

Ultrasound Evaluation of Intestinal Malrotation and Mid Gut Volvulus

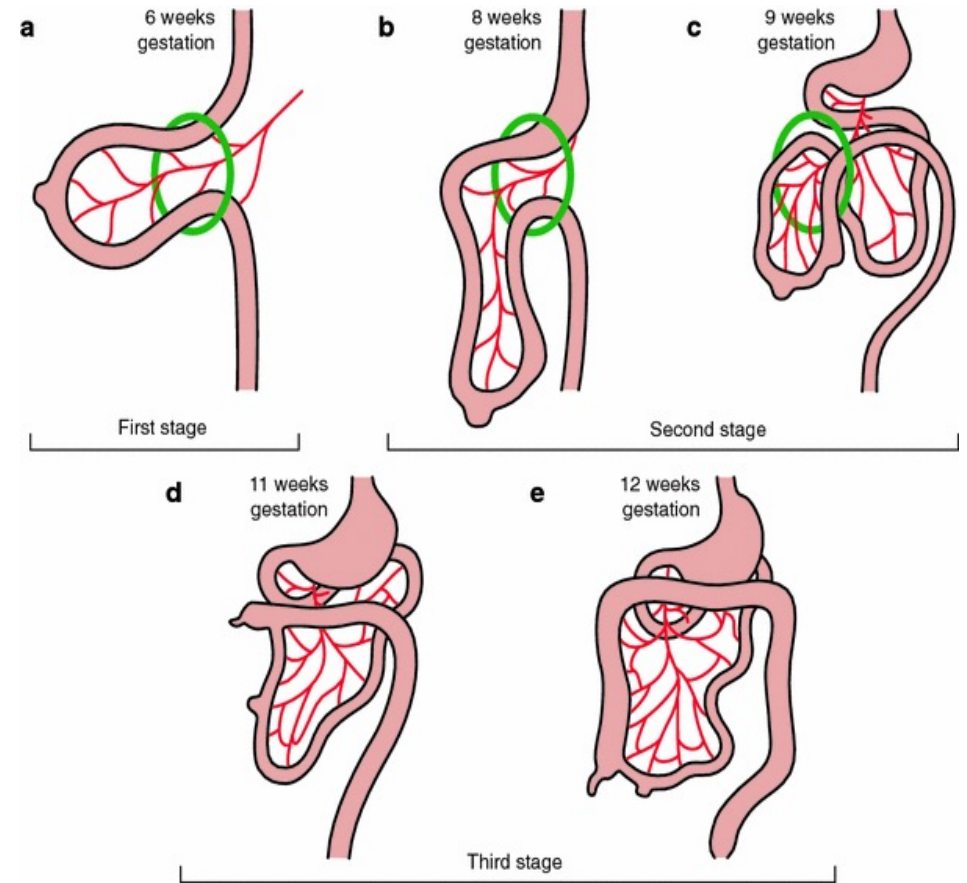
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SCHOOL OF
MEDICINE



- Intestinal malrotation - abnormality of embryonic bowel developmental rotation and fixation
- During normal embryogenesis bowel herniates through base of umbilical cord, elongates, and undergoes $\sim 270^\circ$ CCW rotation, with duodenojejunal flexure ultimately in LUQ
- Malrotation results in narrow mesenteric root attachment
- Predisposes to bowel twisting around the superior mesenteric artery (SMA) resulting in midgut volvulus
- Midgut volvulus is a pediatric surgery emergency because of obstruction and bowel ischemia
- Most cases of midgut volvulus occur at the first year of life



Why US?

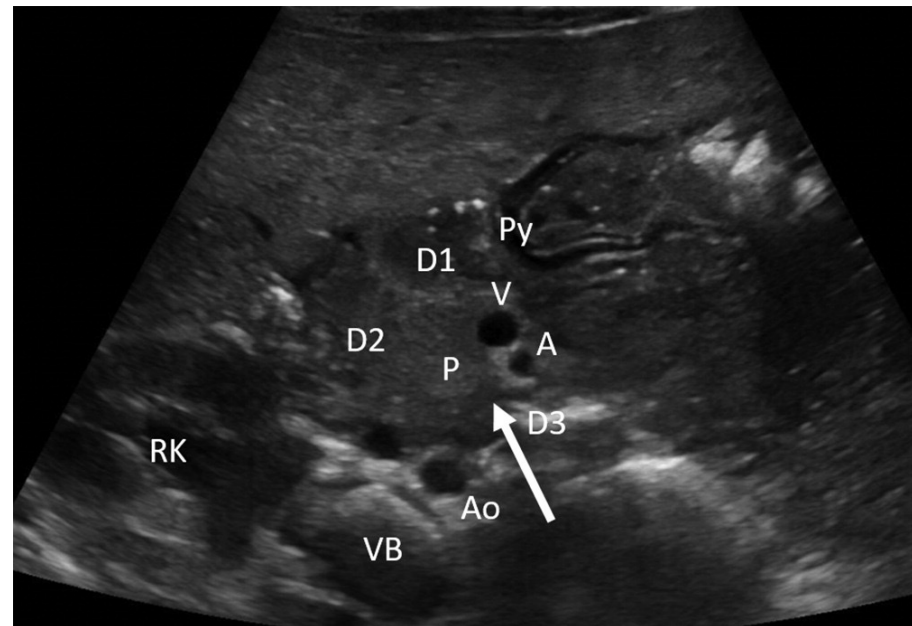
- Decreased radiation dose
- Faster (in house US technologists, do not have to wait for faculty to travel)
- US is portable
- US has comparable or better performance to UGI series
- Cheaper
- Fluoroscopy – historically the gold standard but problematic test

Midgut volvulus Ultrasound Performance

- Multicenter study preliminary data:
 - > Toronto Sickkids, Texas Children's, Phoenix Children's, Yale, NYU
- US diagnostic 795/942 (84%) patients:
 - False positives: 5 Sensitivity: 97.3%
 - False negative: 1 Specificity: 99.3%
- Reported Upper GI performance:
 - For volvulus:
 - Sensitivity: 54-89%
 - For malrotation:
 - Specificity: 85%
 - Sensitivity: 96-100%

US - Normal

- Normal SMV/SMA relationship (SMV to the right of SMA)
- Retroperitoneal Duodenum (between aorta and SMA)
- No clockwise whirlpool sign
- No dilation of proximal duodenum (D1, D2)



- First identify pylorus and duodenal bulb (D1) (similar to pylorus US)
- Identify the SMA and SMV
- Then move caudally to visualize D2 and D3 (just below pancreas)
- May administer sterile water or NS by enteric tube to better see duodenal course
- Tips:
 - Small footprint microconvex probe
 - Graded compression is also helpful to displace gas
 - May scan with pt in caregiver's arms to provide comfortable environment if needed
 - May need to turn baby to the right to help empty gastric contents

- **Age: 0-18 yo**
- **Emergent: bilious emesis – rule out midgut volvulus (mostly during the first year of life)**
- **Non-urgent: rule out malrotation**

- **Still:**
 - **Transverse view: Document SMA / SMV relationship at the level of the pancreas (taken midline, not from the side). Normal: SMA to left of SMV**
 - **Transverse view: Document retroperitoneal course of 3rd portion of the duodenum (D3) - should normally pass between Aorta and SMA**
 - Transverse view: Document any dilatation of stomach or proximal duodenum
 - Transverse view with color doppler: Evaluate for Whirlpool sign (swirling of bowel and SMV about SMA axis)
 - Transverse Cecum and appendix (if visible)

- **Cines:**
 - Transverse:
 - Pylorus and First portion of the duodenum
 - D3
 - **Entire SMA/ SMV - With and Without Doppler from the pancreas to the top of the bladder (dual screen if possible)**
 - **Looking for clockwise whirlpool sign of midgut volvulus (see image bellow)**
 - **if SMA / SMV and D3 obscured by gas, utilized a small, curved probe**
 - Transverse - Cecum with appendix if visible



Normal CT for anatomical comparison

Follow Aorta – SMA axis to know if SMV is to the right of SMA

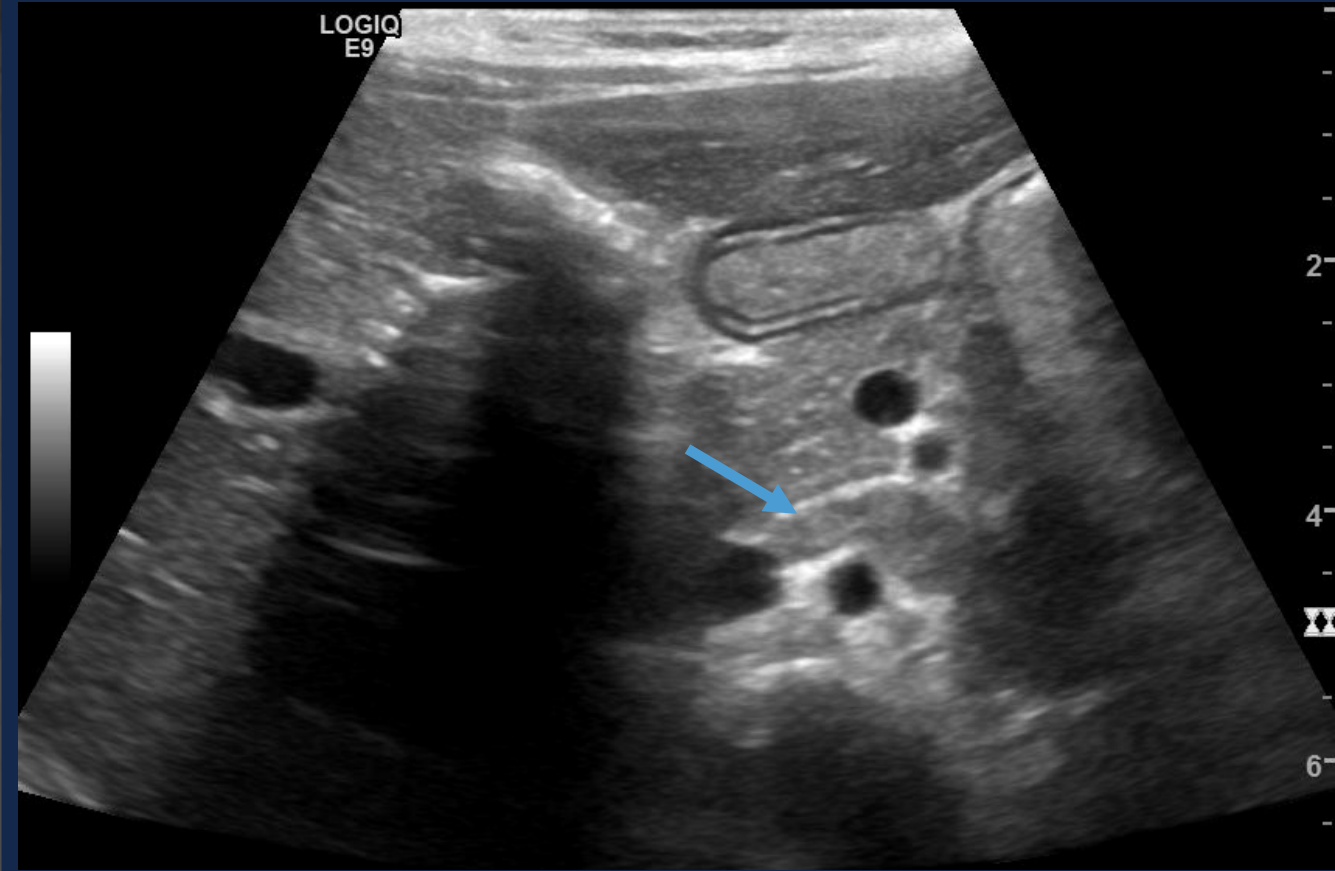
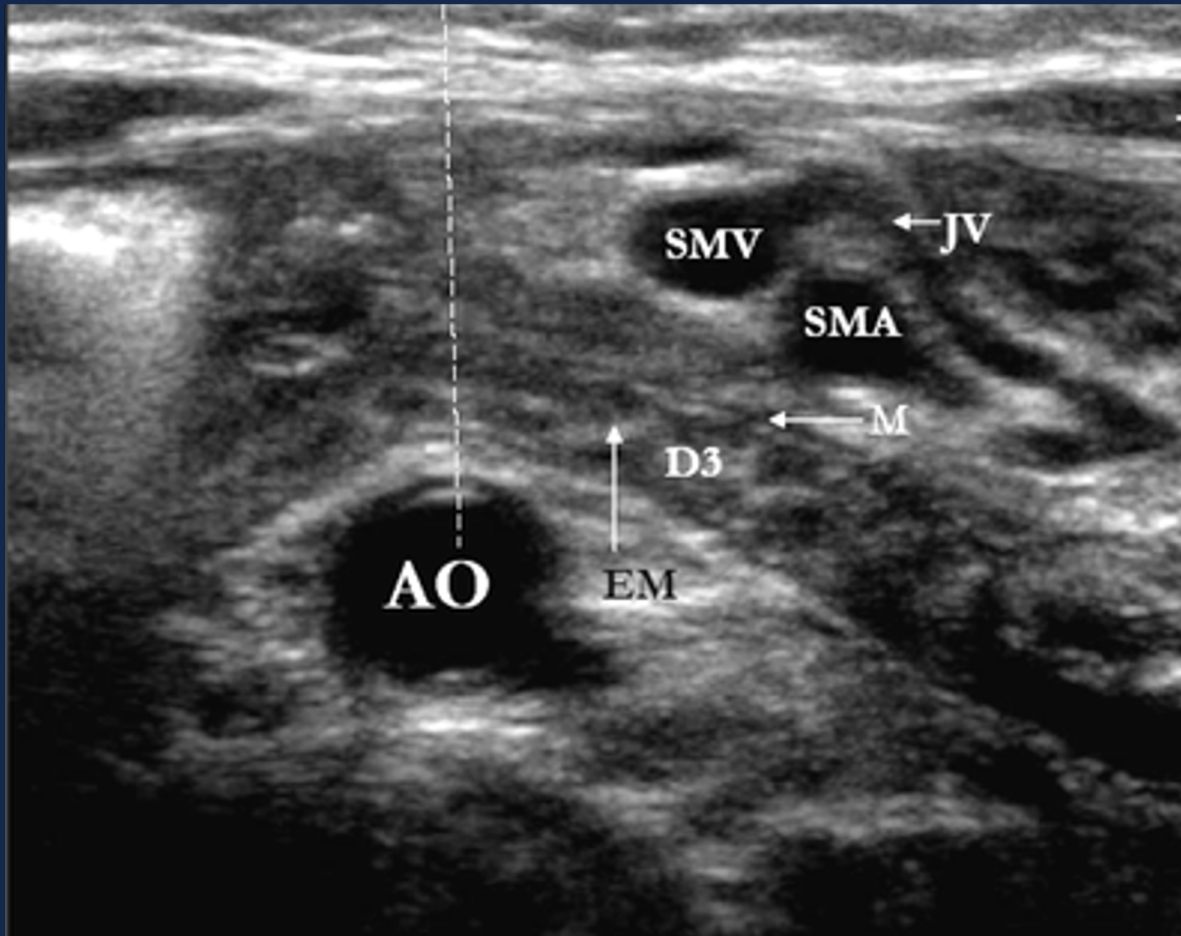


Off axis image – image not performed at the midline



Using Aorta- SMA axis =
normal SMA/SMV relationship

Normal Retroperitoneal 3rd Portion of Duodenum



LOGIQ
E9

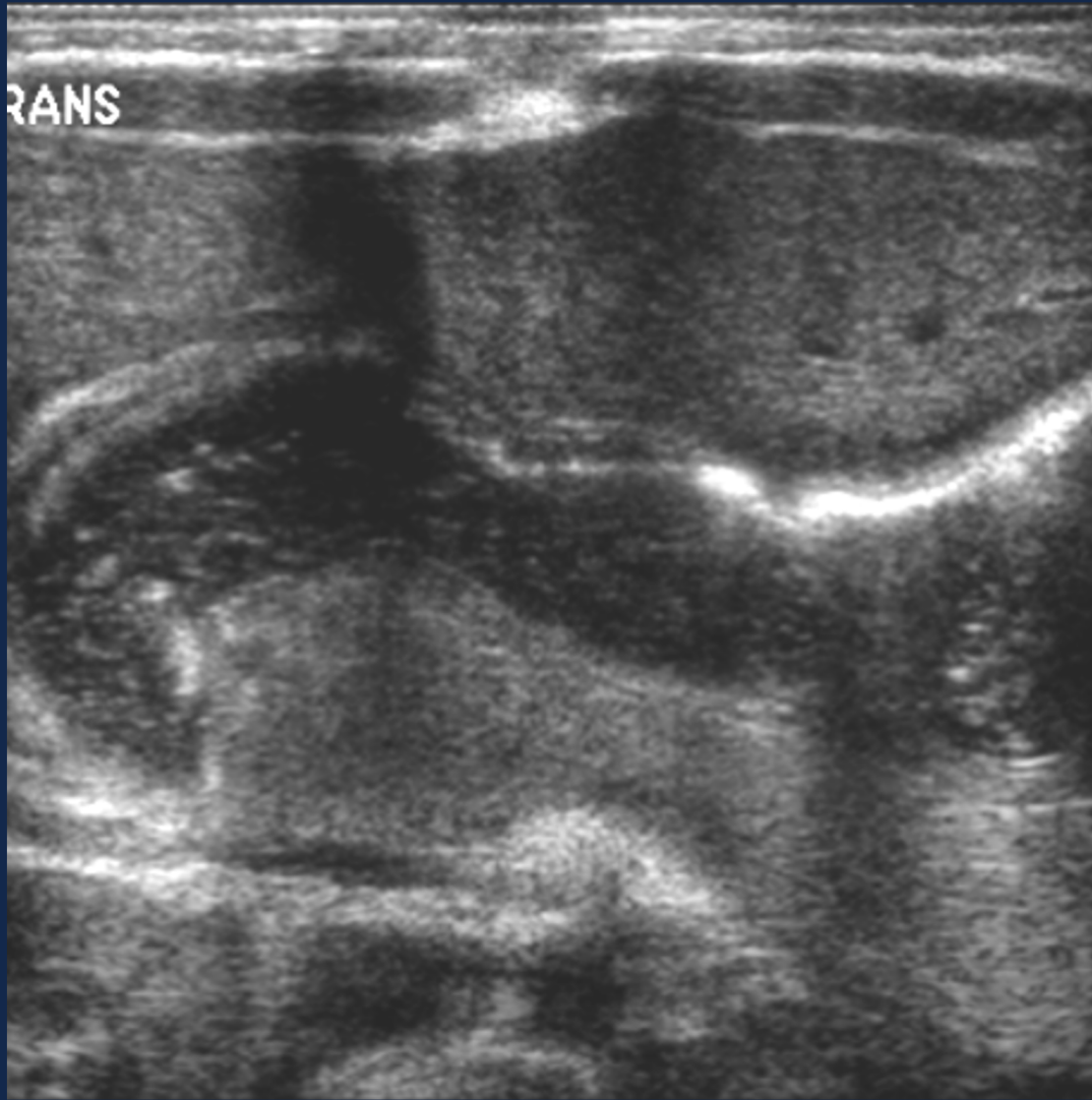
TRANS LIVER LEFT



0
5
10

- Abnormal SMV- SMA relationship (to the left of SMA)
- Intrapertitoneal course of D3 (NOT between Aorta & SMA)

- Whirlpool sign: Clockwise swirl of SMV & bowel loops around SMA in transverse plane
 - (sensitivity of 92% and specificity of 99%)
- Dilation of proximal duodenum (and stomach)
 - With to-and-fro flow of enteric contents
- Other findings:
 - SMA cutoff sign
 - Dilation of SMV distal to volvulus
 - Mesenteric edema
 - Ascites

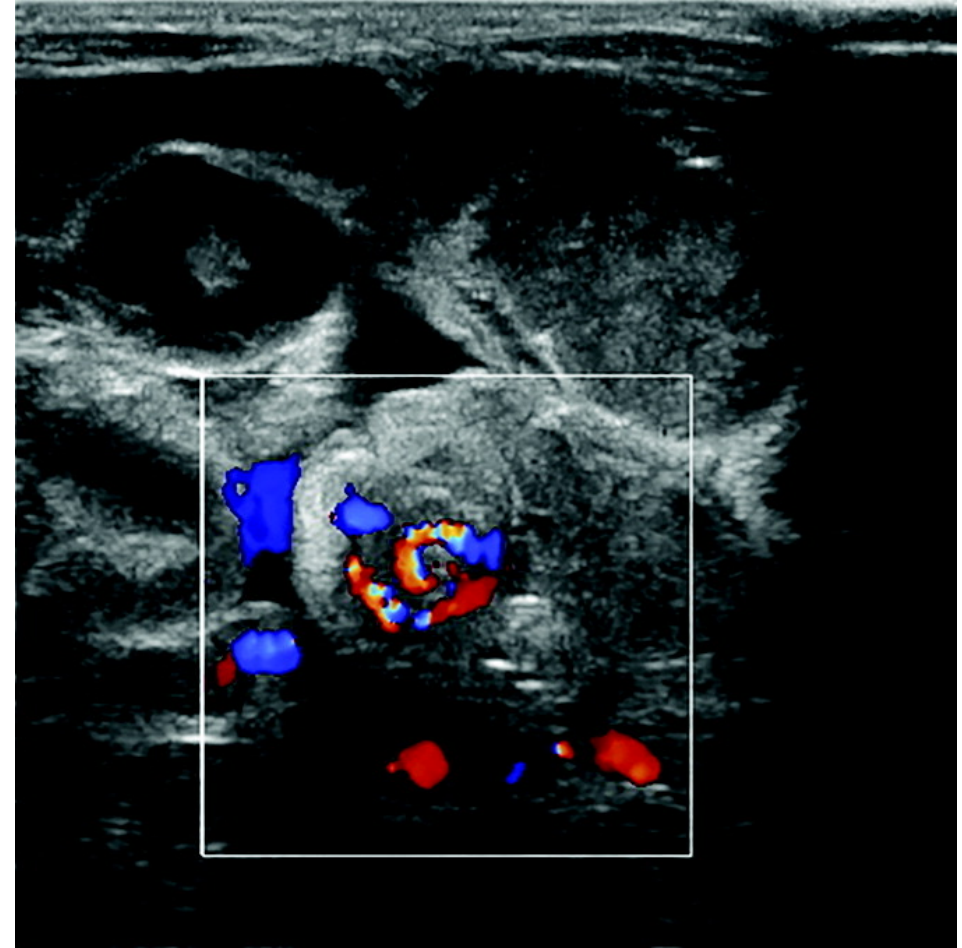
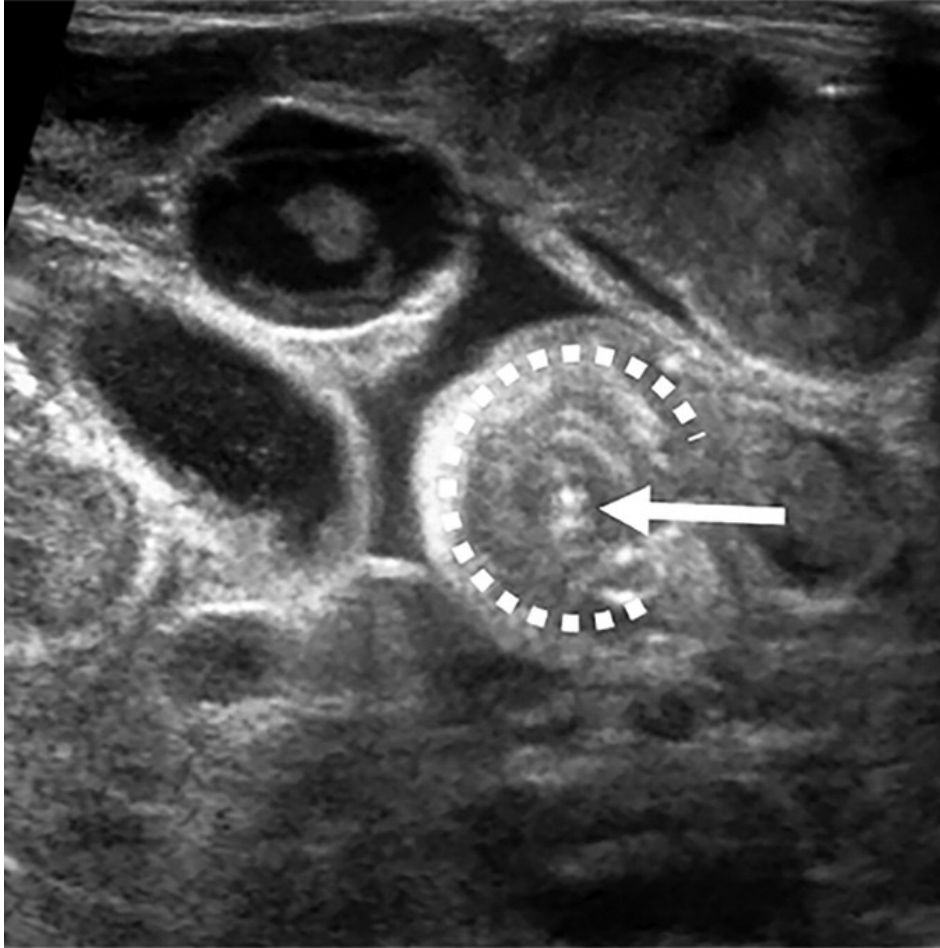


Dilated D1



Dilated D2 and hypoplastic uncinate process

US Midgut Volvulus Findings



Midgut volvulus in 2-day-old boy (33 weeks' gestation) with bilious emesis.

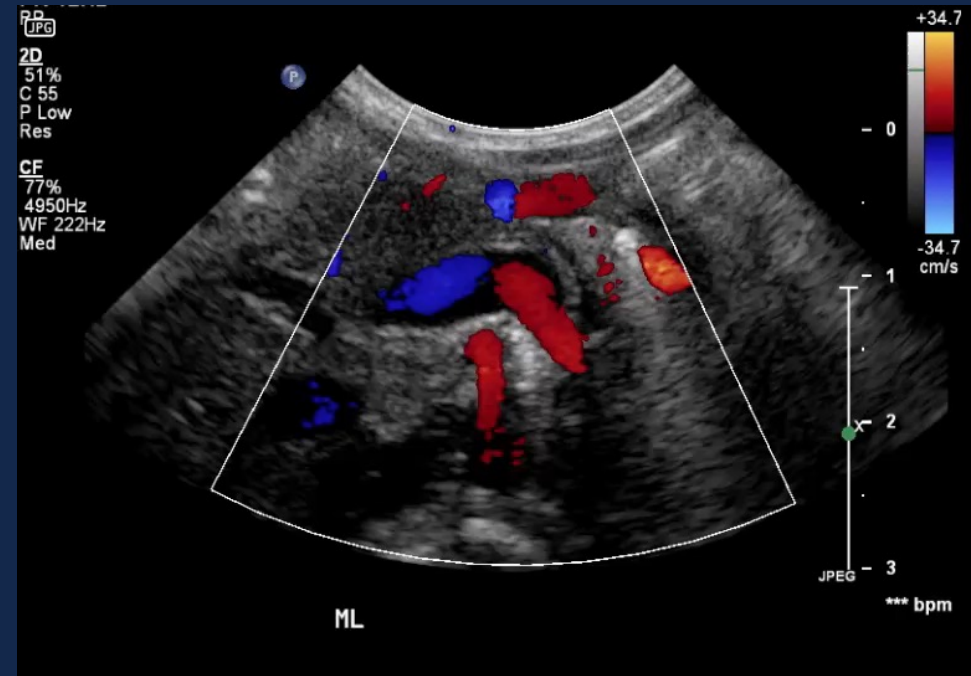
C, Gray-scale (B) and color Doppler (C) ultrasound images of mid abdomen show swirling (curve, B) around superior mesenteric artery (arrow, B), which is described as whirlpool sign on color Doppler and is consistent with diagnosis of volvulus (from Nguyen et al)

US Midgut Volvulus Findings



Clips Courtesy Dr. Cicero Silva

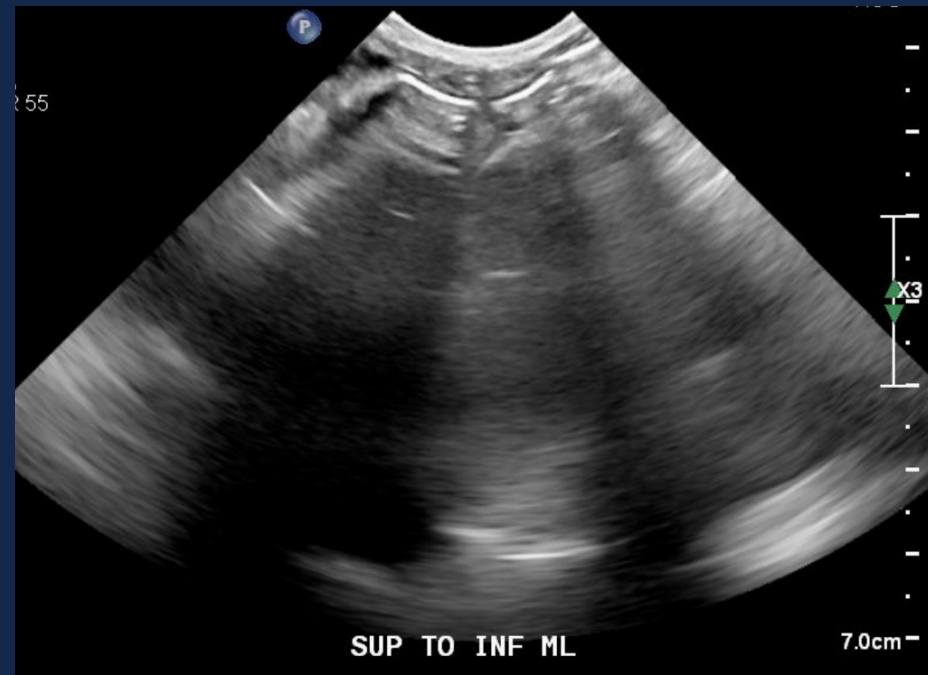
US Midgut Volvulus Findings



Courtesy Dr. Cicero Silva

Non-diagnostic US

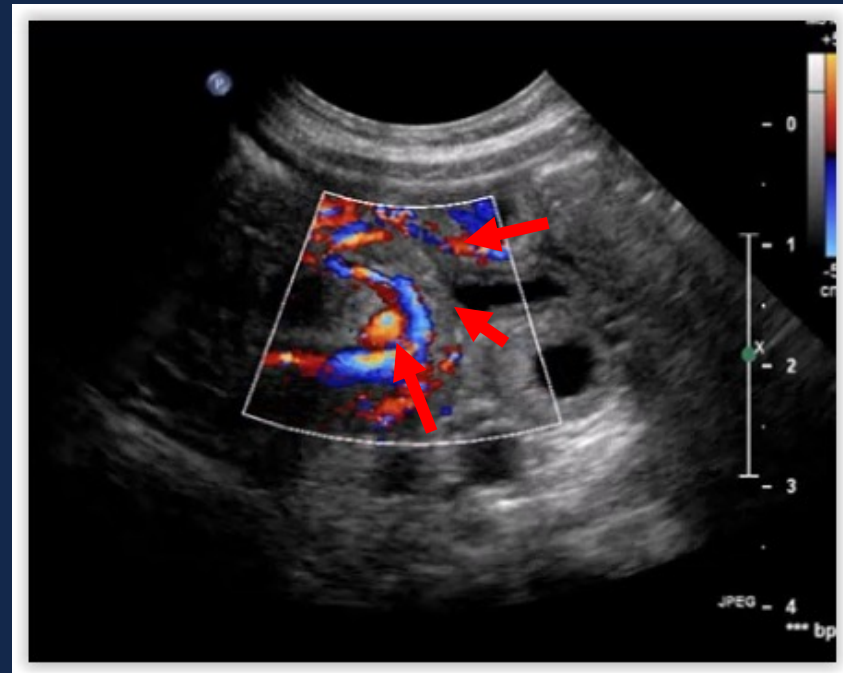
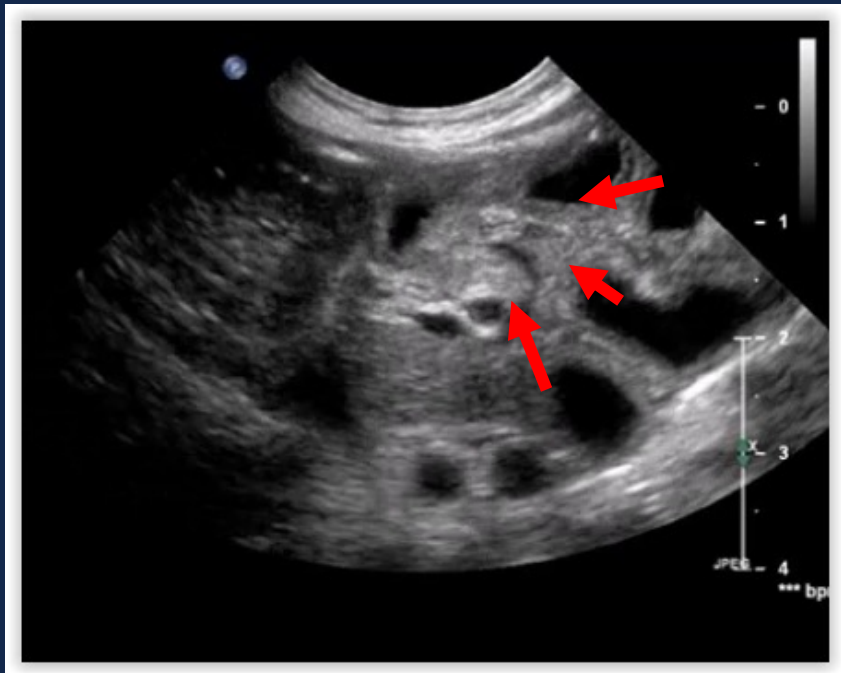
- 16 % Non-diagnostic due to obscuration by bowel gas



Courtesy Dr. Cicero Silva

US pitfall

- Anticlockwise SMV branch 180° swirling around SMA – normal finding – NOT VOLVULUS IF ANTICLOCKWISE



Courtesy Dr. Cicero Silva

US Findings - Scenario 1

- Normal SMV/SMA relationship
- Retroperitoneal Duodenum
- No clockwise whirlpool sign (entire SMA and SM V visualized)
- No dilation of proximal duodenum



Normal Exam
– No malrotation, No Midgut volvulus

- Abnormal SMV/SMA relationship
- Intrapertitoneal Duodenum

- No clockwise whirlpool
- No dilation of D1 / D2

Malrotation, NO Midgut Volvulus

- Whirlpool clockwise sign
- Dilation D1 / D2

Malrotation WITH Midgut Volvulus

US Findings - Scenario 4

- Normal SMV/SMA relationship
- No clockwise whirlpool sign (entire SMA and SMV visualized)
- No dilation of proximal duodenum

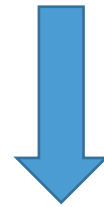


Non-visualized retroperitoneal D3



- No Midgut volvulus, indeterminate for malrotation
- Upper GI can be later, non-emergent

- Bilious emesis - SMA / SMV course obscured by gas



- Non- diagnostic
- Emergent Upper GI

- Master report for Abd Limited US to auto-populate
 - Choose Midgut Volvulus from list of reports
- If report does not auto-populate, you can find the “sonographer Abdomen Limited (peds) Master” report when looking at the “relevant site” reports
- The report will guide you based on the US findings scenarios

US Midgut volvulus – Proposed imaging workflow

- US as first-line exam for bilious emesis, 24/7, to be performed STAT:
 - > If positive for volvulus: surgery
- Fluoroscopy room on stand-by for prompt UGI if:
 - US non-diagnostic for midgut volvulus
- If no midgut volvulus, but indeterminate for malrotation- upper GI can be performed next day

IMPORTANT !

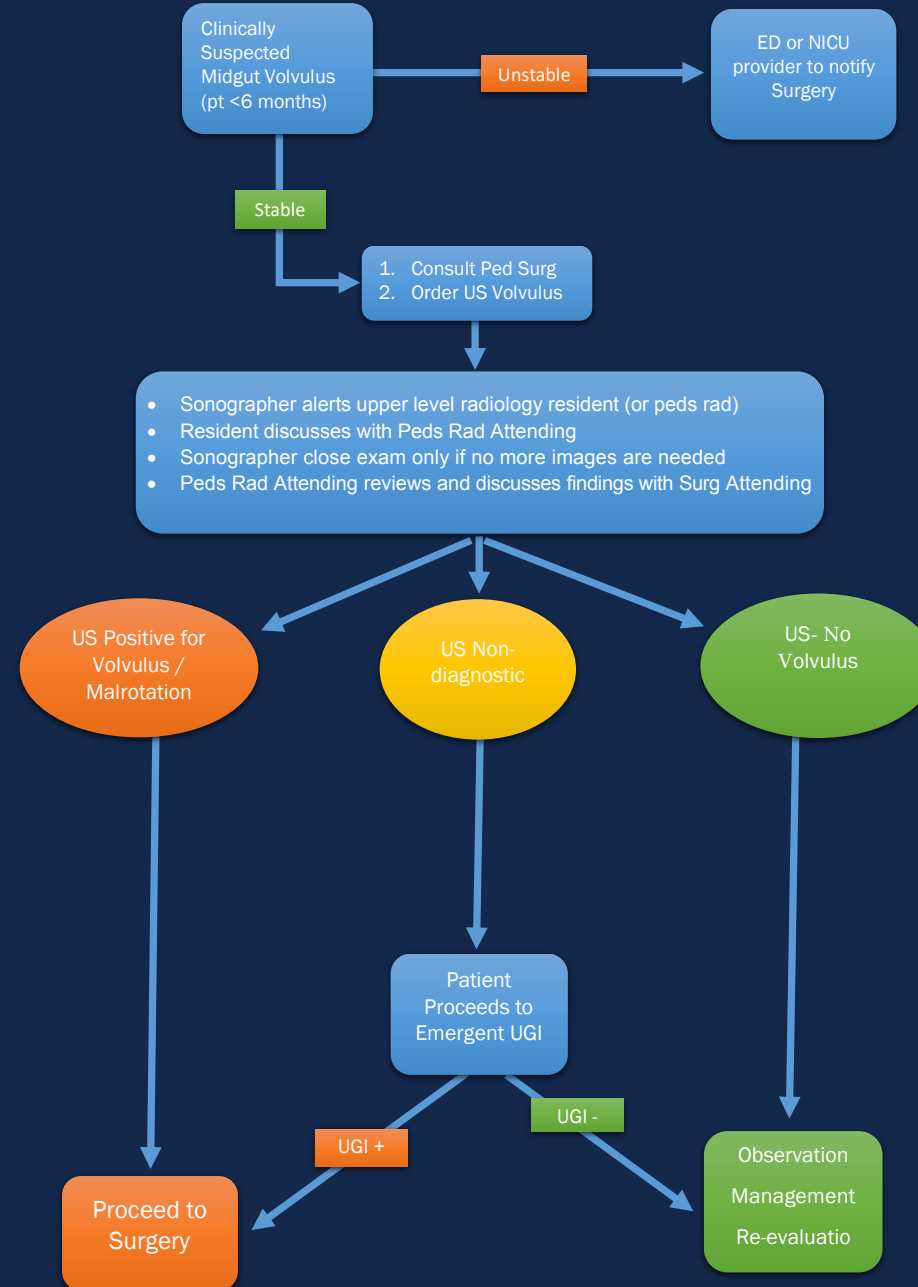
Residents:

* Call Ped Rad faculty for any cases of Bilious Emesis at any time of the day, as soon as aware an US was order for this indication

* Give Flouro techs the heads up that an upper GI may be needed

* On Call Ped Rad faculty will make decision when to close exam and next steps in communication with upper level resident

Midgut Volvulus Algorithm



IMPORTANT !

US Technologists:

* Call Upper level resident as soon as an Emergent US was order for bilious emesis and ask them to call the faculty on call

* Do Not close exam until Ped Rad Faculty approves the case for completion – communication via upper level resident. Faculty may want to scan baby prior to Upper GI if US was inconclusive

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