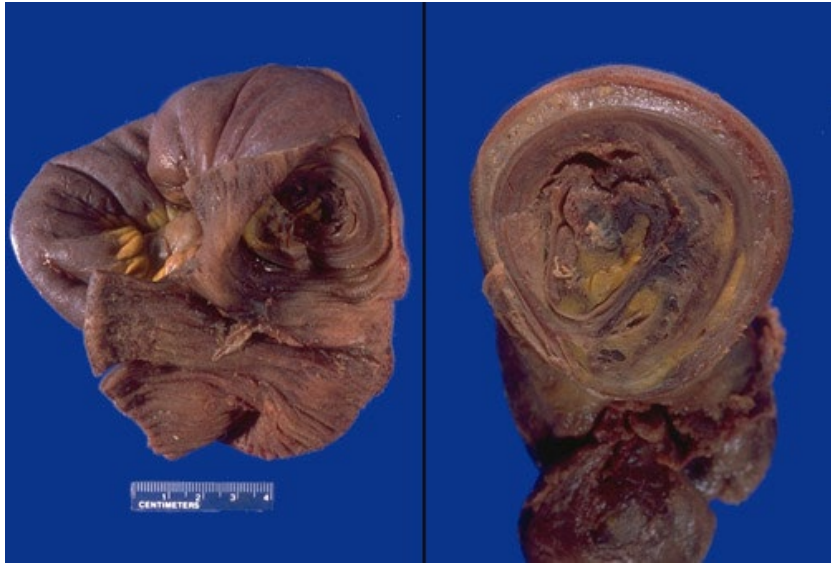
Surgical reduction with
appendectomy
± resection

Hydrostatic Reduction



- Complete when contrast enters ileum
- Repeat in selected patients

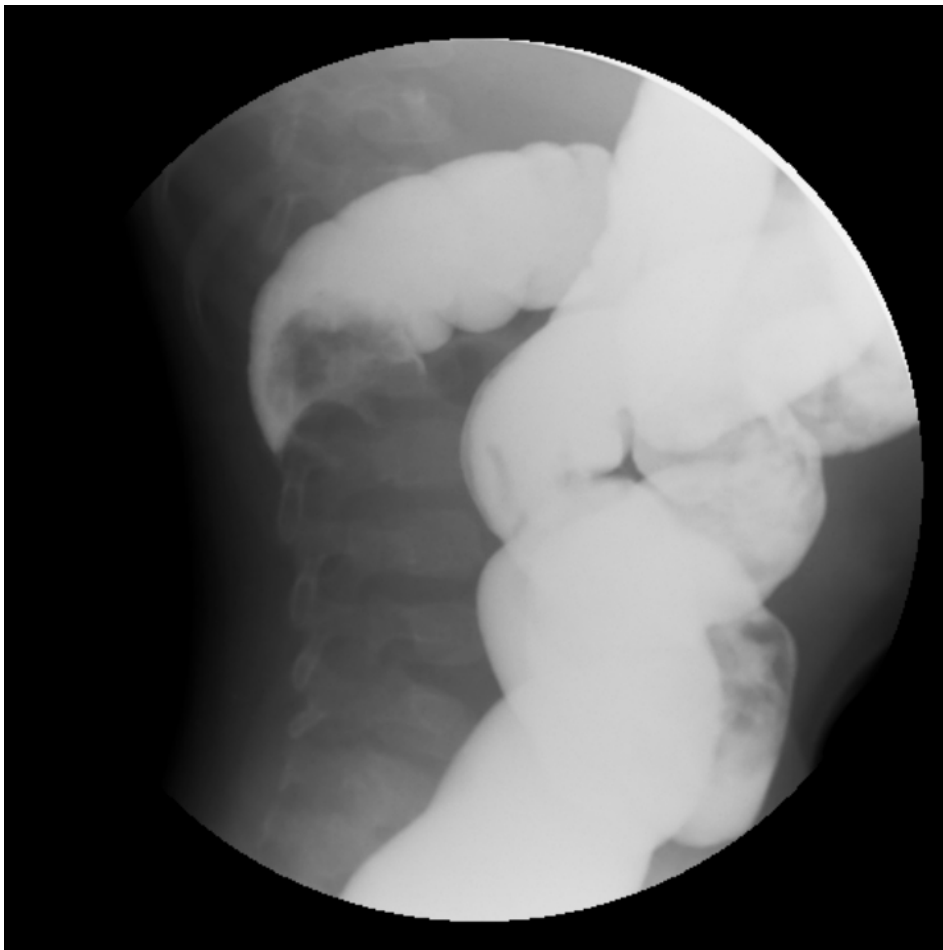
Target Sign Transverse or Cross-Section



Leading Edge



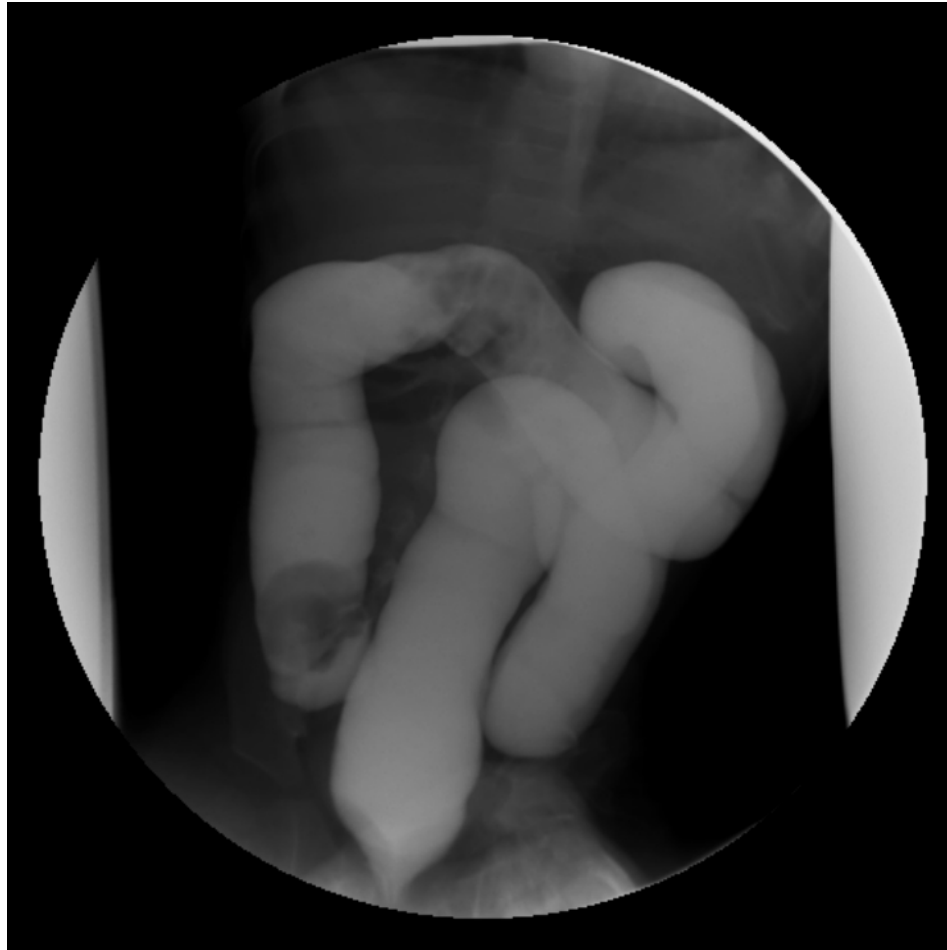
Partial Reduction



Almost Home



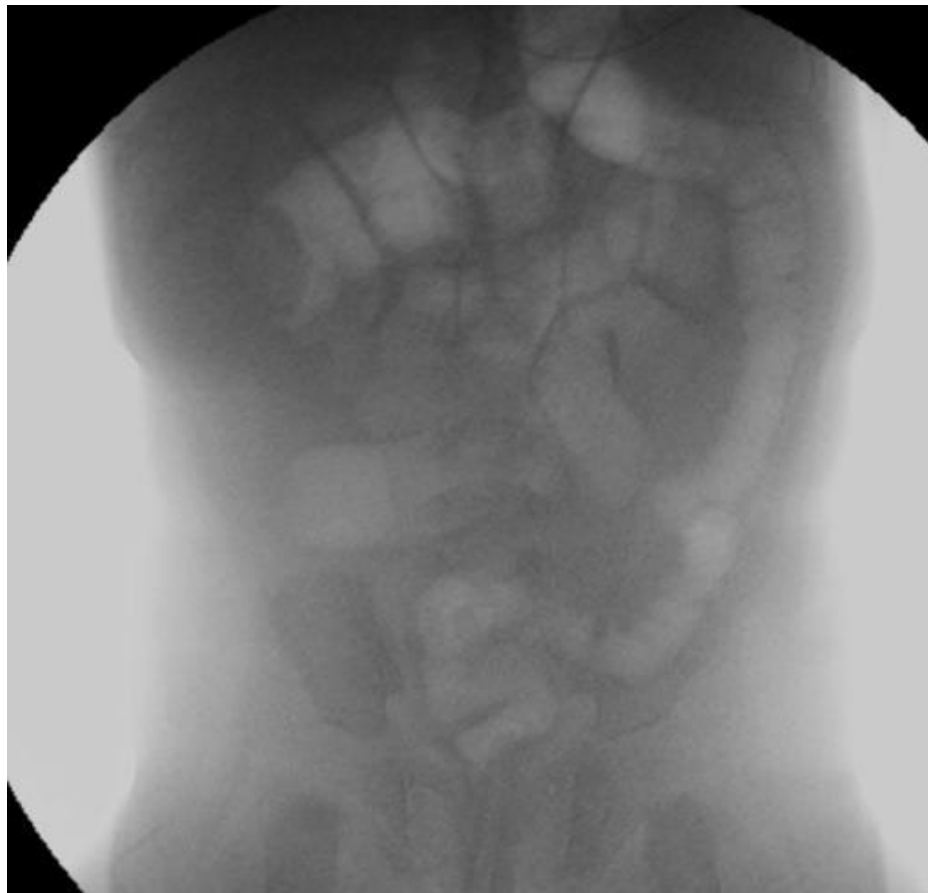
Incomplete Reduction



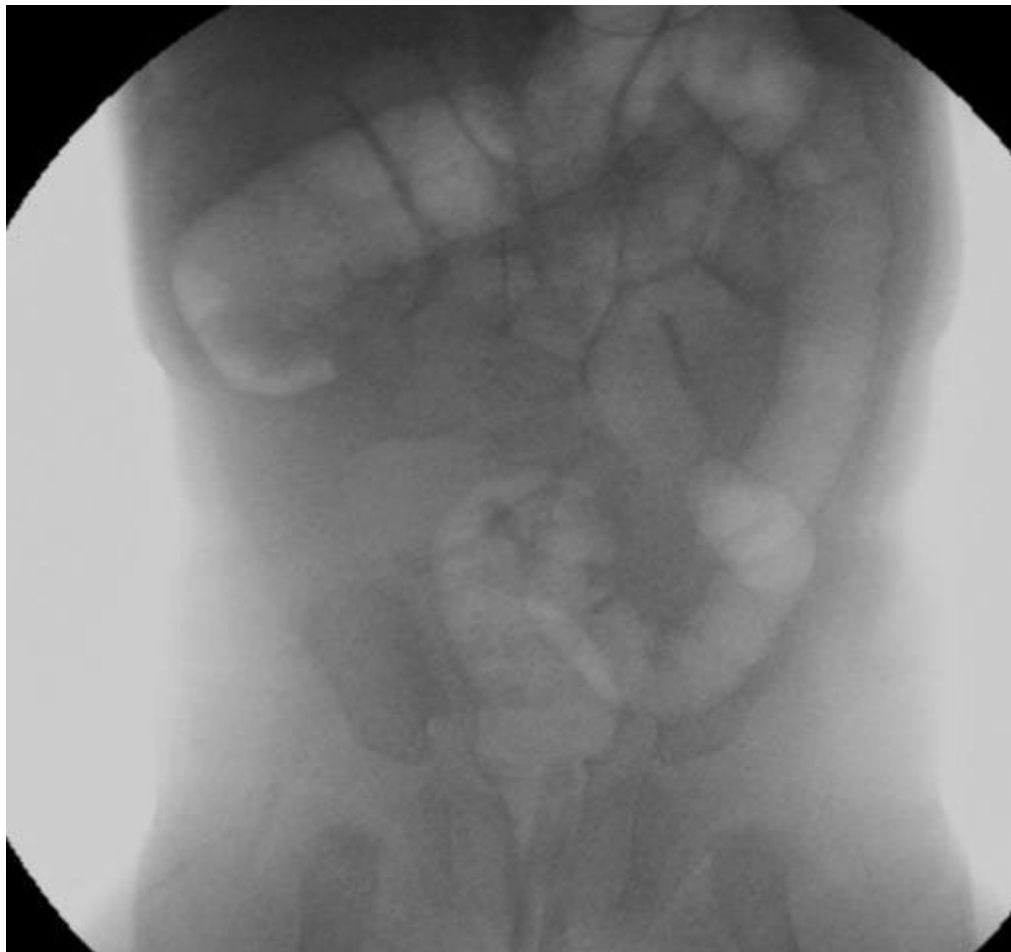
“Coiled Spring”



Pneumatic Reduction



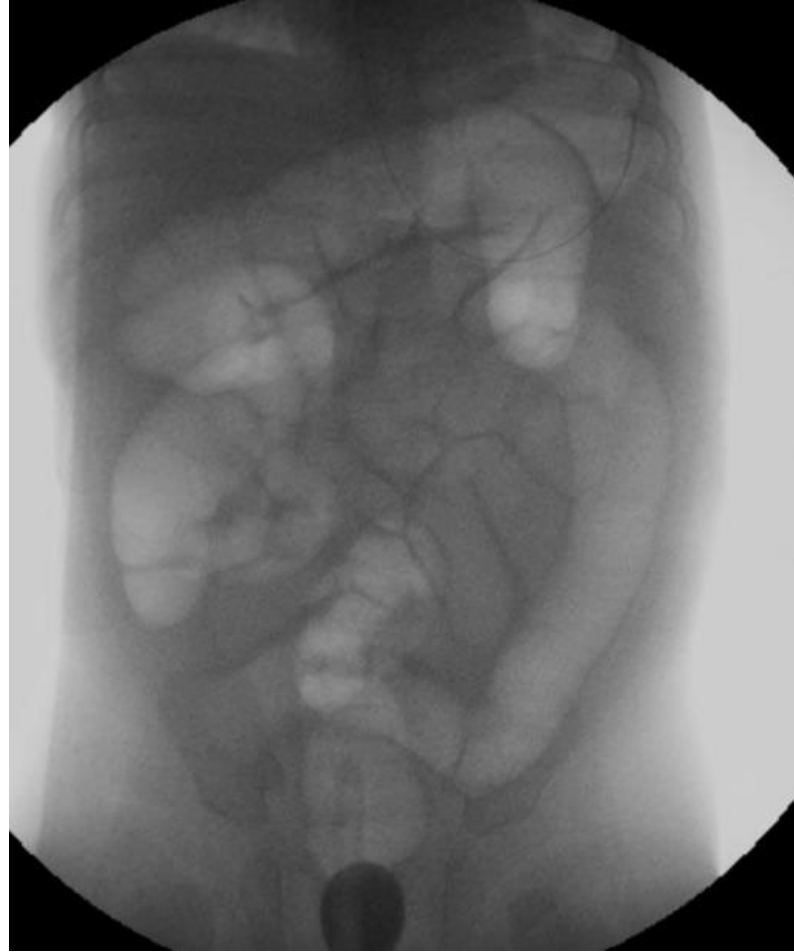
Partial Reduction



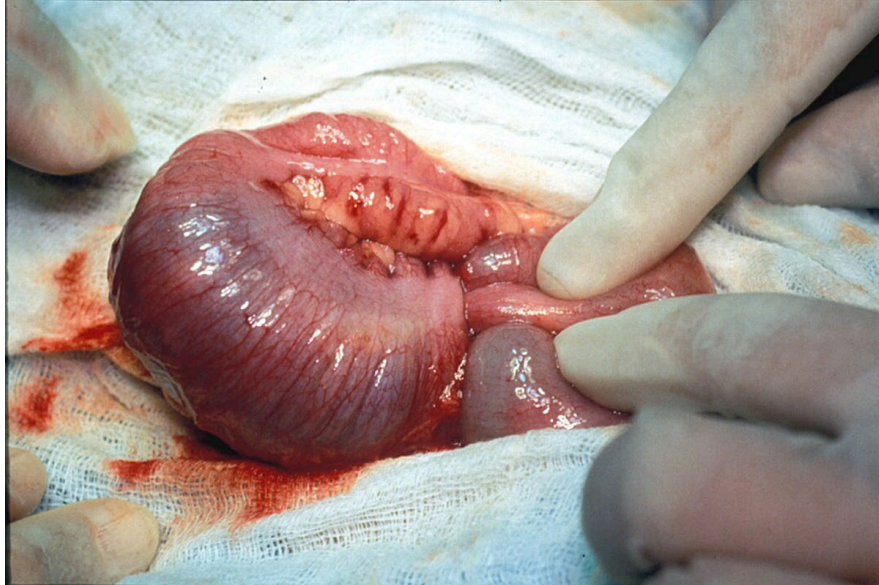
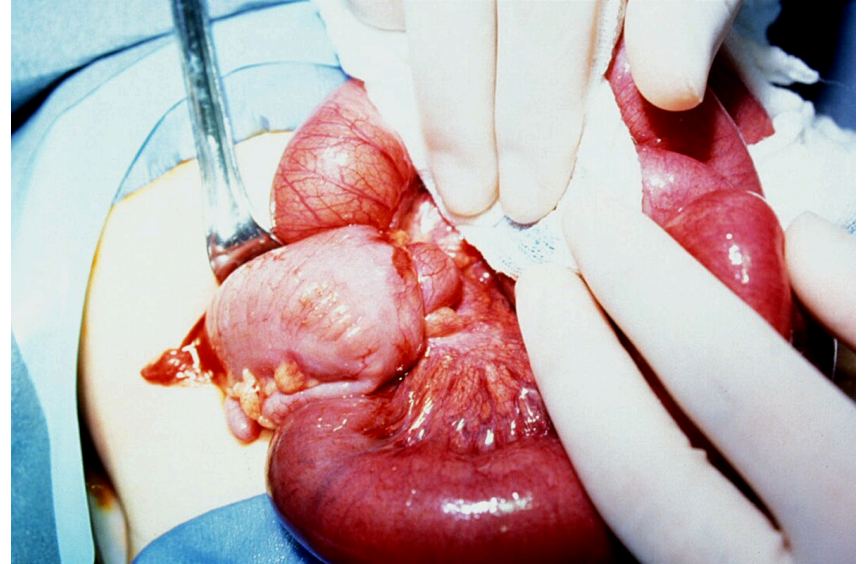
Reduction Progressing



Complete Reduction



Treatment

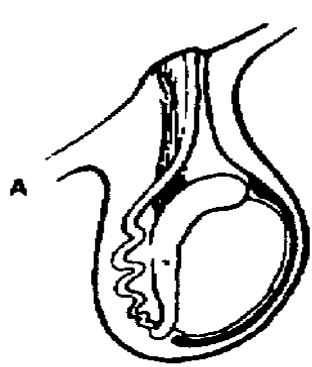


Inguinal hernia — Hydrocele

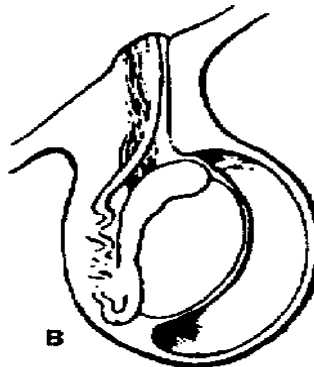
Most common surgical condition in children
risk of incarceration

Embryology — etiology
Patent processus vaginalis

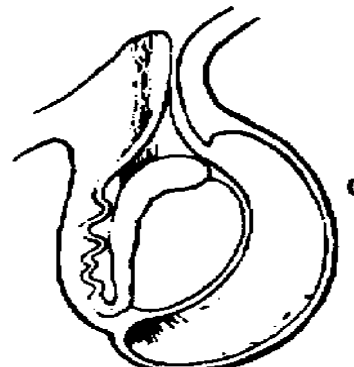
Incidence: 1-5%
Males > Females: 8-10:1
Preemies: 20% males,
2% females
60% R, 30% L, 10% bilateral



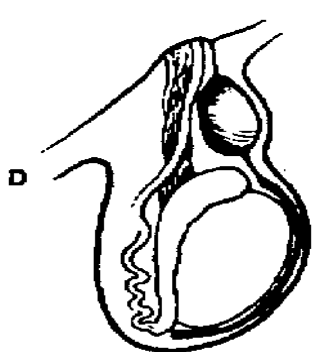
Normal



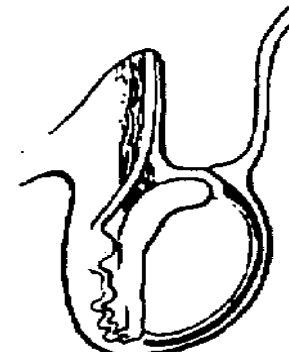
Hydrocele



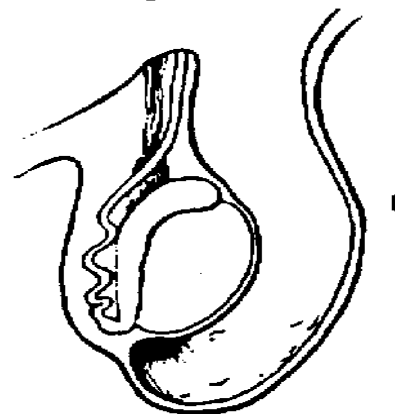
**Communicating
Hydrocele**



**Hydrocele
of Cord**



**Indirect
Hernia**



**Inguinal-Scrotal
Hernia**

Clinical Features

- Hernia – bulge in groin $\pm$ scrotum
 - May rely on history alone
 - May be scrotal only in young children
- Hydrocele – usually scrotal only
- Hydrocele of cord – asymptomatic, irreducible groin mass

Complicated Hernia

- Incarceration : unable to reduce
 - Don't trust transillumination
 - Tense and tender ± obstruction
- Strangulation : incarceration with ischemia
- Acute ? / Symptoms ?

Treatment

- Incarceration:
 - Sedation, manipulation
 - 90-95% reduced if early
 - Immediate operation if not reduced
 - Admit for observation if difficult or prolonged incarceration

Routine hernia

Repair soon after Dx
Especially in infants
60% incarcerate in first
6 months

Hydrocele

Repair at 1-2 years
Associated hernia

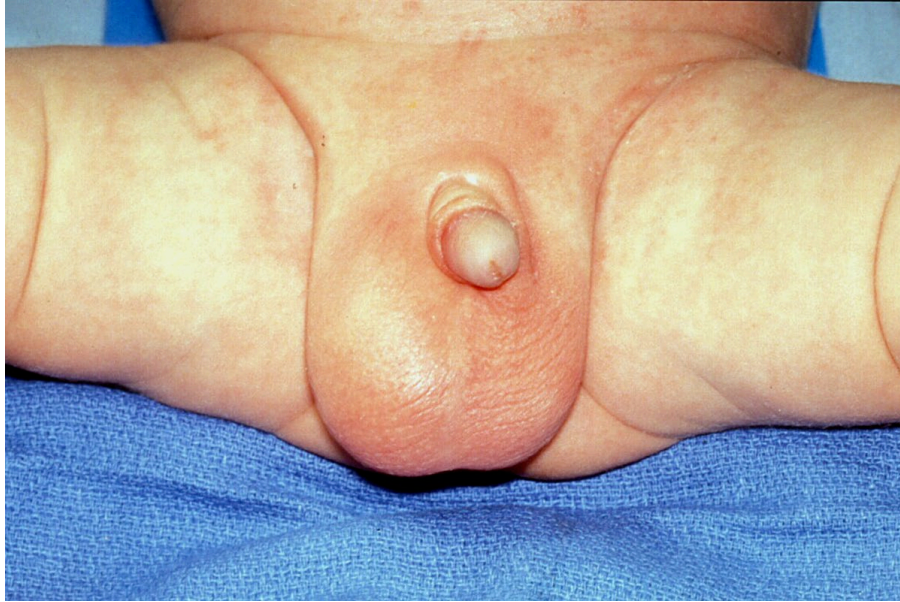
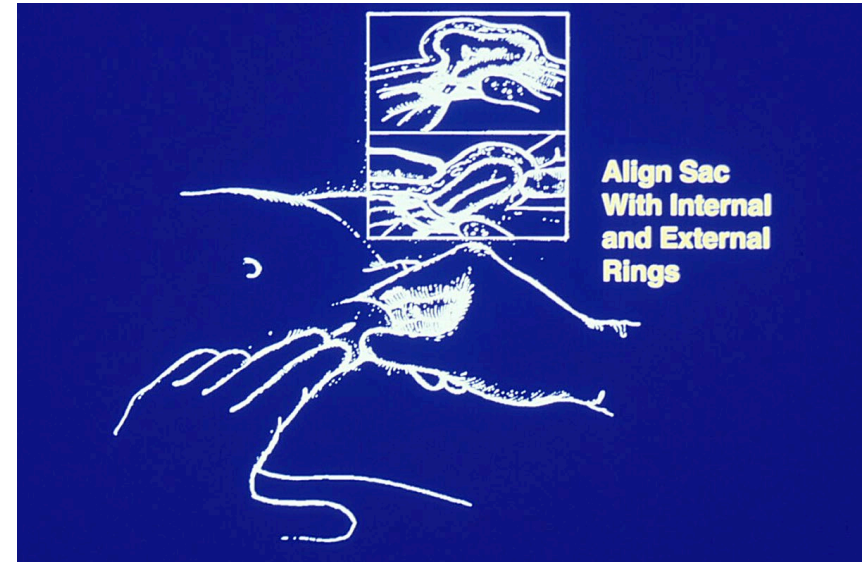
Inguinal Hernia in Girls

- Hernia sac usually contains ovary
- Be wary of fallopian tube in wall
 - Sliding hernia
- Incarceration may be asymptomatic
- Repair next elective day

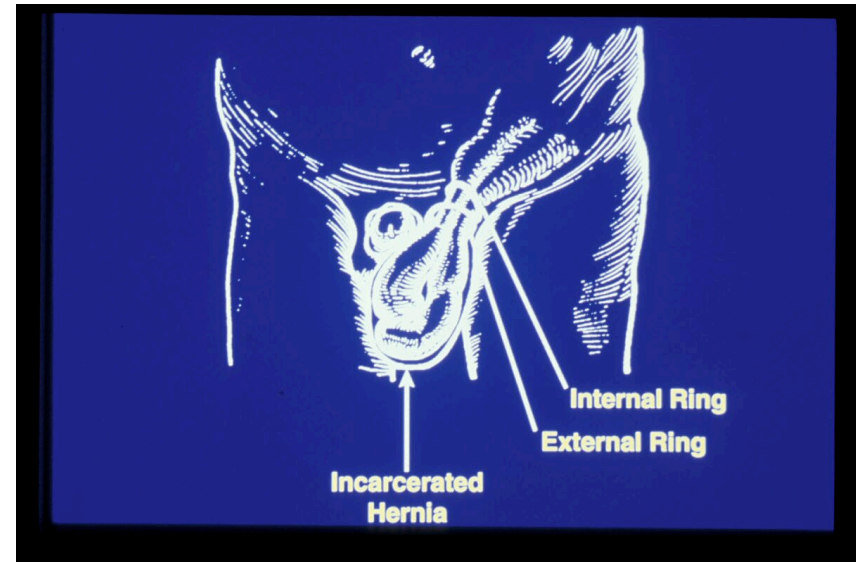
Contralateral Exploration

- Controversial
 - Risks vs Benefits
- Most common approach
 - Boys under 2 years old
 - Girls under 4 years old
 - Presentation with incarceration
 - Limited access to medical care

Inguinal Hernia - Hydrocele



Inguinal Hernia - Hydrocele



Pyloric stenosis

Epidemiology

Incidence: 3/1,000 infants

80% males

Inheritance

Siblings: 15-fold risk (5%)

Offspring: Maternal Hx: 13%

Paternal Hx: 5%

Presentation: usually 3-6 weeks

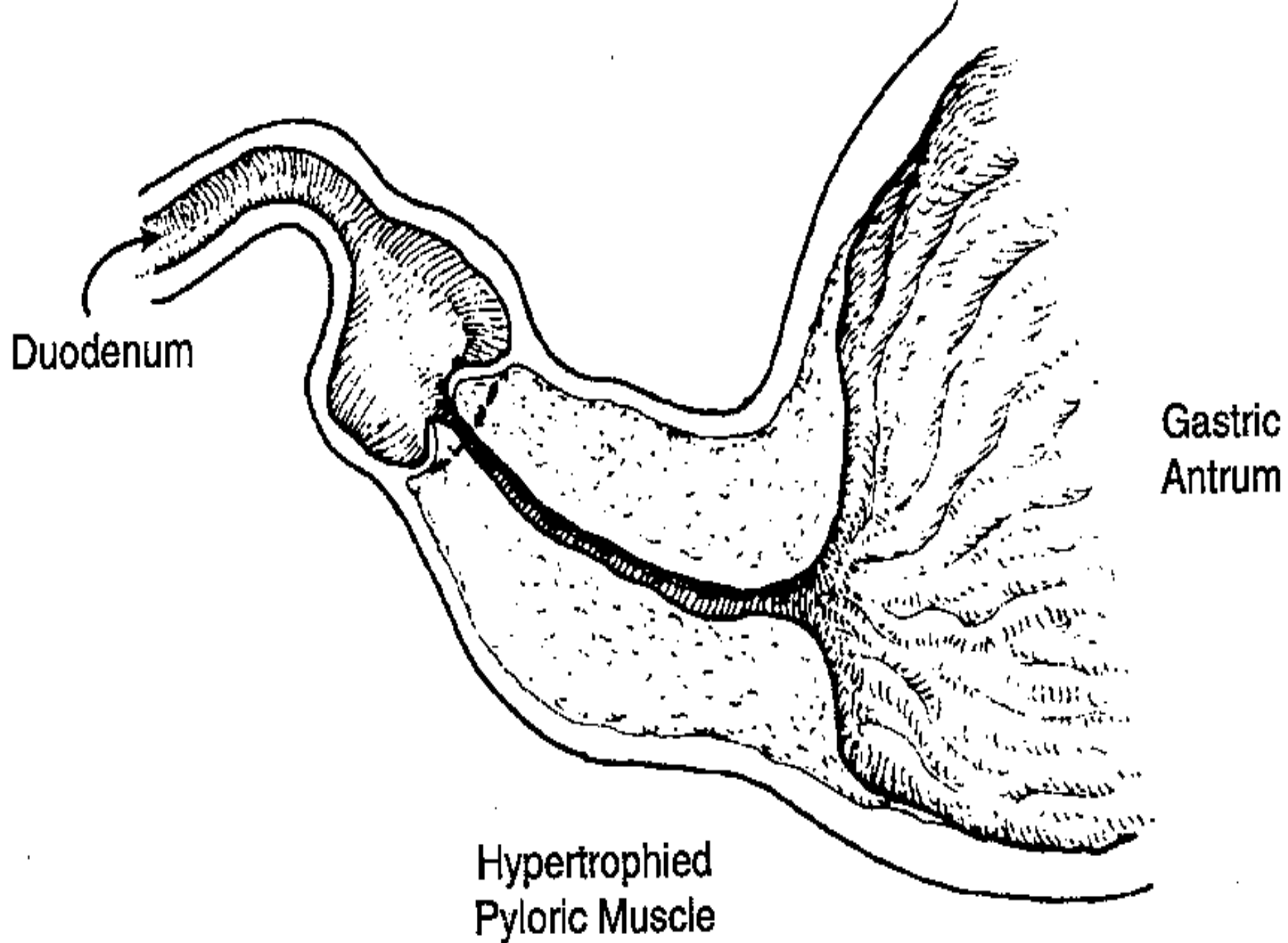
Forceful, nonbilious emesis

Palpable mass

Dehydration

Hypokalemia, hypochloremic
metabolic alkalosis

Paradoxical aciduria



Pyloric Stenosis



Diagnosis

Palpable epigastric mass — “olive”

Ultrasound

Diameter >14 mm

Thickness >5 mm

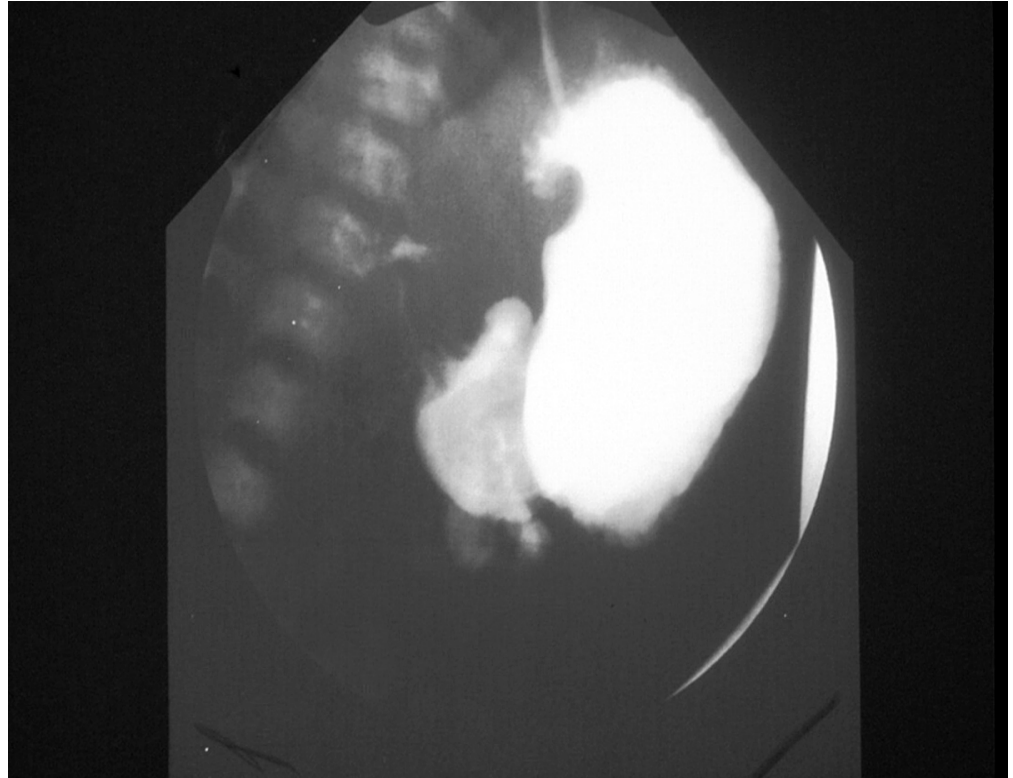
Length > 16 mm

HPS - Ultrasound



UGI – “Gold Standard”

- String sign
- Shoulder sign
- Delayed emptying
- Not operator dependent



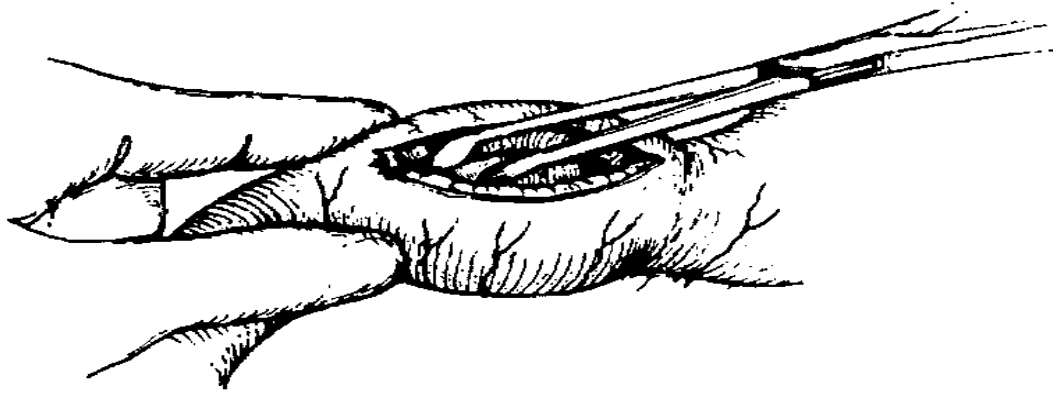
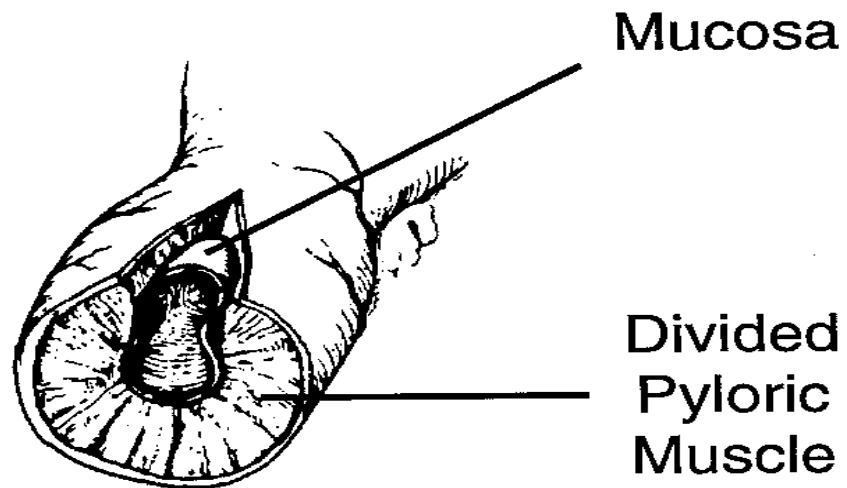
Treatment

Correct fluids and electrolytes

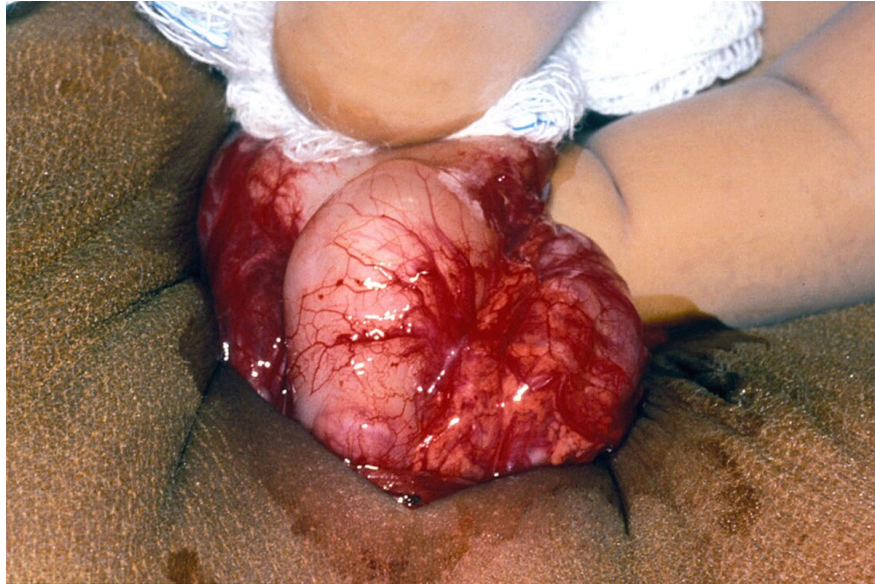
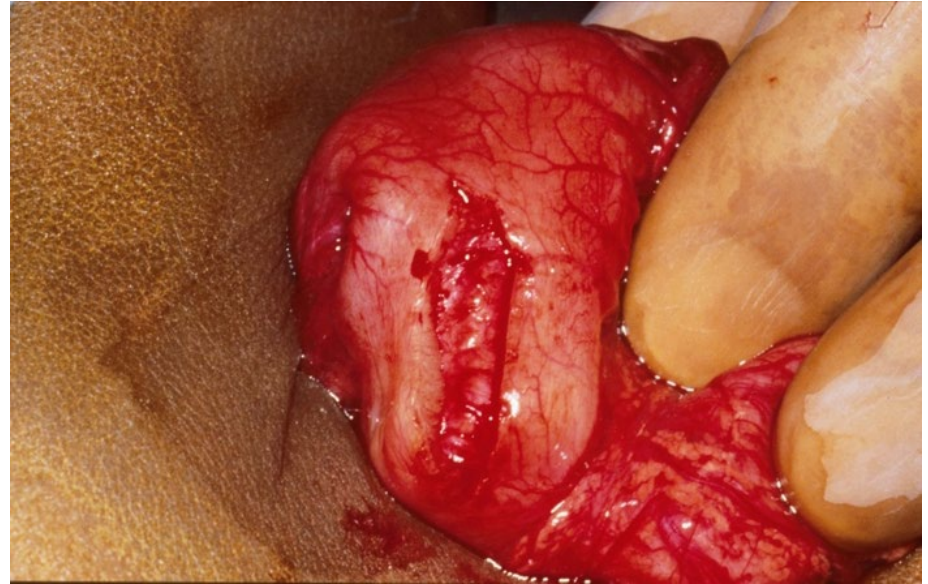
10-20 cc/kg saline bolus
D₅ 1/2 NS with KCl (150-200
cc/kg/day)

Ramstedt pyloromyotomy
Failure: 0.5%
Mortality: nil

Post-op apnea monitoring



Pyloromyotomy





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