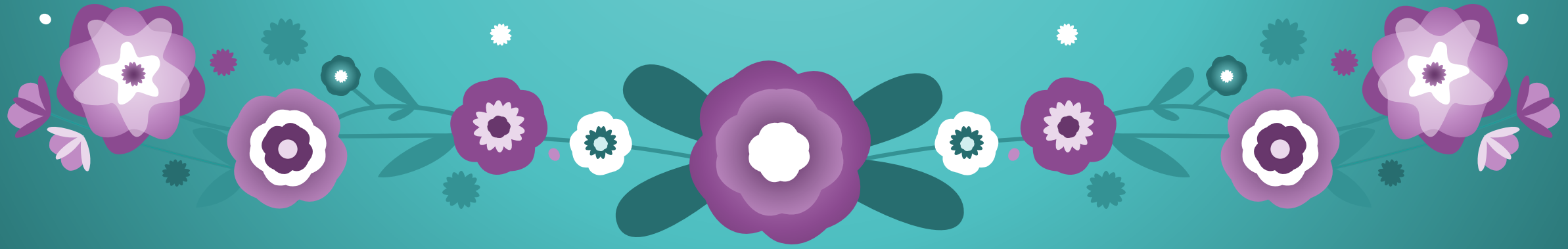
Intestinal Obstruction in Children

By Raed Al-Taher, M.D.



How to classify?

Degree	Age	Organ	Site	Cause
• Partial • Complete	• Neonatal • Infantile • Older children	• Duodenum • Jejunum • Ileum • Colon • Anus	• External • Mural • Intraluminal	• Mechanical • Inflammatory • Ischemic • Metabolic

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Age

Neonatal

- **Malrotation** – Intestinal obstruction by Ladd band
- Malrotation – Mid-gut volvulus
- **Intestinal atresia**
- **Necrotizing enterocolitis**
- **Meconium ileus**
- Meconium plug
- **Hirschsprung disease**
- **Anorectal malformations**
- Inguinal hernia

Infantile

- Malrotation – Intestinal obstruction by Ladd band
- Hirschsprung disease
- **Hypertrophic pyloric stenosis**
- **Intussusception**
- Inguinal hernia
- Constipation

Older children

- Inguinal hernia
- Habitual constipation
- Postoperative adhesions
- Peritonitis
- Hirschsprung disease
- Peritonitis
- Meckel diverticulum (band/ -itis/ intussusception)
- FB ingestion
- Intussusception

* Disorders in RED will be discussed in this lecture.

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Site

External	Mural	Intraluminal
• Postoperative adhesions • Meckel diverticulum (vitelline duct/band) • Abdominal masses/tumors • Herniation • **Malrotation** – Intestinal obstruction by Ladd band • Malrotation – Mid-gut volvulus	• **Intussusception** • **Hypertrophic pyloric stenosis** • **Hirschsprung disease** • **Intestinal atresia** • Malrotation – Mid-gut volvulus • **Necrotizing enterocolitis** • **Anorectal malformations** • Peritonitis • Meckel diverticulum (diverticulitis/ intussusception) • Paralytic ileus (postoperative, narcotics, electrolyte disturbances)	• Constipation • **Meconium ileus** • Meconium plug • FB ingestion (bezoars)

* Disorders in RED will be discussed in this lecture.

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Summary

	Short definition	M.C. Presentation	Best Dx & specific signs	Types	Best Tx
Intestinal atresia 	Congenital atretic segment of (small or large) bowel	Newborn with bilious vomiting + abdominal distension	• Clinical • AXR (double bubble sign for duodenal atresia)	I, II, IIIa, IIIb, & IV	Surgery: • Resection + anastomosis • Duodeno-duodenostomy without resection for duodenal atresia
Malrotation 	Congenital abnormal rotation of (small & large) bowel, results in short mesentery & midgut volvulus	Neonate with bilious vomiting	• Clinical • Upper GI contrast study	-	Emergent surgery: • Ladd's procedure
MI 	Congenital thick meconium obstructing distal small bowel	Newborn with bilious vomiting + abdominal distension + delayed passage of meconium	• Clinical • Contrast enema (Neuhauser sign) • Testing for CF	• Simple • Complicated	Conservative: • Rectal washouts • Pancreatic enzymes +/- Ileostomy for irrigation +/- Surgery for complications
NEC 	Acquired (small &/or large) bowel hypoperfusion and necrosis	Premature neonate in sepsis + bilious vomiting + abdominal distension +/- bloody stool	• Clinical • AXR (pneumatosis)	Bell's staging: I. Suspected II. Definite III. Advanced	Conservative: • NPO + NGT + IV F + ABx +/- Surgery for complications + Ileostomy
HD 	Congenital aganglionosis of distal large bowel	Newborn with bilious vomiting + tense abdominal distension + delayed passage of meconium + gush of liquid stool on DRE	• Clinical • Contrast enema (transitional zone) • Rectal biopsy	• Ultrashort segment • Short segment (recto-sigmoid) • Long segment (includes total colonic & total GI)	Surgery: • +/- Colostomy • Pull-through
ARM 	Congenital absence/abnormality of the anus	Newborn with abnormal anus +/- meconium via urethra or vestibule	• PEx (perineal inspection) • +/- Cross-table x-ray • +/- Colostography	• High/low • With/without fistula	Surgery: • +/- Colostomy • Anorectoplasty
HPS 	Acquired hypertrophy of pyloric muscle	2-8 weeks term neonate with progressive non-bilious projectile vomiting + hypochloremic hypokalemic metabolic alkalosis	• Clinical (olive sign) • Abdominal US	-	Surgery: • Pyloromyotomy
Intussusception 	Acquired invagination of proximal bowel into distal bowel (small &/or large)	3mo-3yrs infant/toddler with abdominal colics +/- vomiting +/- currant jelly stool + Hx of recent URTI or GE	• Clinical (Dance sign) • Abdominal US (target or donut sign, & psuedokidney sign)	• Primary (idiopathic) • Secondary	Conservative: • Reduction enema +/- Surgical reduction (if enema failed or C/I)

Intestinal Atresia

- 1 in 3,000 | black > white | jejunoileal
- 1 in 5,000 | F>M (slight) | duodenal
- 1 in 50,000 | colonic

Jejunoileal > duodenal > colonic

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Intestinal Atresia

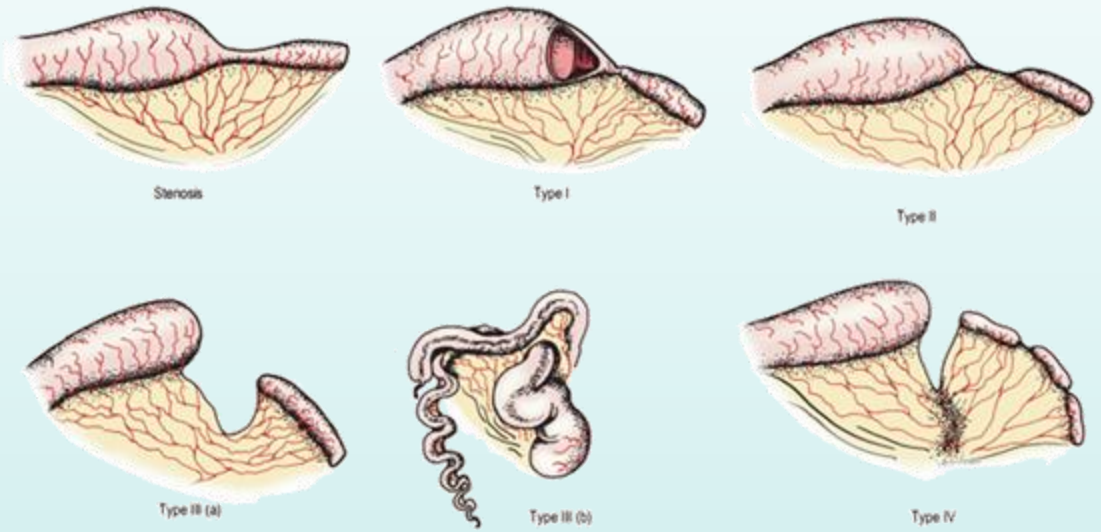
Pathology

- Theory:

Intrauterine vascular insult to intestinal segment after being completely developed

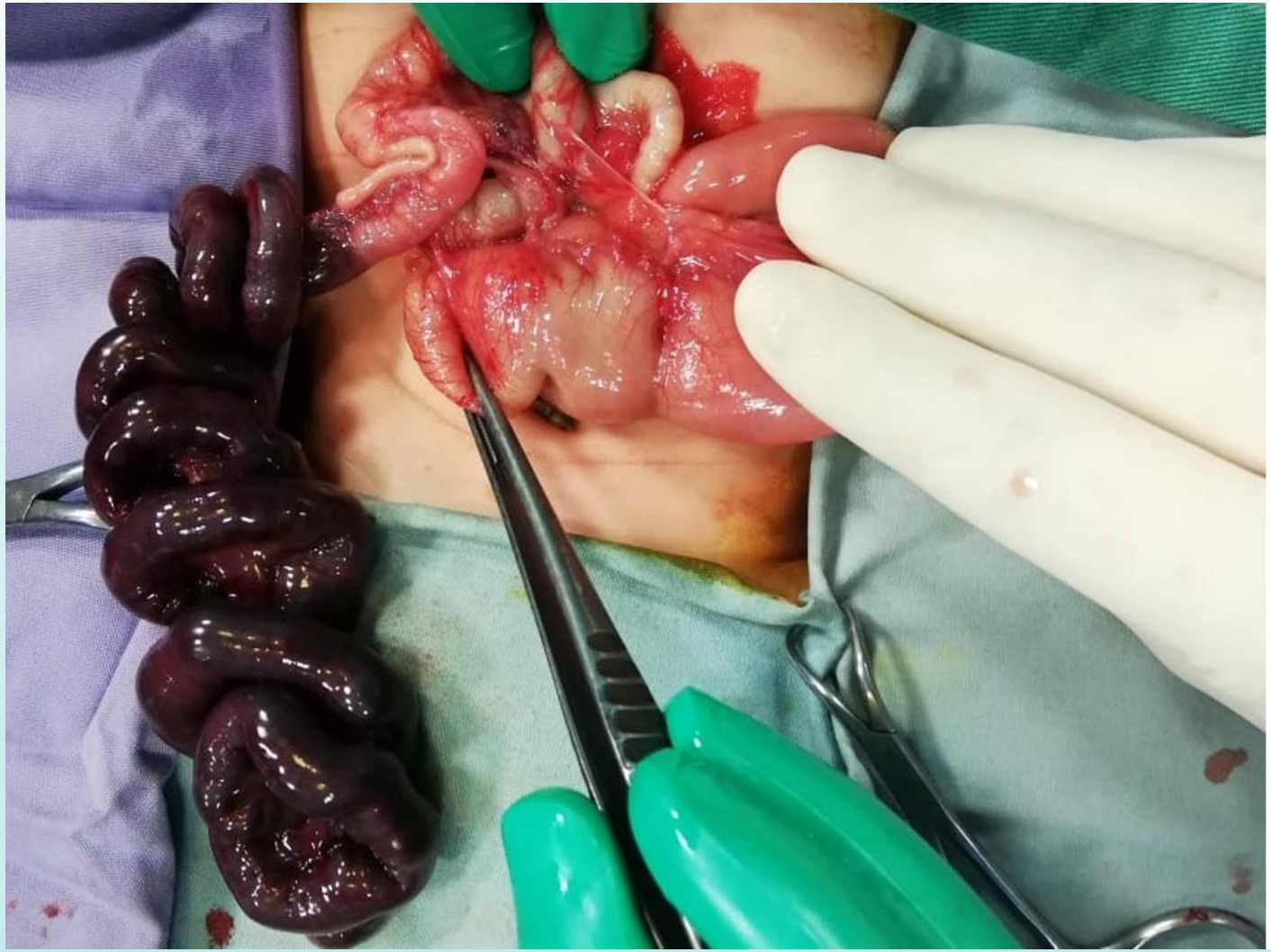
Meconium can be found in distal bowel beyond the site of obstruction

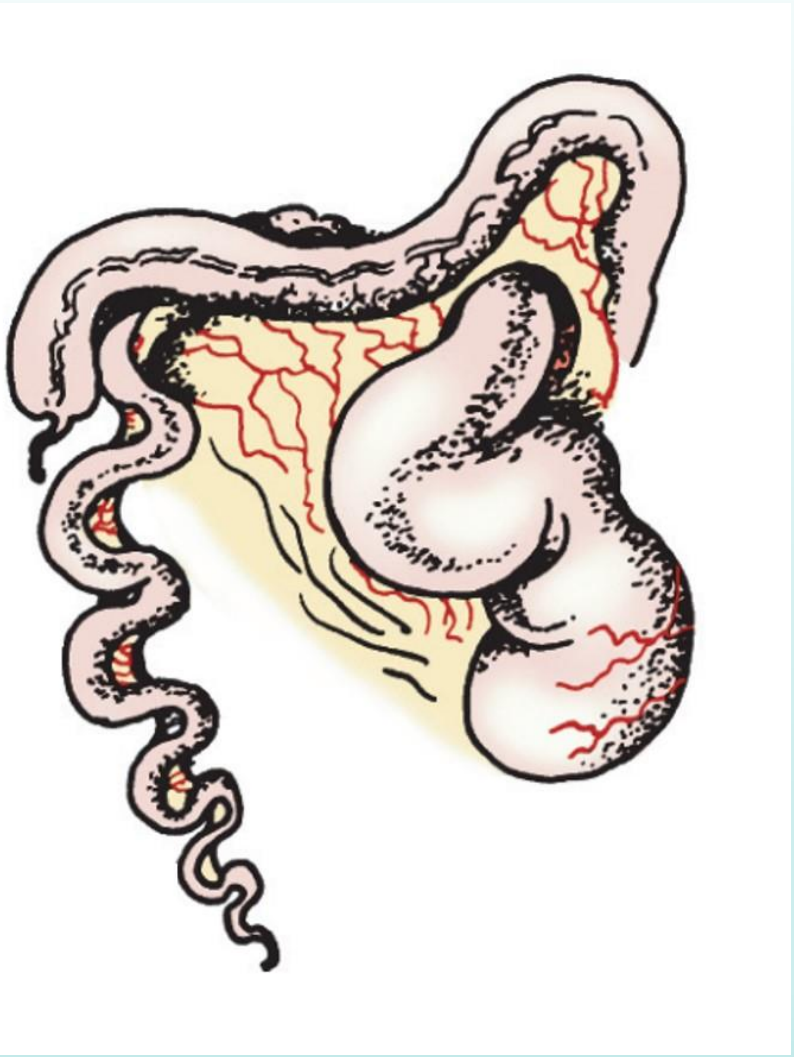
Intestinal Atresia



Classification (applicable to all parts of the intestine)

- Type 0 – Stenosis (no atresia)
- Type I – Membrane or web
- Type II – Fibrous cord joins two blind ends of bowel
- Type III
  - IIIa – Gap between ends with a V-shaped mesenteric defect
  - IIIb – Large defect in the mesentery, significant intestinal loss and distal intestine winds round a single, fragile vascular pedicle (“apple-peel” or “Christmas tree” atresia)
- Type IV – Multiple atresia (“string of sausages” appearance)





Jejunal atresia – type IIIb

“Apple-peel” atresia complicated by necrosis.

Intestinal Atresia

Clinical Features

- Antenatal:
  - US may show:
    - polyhydramnios (↑ with the more proximal atresias).
    - "double bubble"
    - dilated proximal loops
    - echogenic bowel

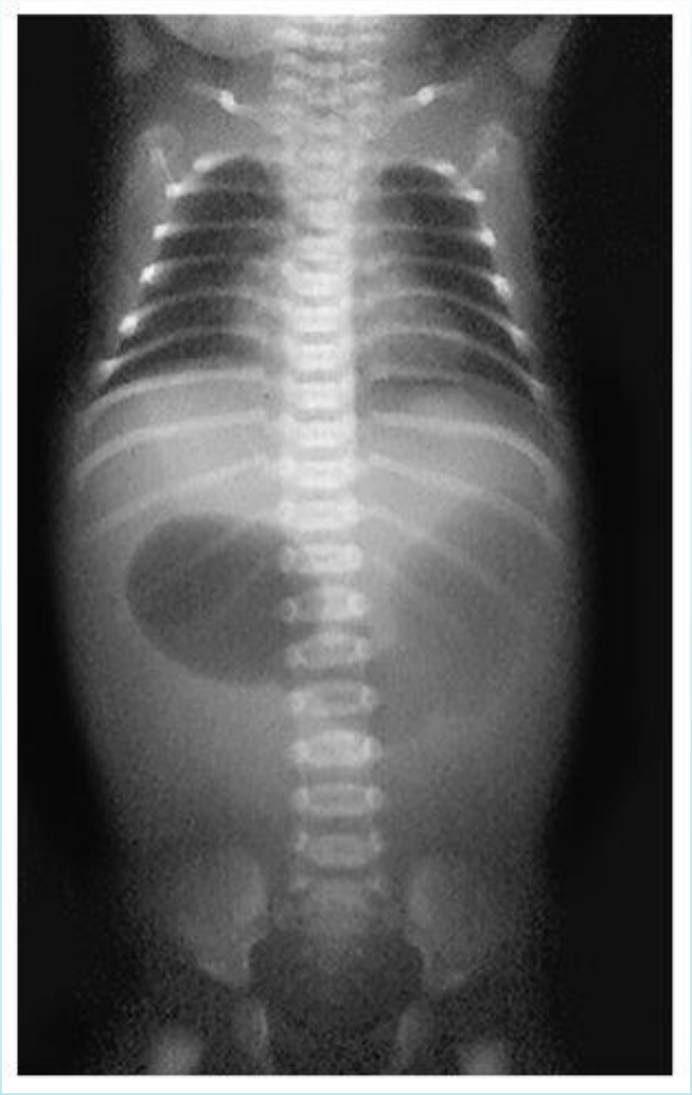
- Postnatally:
  - Bile-vomiting
  - Varying degrees of distension (depending on level of obstruction)

Intestinal Atresia

Investigations

- **AXR**
  - Features of obstruction
  - **"Double bubble" and no distal gas (classical feature in duodenal obstruction)**
  - Peritoneal calcification: suggests perforation and meconium cyst formation

- **Contrast enema**
  - may show **microcolon**
  - helps ruling out Hirschsprung disease or meconium plug



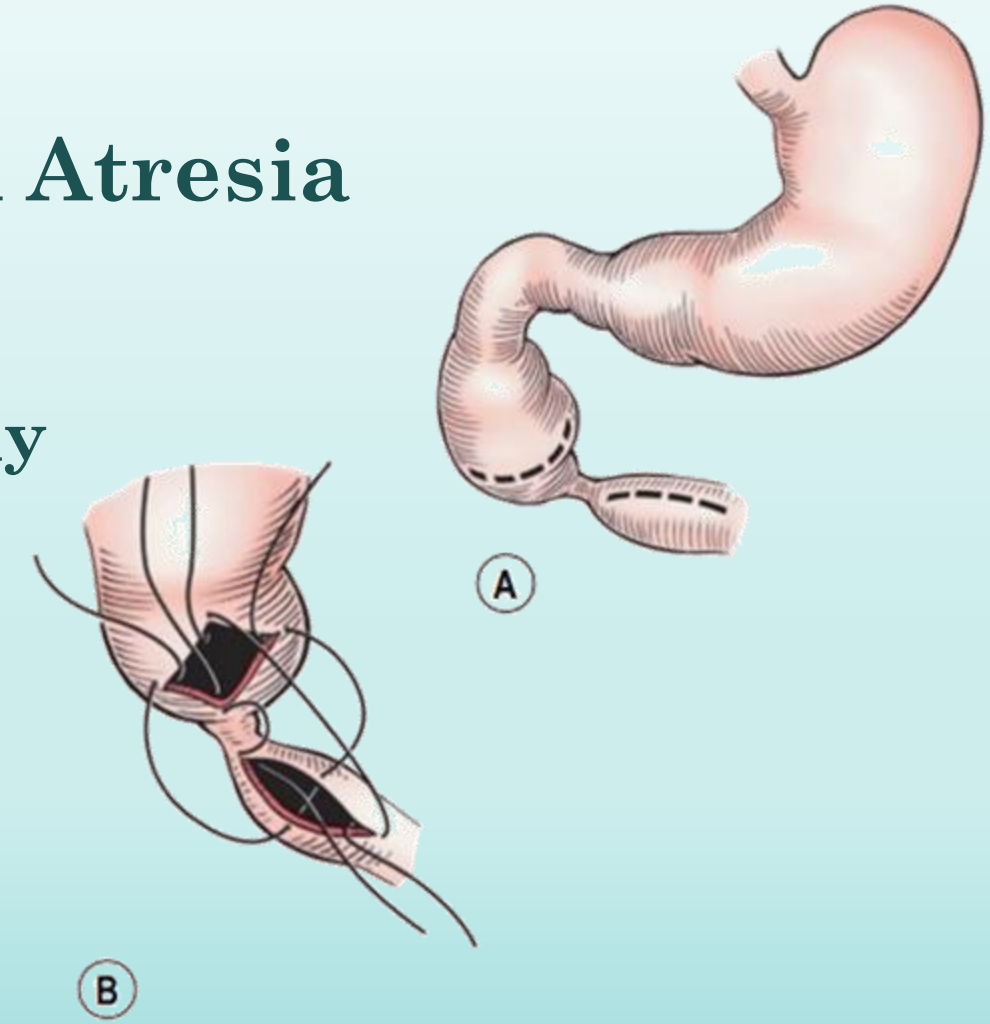
“Double bubble” and no distal gas
(classical feature in duodenal atresia)

Intestinal Atresia

Surgery for Duodenal Atresia

➔Duodeno-duodenostomy

➔without any resection



Holcomb, G. W., Murphy, J. P., & Peter, S. D. S. (2019). Holcomb and Ashcraft's Pediatric Surgery.

Intestinal Atresia

Surgery for Jejuno-ileal Atresia

➔ Resection & re-anastomosis

1. Assess viability and length of residual bowel
2. Assess patency of distal bowel lumen
3. Resection of atretic segment(s) and re-anastomosis

Intestinal Atresia

Surgery for Colon Atresia

- Resection of atretic segment + either one of these:
  - Primary anastomosis
  - Colostomy creation and staged anastomosis

Malrotation

A spectrum of anomalies of rotation and fixation of the intestines

(principally the midgut)

Malrotation

Associated with:

- Gastroschisis and omphalocele
- Diaphragmatic hernia
- Duodenal atresia and biliary atresia
- Intussusception (Waugh's syndrome)
- Dysmotility and pseudo-obstruction syndromes

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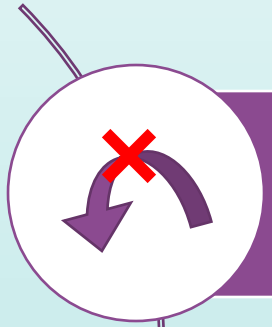
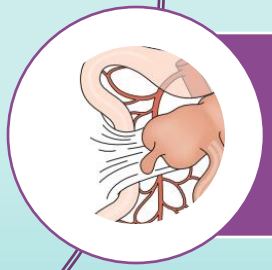
Malrotation

- The commonest variant:



Failure of final 90° anticlockwise rotation taking the cecum from RUQ to RLQ



Cecum is fixed to retroperitoneum by peritoneal bands running anteriorly to the 2nd part of duodenum (Ladd's bands).

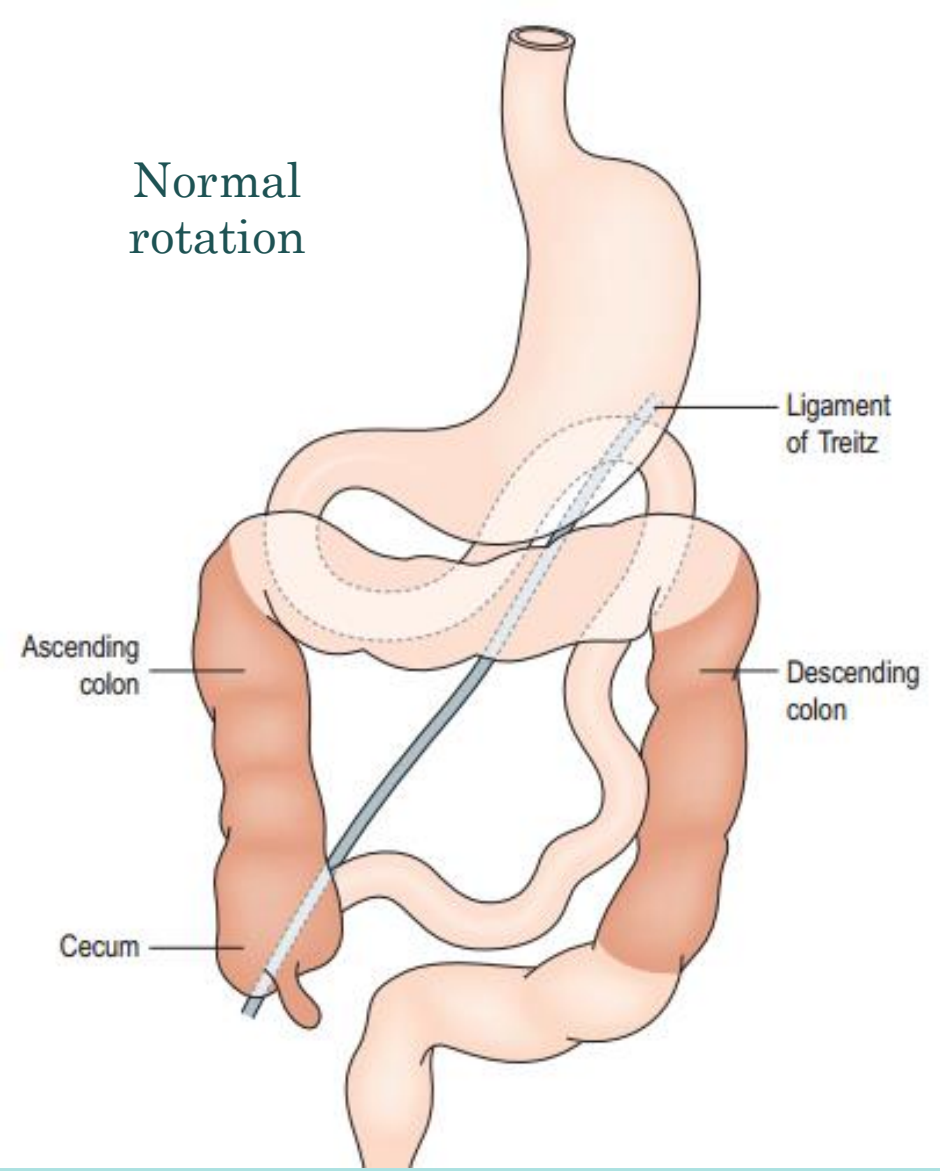
Malrotation

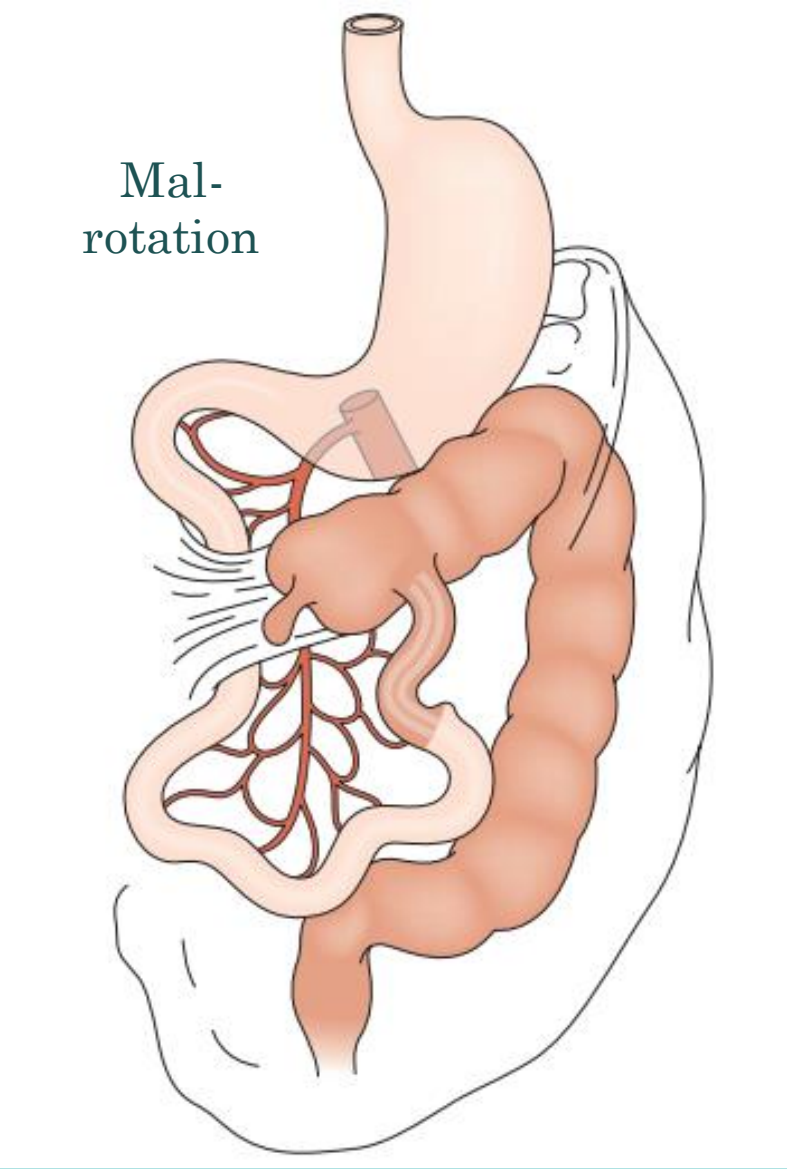
- The key pathology is:
  - The distance between the two ends of the small bowel mesentery

    (between DJ junction and IC valve)

→ when diminished

→ ↑ **risk of volvulus**





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Malrotation

Clinical Features

- Can present at any age.
- Classic presentation:

Early:
- bile vomiting

Late:
- intermittent or acute abdominal pain
- diarrhea then constipation
- failure to thrive
- passage of altered blood

Malrotation

Clinical Features

On physical examination:

- Malrotation without volvulus:
  - **Abdomen is soft and non-tender**

- Malrotation with volvulus:
  - **Abdomen is rigid and tender**
  - **Upper abdominal distension**
  - **Blood-stained stools**

Malrotation

Clinical Features

- Chronic midgut volvulus (<10% of cases)
  - mesenteric thickening
  - lymphatic obstruction leading to chylous ascites

Malrotation

Investigations

1. AXR

- "Normal" in most cases.
- Abnormal features:
  - Malposition of the bowel ("small bowel" to the right and "colon" to the left)
  - Lack of distal bowel gas ("gasless" abdomen or a "double bubble" appearance)
  - "Whirled" appearance of mid-abdominal bowel
  - Thick-walled, tubular bowel loops (suggesting chronic volvulus)

2. Upper GI contrast study

- **investigation of choice** (if time permits!)

Contrast studies in malrotation

	Normal features	Abnormal features
Overall	"C" shaped duodenum	Redundant duodenum, right-sided jejunal loops
Lateral appearance	Overlapping, posterior position of second and fourth parts	Anterior position of fourth part
Duodeno-jejunal flexure	Left of spinal pedicles; rising to at least level of L1/L2 disk space	Right-sided or centrally placed. Failure of ascent to level of pylorus

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Handbook of Pediatric Surgery, by C. Sinha and M. Davenport, 2nd edition, 2022.

Malrotation

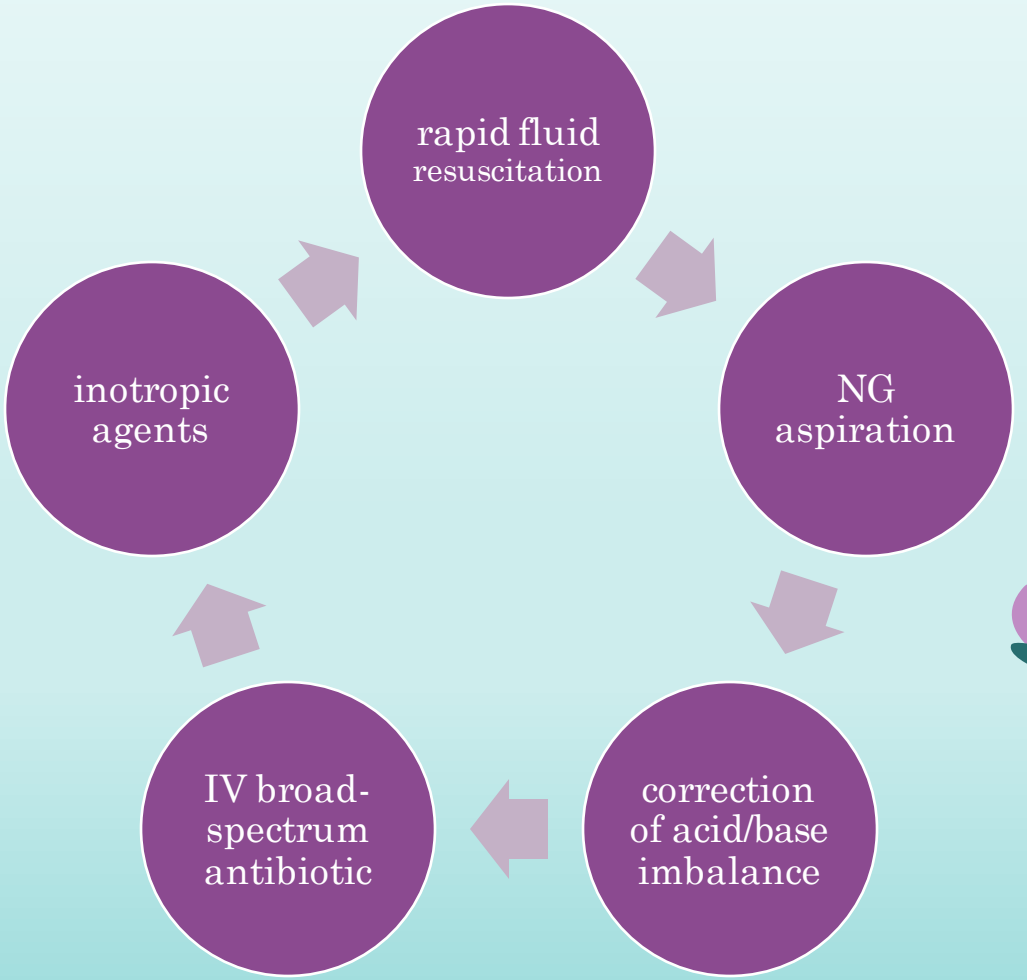
Management

- If volvulus is likely..

→ every minute counts

→ **Urgent laparotomy**

- Other elements to be considered meanwhile →



Malrotation

Management: Surgery (Ladd's Procedure)

1. Division of Ladd's bands
2. Widening of mesenteric base
3. Position bowel (small bowel right and large bowel left)
4. ± Appendectomy

Meconium Ileus (MI)

Distal ileal intraluminal obstruction due to presence of abnormally thick meconium.

~90% of infants with MI will have **cystic fibrosis**

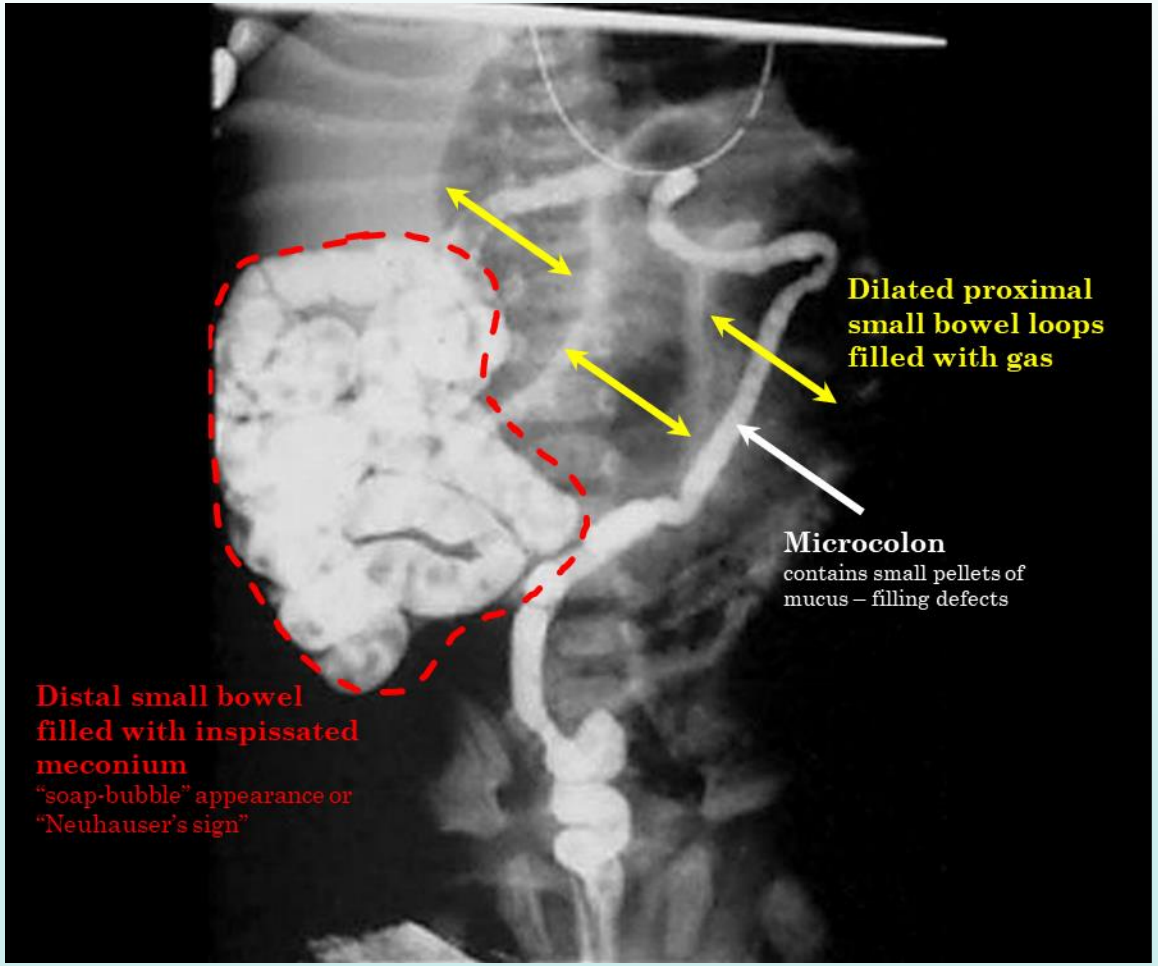
Meconium Ileus

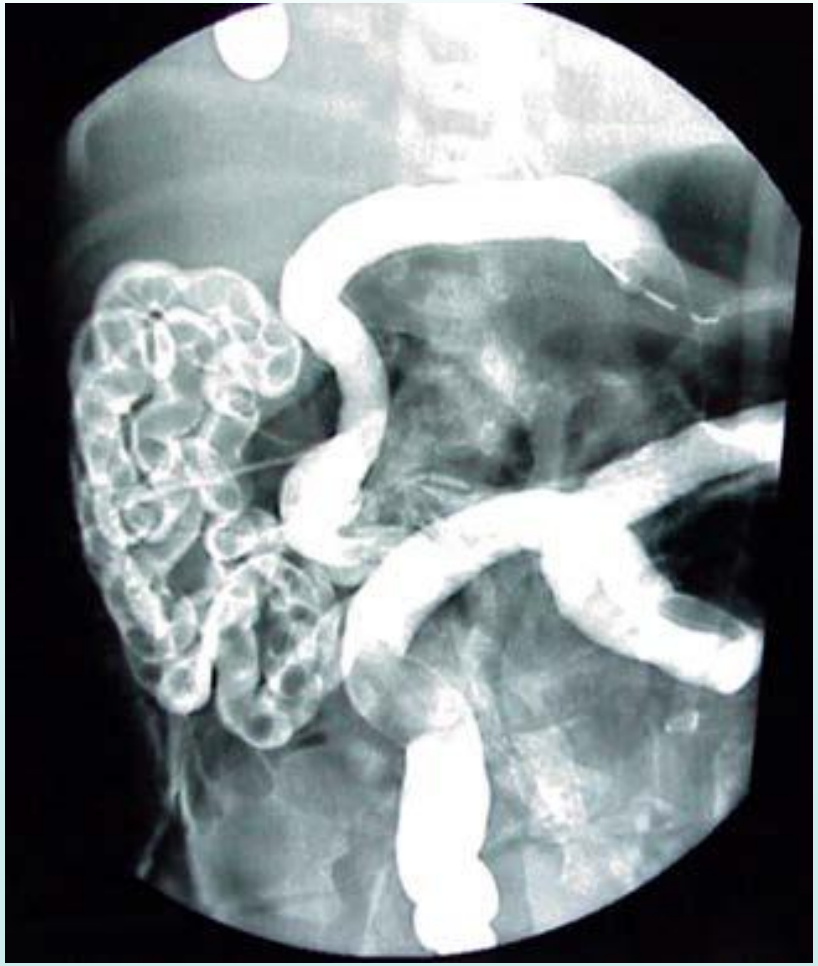
Investigation

1. AXR:
   - Dilated proximal bowel loops
   - “Soap-bubble” appearance or "Neuhauser’s sign" (in the loops filled with meconium)
   - Calcification (in meconium peritonitis)

2. Contrast enema
   - Microcolon (contain small pellets of mucus)

3. Confirmation of CF:
   a) Sweat-Chloride test (normal <40, diagnostic ≥60 mmol/L)
   b) Gene mutation analysis
   c) Immunoreactive trypsinogen (basis for screening - ↑↑ levels in CF)





Contrast Enema of two MI cases

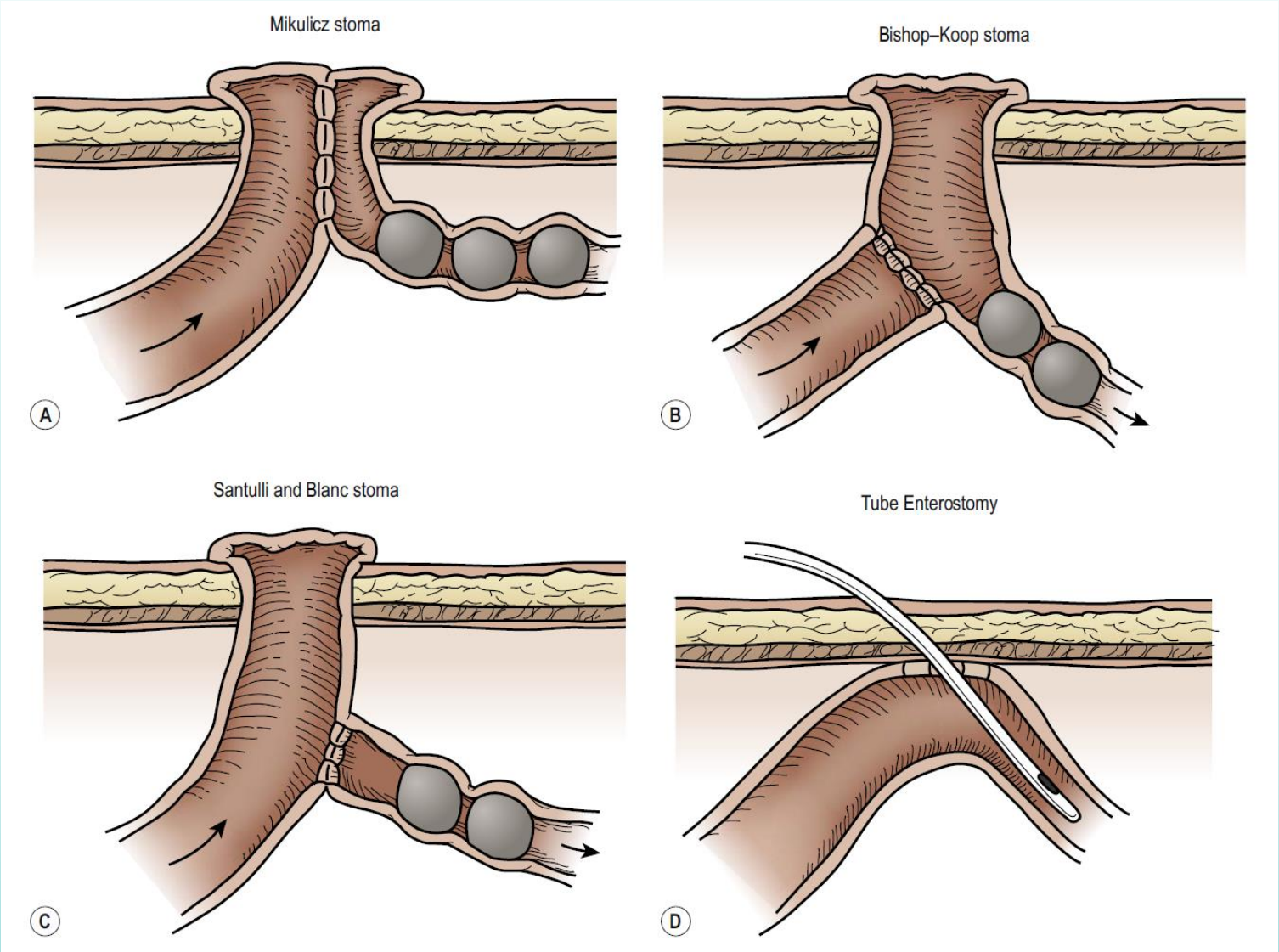
Meconium Ileus

Management

- Conservative:
  - Water-soluble contrast enema (success 60–70% in simple MI)

- Surgery:
  - **Simple MI:** ileotomy and irrigation using N-acetylcysteine or normal saline, followed by either:
    - Simple closure and return
    - Enterostomy tube
    - Ileostomy creation (Double-barrelled Mikulicz, Bishop-Koop, or Santulli)
  - **Complicated MI:** Resection of ischemic bowel + diverting stoma or primary anastomosis

Variations in ileostomy for meconium ileus



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Holcomb, G. W., Murphy, J. P., & Peter, S. D. S. (2019). Holcomb and Ashcraft's Pediatric Surgery.

Meconium Ileus

Management

Postoperative care:

- Parenteral nutrition
- N-acetylcysteine (10%) enterally (5–10 mL)
- Enteral pancreatic enzymes (e.g., Creon®, Pancrease®)
- Antibiotics
- Involvement of CF team

Necrotizing Enterocolitis (NEC)

- 1–3/1,000 live-births | M:F = 2:1 | Black > white
- **>90% occur in preterm infants**
- **Term infants (10%)** – associated with congenital heart disease or birth asphyxia
- **↓ incidence in breast-fed infants**

Necrotizing Enterocolitis

Pathophysiology

- Multifactorial; a unique response in the immature, neonatal gut to “stress”

- NEC may be:
  - Focal
  - Diffuse

- Most commonly affected sites:
  - Terminal ileum
  - Colon

Immaturity of the preterm gut

Early enteral feeding

Splanchnic hypoperfusion

Important slide

Possible causal factors in NEC

Necrotizing Enterocolitis

Pathophysiology

- Submucosal and subserosal gas-filled cysts

  (N_2 or H_2 from gas-forming bacteria)

- Histologically:
  - Mucosal ulceration
  - Transmural coagulative necrosis
  - Microthrombi in mesenteric vessels

Necrotizing Enterocolitis

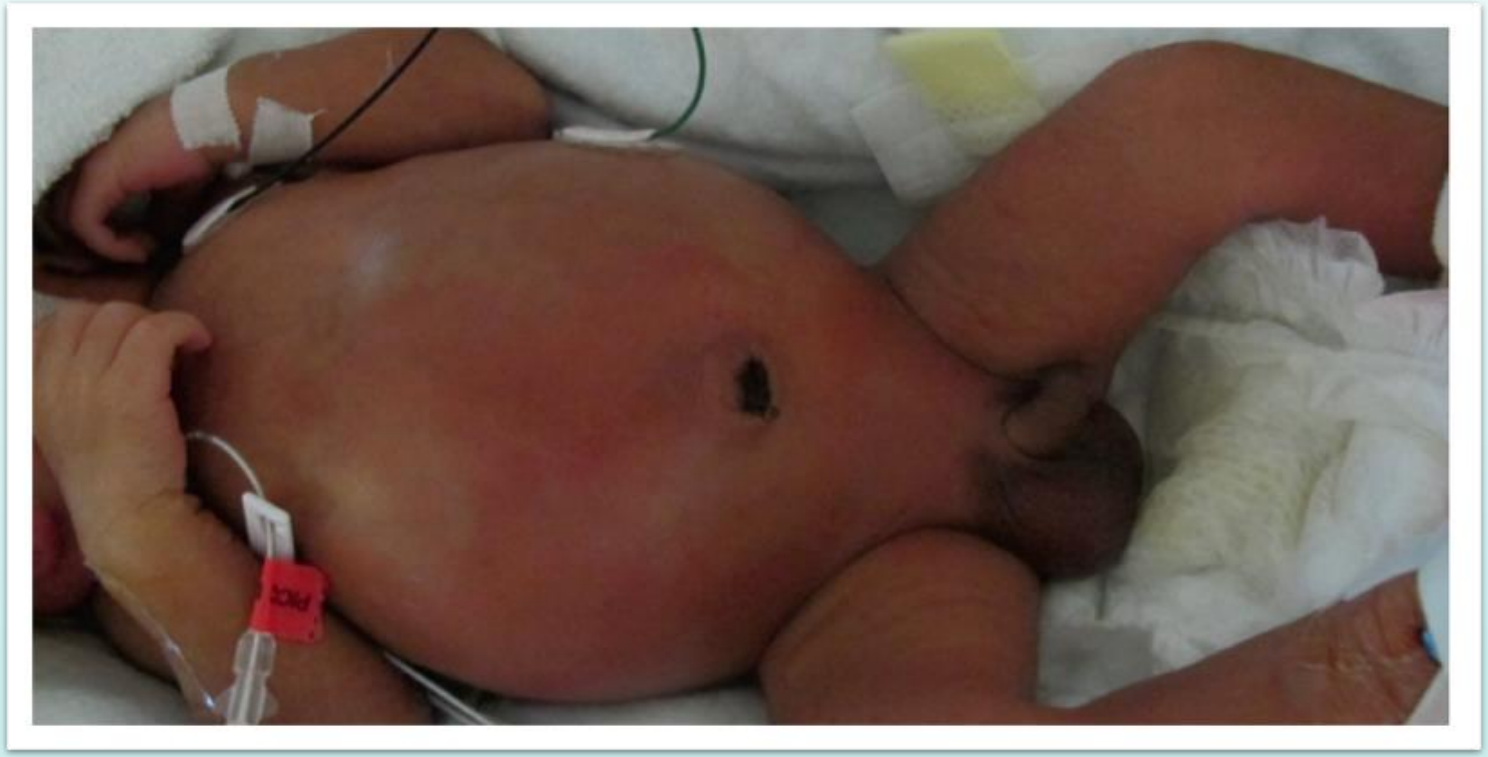
Clinical Features

- **Nonspecific signs**

  related to sepsis and ischemia
  - Tachycardia
  - Hypotension
  - Metabolic acidosis
  - Unstable body temperature
  - Increasing O_2 requirement
  - Thrombocytopenia
  - Coagulopathy

- **Specific local signs**

  related to the affected bowel loops
  - Peritonism
  - Abdominal wall erythema
  - Bile-vomiting
  - GI bleeding
  - Abdominal mass formation



Abdominal wall erythema

Bell's Staging of NEC

	Clinical	Radiology
I – suspected	Irritable, apnea, bile-aspirates, abdo. Distension, +ve fecal occult blood	Intestinal distension
II – definite	GI bleeding ± Abdo. mass	Pneumatosis, “fixed” loops, portal venous gas
III – advanced	Shock, marked GI bleeding	Pneumoperitoneum, severe ascites

Handbook of Pediatric Surgery, by C. Sinha and M. Davenport, 2nd edition, 2022.

Necrotizing Enterocolitis

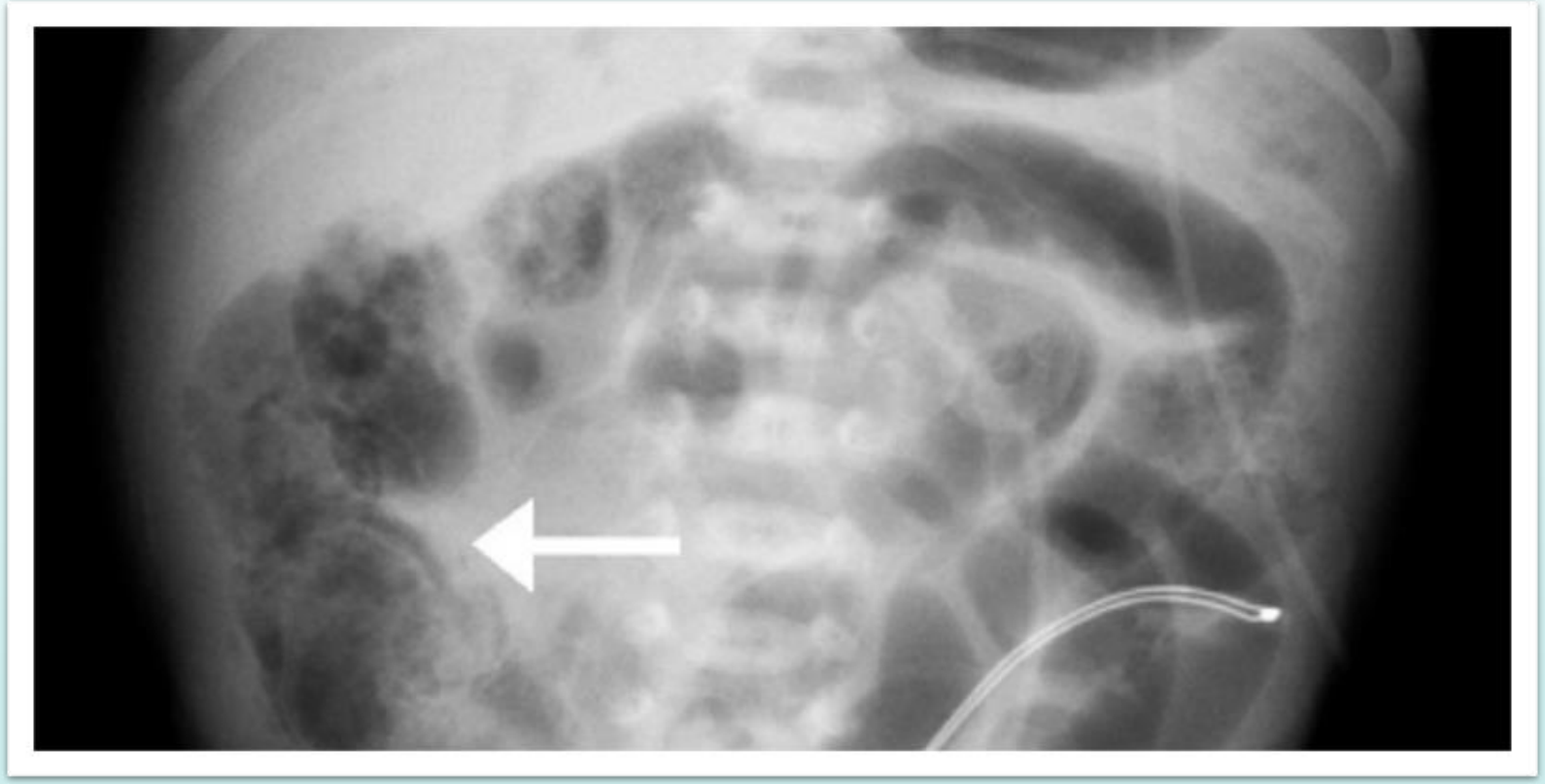
Investigations

1. Blood work-up for signs of sepsis
   a) CBC
   b) Coagulation screen (INR, fibrinogen, D-dimers)
   c) Lactate and ABGs

Necrotizing Enterocolitis

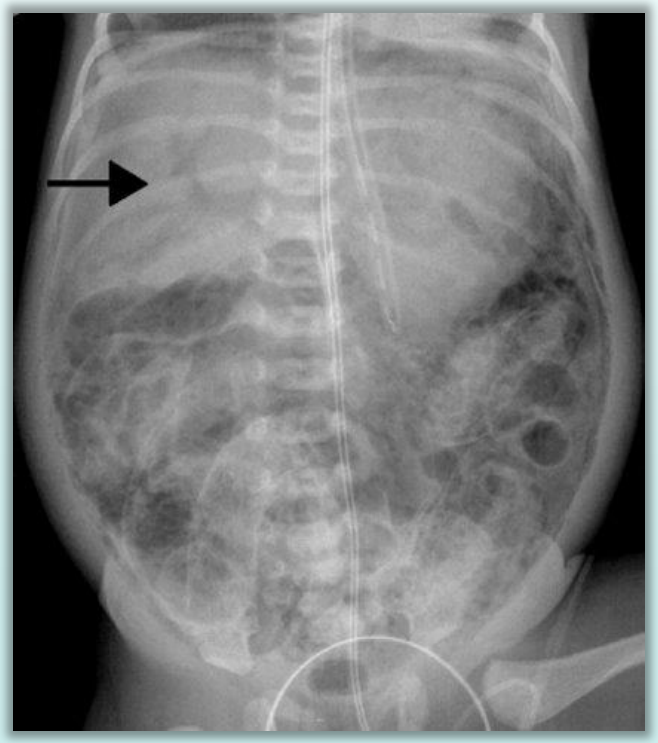
Investigations

2. AXR (AP ± lateral)
   a) Early signs – nonspecific distension
   b) Late signs:
      - **Pneumatosis** (linear radiolucent bands/bubbles parallel to the bowel wall)
      - **Portal venous gas**
      - **Extravisceral free air** (air under diaphragm or "football sign")

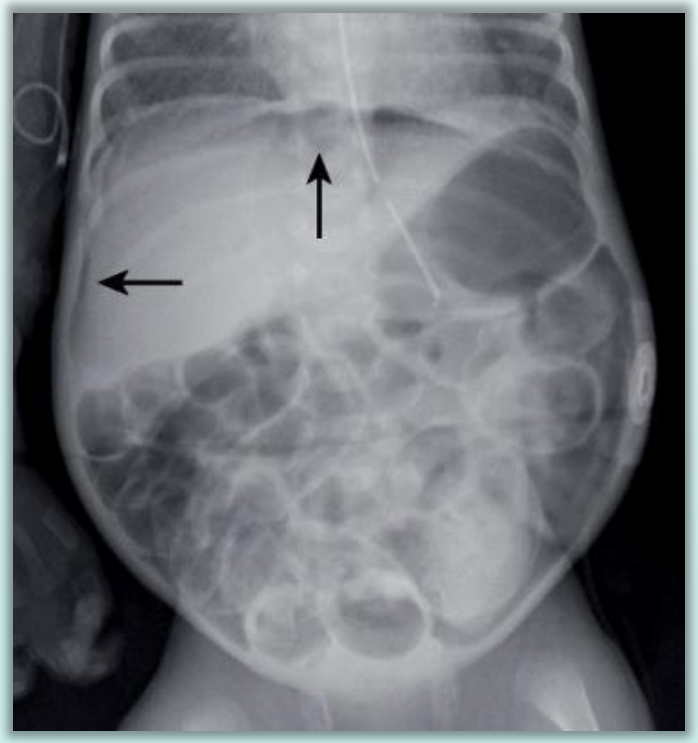


Pneumatosis Intestinalis

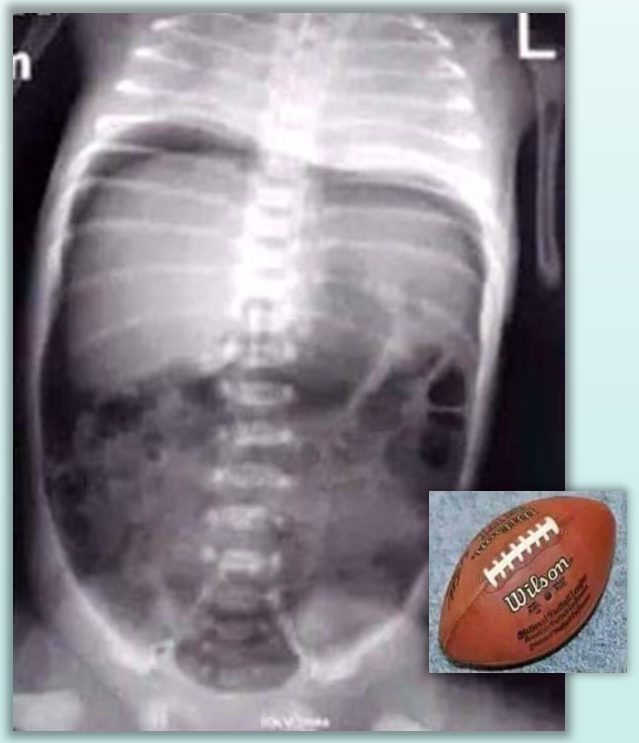
seen as linear radiolucent bands parallel to the wall of the bowel or "soap-bubble" appearance



Portal venous gas



Pneumoperitoneum
(Extravisceral free air)



Pneumoperitoneum
(Football sign)*

*From https://meducation.net

Necrotizing Enterocolitis

Management

- Supportive:
  - Resting the gut
  - Optimizing hemodynamic and metabolic conditions

Nil by mouth (NPO)

And

NG tube

Restoration of..

- fluid losses (3rd space)
- hematocrit
- temperature instability
- glucose instability
- acid–base imbalance

Appropriate oxygenation

Broad-spectrum antibiotics

Necrotizing Enterocolitis

Management

- Serial radiography to assess onset of complications (as perforation)
- If improving.. continue for 7–10 days before restarting enteral nutrition

Necrotizing Enterocolitis

Management

Indications of Surgery:

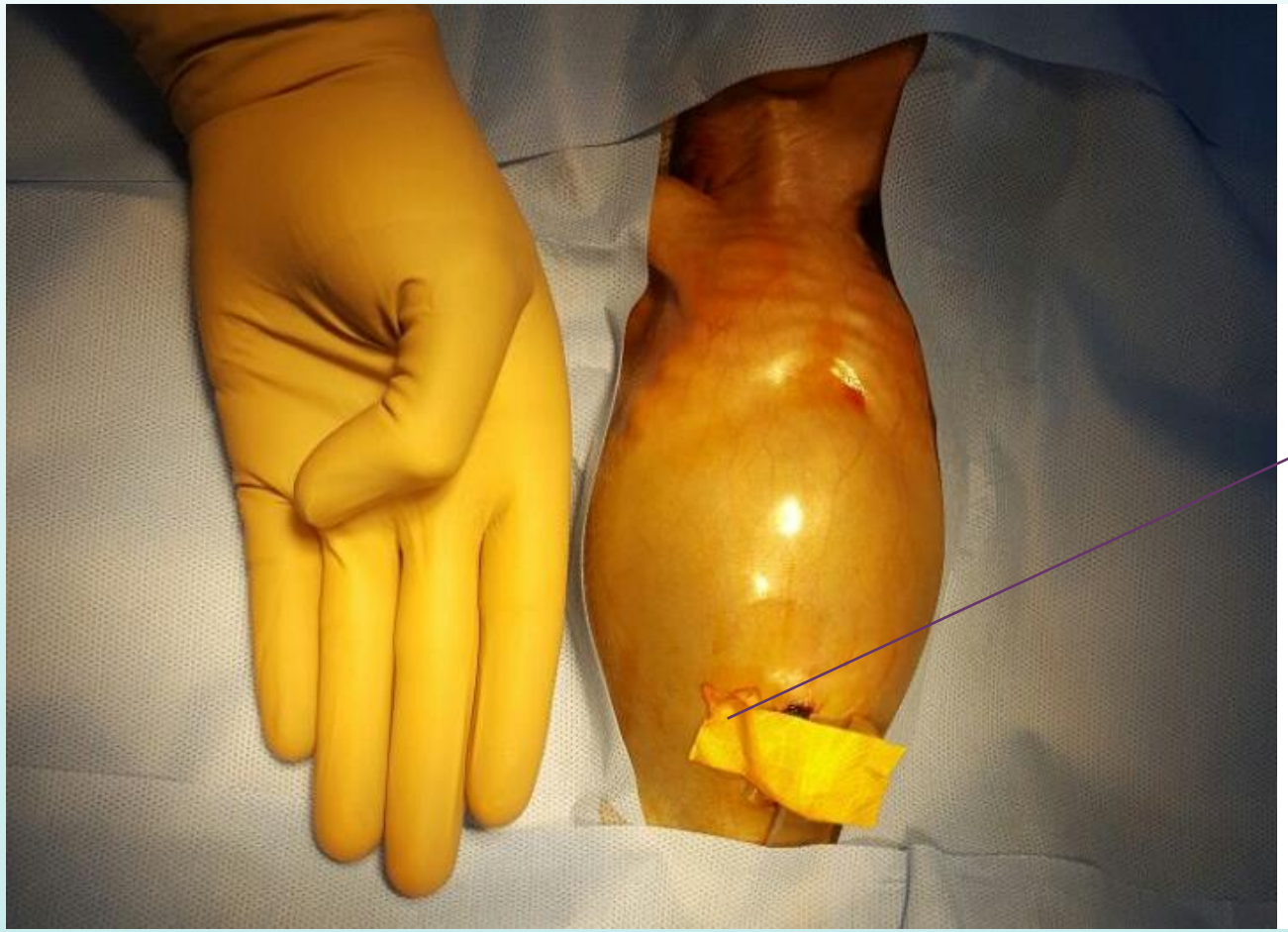
- Pneumoperitoneum (perforation) (Stage III Bell's)
- Failure to progress (after 24 hr of full supportive management)
- Obstructive features (↑ distension, ↑ bile-aspirates)
- "Fixed-loop" on serial imaging
- ↑ Abdominal wall erythema
- Palpable abdominal mass

Necrotizing Enterocolitis

Management

Surgery options:

- Resection + ileostomy creation
- "Clip and drop" technique (for pan-intestinal disease)
  + 24-hour second-look laparotomy
- Primary peritoneal drainage (PPD) (if unstable)



Part of surgical gloves used as a drain for open peritoneal drainage

Primary peritoneal drainage (PPD)
in an ELBW newborn

Necrotizing Enterocolitis

Outcome and Complications

- **Mortality 20-50% (higher in VLBW and ELBW)**
- Short-gut syndrome (~25%)
- Strictures (20%)

Necrotizing Enterocolitis

Possible Prevention Strategies (little evidence yet)

1. Breast milk (fourfold reduction in NEC incidence vs. formula)
2. Avoidance of indomethacin/ibuprofen/ranitidine and maintenance of gastric acidity
3. Probiotics (e.g., lactobacillus/bifidobacterium)
4. Oral antibiotics
5. Oral/IV immunoglobulin (IgA/IgG)
6. Amino-acid supplementation (glutamine)

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Hirschsprung's Disease

Embryology

- Migration of neuroenteric cells from the neural crest to GI tract, reach:
  1. Esophagus - 5th week
  2. Mid-gut - 7th week
  3. Distal colon - 12th week

Anatomy

- The normal intestine contains two distinct nerve plexi:
  1. Submucosal plexus (of Meissner)
  2. Myenteric or intermuscular plexus (of Auerbach)

Hirschsprung's Disease

Genetics

- Risk in siblings is 3–4% (↑ with long-segment disease)
- Gene mutation (50% familial and 15–35% isolated)
  - RET gene (Ch 10q11 | associated with Down's syndrome)
  - Other genes (SOX10, EDNRB, GDNF , EDN3, ECE1, NTN, SIP1).

Pathology

- Lack of progression of peristaltic wave into the aganglionic segment of intestine
- Absent or abnormal internal anal sphincter relaxation

Hirschsprung's Disease

Associated anomalies (variable incidence ~10%)

- *Down's syndrome* (~5%)
- Neurocristopathies as:
  - *Waardenburg–Shah* syndrome; white forelock, bicolored iris, deafness
  - *Hypoventilation syndrome* (Ondine's curse) – association with HD termed Haddad syndrome
- Mental retardation syndromes
  - *Smith-Lemli-Optiz* syndrome; mental retardation, polydactly, defect in cholesterol metabolism
  - *Mowat-Wilson syndrome;* mental retardation, characteristic facies
- Development colon anomalies
  - Colon atresia, anorectal atresia
- Miscellaneous
  - *Kaufman-McKusick syndrome;* hydrometrocolpos, hypospadias, polydactyl

[N.B. MEN type 2B (Marfanoid habitus, medullary thyroid cancer, café au lait spots, mucosal neuroma) is associated with *hyperganglionosis* (functionally similar to HD)]

Don't memorize this slide

Hirschsprung's Disease

Variable Affected Segment

- Short segment (recto-sigmoid) (75%)
- Long segment:
  - Total colonic +/- ileal involvement
  - Total intestinal aganglionosis (incompatible with life)
- Ultra-short segment disease (rare)
- Segmental disease or "skip" lesions (extremely rare)

Hirschsprung's Disease

Clinical Features

Two overlapping scenarios

1. Neonatal bowel obstruction:
   - Delayed passage of meconium
   - Abdominal distension
   - Bile vomiting
   - ± Enterocolitis

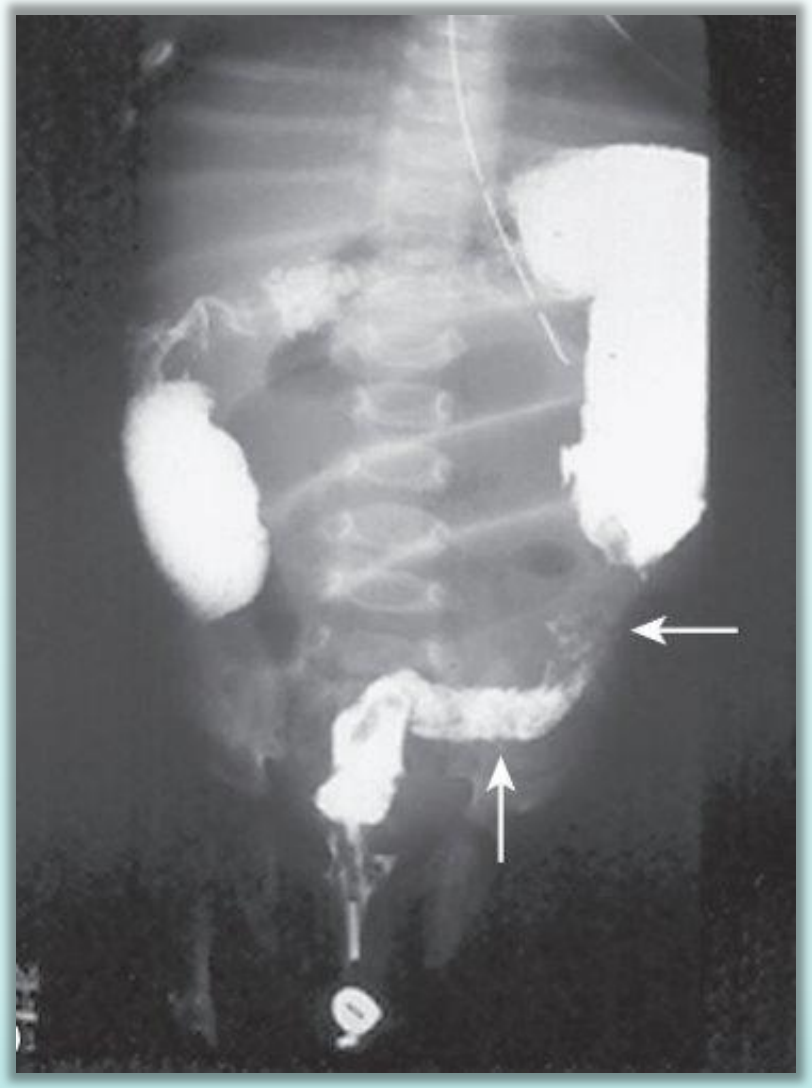
2. Chronic constipation (no encopresis/soiling)
   - ± Enterocolitis
   - Failure to thrive

- Explosive discharge of liquid fecal matter after DRE

Hirschsprung's Disease

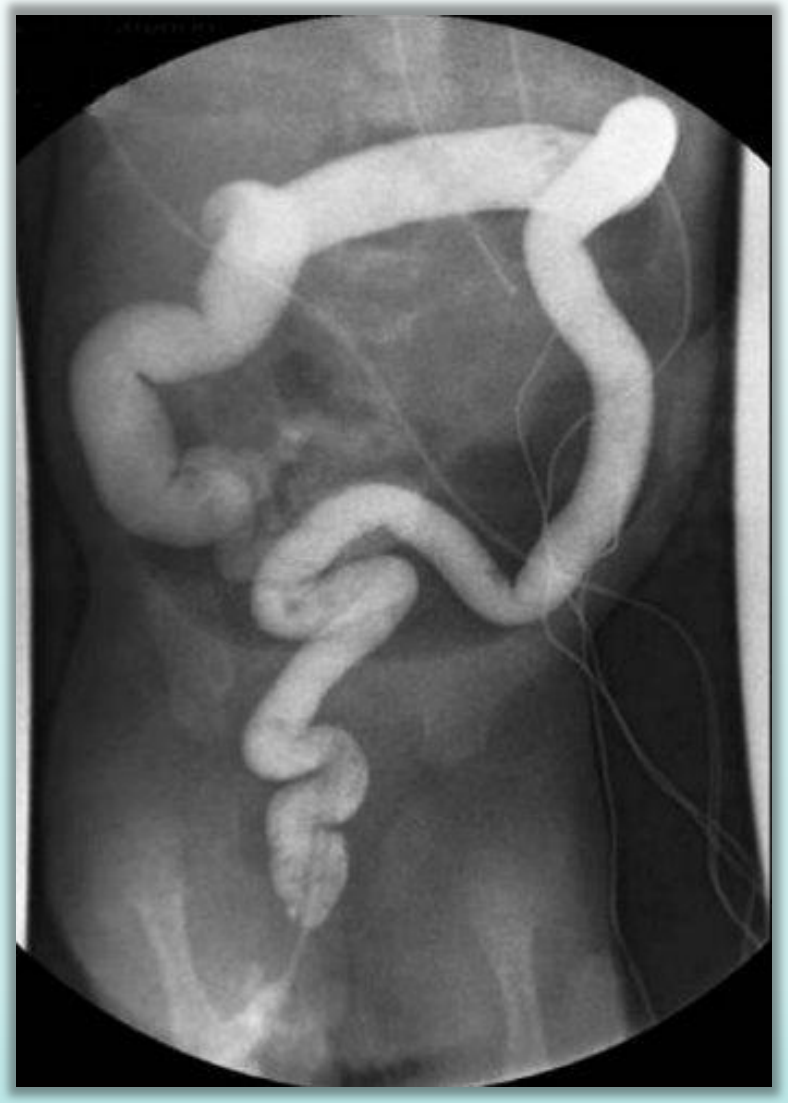
Investigations

1. AXR (non-specific signs of intestinal obstruction)
2. **Contrast enema**
   - dilated proximal colon
   - small-caliber distal colon
   - transitional zone
   - retained contrast on a 24-hour film
3. **Rectal biopsy** (suction or open under GA)
   - 1, 2, and 3 cm above dentate line
   - Characteristic HP features:
     - Absence of ganglion cells
     - Hypertrophied nerve bundles
     - Acetyl cholinesterase staining
     - Absence of Calretinin staining
     - Immunohistochemistry (e.g., LDH, S100, SDH, etc.)
4. Anorectal manometry (absence of Recto-Anal Inhibitory Reflex)



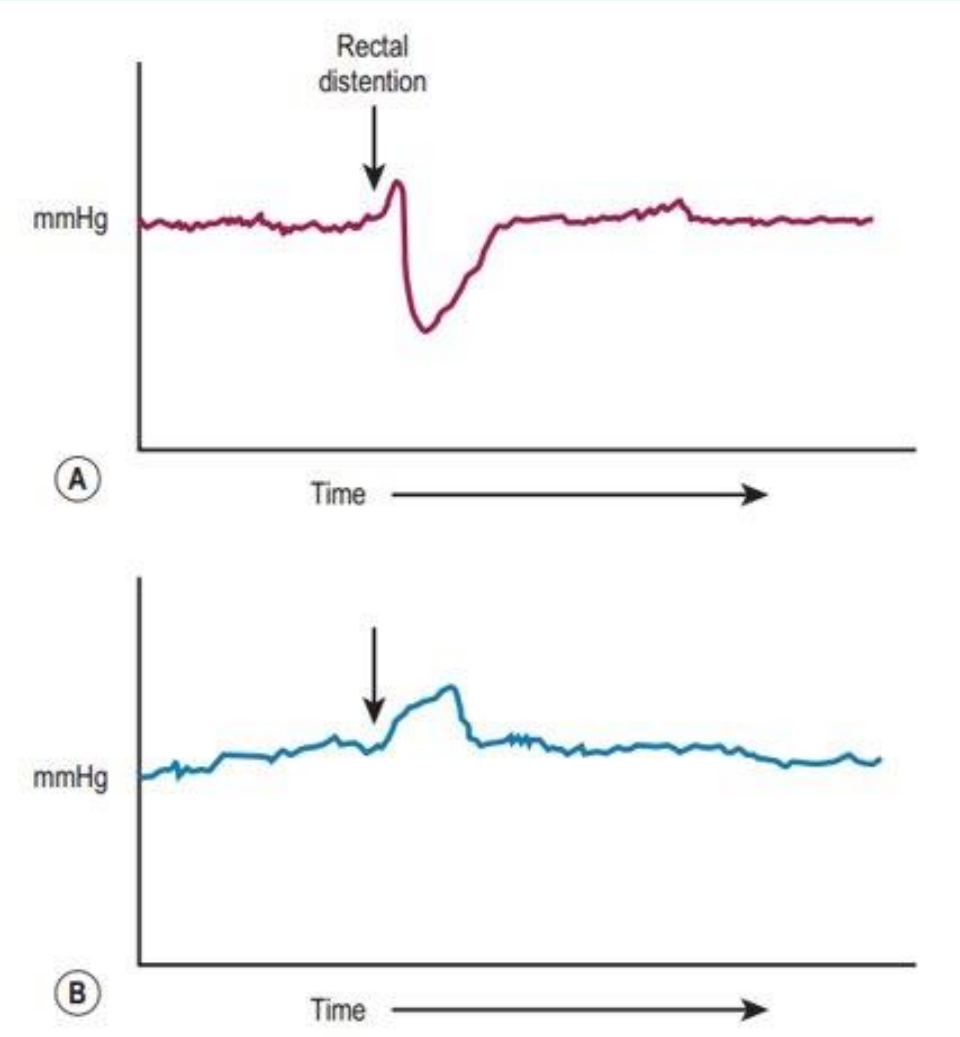
Contrast Enema

showing dilated proximal segment and distal narrow segment with transitional zone in between



Contrast Enema

showing narrow colon, suggesting "Total Colonic HD"



Anorectal Manometry

A. Presence of Recto-Anal Inhibitory Reflex → Normal

B. Absence of Recto-Anal Inhibitory Reflex → HD

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Hirschsprung's Disease

Management

- Daily rectal washouts by parents
- Colostomy (if unstable)
- Pull-through procedure (resection of aganglionic segment, bringing the ganglionic bowel through the pelvis and anastomosing it to the anus)
  - Swenson's pull-through
  - Duhamel's retrorectal pull-through
  - Soave's endorectal pull-through
  - Laparoscopic-assisted pull-through
  - Trans-anal pull-through

Hirschsprung's Disease

HD Associated Enterocolitis (HAEC)

= HD + sepsis, fever, diarrhea, +/- bloody stool

- Active intervention is required:
  - Rectal washouts (10–20 mL/kg of normal saline x3 daily)
  - Antibiotics (e.g., vancomycin, metronidazole)
  - ± Colostomy

Anorectal Malformations

The terminal part of the hindgut is abnormally placed

Anorectal Malformations

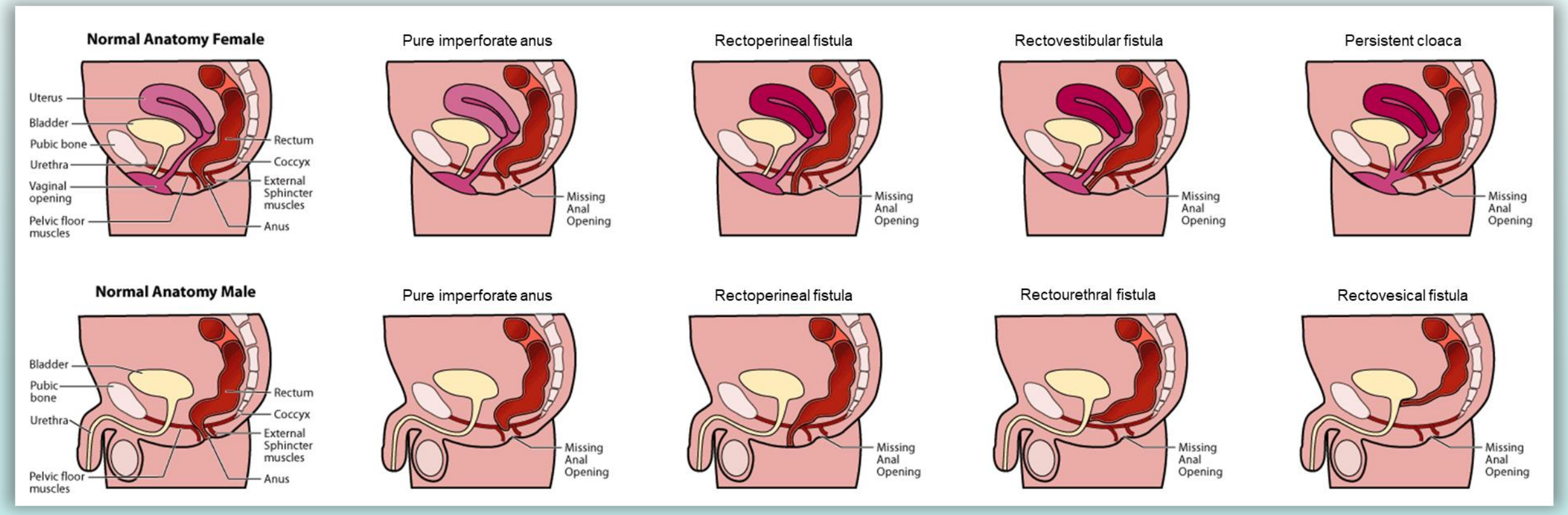
- Incidence ~1 in 5,000
- Male>female (60:40)

- Present as imperforate anus:
  - with fistula (majority) (connection between distal rectum and genitourinary tract)
  - without fistula (5%) (associated with Down's syndrome)

Anorectal Malformations

Anatomical classification

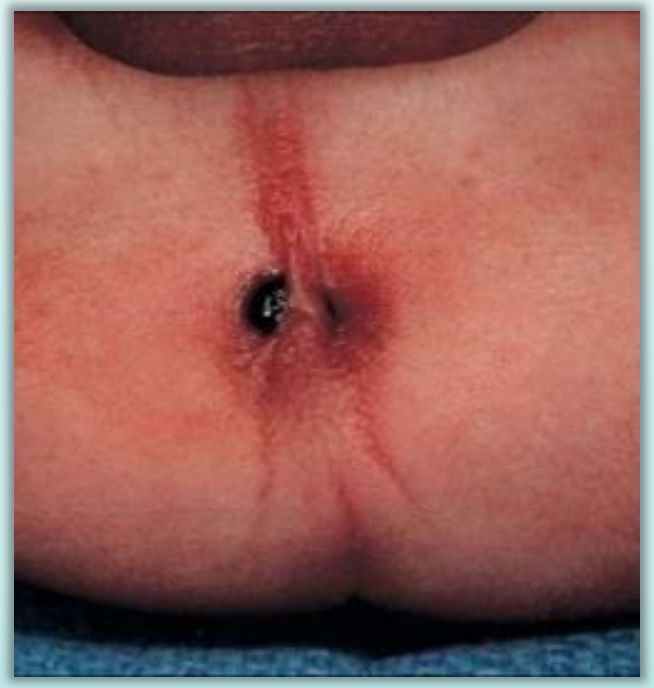
Males	Females
Anteriorly displaced anus	Anteriorly displaced anus
Recto-perineal fistula	Recto-perineal fistula
Recto-bulbar urethral fistula (most common)	Recto-vestibular fistula (most common)
Recto-membranous urethral fistula	Recto-vaginal fistula
Recto-prostatic urethral fistula	
Recto-bladder neck fistula	
Imperforate anus without fistula	Imperforate anus without fistula
Rectal atresia (normal anal opening)	Rectal atresia (normal anal opening)
-	Persistent cloaca



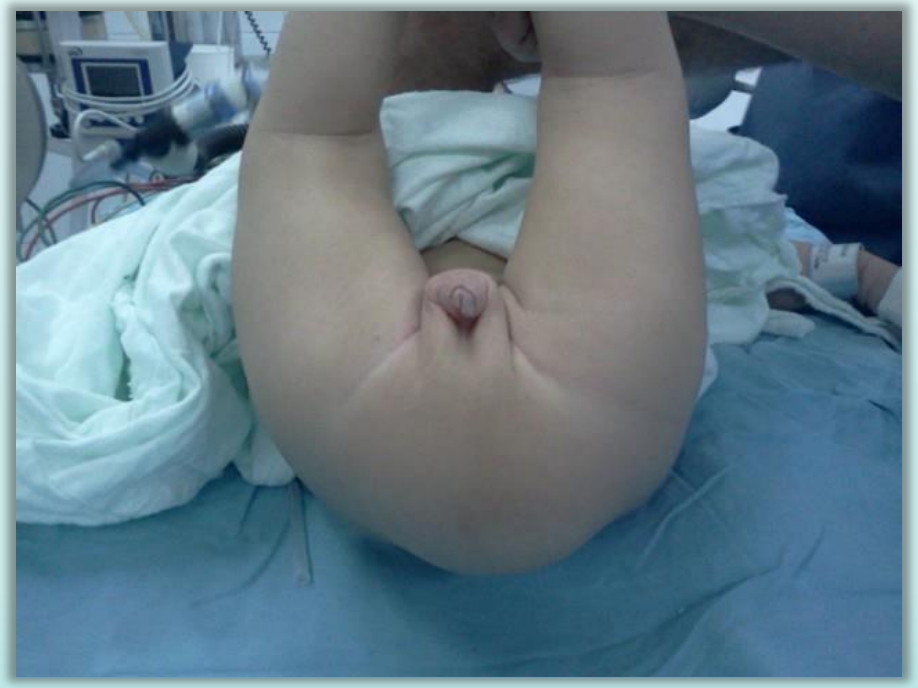
* Source: http://surgery.ucsf.edu/conditions--procedures/anorectal-malformation.aspx

Clinical Features

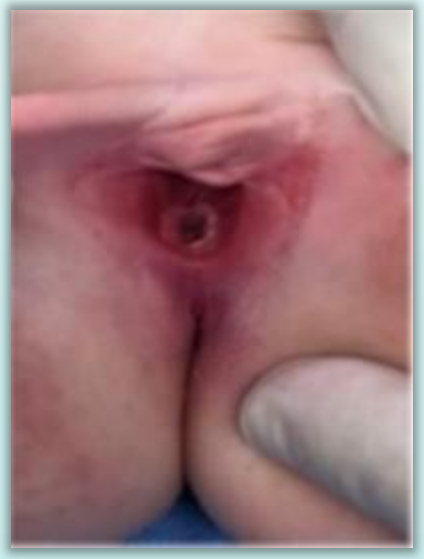
- Clinical examination is the most important part
  (makes the Dx in 90% of cases)



"Bucket-handle" deformity, suggesting a low type ARM



Imperforate anus with flat perineum, suggesting a high type ARM



Single UG orifice with no anus suggesting a Persistent cloaca*

*https://sites.uclouvain.be/anesthweekly/MRP_ENG/index.html?PersistentCloaca

Anorectal Malformations

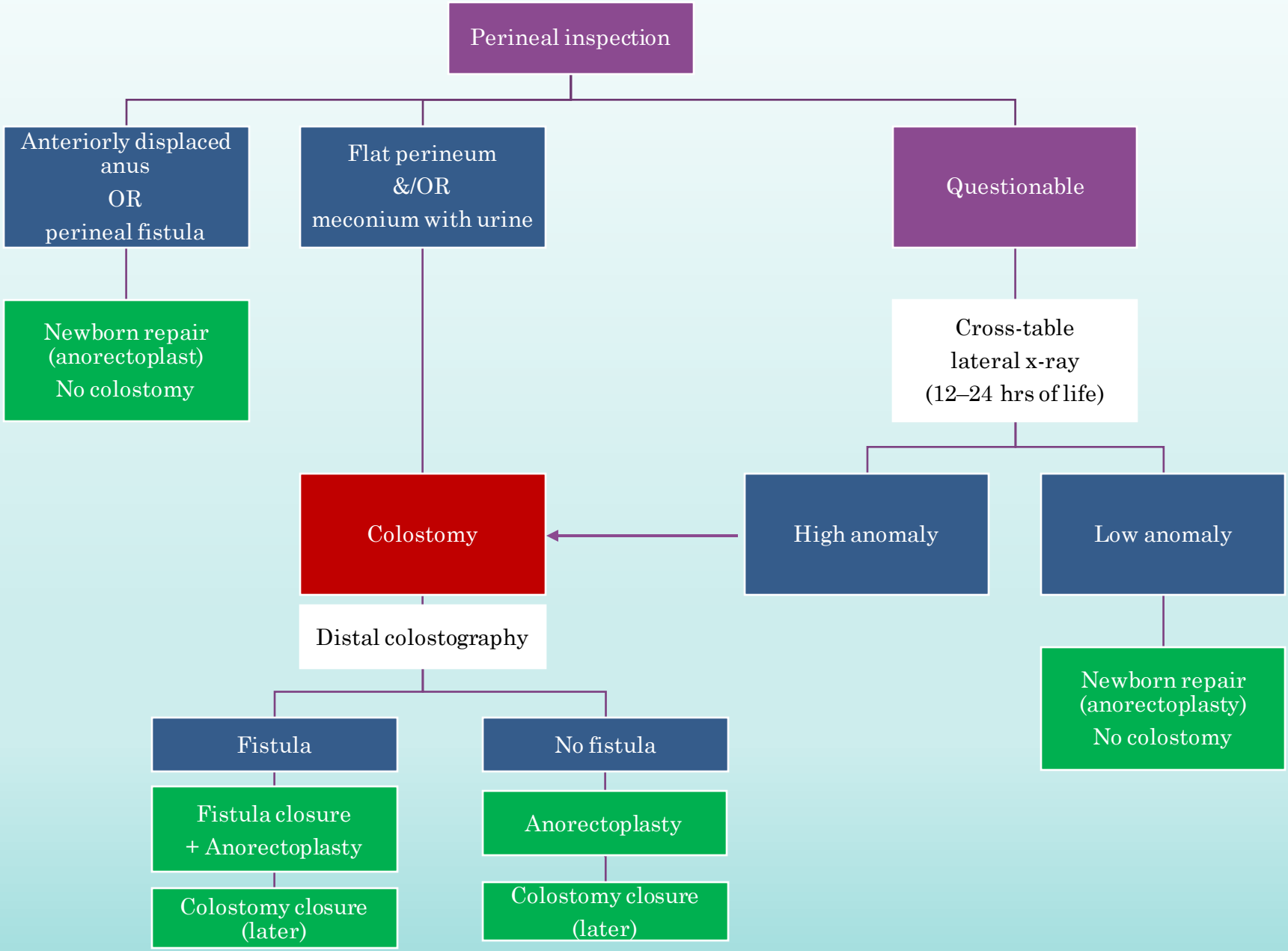
Initial management

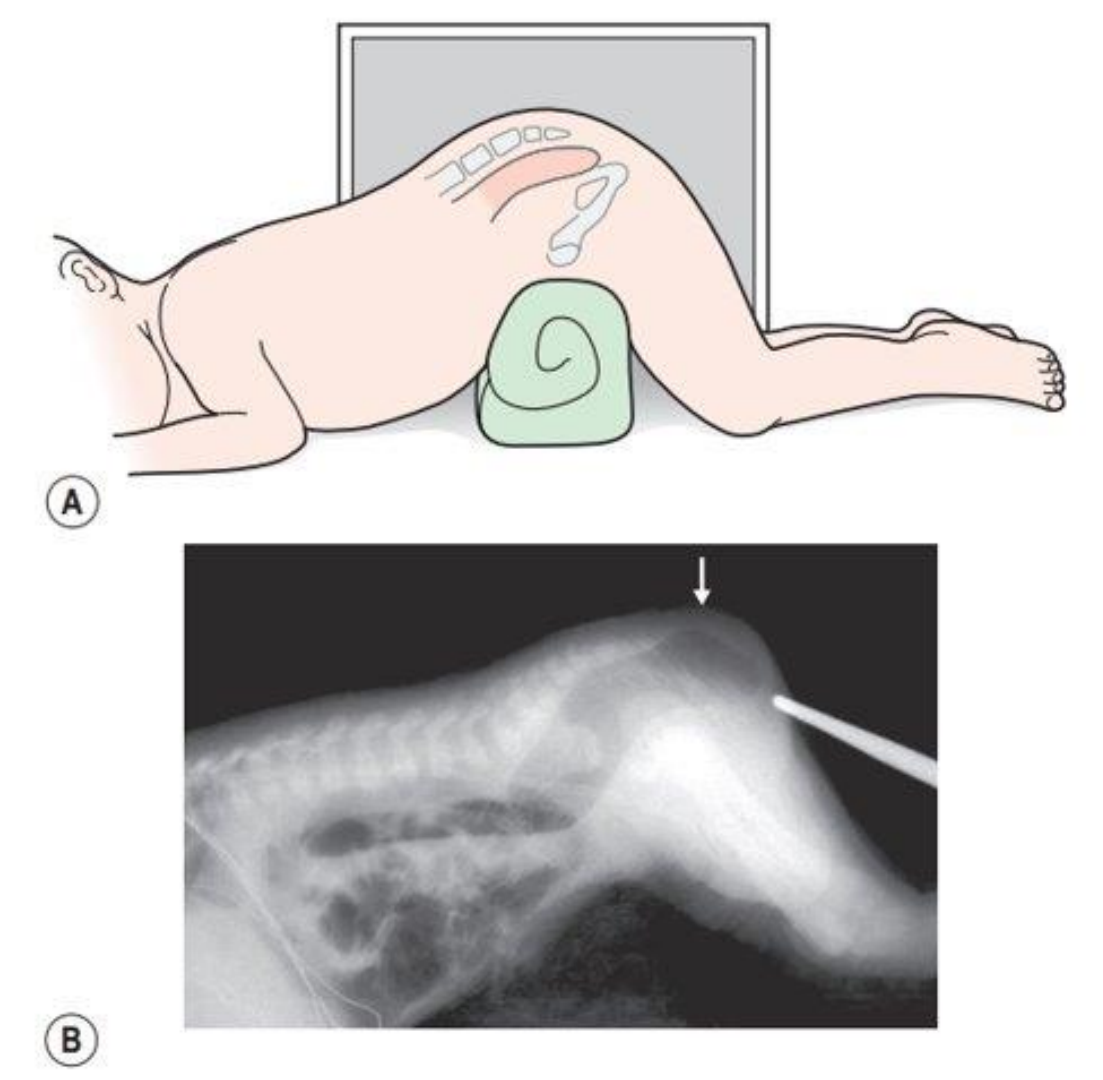
- Nasogastric tube (for decompression, & to rule out esophageal atresia)
- NPO + IV fluids
- Antibiotic prophylaxis
- Watchful waiting (for 12-24 hrs)
- Rule out VACTERL associations
  - Vertebral PEx & imaging
  - Echocardiography
  - NGT + CXR
  - Renal US
  - Limbs PEx

Then..

- Follow the management **algorithms**

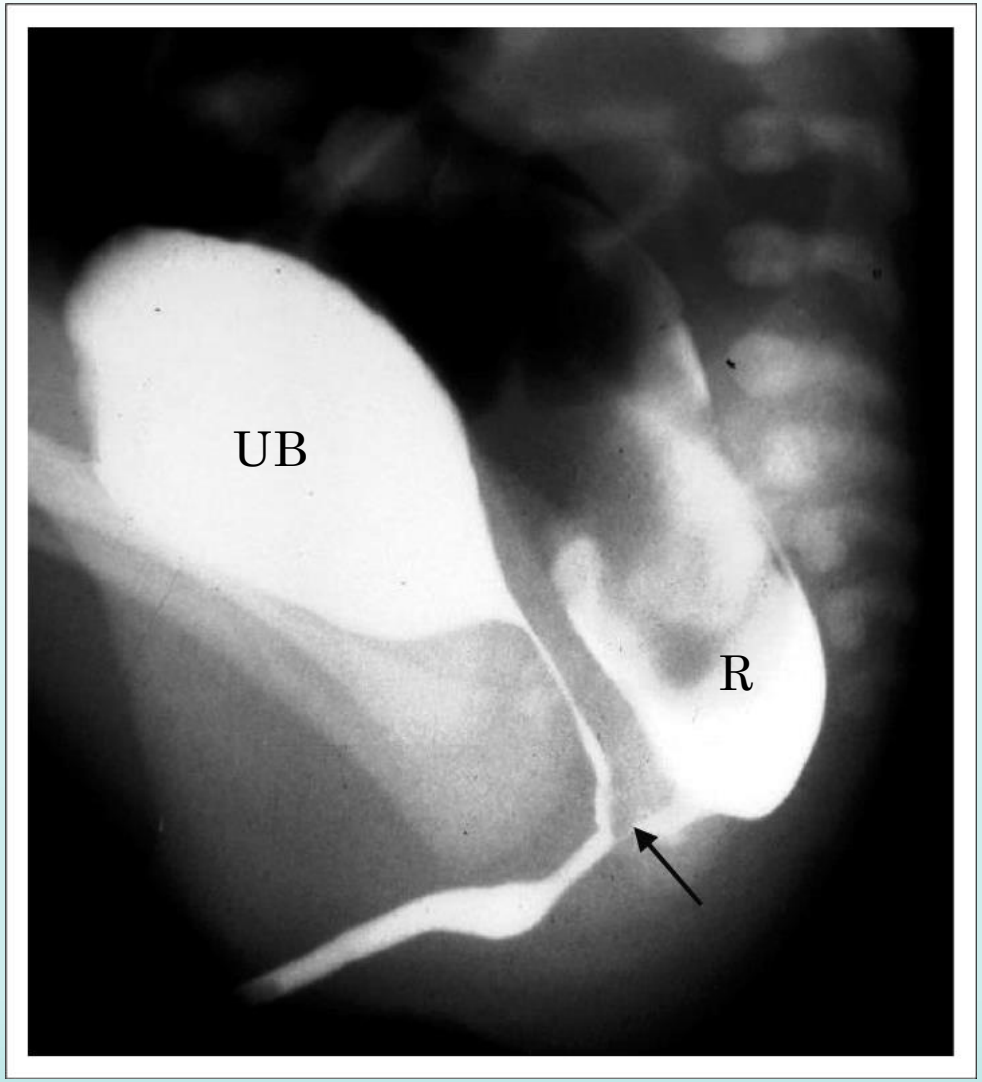
Algorithm for male infant





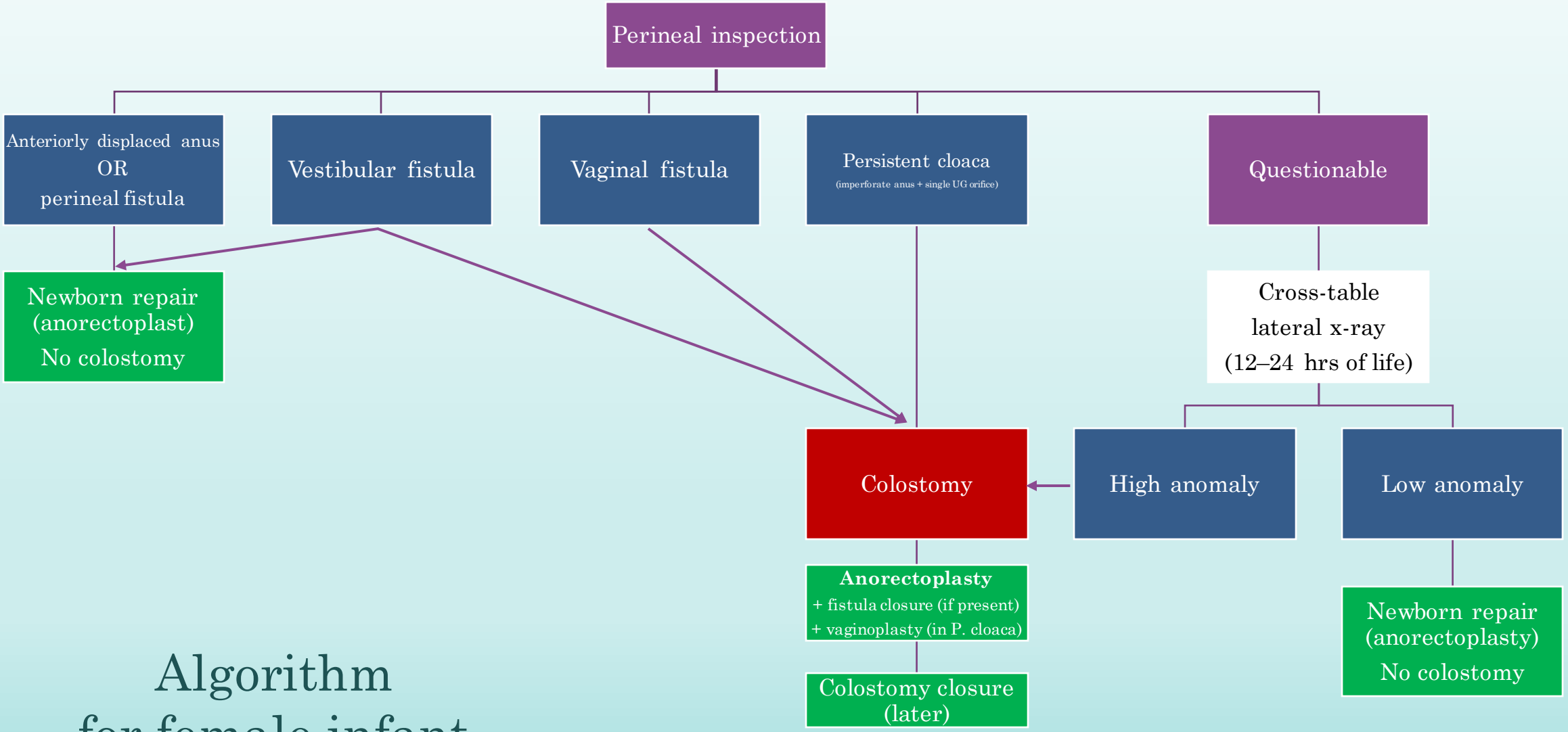
Cross-table lateral film (after 12–24 h of life) in Jackknife position

to localize the distance of rectal gas from perineum



Distal Colostogram

Shows that contrast is passing through a recto-membranous urethral fistula (black arrow) filling the urinary bladder and urethra



Algorithm for female infant

Anorectal Malformations

Outcome

- Lower long-term continence:
  - In higher anomalies
  - If associated sacral anomaly
- Long-term constipation in lower anomalies

Hypertrophic Pyloric Stenosis (HPS)

- M:F = 4 : 1
- Risk factors:
  - Family history
  - Male gender
  - Younger maternal age
  - Being a first-born infant
  - Maternal feeding patterns

Etiology

Unknown (multifactorial with environmental influences)

- Genetic factors
  - race discrepancies
  - increased frequency in **males**
  - birth order (**first-born infants** with a positive family history)
- Environmental factors
  - method of feeding (breast vs **formula**)
  - seasonal variability
  - exposure to erythromycin
  - **transpyloric feeding** in premature infants
- Other factors
  - excessive substance P
  - decreased neurotrophins
  - deficient nitric oxide synthase
  - gastrin hypersecretion

Diagnosis

Classic presentation:

- nonbilious, progressive projectile vomiting (of recent feedings)
- full-term neonate
- 2-8 weeks old

Diagnosis

PEx:

- General:
  - Usually appears well (early)
  - Dehydration, somnolence (late)

- Abdominal Ex:
  - Visible gastric peristaltic waves
  - Palpable pylorus "olive sign" (70–90% of patients)

Labs:

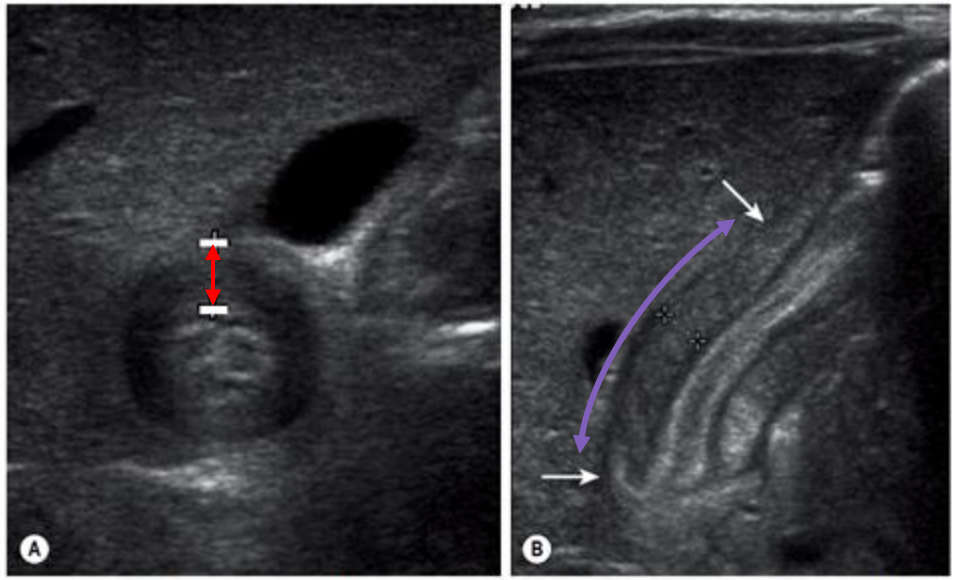
- Hypochloremic
- Hypokalemic
- Metabolic alkalosis

Diagnosis

Ultrasound:

- Standard technique for diagnosis

Muscle Thickness ≥ 4 mm



Pyloric channel length ≥ 16 mm

FIGURE 29-1 ■ Ultrasonography has become the standard imaging study for diagnosing pyloric stenosis and has supplanted physical examination at most institutions. The (A) transverse and (B) longitudinal views of hypertrophic pyloric stenosis are seen here. Muscle thickness greater than or equal to 4 mm on the transverse view or a length greater than or equal to 16 mm on the longitudinal view is diagnostic of pyloric stenosis. On this study, the pyloric wall thickness was 5 mm and the length (arrows) was 20 mm.

Holcomb, G. W., Murphy, J. P., & Peter, S. D. S. (2019). Holcomb and Ashcraft's Pediatric Surgery.

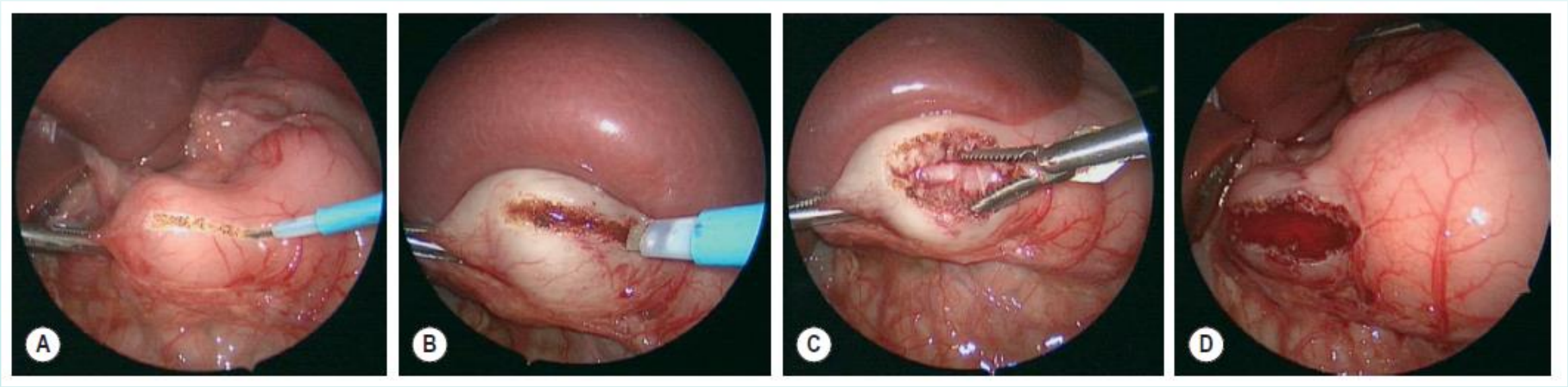
Treatment

- Preop. supportive measures:
  - NPO
  - IV fluid resuscitation
  - Correction of electrolytes

- Surgery:
  - Non-emergent
  - Laparotomic or laparoscopic “Pyloromyotomy”

to incise (otomy) the muscle (myo) of the pylorus (pyloro)

- Other reported modalities (require long periods, and often not effective):
  - medical treatment with atropine
  - pyloric dilation



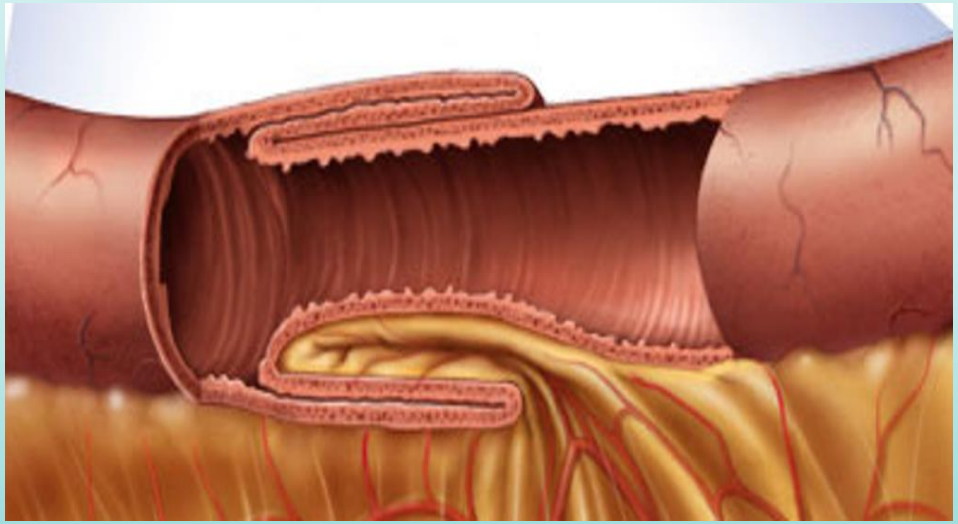
Holcomb, G. W., Murphy, J. P., & Peter, S. D. S. (2019). Holcomb and Ashcraft's Pediatric Surgery.

Complications of Pyloromyotomy

- Mucosal perforation (1-2%)
- Postoperative emesis (occur in most infants)
- Prolonged postoperative emesis
  (less common | due to GER or incomplete myotomy)

Intussusception

An acquired invagination
of the proximal bowel (intussusceptum)
into the distal bowel (intussuscipiens)



Consequence

The **mesentery** of the proximal bowel is compressed..

→ venous obstruction + bowel wall edema

→may progress into arterial insufficiency + ischemia and bowel wall necrosis

Types

- Primary (idiopathic) most common
- Secondary (lead point)

Primary Intussusception

- Generally attributed to **hypertrophied Peyer patches**
- Frequently after a recent URTI or gastroenteritis
  (adenoviruses and rotaviruses in 50% of cases)
- Incidence
  - can occur at any age
  - most are well-nourished, healthy infants
  - two-thirds are boys
  - highest incidence in infants 4-9 months
  - uncommon < 3 months and > 3 years of age

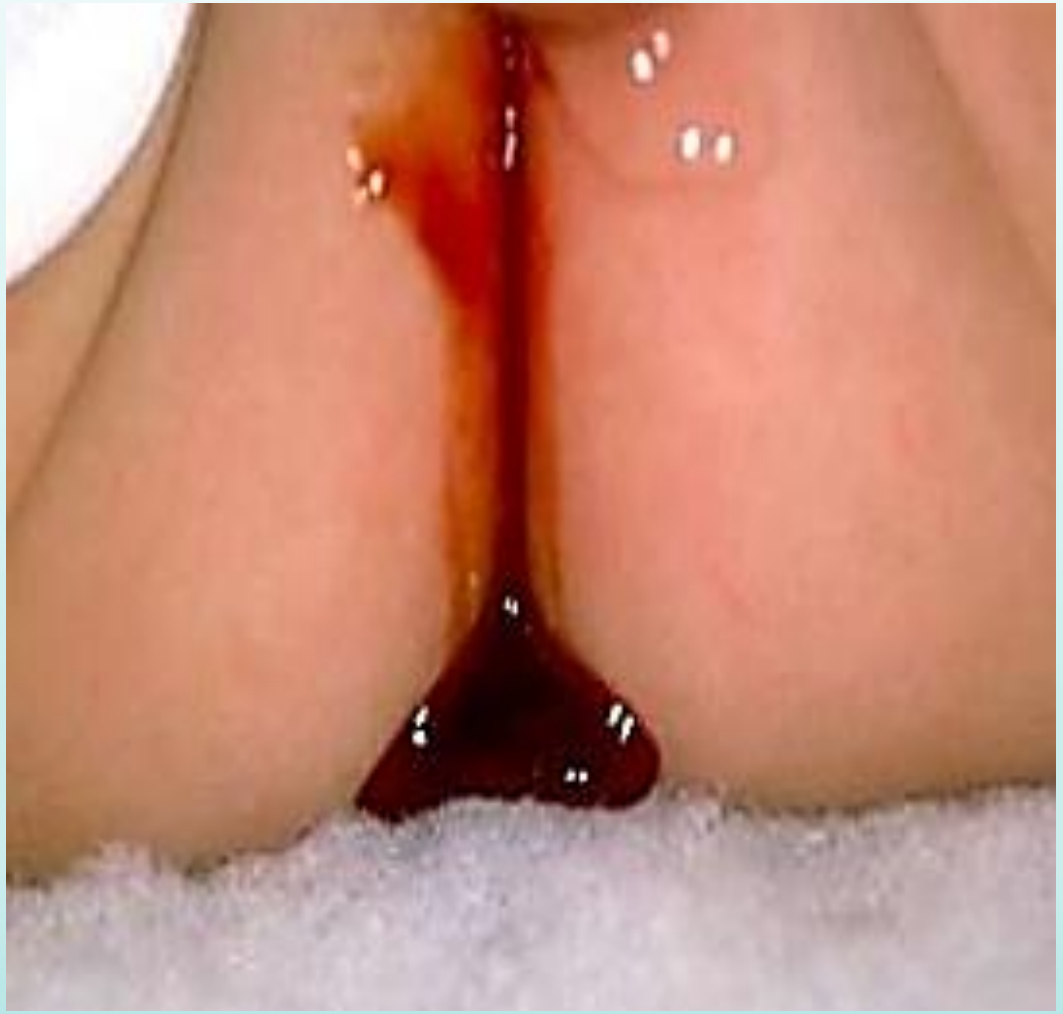
Secondary Intussusception

- There is an identifiable lesion → serves as a lead point:
  - Meckel diverticulum (most common)
  - Polyps
  - Duplications
  - Appendix
  - Hemangiomas
  - Carcinoid tumors
  - Foreign bodies
  - Ectopic pancreas or gastric mucosa
  - Hamartomas from Peutz–Jeghers syndrome
  - Lipomas
  - Malignant causes (rare | ↑ with age | as lymphomas and small bowel tumors)
  - Systemic diseases (as Henoch–Schönlein purpura and cystic fibrosis)
  - Celiac disease
  - *Clostridium difficile* colitis

Clinical presentation

- Classic presentation (infant or young child):
  1. intermittent, crampy abdominal pain
  2. 'currant jelly' stools (bowel ischemia and mucosal sloughing)
  3. palpable abdominal mass

→ this triad is seen in <25% of children



Clinical presentation

- Abdominal pain:
  - Sudden (often ceases as suddenly as it started every 15-30 minutes)
  - Child may stiffen + pulls the legs up to the abdomen
  - Between attacks → may appear comfortable

- Associated with:
  - Hyperextension
  - Breath holding
  - Vomiting (gastric early | bile later)
  - Abdominal distension
  - Lethargy (later)
  - Red currant jelly stools (later)

Physical examination

- Vital signs
  - Normal (early)
  - Hypotension, fever, &/or tachycardia (late)
- Signs of dehydration (early &/or late)
- Abdominal PEx:
  - RLQ can appear flat or empty (Dance sign)
  - RUQ mass (Sausage-shaped or curved mass)
  - Audible peristaltic rushes (early)
  - On rectal Ex: bloodstained mucus or blood (late)
- +/- Prolapse of the intussusceptum through the anus (late)

Ultrasonography (US)

- 'Target' or 'donut' lesion (in transverse plane)
- 'Pseudokidney' sign (on longitudinal plane)

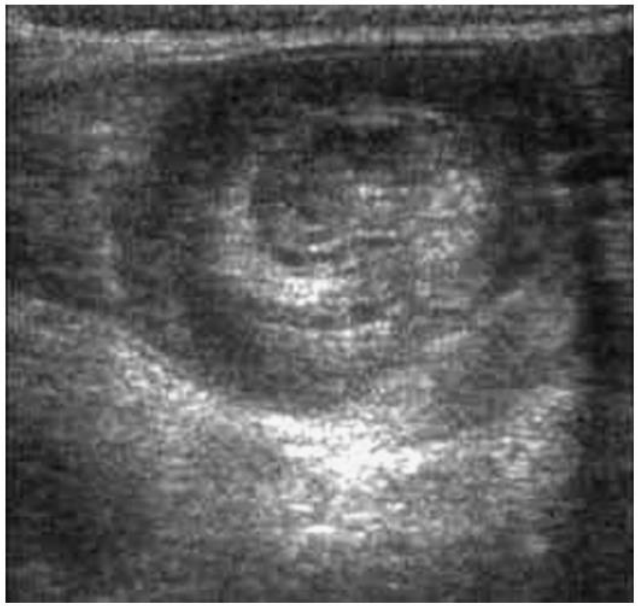


FIGURE 38-4 ■ This transverse sonographic image shows the alternating rings of low and high echogenicity due to an intussusception. This finding has been called a 'target' sign.

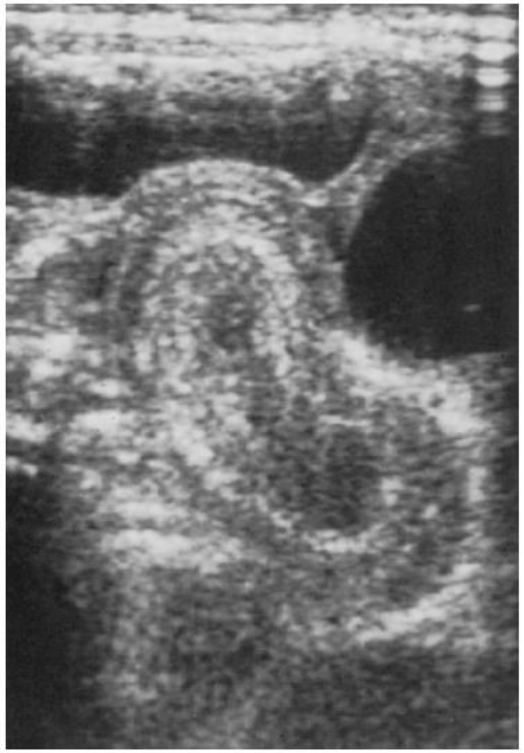


FIGURE 38-5 ■ Sonogram showing the 'pseudokidney' sign seen with intussusception on longitudinal section.

Holcomb, G. W., Murphy, J. P., & Peter, S. D. S. (2019). Holcomb and Ashcraft's Pediatric Surgery.

Nonoperative management

- NGT (to decompress the stomach)
- Bowel rest (NPO)
- IV fluid resuscitation
- CBC and serum electrolytes

Nonoperative management

Hydrostatic/ Pneumatic Reduction

- Under fluoroscopy or ultrasound guidance
- When there are no contraindications

Contraindications:

- Intestinal perforation
- Peritonitis
- Persistent hypotension

- Successful reduction (≈85%), followed by:
  - Admission for observation
  - Short period of bowel rest (NPO)
  - IV fluids

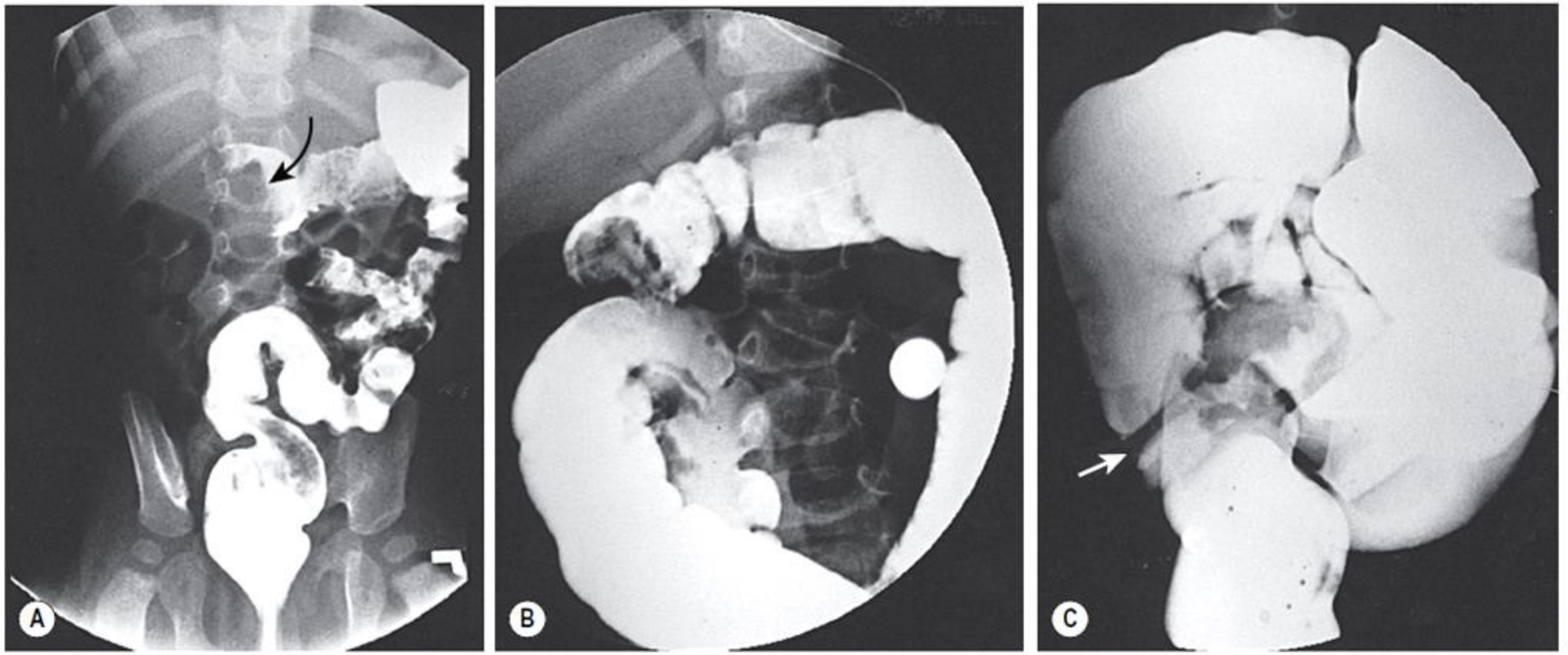


FIGURE 38-7 ■ Fluoroscopic examination using isotonic contrast for hydrostatic reduction of intussusception. **(A)** Intussusception (arrow) seen in midtransverse colon. **(B)** Reduction has occurred to the hepatic flexure. **(C)** Complete reduction with reflux of contrast medium into the terminal ileum. Note the edematous ileocecal valve (arrow).

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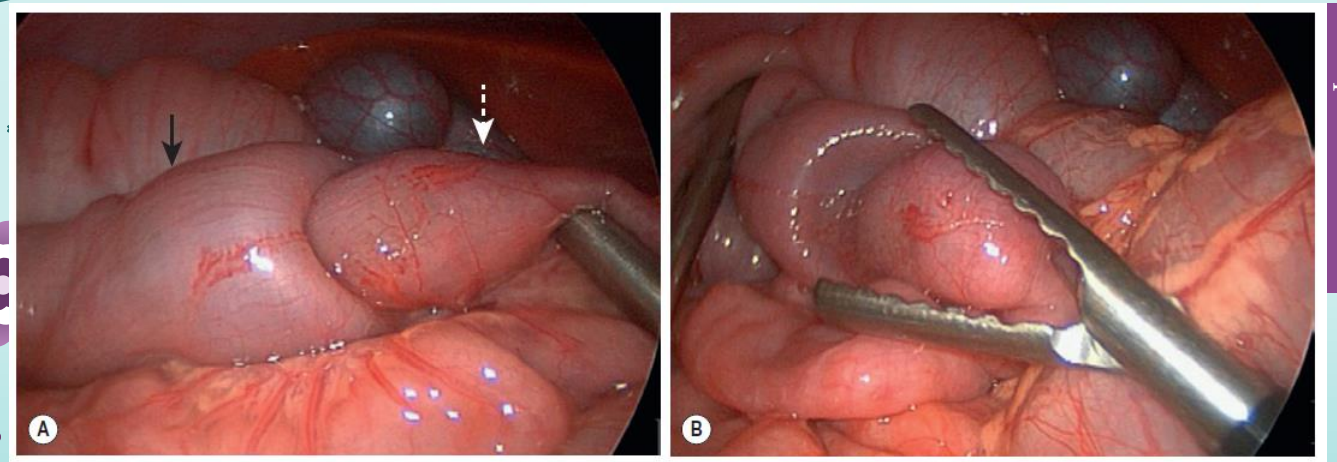
Operative management

- **Indications**:
  - Nonoperative reduction is unsuccessful or incomplete
  - Signs of peritonitis/ pneumoperitoneum
  - Presence of a lead point (secondary intussusception)



Lap. reduction

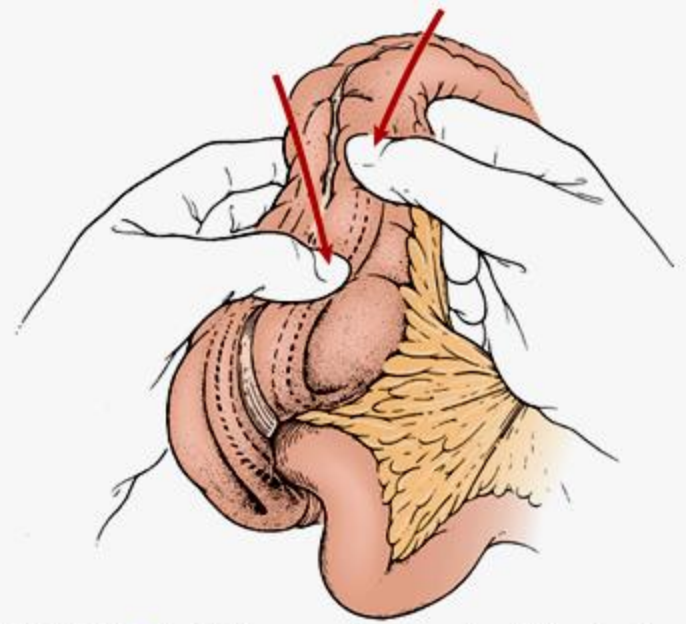


FIGURE 38-9 ■ A right lower quadrant muscle-splitting incision allows delivery of the intussusception through the incision. Gentle and continuous massage from distal to proximal usually results in reduction of the intussusception.

Open reduction

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THANK YOU!

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