



Internal Hernias after Laparoscopic Roux-en-Y Gastric Bypass: a tricky but relevant CT diagnosis

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LEARNING OBJECTIVES

- ❖ To illustrate the CT findings of internal hernia (IH) in patients with laparoscopic Roux-en-Y gastric bypass (LRYGB).
- ❖ To focus on the importance of postsurgical anatomy to make an accurate diagnosis.



BACKGROUND

- ❖ LRYGB is one of the most commonly worldwide-performed surgical procedures for morbid obesity, considered by many the gold standard. This is due to its durable clinical outcomes in terms of excess weight loss and other comorbidities compared to other bariatric procedures.

[Surg Obes Relat Dis](#). 2017 Feb;13(2):170-180. doi: 10.1016/j.soard.2016.08.011. Epub 2016 Aug 18.

Long-term and midterm outcomes of laparoscopic sleeve gastrectomy versus Roux-en-Y gastric bypass: a systematic review and meta-analysis of comparative studies.

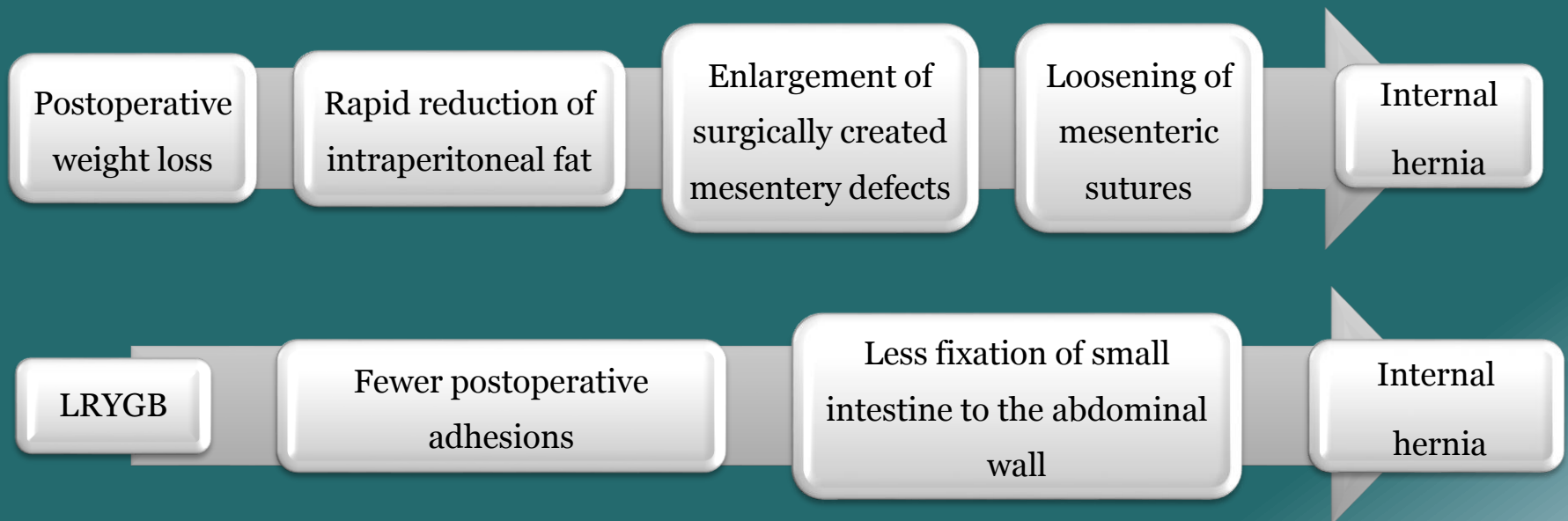
[Shoar S¹](#), [Saber AA²](#).

- ❖ The antecolic procedure, specially with closure of both the mesenteric and Petersen defects, has the lowest incidence of IH with low risk of major complications.
- ❖ However, since there are no randomized trials comparing the two approaches yet, the choice between an antecolic and a retrocolic Roux limb is left to the surgeon's choice.



BACKGROUND

- ❖ Postoperative internal hernia (IH) still remains to be an **important cause of morbidity** in these patients (0-5%) . Its formation is summarized:



[Obes Surg.](#) 2007 Dec;17(12):1563-6. Epub 2007 Nov 15.

Trends in internal hernia incidence after laparoscopic Roux-en-Y gastric bypass.

[Ahmed AR](#)¹, [Rickards G](#), [Husain S](#), [Johnson J](#), [Boss T](#), [O'Malley W](#).

BACKGROUND

- ❖ IH clinical diagnosis can result troublesome. It usually appears as a late complication, presenting variably from acute to chronic intermittent abdominal pain. The clinical presentation will depend on the persistence or transience of the bowel through the mesentery defect and on the existence or not of strangulation.
- ❖ In fact, IH has even been reported to be the most frequent cause of small bowel obstruction (SBO) occurring after LRYGB.

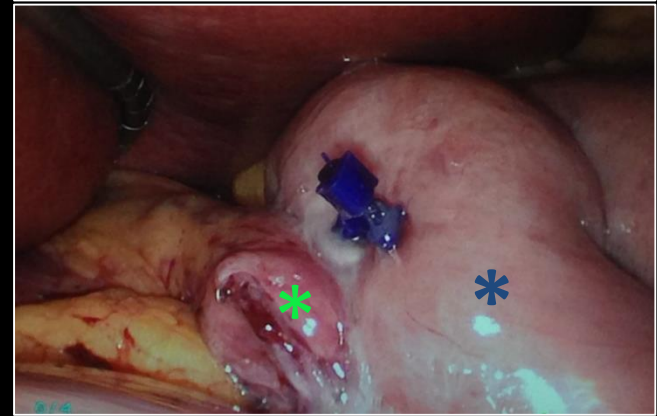
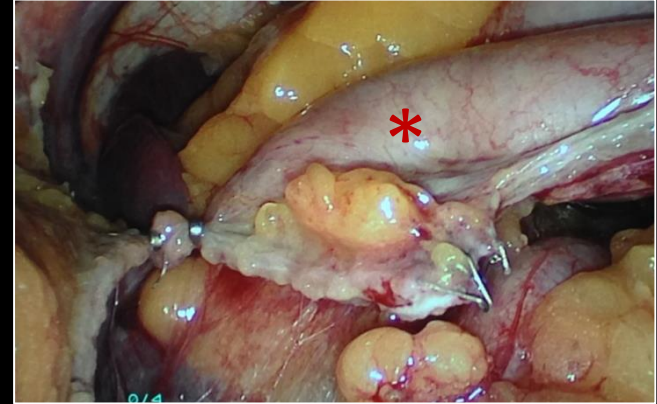
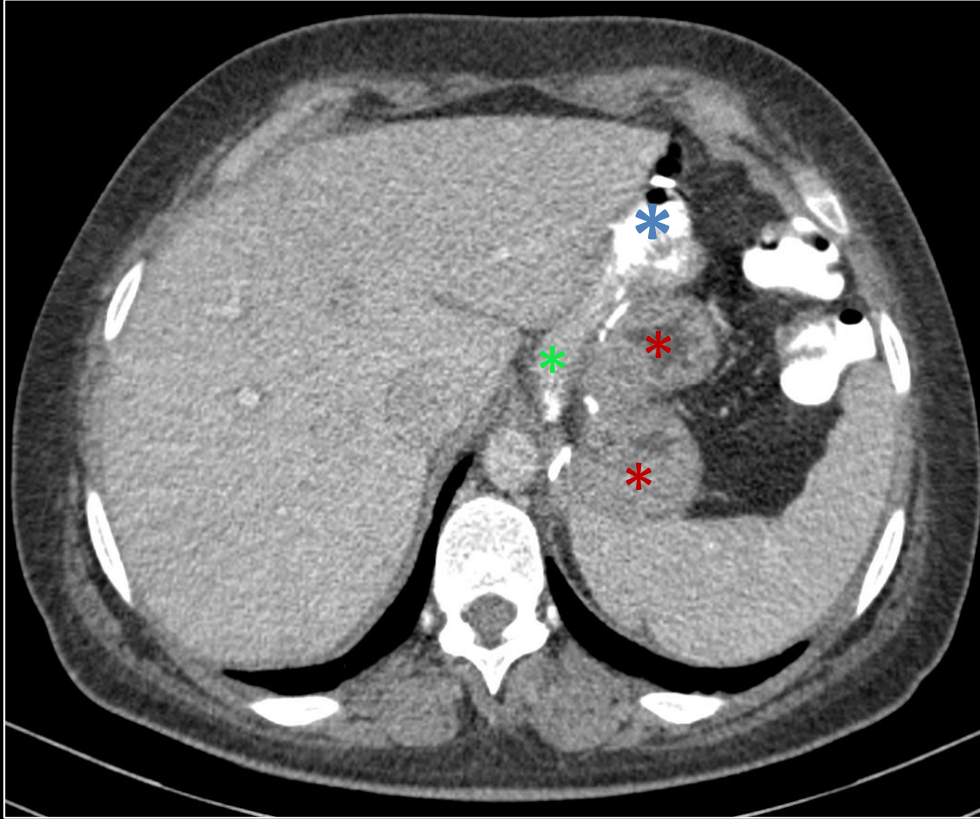
IMAGING FINDINGS

- ❖ **Computed tomography (CT)** remains the imaging modality of choice for diagnosing IH. The LRYGB is a procedure which modifies the gastrointestinal tract anatomy, making its recognition troublesome sometimes and implying a considerable interobserver variability.
- ❖ For that reason, holding a heightened awareness and understanding of the altered anatomy and the typical CT signs of IH is important not to delay diagnosis and subsequently increase morbidity and mortality.

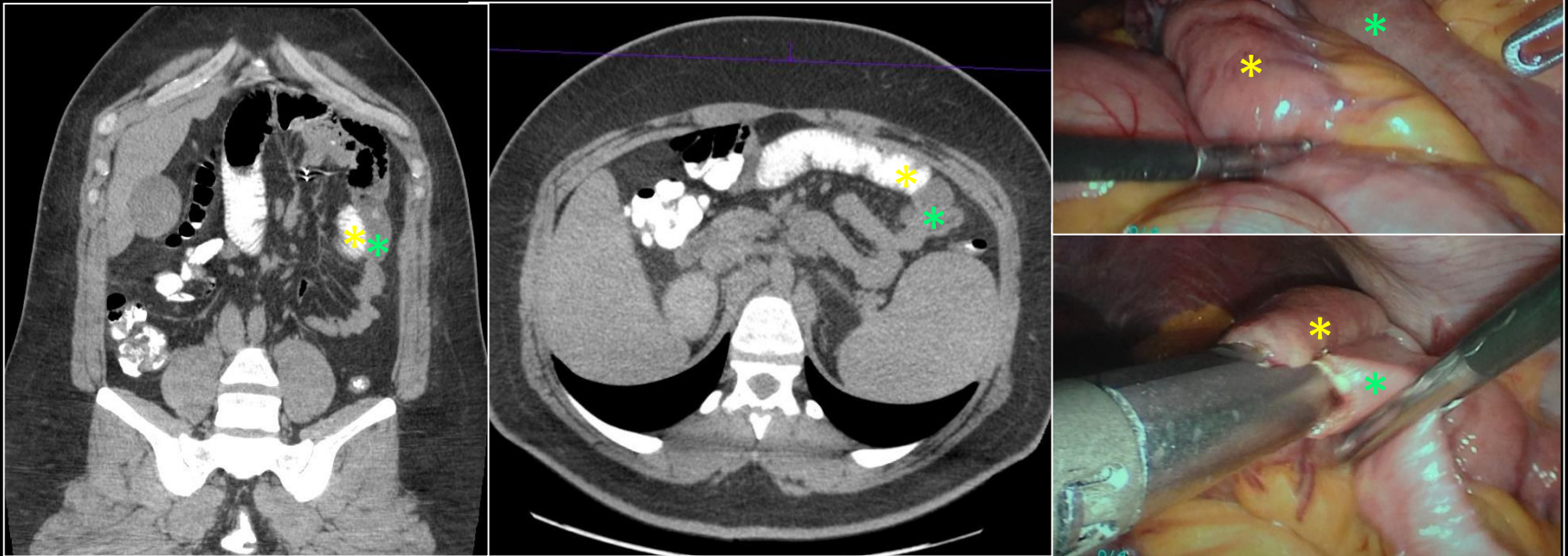
IMAGING FINDINGS

a) LRYGB Modified Anatomy

- ❖ The LRYGB consists of creating two limbs. The first one implies the **gastric pouch**, which is the lesser gastric curvature, isolated and linked to a loop of jejunum called the **Roux or alimentary limb**, creating a side-to-side gastrojejunostomy. This limb can be placed retrocolic, through an opening created in the transverse mesocolon, or antecolic, in front of it.
- ❖ The other one is called **biliopancreatic limb** and is composed of the excluded stomach, the duodenum and the proximal jejunum.
- ❖ Finally, a jejunojejunostomy is created at approximately 30cm from the Treitz's angle, joining the Roux limb and the biliopancreatic limb.



Axial images of MDCT with oral and intravenous contrast (*left*) and images from a LRYGB (*right*) showing the excluded stomach (*red asterisk*) and the gastric pouch (*green asterisk*) anastomosed to the Roux limb (*blue asterisk*) forming the gastrojejunostomy.



Coronal (*left*) and axial (*middle*) images of MDCT with oral and intravenous contrast and images from a LRYGB (*right*) showing the alimentary limb (*yellow asterisk*) joined to the biliopancreatic limb (*green asterisk*) forming the jejunojejunostomy.

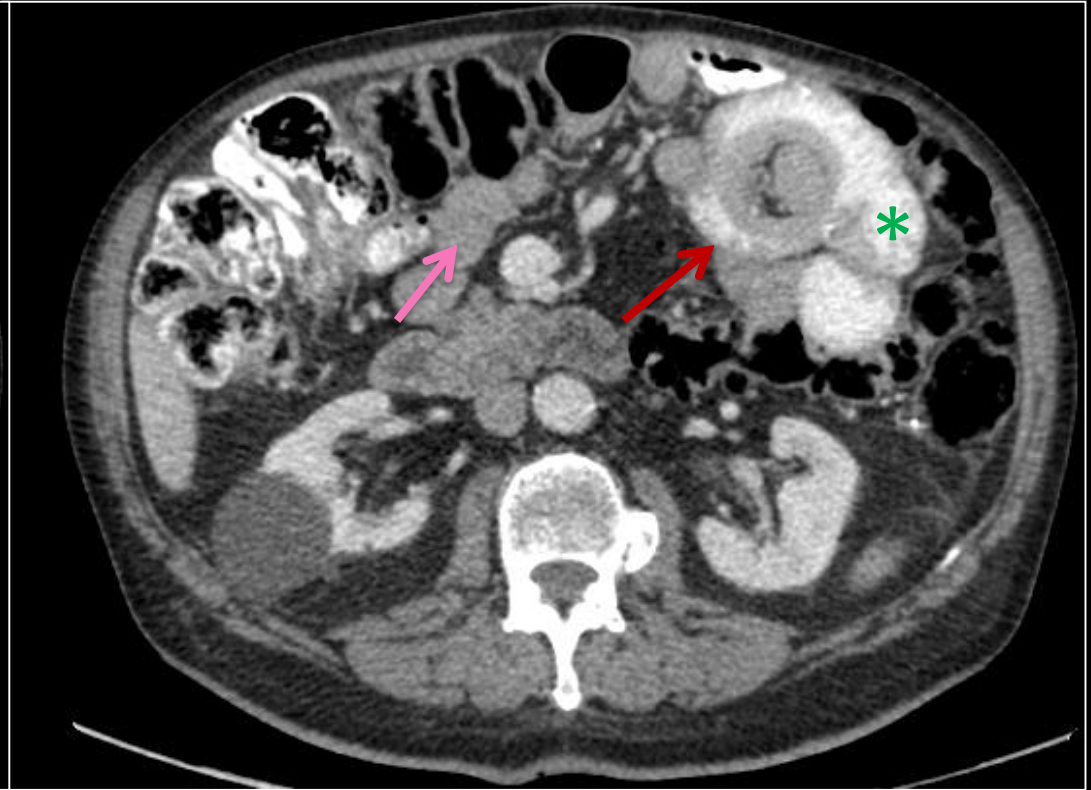
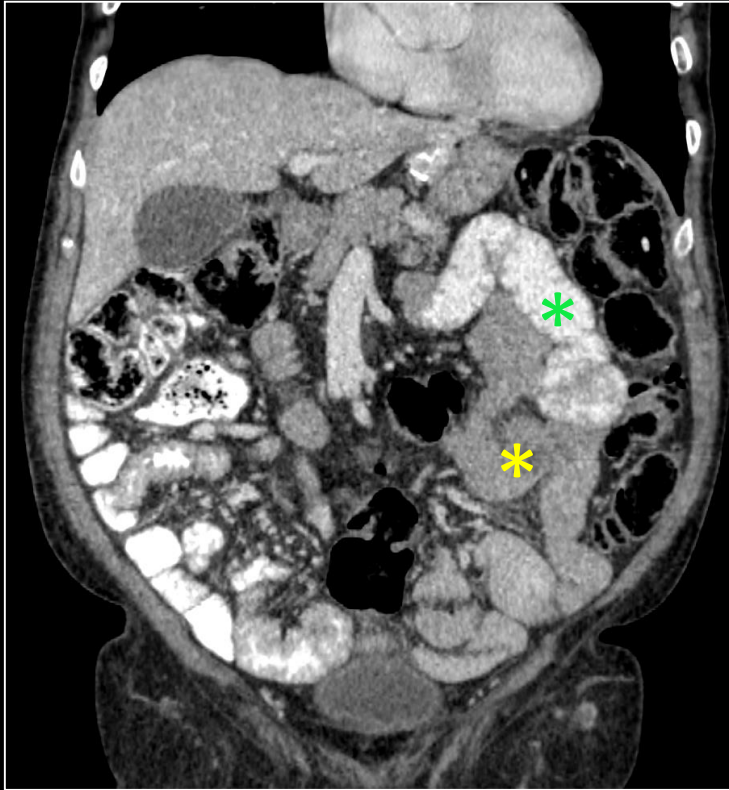
IMAGING FINDINGS

b) IH CT Signs

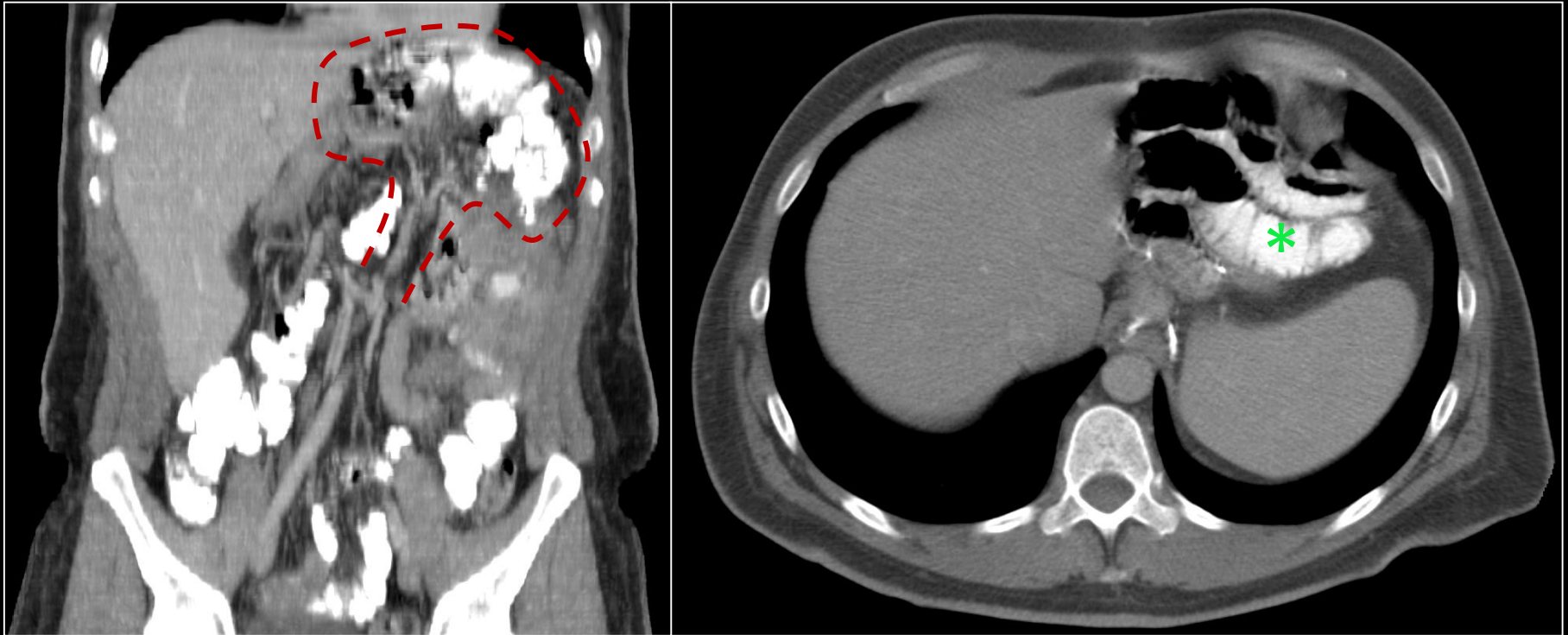
❖ Several CT findings in IH have been typically described:

Mesentery swirl sign	Small bowel obstruction
Mushroom sign	Hurricane eye sign
Clustered loops	Right sided jejuno-jejunal anastomosis
Small bowel behind the superior mesentery artery	

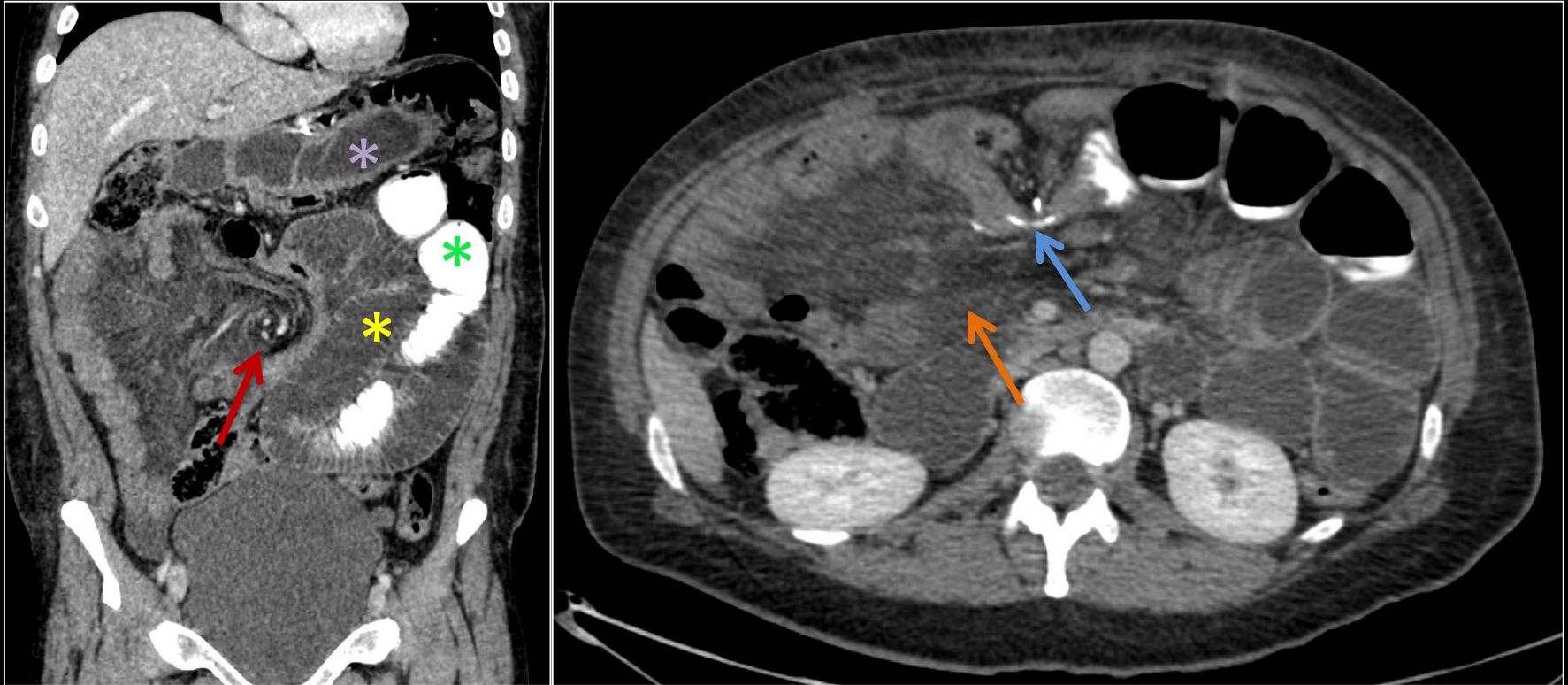
❖ In order to illustrate these signs, we reviewed the bariatric surgery database of the Hospital Universitario Morales Meseguer (Murcia, Spain) from 1997 to 2017 (503 patients), so as to identify patients with an IH diagnosed at re-laparotomy and with a preoperative multidetector CT (8 patients).



CASE 1. LRYGB with intermittent postprandial abdominal pain and sweating in the last three months. Normal gastroscopy and Upper GI Series. Coronal (A) and axial (B) images of MDCT with oral and intravenous contrast, show a dilatation of the Roux limb near distal jejunojunctional anastomosis (*green asterisk*) with normal caliber of the biliopancreatic (*yellow asterisk*) limbs. **Abnormal right-sided position of the proximal aspect of biliopancreatic limb** (*pink arrow*) and jejunojejunal intussusception (*red arrow*). Surgical diagnosis confirmed a Petersen IH.



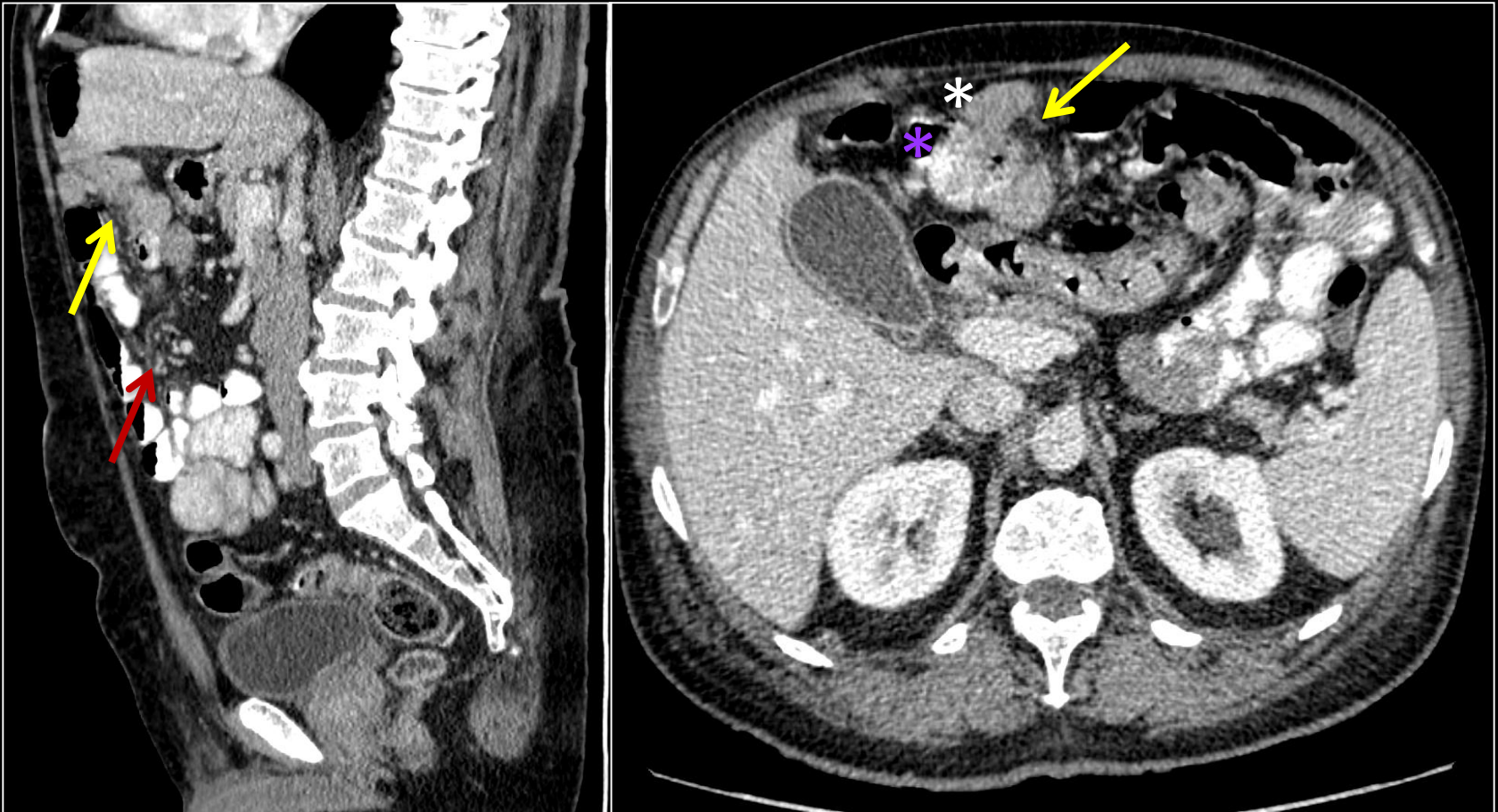
CASE 2. LRYGB with colic intermittent postprandial abdominal pain. Coronal-4.8 mm *maximum intensity projection* (MIP) reconstruction (A) and axial (B) MDCT images with oral and intravenous contrast, show an upper-left quadrant herniation of Roux limb and its mesentery through the Petersen's space. Coronal MIP nicely evidences **mushroom-shaped** cluster of herniated small intestine loops (*red dashed lines*) above the diaphragm (*green asterisk*). Surgical diagnosis: Petersen IH.



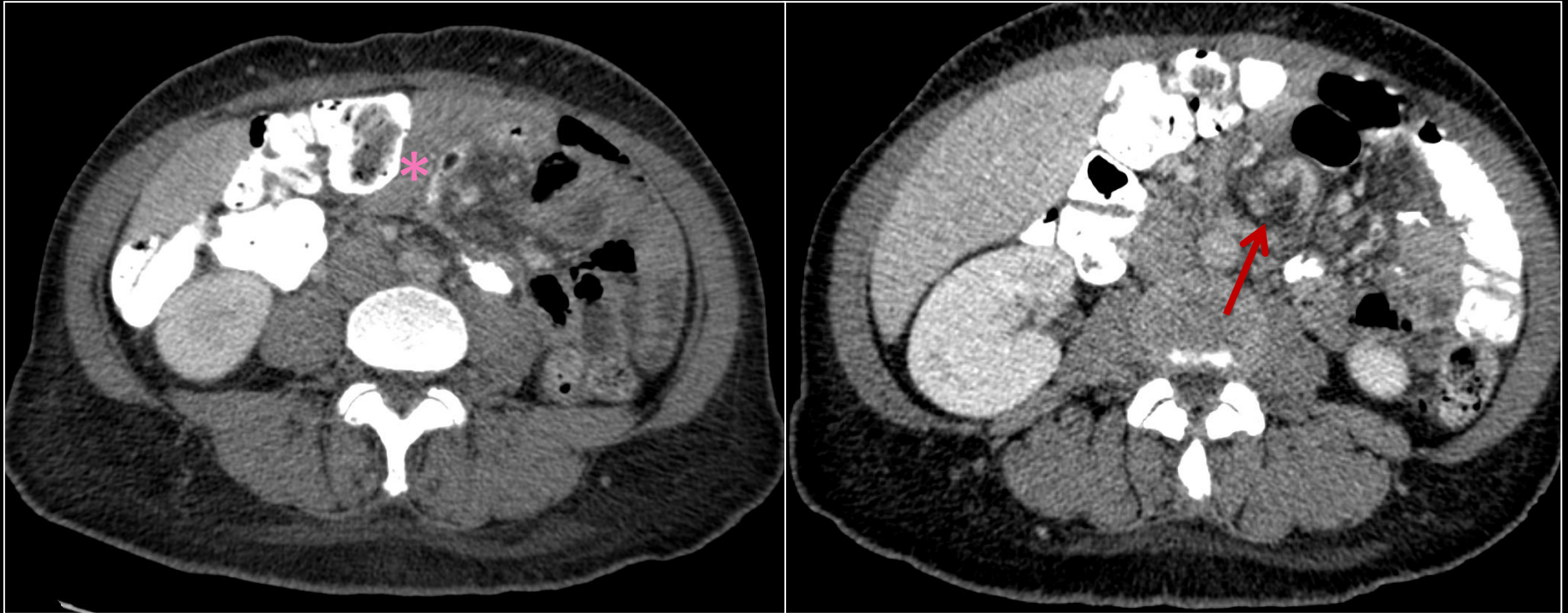
CASE 3. LRYGB patient with acute, back irradiated abdominal pain and neutrophilia. Coronal (A) and axial (B) images of abdominal CT with oral and intravenous contrast showing dilatation of the excluded stomach (*purple asterisk*), the alimentary (*green asterisk*) and biliopancreatic (*yellow asterisk*) limbs, having a abrupt change of caliber just next to the jejunojejunal anastomosis, suggesting **SBO**. **“Swirled” appearance of the mesentery vessels** (*red arrow*) and herniation of some non-dilated loops to the right hemiabdomen (*orange arrow*) through the jejunojejunostomy (*blue arrow*). Surgical diagnosis: **jejunojejunal internal hernia**.



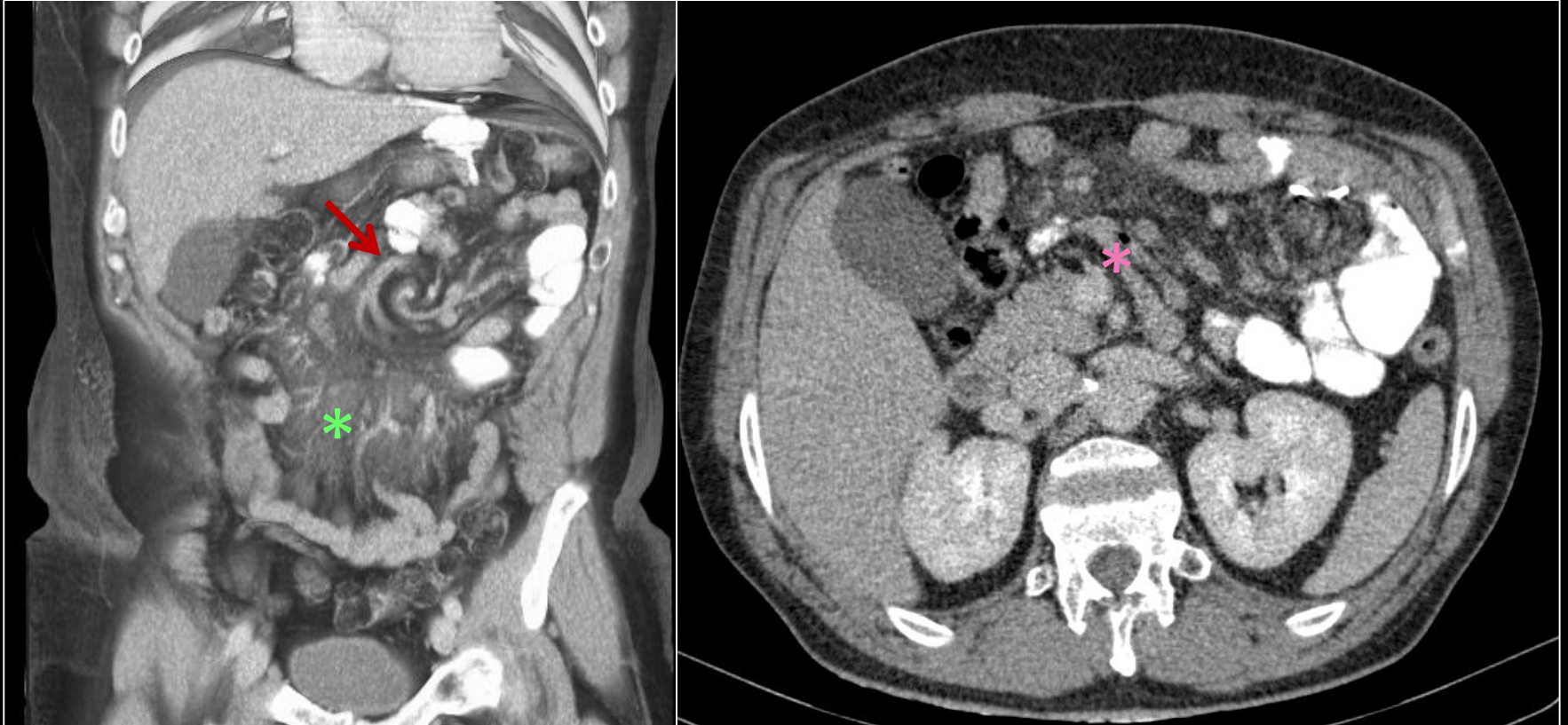
Movie from the same patient (coronal MDCT images with oral and intravenous contrast) showing a dilatation of the excluded stomach and both alimentary and biliopancreatic loops just before the jejunojunal anastomosis, suggesting an internal hernia at this point. We can also see the swirled mesentery next to the anastomosis and some loops of non-dilated small bowel herniated to the right hemiabdomen, participating in the jejunojunal hernia.



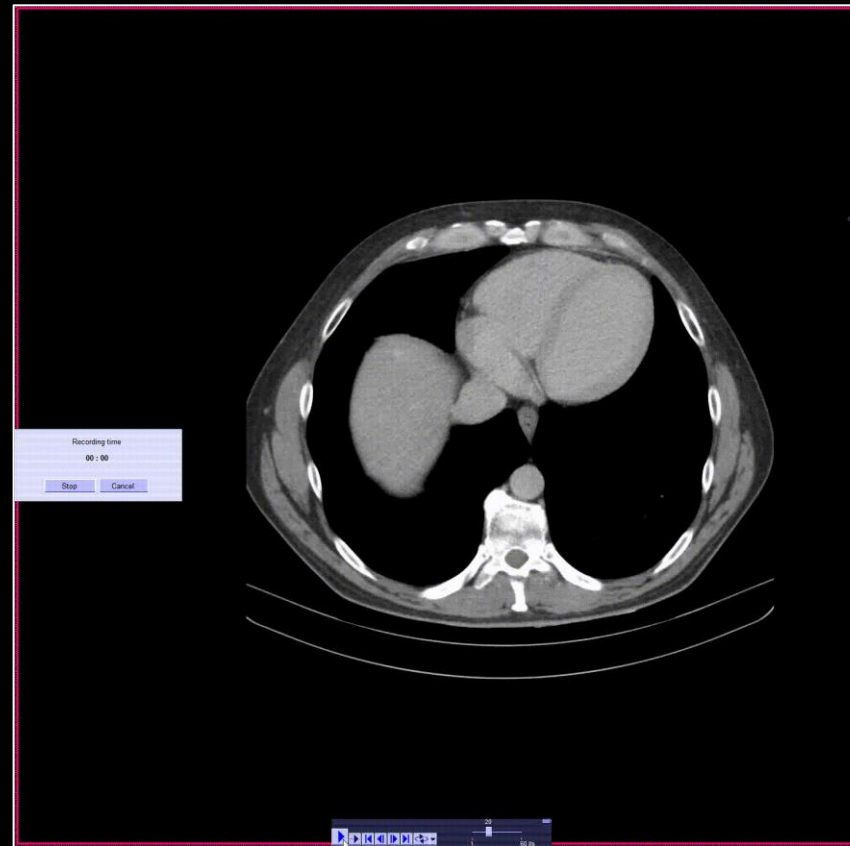
CASE 4. LRYGB with intermittent abdominal pain and episodes with nausea and vomiting. Sagittal (A) and axial (B) MDCT images with oral and intravenous contrast, show abnormal location of small bowel loops (*yellow arrow*) at the right upper-quadrant between the transverse colon (*purple asterisk*) and anterior abdominal wall (*white asterisk*), suggesting transmesenteric IH. The mesentery vessels are a bit “**swirled**” as well (*red arrow*). Surgical diagnosis: **IH**.



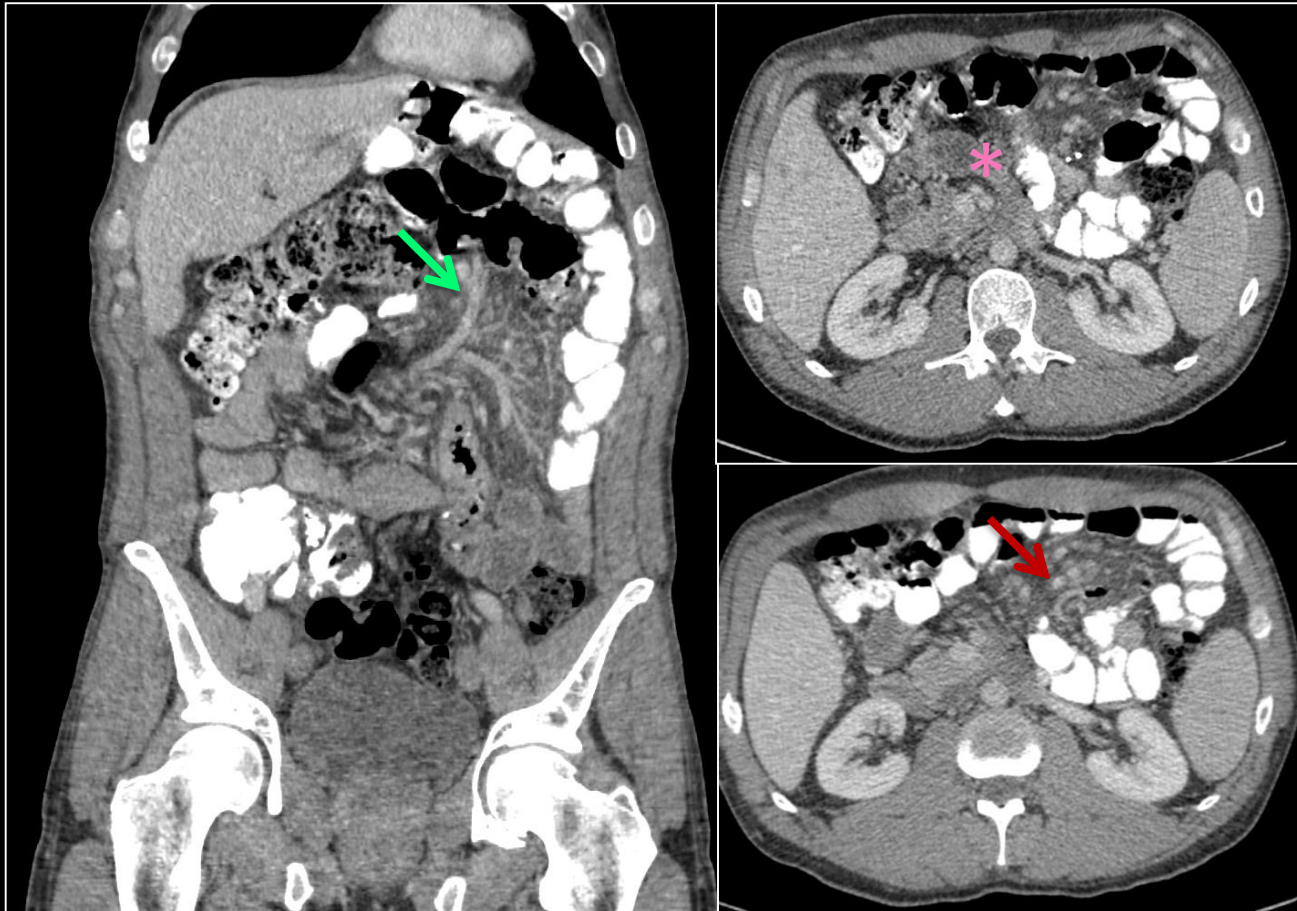
CASE 5. LRYGB with worsening of intermittent chronic abdominal pain. Axial images (A, B) MDCT with oral and intravenous contrast show an anterior and **right displacement of the Treitz angle** (*pink asterisk*) and a “**swirled**” appearance of the adjacent mesenteric vessels (*red arrow*) suggesting a Petersen’s internal hernia. Radiological diagnosis was confirmed at surgery.



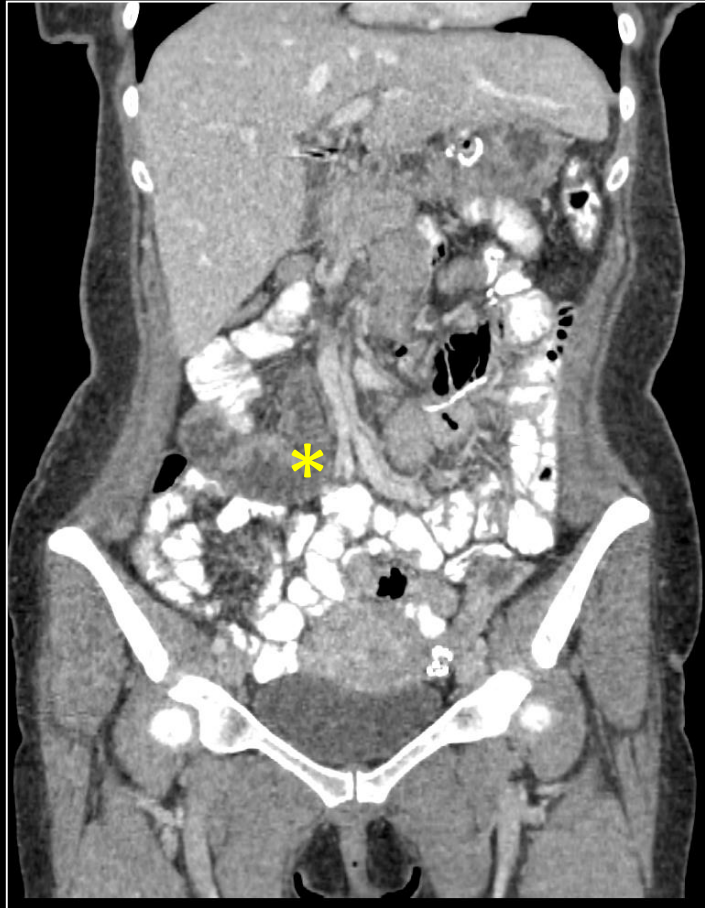
CASE 6. LRYGB with acute abdominal pain, profuse sweating and absence of gas expulsion. Coronal soft-tissue VR reconstruction (A) and axial (B) MDCT images with oral and intravenous contrast, show **swirled mesentery vessels** (red arrow), small bowel mesentery oedema (green asterisk), and a **right displacement of the Treitz angle** (pink asterisk). **Surgical diagnosis: Petersen's IH.**



Movie from the same patient (axial MDCT images with oral and intravenous contrast) showing a swirled disposition of some small bowel mesentery vessels with associated oedema in the left upper hemiabdomen, as far as a right displacement of the Treitz's angle, suggesting an IH, and finally confirming a Petersen's space IH in the surgery procedure.



CASE 7. LRYGB with left acute abdominal pain and peritoneal tenderness. Coronal (*left*) and axial (*right*) MDCT images with oral and intravenous contrast showing a ingurgitation of the small bowel mesentery vessels and oedema (*green arrow*), as far as swirled mesentery vessels and enlarged lymphs nodes (*red arrow*) located in the left hemiabdomen. There is also a **right displacement of the Treitz's angle** (*pink asterisk*). Surgical diagnosis: **Petersen's IH.**



CASE 8. LRYGB patient high clinical suspicion of IH. Coronal image of abdominal CT with oral and intravenous contrast showing a right displacement of the biliopancreatic loop (*yellow asterisk*), with no dilation nor other signs. Surgical diagnosis: **Petersen's IH.**



IMAGING FINDINGS

c) Mesentery Defects Closure in LRYGB

- ❖ A recent meta-analysis concludes that route of the Roux limb (antecolic) and closure of mesenteric and/or mesocolonic defects have **the lowest internal herniation incidence** following LRYGB (1%; $P < 0,001$).
- ❖ However, mesenteric defect closure (MDC) at the time of primary surgery does decrease, although not eliminate, the incidence of IH.
- ❖ Current **controversy** exists regarding MDC in surgical literature. Two ongoing randomized clinical trials are evaluating various techniques of closure (*running non-absorbable suture or staple device vs leaving defects open*) with adequate length and quality follow-up, in order to reach consensus on the preferred method of closure.

[Br J Surg.](#) 2015 Apr;102(5):451-60. doi: 10.1002/bjs.9738. Epub 2015 Feb 24.

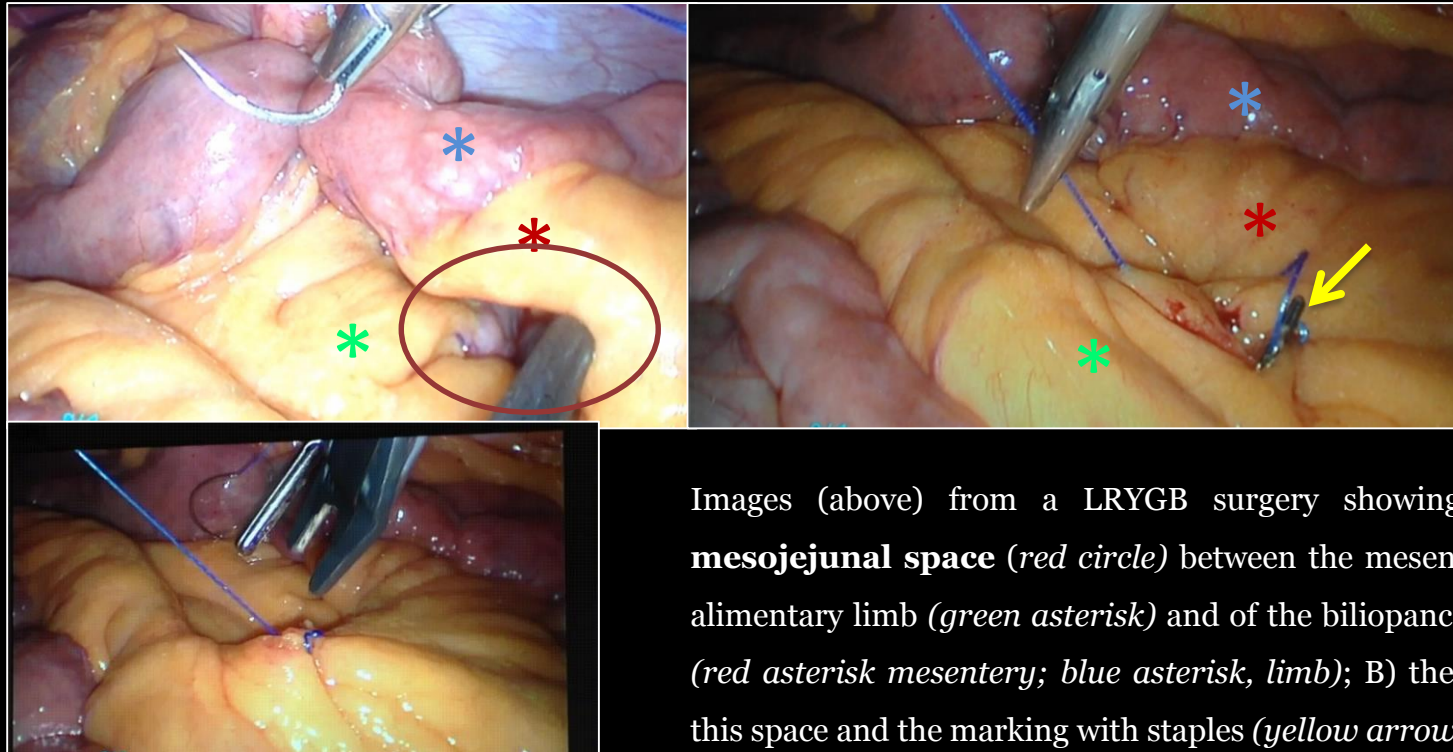
Meta-analysis of internal herniation after gastric bypass surgery.

[Geubbels N¹](#), [Lijftogt N](#), [Fiocco M](#), [van Leersum NJ](#), [Wouters MW](#), [de Brauw LM](#).

IMAGING FINDINGS

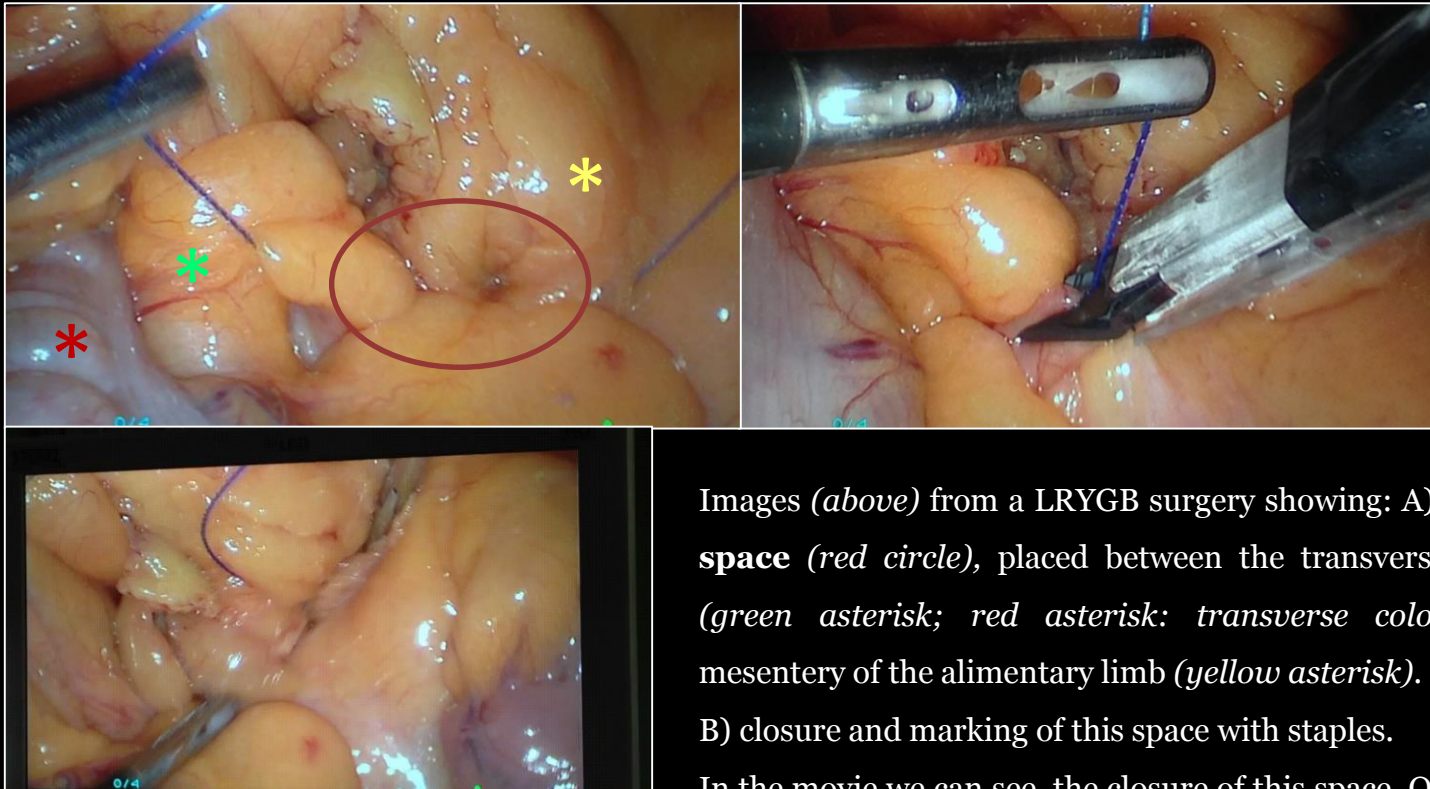
❖ We have collected from our bariatric surgery database clinical data from patients with both primary closed and stapled Petersen's space and jejunojejunostomy (performed in our hospital since 2015), whom a CT scan was requested to rule out some gastrointestinal complications:

- Sample size: 16 patients (10 female/6 male).
- BMI (mean, range): 44,12 (39 – 53).
- Time Delay LRYGB-CT scan (median, RIQ): 12,5 (7,25 – 30,75) months.
- CT was performed in an emergency basis during early postoperative period (8 patients).
- CT was performed in an ambulatory basis (8 patients) for intermittent abdominal pain.
- Until now no IH have been clearly demonstrated. Only 1 patient experienced remission of complaints after relaparotomy: *“at surgery, a partially opened Petersen space was observed and fixed, jejunojejunal space was normal, and some adhesions between Roux limb and distal anastomosis were released”*.



Images (above) from a LRYGB surgery showing: A) **the mesojejunal space** (*red circle*) between the mesentery of the alimentary limb (*green asterisk*) and of the biliopancreatic limb (*red asterisk mesentery; blue asterisk, limb*); B) the closure of this space and the marking with staples (*yellow arrow*).

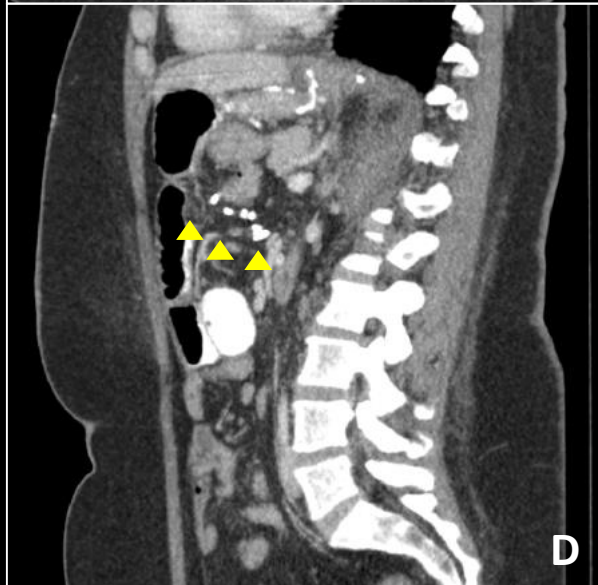
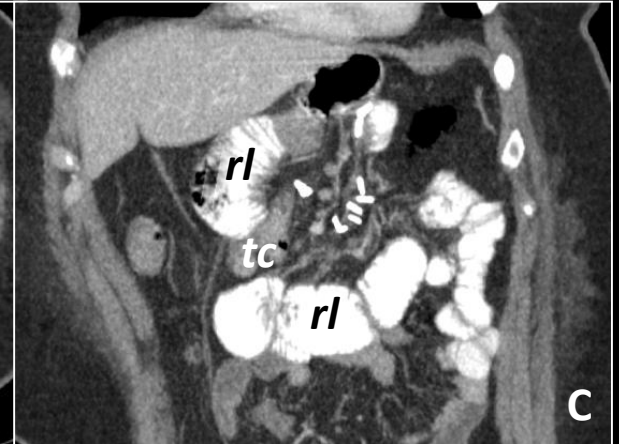
In the movie we can also see the marking of this space with staples.



Images (*above*) from a LRYGB surgery showing: A) **Petersen's space** (*red circle*), placed between the transverse mesocolon (*green asterisk*; *red asterisk*: *transverse colon*) and the mesentery of the alimentary limb (*yellow asterisk*).

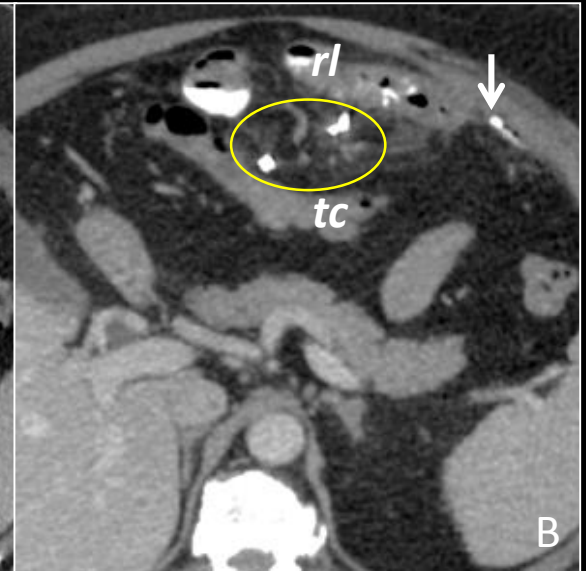
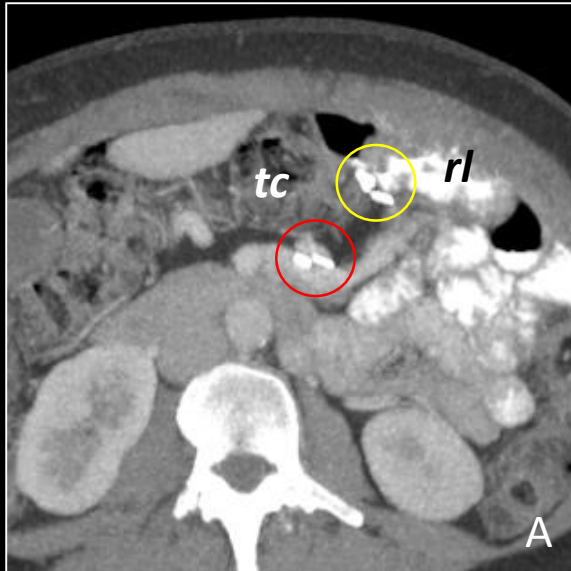
B) closure and marking of this space with staples.

In the movie we can see the closure of this space. On the left we can see the transverse colon and mesocolon and on the right, the mesentery of the Roux limb.



Seven p.o. day in a LRYGB patient with acute abdominal pain. MDCT in axial, coronal and sagittal plane shows staples at the Petersen space (A and C, *tc*: transverse colon, *rl*: Roux limb), and posterior to jejunojejunal space (*arrowheads* in B).

Sagittal-MPR (D) nicely displays the stapled-MDC tracking the space between transverse colon and Roux-limb (*yellow arrowheads*).



MDCT axial MIP reconstruction (A): Thirty-three p.o. month LRYGB with intermittent abdominal pain. *Red hollow circle* surrounding staples at the root of the mesentery between transverse colon (tc) and Roux limb (rl). *Yellow hollow circle* shows mesenteric closure at jejunojejunal anastomosis.

MDCT axial images (B) in 5 p.o. day LRYGB with fever and epigastric pain. Gastrojejunal anastomotic leak (*not shown*) was depicted, which was entirely collected by surgical drainage (*white arrow*).



Twelve p.o. month LRYGB with colic abdominal pain. Coronal MPR and axial MDCT images (*left*) show staples placed at Petersen's space (note closed relationship to middle colic vein - *red arrow*), and at a cranial level, metallic landmarks at jejunojejunal mesentery.

A false-positive finding was reported. Namely, grouping of non-dilated biliopancreatic loop (*yellow asterisk*) and round appearance of distal mesenteric fat (**hurricane eye sign**) (*yellow arrow*). At surgery, a partially opened Petersen's space was fixed, jejunojejunal space was normal, and some adhesions between alimentary limb and distal anastomosis were released.

CONCLUSIONS

- ❖ IH are a well-known complication of LRYGB and a diagnostic challenge.
- ❖ Postsurgical anatomy and CT imaging are important to make a prompt diagnosis.

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