MECKEL'S DIVERTICULUM : CATCH ME IF YOU CAN !

PENGAM A.[1], BAZERIES P.[1], COTY JB.[1], CARTIER V.[1] LEBIGOT J.[1], RIDEREAU C.[1], HAMY A.[2], CASA C.[2], AUBÉ C.[1]

JUNE 12–15 ESGAR 2018 DUBLIN IRELAND

(1) Diagnostic and Interventional Radiology Department – University Hospital of Angers (FRANCE)
(2) Visceral Surgery Department – University Hospital of Angers (FRANCE)

SUMMARY :

- **EMBRYOLOGY & ANATOMY**
- **IMAGING FINDINGS**
- **COMPLICATIONS**
  - Bowel obstructions
    - Diverticular flange
    - Intussusception
    - Littre hernia
    - Bezoar
  - Inflammation: Meckel's diverticulitis
  - Tumors
  - Hemorrhage
- **CONCLUSION**

EPIDEMIOLOGY

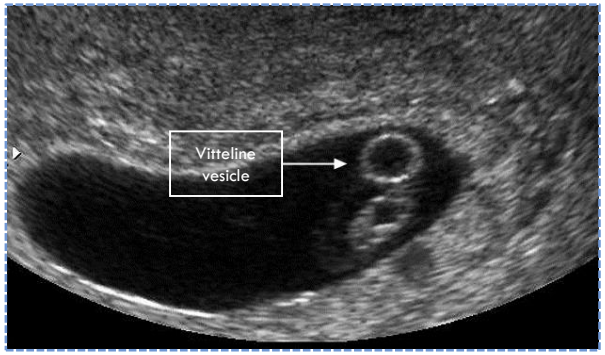
- Meckel's diverticulum is the most common malformation of the GI tract
- Prevalence varies from 0.3% to 3% and prevalence is about 2%
- Male predominance (sex ratio 2:1)
- 53% of Meckel's diverticulum are diagnosed in the first two years of life

CLINICAL

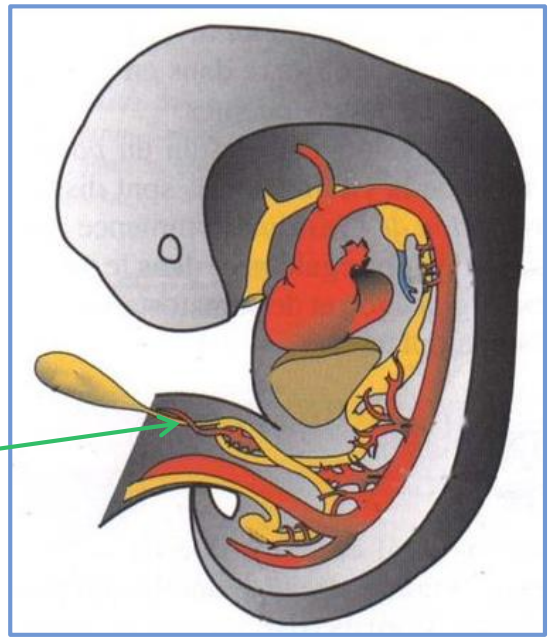
- Mostly asymptomatic :
  - Accidentally discovered in imaging or during abdominal surgery
  - 2-4% symptomatic
- Complications mostly occur during childhood
- The probability of becoming symptomatic decreases with age

NORMAL EMBRYOLOGY

- MD is a vestigial remnant of the omphalomesenteric duct :
  (also known as "vitelline duct" or "yolk stalk")



Omphalomesenteric duct



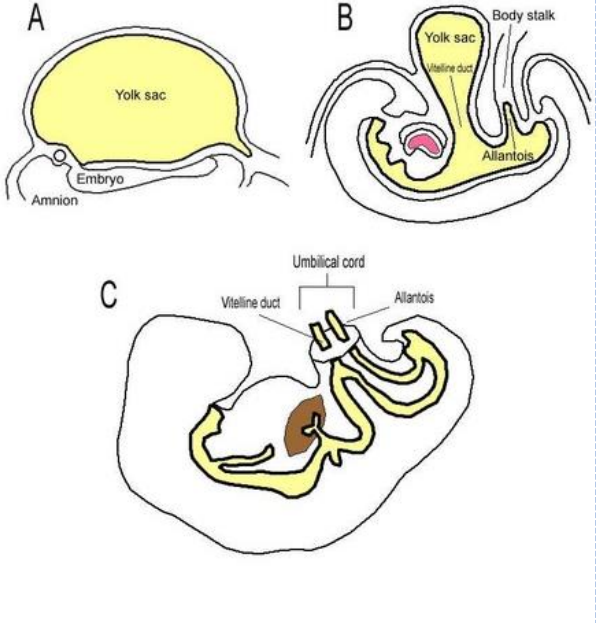
Until 9th week

First trimester ultrasonography P.Bourgeot, Y.Robert

NORMAL EMBRYOLOGY

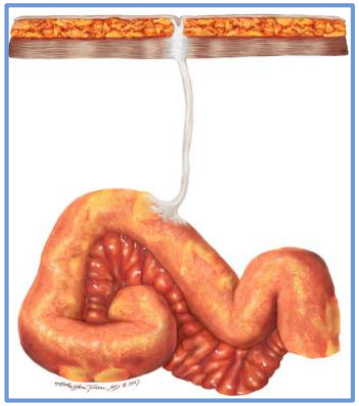
❖ After the **10th week :**

- ➢ Primitive intestine rotations and reintegration into the abdominal cavity
- ➢ Omphalomesenteric duct involutes into a thin fibrous band, gradually absorbed
- ➢ Constitution of the abdominal wall



PATHOLOGIC EMBRYOLOGY

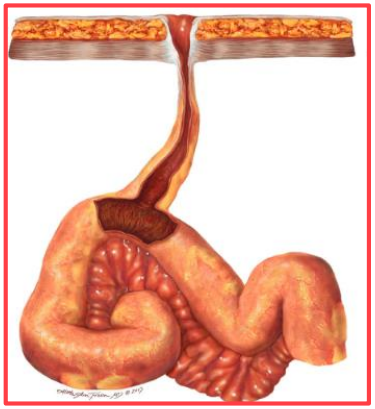
- Incomplete involution of omphalomesenteric duct induces a spectrum of various congenital anomalies :



Residual fibrous tract

Enteral cyst

Umbilical sinus

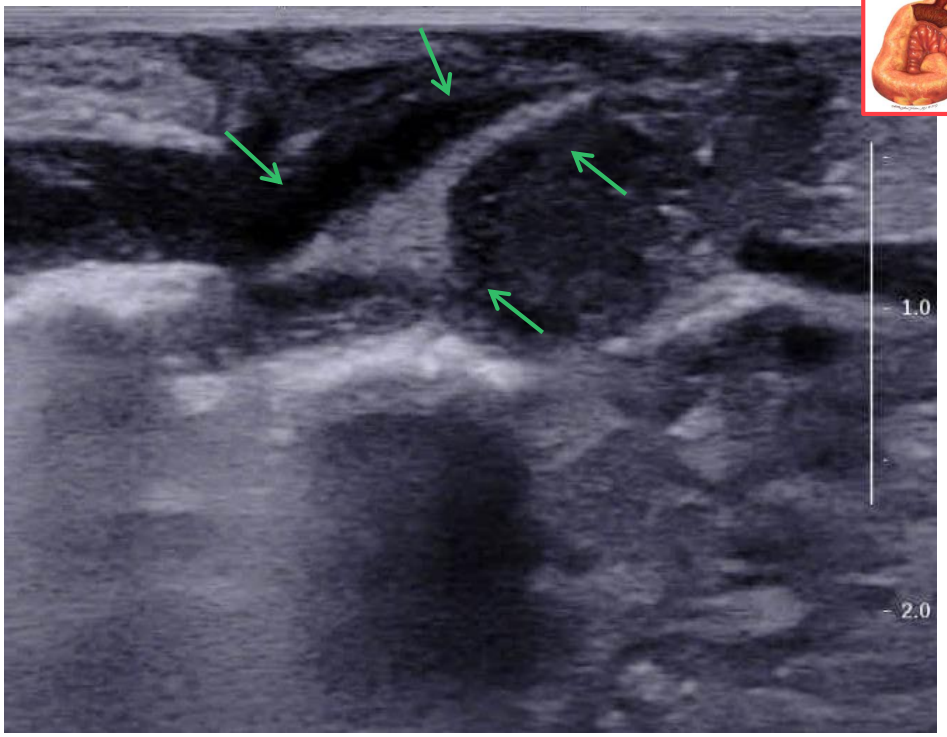


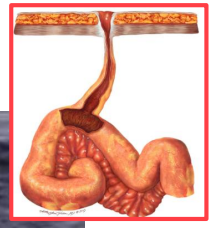
Entero-umbilical fistula

A D. Levy, C M. Hobbs. Radiographics 2004; 24:565 - 587

ENTERO-UMBILICAL FISTULA

- Clinically evident entero-umbilical fistula in 13 days old male



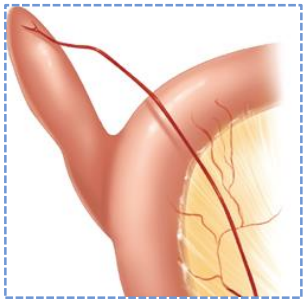


- Ultrasonography exploration (sagittal) passing through the umbilicus evidences the connection with small bowel

MECKEL'S DIVERTICULUM

❖ MD is the most frequent remnant of omphalomesenteric duct :

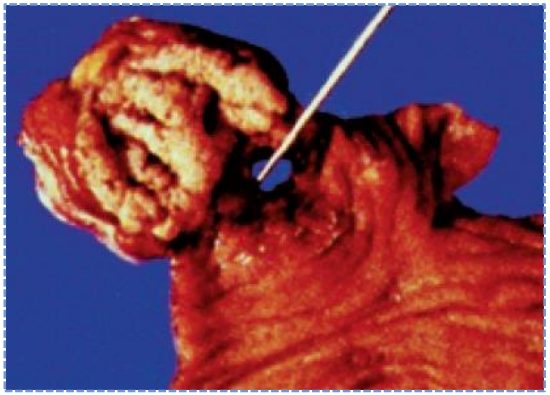
- Single cystic or tubular structure
- True diverticulum :
  - 3 layers of the bowel wall
  - Digestive lumen : Air-filled ending pouch
- Average length ~ 5cm
- Always developed on the terminal ileum :
  - Implanted on the anti-mesenteric border
  - From 10 to 100 cm of the ileocecal valve



- Sometimes specific artery : right vitelline artery, branch of the superior mesenteric artery (only evidenced by arteriography)

MECKEL'S DIVERTICULUM

- Often abnormal mucosa and submucosa :
  - Heterotopic gastric mucosa : 50% of cases
    - Ulcer is the first cause of bleeding from Meckel's diverticulum
    - Lower gastrointestinal hemorrhage is rarely found in conventional imaging
    - Requires metabolic imaging exploration by Tc99 Pertechnate Scintigraphy



Heteropia of gastric mucosa with ulcerous perforation
G Schumtz et al. Occlusion intestinale et diverticule de Meckel, Feuillets de Radiologie 2003

  - Heterotopic pancreatic tissue : rare (5% of cases)

MECKEL'S DIVERTICULUM

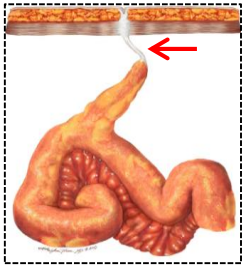
❖ Two different types :

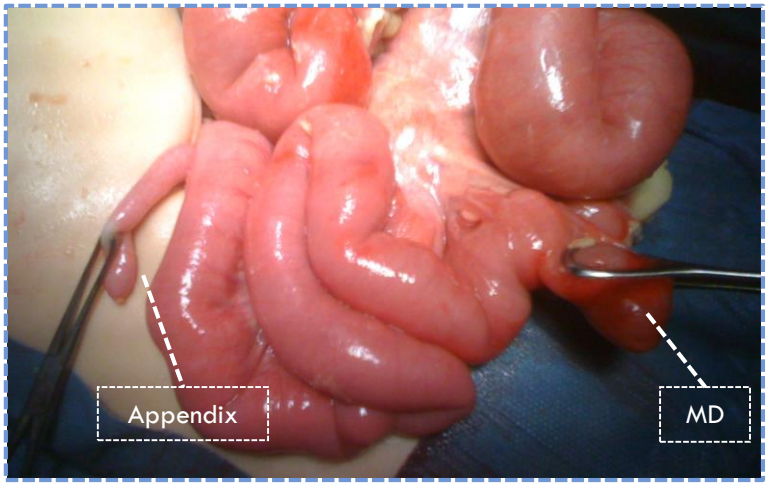
Free MD : 85% cases

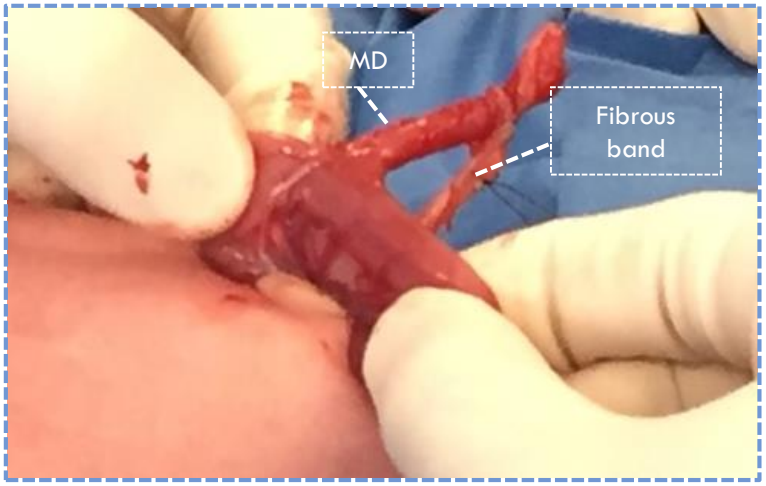
- Not connected to the umbilicus
- Free to move anywhere in the peritoneal cavity

Fixed MD : 15% cases

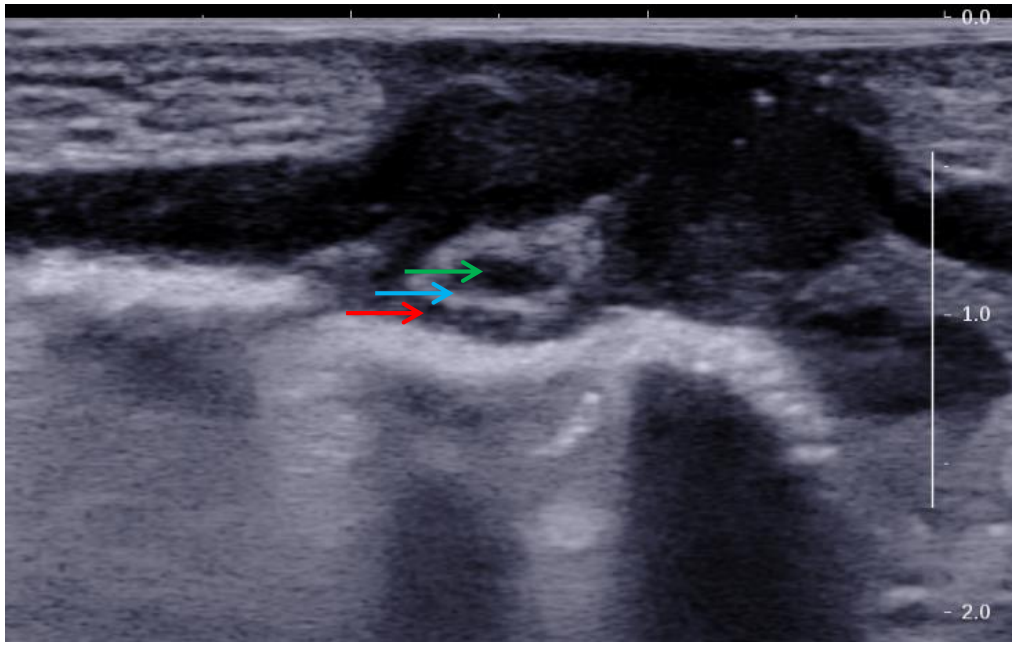
- Connected by flange or fibrous cord
- Attached to the abdominal anterior wall
- Oriented towards the umbilicus







ULTRASONOGRAPHY



- Ultrasonography is a relevant first-line exam in children
- Meckel's diverticulum remains often difficult to find among mobile small bowel loops
- Ultrasonography is useful to rule out differential diagnoses and to confirm the intestinal nature of the structure constituted by the three typical layers of intestinal wall :
  - Mucosa (hypoechoic)
  - Submuscosa (hyperechoic)
  - Muscularis propria (hypoechoic)

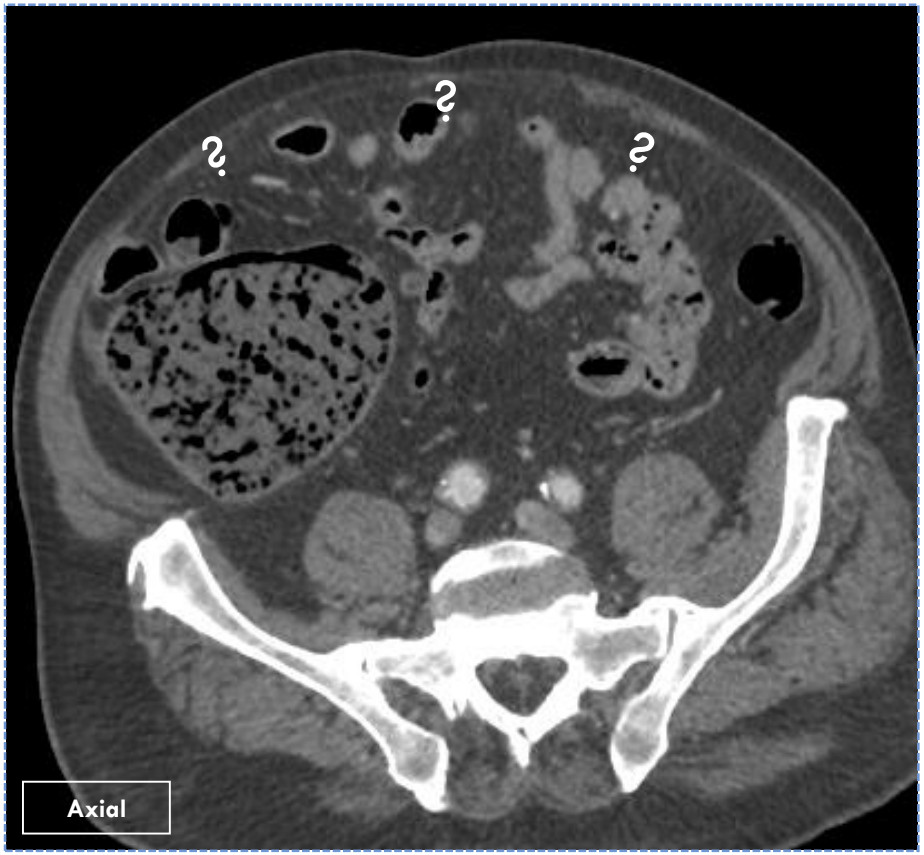
CT SCAN

- CT scan is the reference examination in adult
  - 3D exploration with excellent spatial resolution
  - Possibility of Multiplanar Reconstructions (MPR)
  - Exhaustive ileum exploration, eventually improved by water enema
  - Allow to follow and “unroll” each intestinal loops
  - Post-contrast imaging at portal venous phase contrast improve intestinal loops analysis

CT SCAN

Preoperative imaging evaluation for colorectal cancer in 84-year-old male :

- The Meckel's diverticulum is very difficult to highlight with basic reconstructions

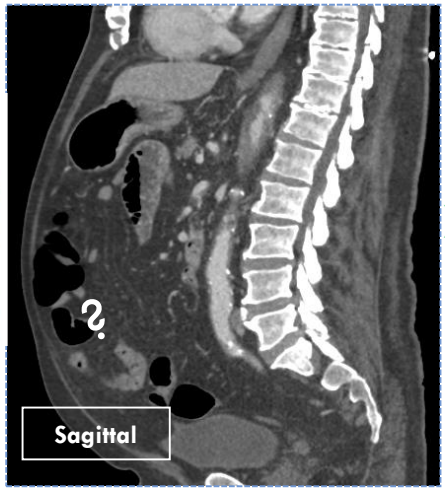


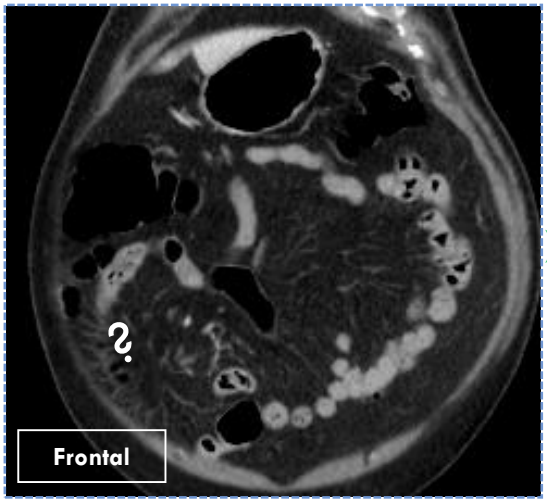
CT SCAN

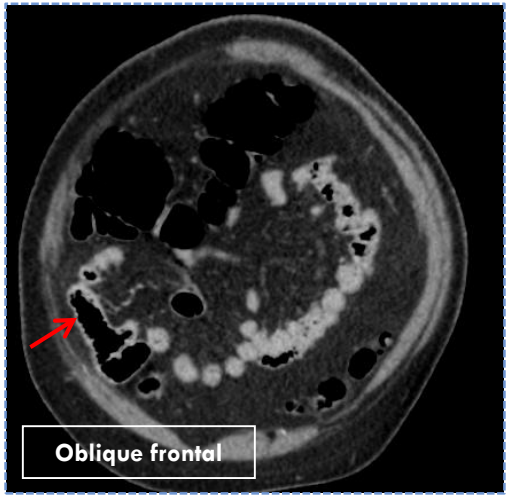
- Finding Meckel's diverticulum requires :
  - Systematic analysis of each small bowel loop
  - The use of oblique and Multiplanar Reconstructions (MPR)
    - At least, coronal and sagittal reconstructions
    - MinIP can help to improve Meckel's diverticulum detection
  - Focused and attentive research on terminal ileum
  - To research blind loop meeting diagnostic criteria of Meckel's diverticulum

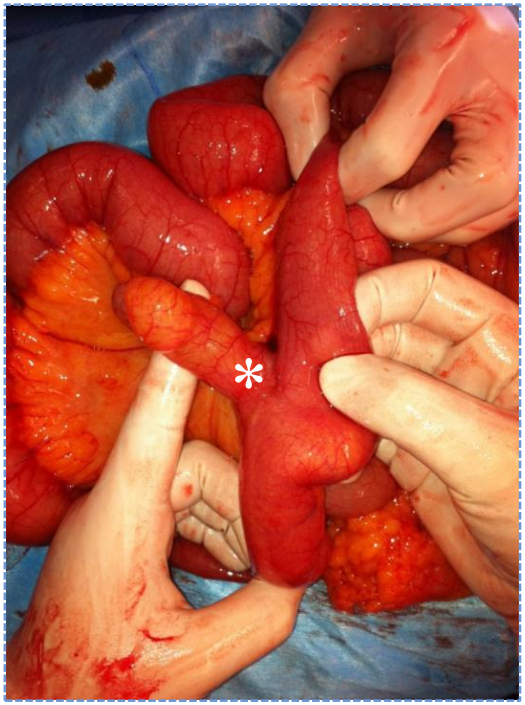
CT SCAN

Preoperative imaging evaluation for colorectal cancer in 84-year-old male :









CT scan oblique reconstructions allow to fortuitously evidence a six centimeters-long air-filled-ending pouch arising from the antimesenteric side of the distal ileum

Peroperative constatations confirm presence of a Meckel's diverticulum

COMPLICATIONS

- Meckel's diverticulum has various clinical presentations and it is difficult to make a precise diagnosis preoperatively :
  - Bowel obstruction (50%) : the most frequent clinical presentation in adults
  - Diverticulitis (30%)
  - Hemorrhage (20%) : the most frequent clinical presentation in children
  - Tumors

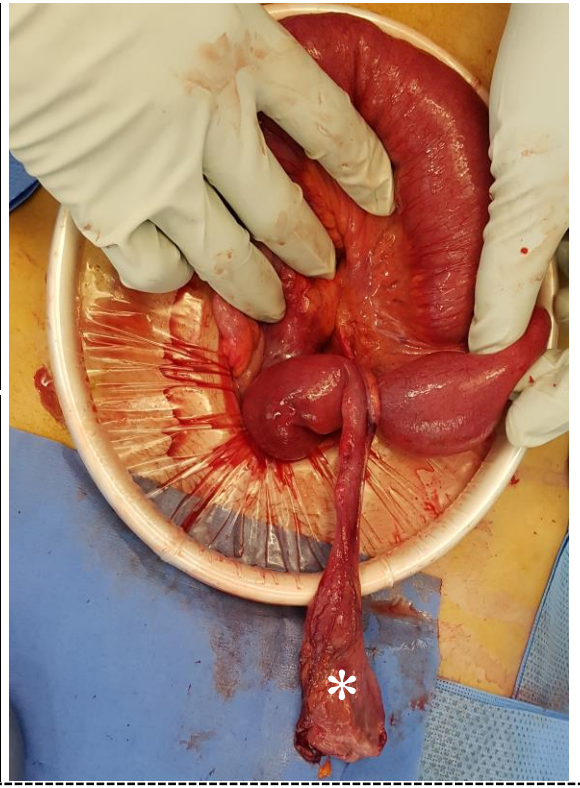
- MD is often missed in adults because of lack of suspicion and difficulty in detection

BOWEL OBSTRUCTION

- Various mechanisms :
  - Volvulus
  - Adhesion/flange
  - Intussusception
  - Hernia : external (Littré) or internal
  - Bezoar
- High risk of ischemic necrosis (strangulation)

BOWEL OBSTRUCTION

❖ Bowel volvulus :

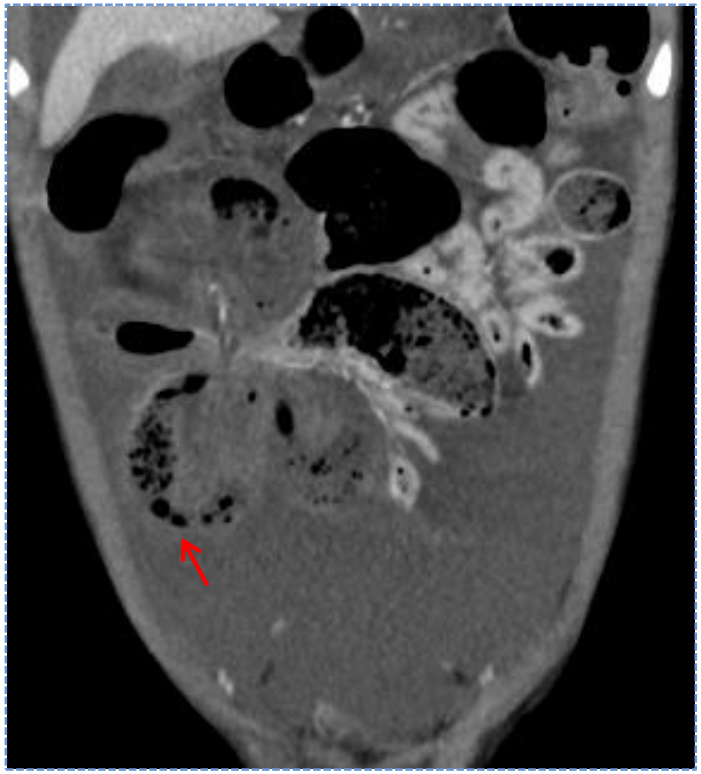


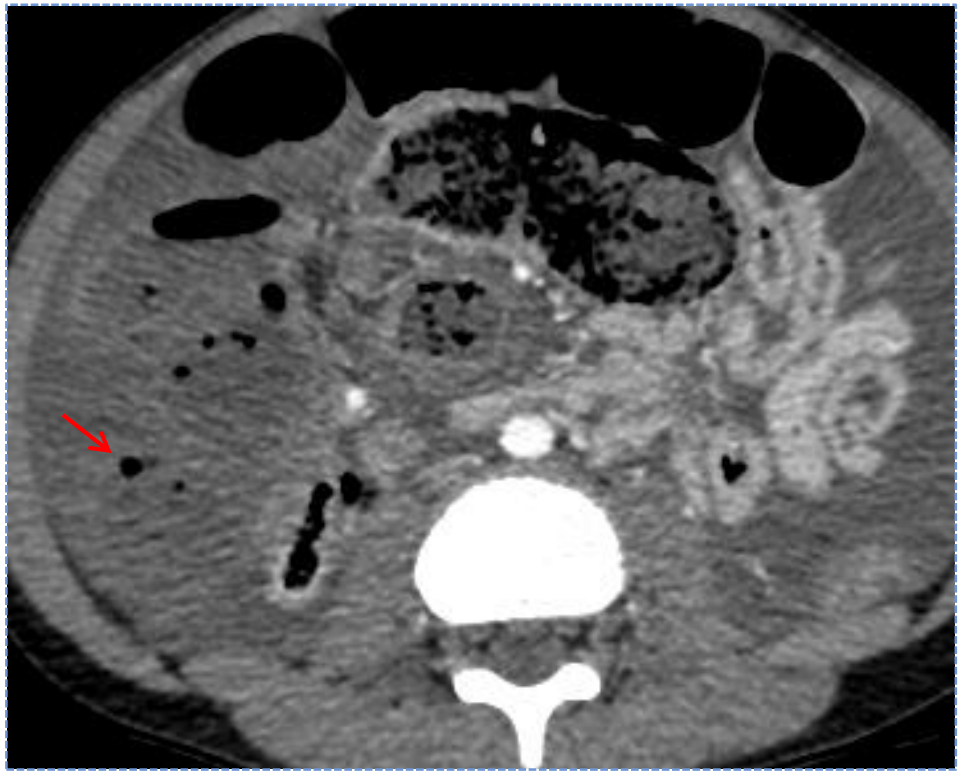
➢ 16-year-old male admitted for abdominal pain and vomiting :

- CT scan demonstrates a mechanical small bowel obstruction with a whirl sign highly evocative of bowel volvulus without wall necrosis of strangulated loops.
- Peroperative observations evidenced a Meckel's diverticulum responsible of this volvulus.
- Even retrospectively knowing surgical findings, MD remains inaccessible to radiological diagnosis.

BOWEL OBSTRUCTION

❖ Bowel volvulus :



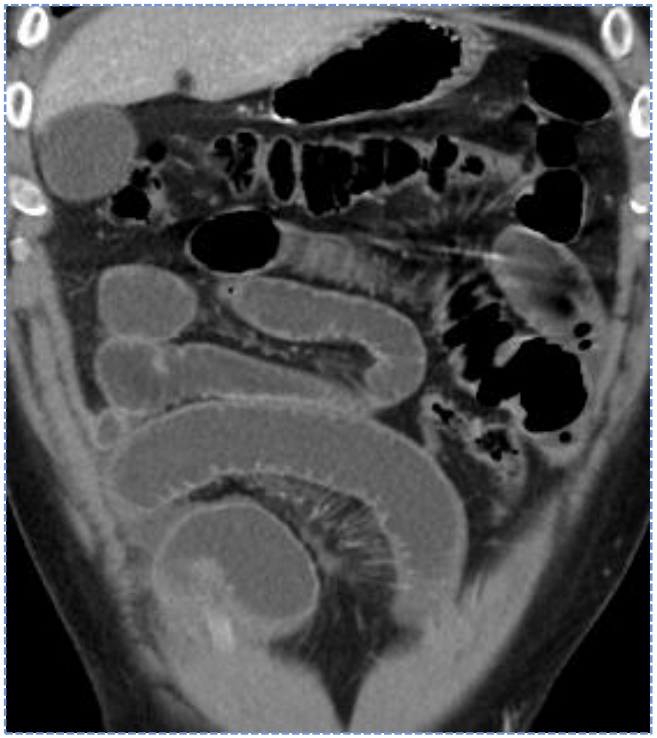


➢ 8-years-old male admitted for abdominal pain without fever:

- CT scan demonstrates an intra-peritoneal fluid effusion with infarction of the distal small bowel and the right colon. The first hypothesis was bowel volvulus without common mesentery.
- Peroperative observations evidenced a Meckel's diverticulum responsible of this volvulus
- Even retrospectively knowing surgical findings, MD remains inaccessible to radiological diagnosis

BOWEL OBSTRUCTION

❖ Adhesion/flange :

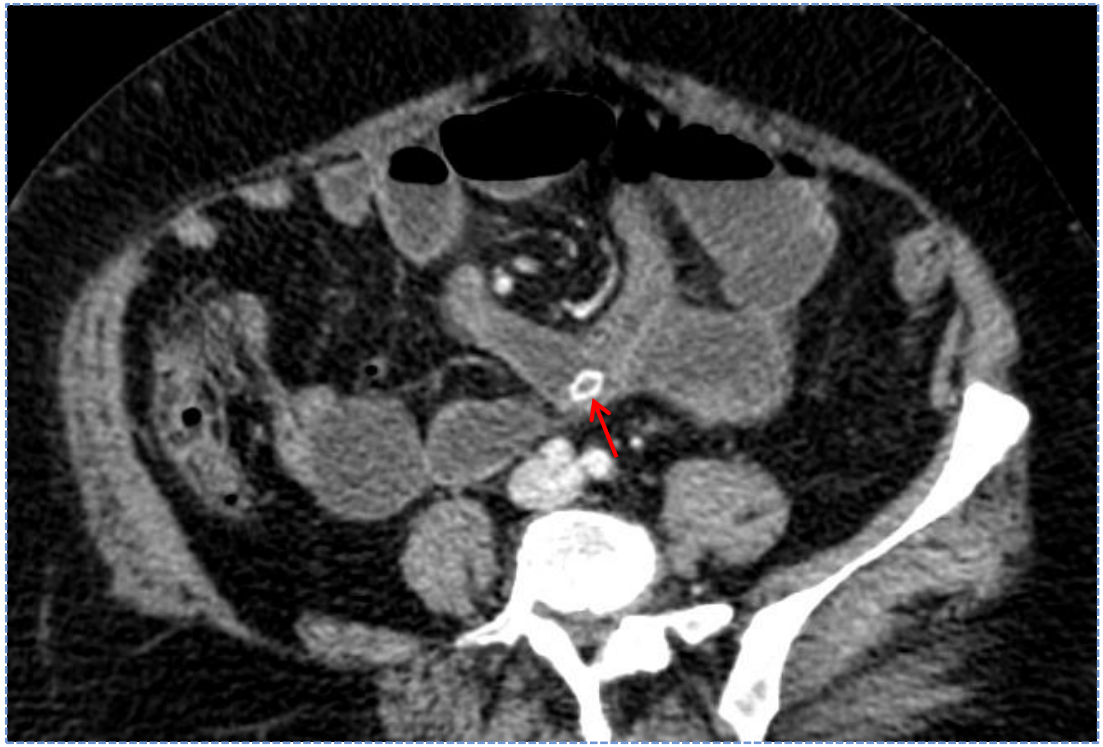


➢ 40-years-old male admitted for brutal abdominal pain :

- CT scan demonstrates a mechanical bowel obstruction with a narrow transition and “beak sign” with strangulation (edema with mesenteric venous congestion). Initial report concluded to mechanical occlusion of single flange.
- Peroperative observations evidenced a Meckel’s diverticulum responsible of this obstruction

BOWEL OBSTRUCTION

❖ Adhesion/flange :

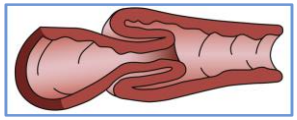


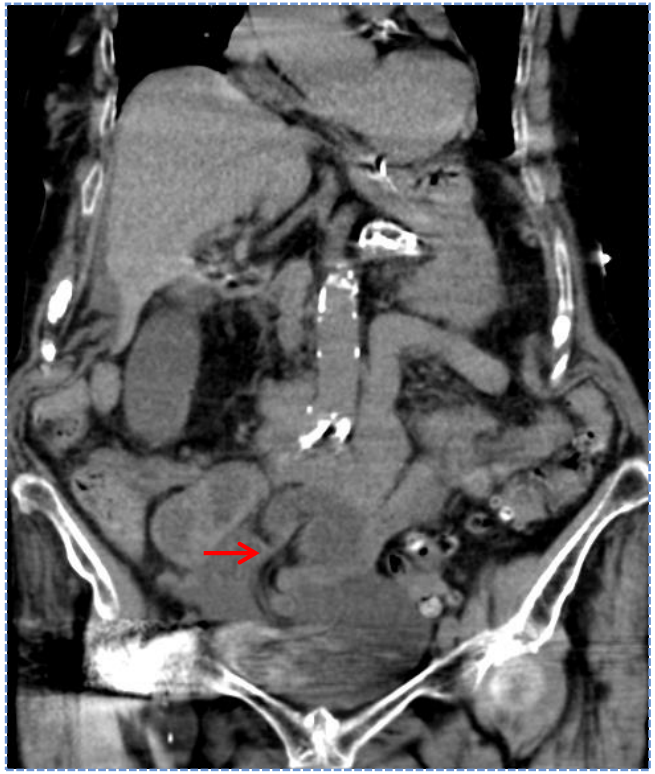
➢ 40-years-old male admitted for brutal abdominal pain :

- CT scan demonstrates a mechanical bowel obstruction with a narrow transition and “beak sign” with strangulation (edema with mesenteric venous congestion) related to tubular blind intestinal structure with enterolith.
- Peroperative observations confirmed presence of a Meckel’s diverticulum responsible of this occlusion

BOWEL OBSTRUCTION

❖ Intussusception :

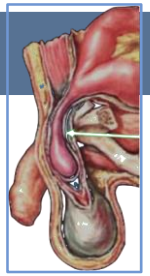




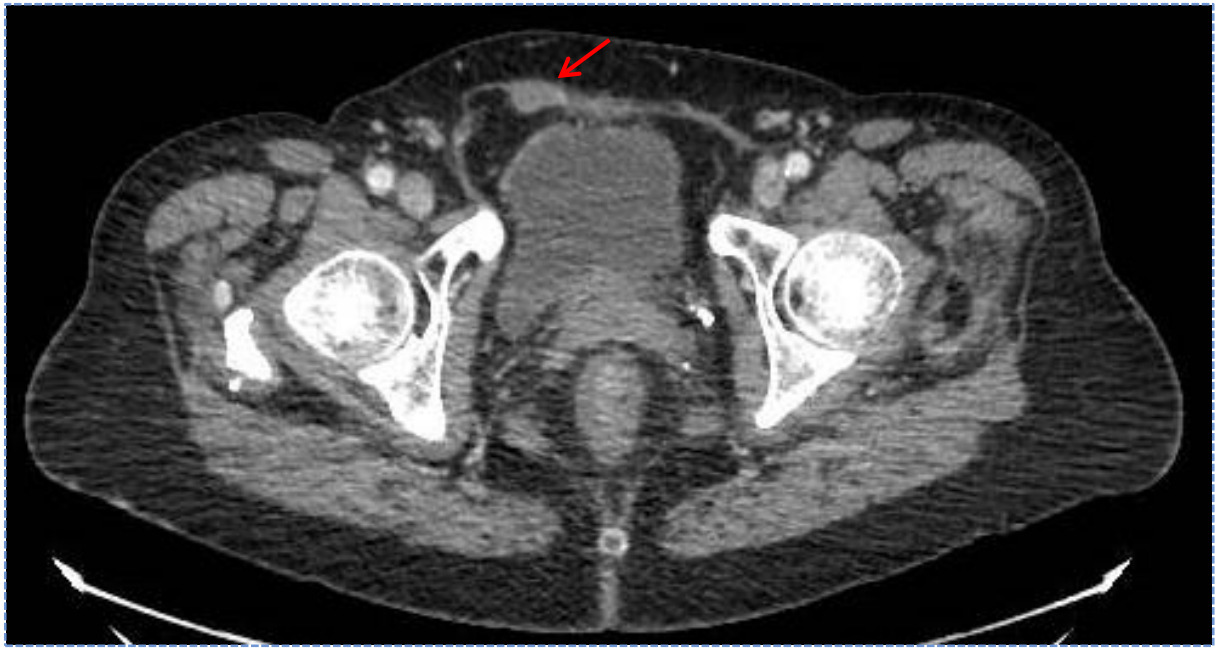
➢ 88-year-old male with intestinal obstruction and vomiting :

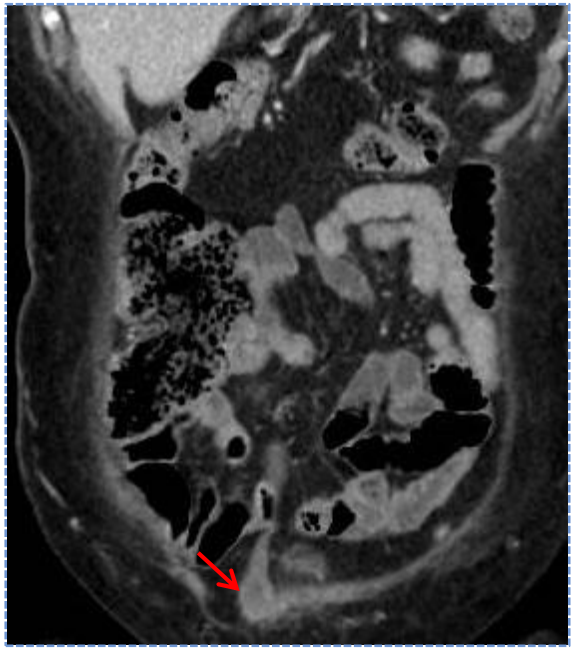
- CT scan demonstrates a bowel-within-bowel sign, specific of a small bowel intussusception.
- Peroperative observations evidenced an inverted Meckel's diverticulum as lead point for the ileoileal intussusception
- Even retrospectively knowing surgical findings, MD remains inaccessible to radiological diagnosis.

BOWEL OBSTRUCTION



❖ Littré hernia : MD involvement in indirect inguinal hernia



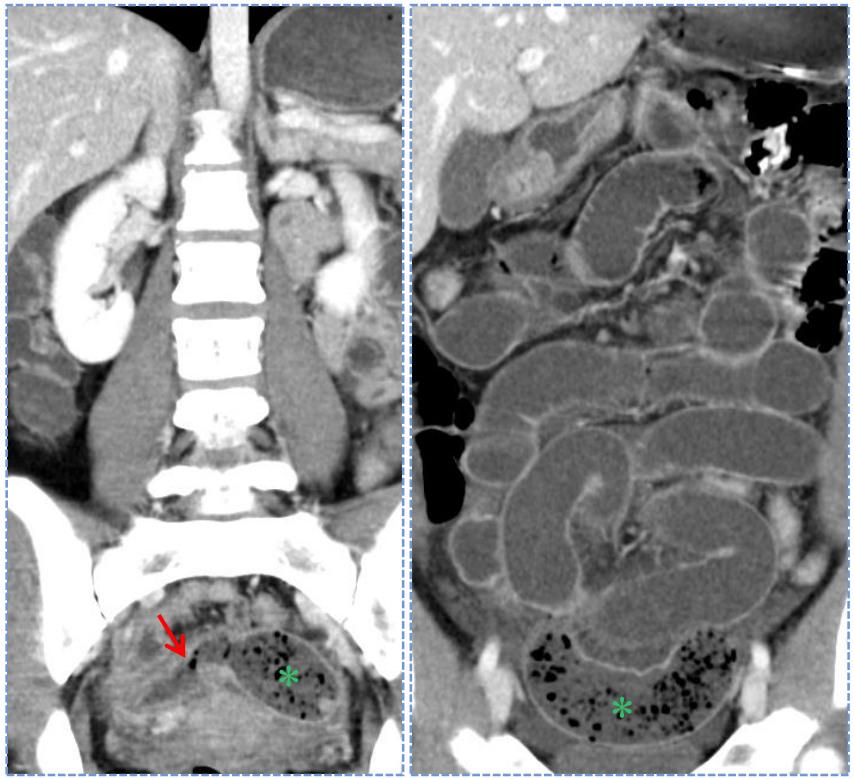


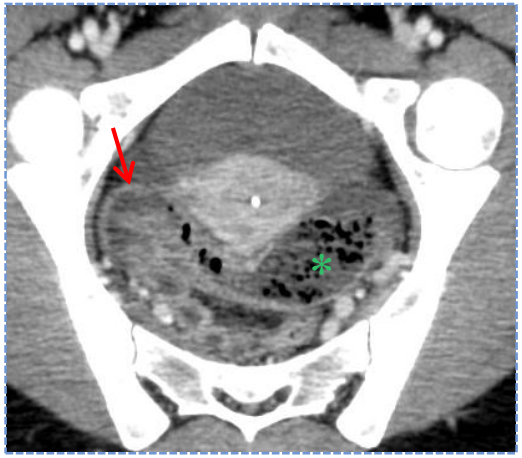
➢ 71-year-old female with intestinal abdominal pain, without occlusion:

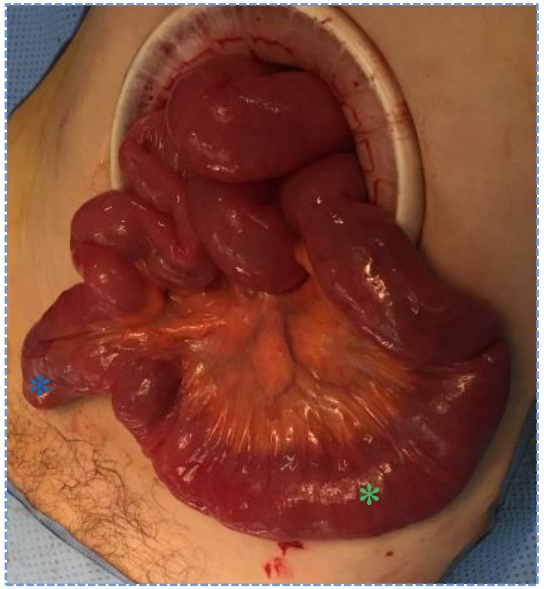
- CT scan accidentally demonstrates an air-filled-ending pouch arising from the antimesenteric side of the distal ileum, ingaging into a inguinal hernia

BOWEL OBSTRUCTION

❖ Bezoar







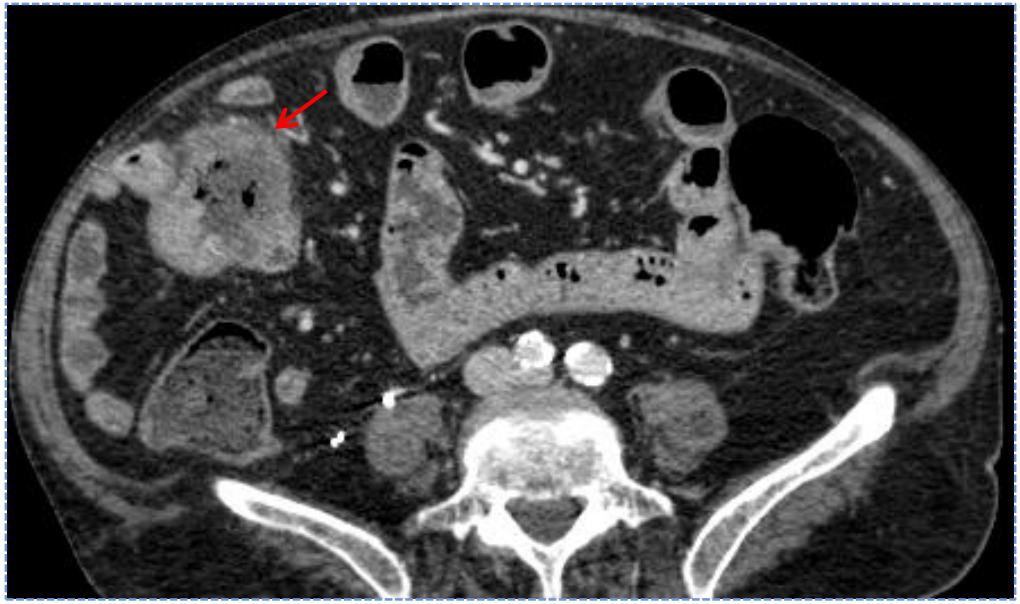
- 34-year-old female with severe abdominal pain and vomiting :
  - CT scan demonstrates a small bowel obstruction upstream a well-defined mass with mottled gas pattern within a progressive transitional zone
  - Initial report concluded to feces-sign upstream pelvic fibrous adhesions
  - Peroperative observations evidenced a phytobezoar upstream a small Meckel's diverticulum

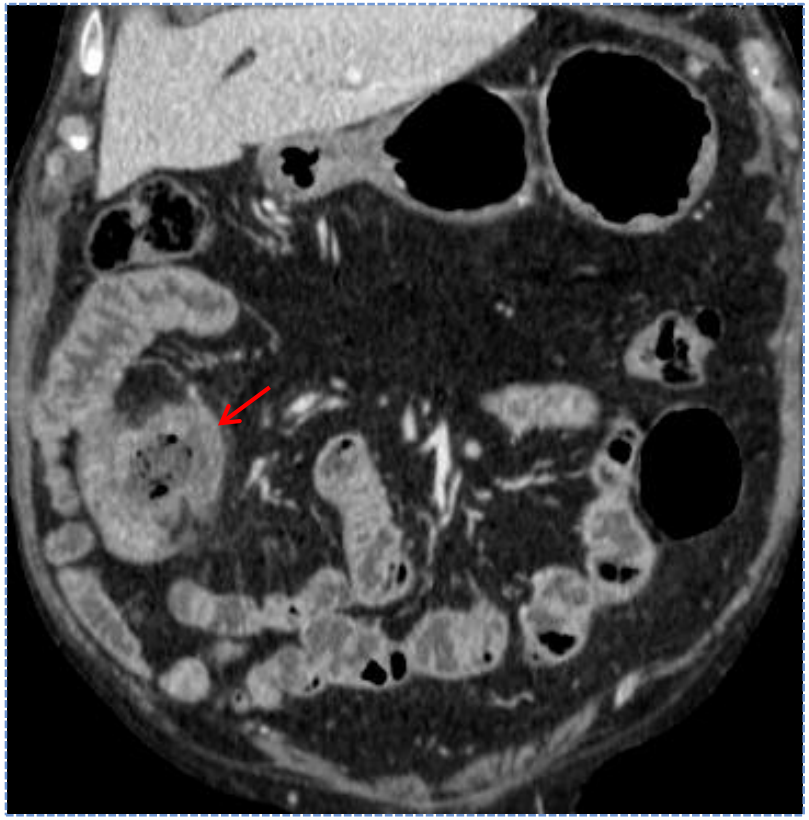
INFLAMMATION

- Meckel's diverticulitis :
  - Mimicking appendicitis
  - Periumbilical pain
  - Reflex ileus
  - Complications : abscess, perforation, peritonitis

INFLAMMATION

- Meckel's diverticulitis





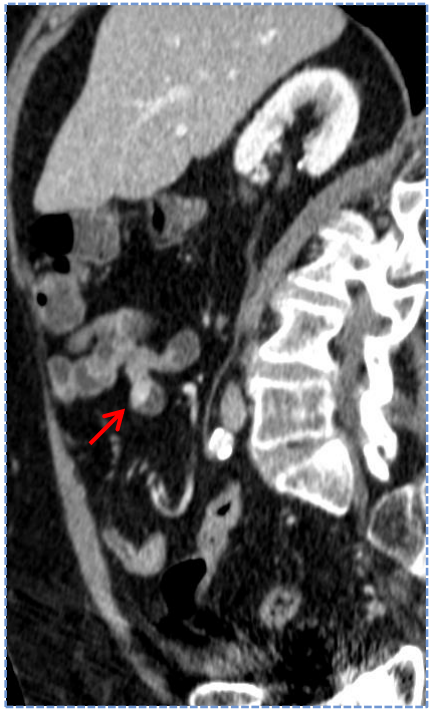
- 54-year-old male with a defense in right iliac fossa with fever and biological inflammatory syndrome.
  - CT scan demonstrates an inflammatory wall thickening of a diverticular structure arising from distal ileum, with surrounding fat infiltration
  - Peroperative observations confirmed Meckel's diverticulitis

TUMORS

- Rare : 0,5 to 3% of complications
- Surgical discovery in 70% of cases
- Sometimes symptomatic: transit modification, pain, GI bleeding ...
- Different types :
  - Neuroendocrine tumor (carcinoïd) : most frequent
  - Stromal tumors : GIST, leiomyomas, leiomyosarcomas
  - Adenocarcinoma

TUMORS

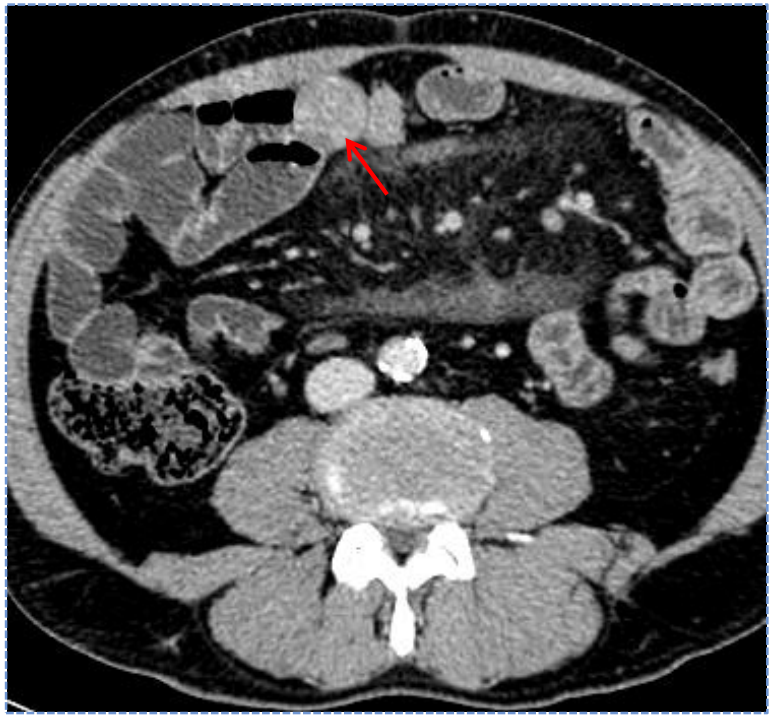
❖ Carcinoïd :

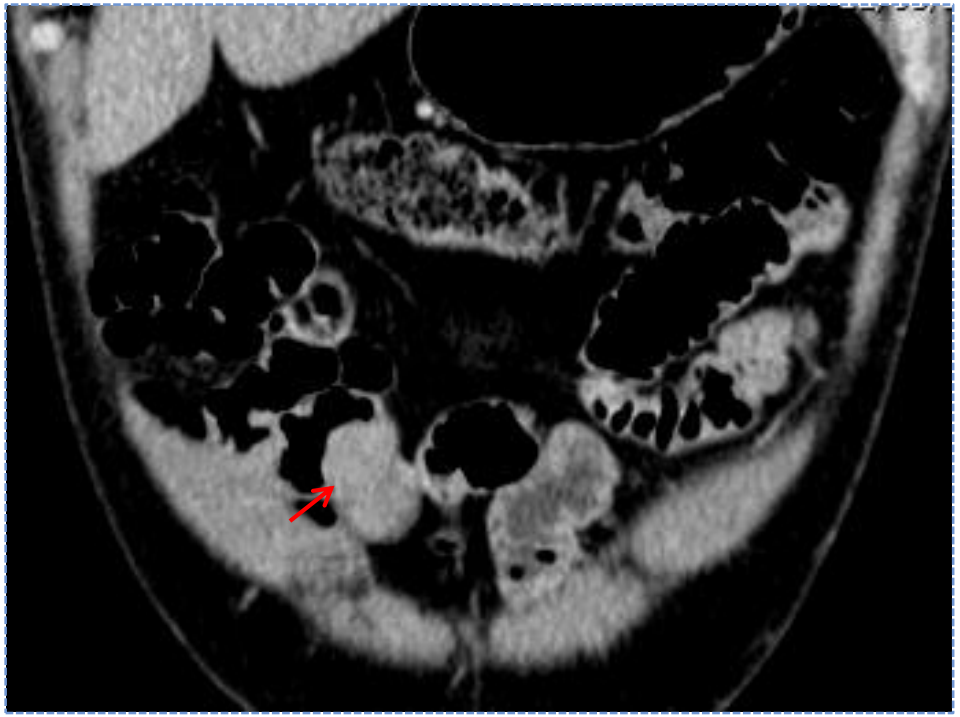


- 84-year-old male admitted for chronic diarrhea:
  - CT scan demonstrates an 10 mm soft tissue lesion filling the lumen of a blind intestinal loop, highly vascularized, evocative of neuroendocrine tumor
  - Pathologists observations evidenced a carcinoid tumor into a Meckel's diverticulum.

TUMORS

❖ Leiomyoma :





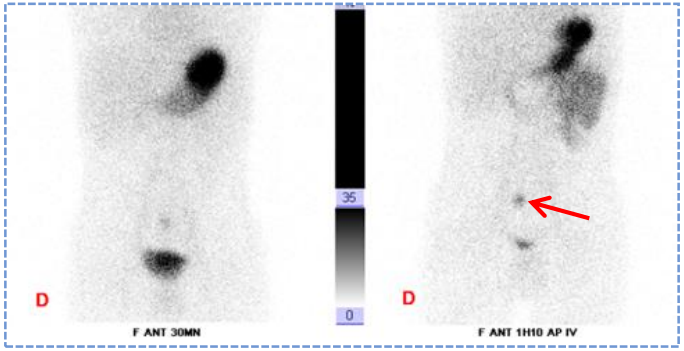
➢ 64-year-old male with iron deficiency anemia:

- CT scan demonstrates an 30 mm soft tissue lesion within the lumen of a blind intestinal loop, homogeneously enhanced at venous phase
- Pathologists observations evidenced a leiomyoma into a Meckel's diverticulum

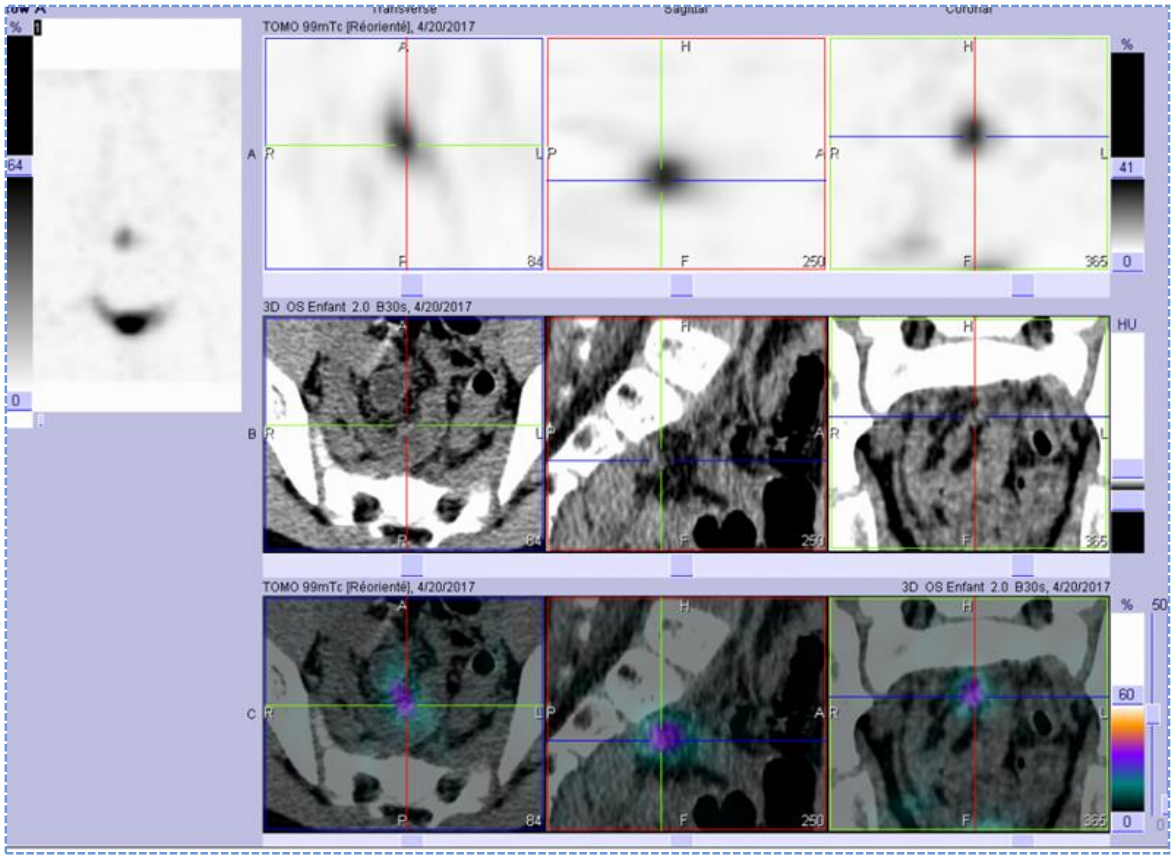
HEMORRHAGE

- Most common complication in children
- The bleeding can be acute or chronic
- Related to gastric heteropia within the Meckel's diverticulum
- High diagnostic performance of Tc99m pertechnetate scintigraphy to evidence the ectopic gastric mucosa

HEMORRHAGE



Courtesy of Dr Bailly.C, Nuclear medicine Departement University Hospital of Nantes (FRANCE)



- 8-year-old male with severe haemorrhagic syndrome and rectal bleeding :
  - CT scan and ultrasound were considered as normal.
  - The Tc99 pertechnate scintigraphy shows an hyperfixation of a small bowel loop corresponding to gastric heterotopia in a MD

CONCLUSION :

- MD is rare and remains difficult to evidence in conventional imaging even for trained radiologist

- MD is often missed in adults because of lack of suspicion and difficulty in detection, with subsequent surgical diagnosis :

  - MD should be considered especially when interpreting examinations for abdominal pain, small-bowel obstruction, and gastrointestinal bleeding
  - Diagnosis requires the use of all available tools : RMP …

- Anyway, the main objective is more the evaluation of the complications than the visualization of the Meckel's diverticulum itself :

  - Bowel obstruction : ischemia and necrosis
  - Diverticulitis : abscess, perforation, peritonitis …

BIBLIOGRAPHY

- G Schumtz et al. Occlusion intestinale et diverticule de Meckel, Feuillets de Radiologie 2003
- Comparative anatomy – the digestive system – University of Cumberlands
- Kliegman R, Stanton B, St Geme J, Schor N. Intestinal duplications, Meckel diverticulum, and other remnants of the omphalomesenteric duct. In: Behrman R, editor. Nelson Textbook of Pediatrics. ed 20. Philadelphia: Elsevier; 2016. pp. 1804–1805
- P Carlioz Le diverticule de Meckel, de l'embryologie à la chirurgie Mémoires de l'Academie de chirurgie 2014
- Meckel Diverticulum : Radiologic features with pathologic correlation Angela D.Levy, LTC, MC, USA, Christine Hobbs
- C Barbary Imagerie des complications du diverticule de Meckel Journal de radiologie Vol 85, N°3 – mars 2004