

CT enteroclysis: a pictorial essay

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Résumé

L'enteroscaner : revue iconographique

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L'objectif de l'entéros scanner est de distendre l'ensemble de l'intestin grêle de façon homogène et suffisante à l'aide d'une sonde naso-jéjunale et d'un entérocluseur permettant l'administration d'un agent opacifiant neutre. Il s'agit actuellement de la meilleure méthode d'exploration radiologique du grêle du fait sa résolution spatiale et sa rapidité de réalisation. Il est effectivement très performant dans l'exploration des pathologies transmuraux et extramurales en particulier tumorales pour des lésions de petite taille. Il reste inefficace dans l'exploration des anomalies du versant endoluminal de la muqueuse intestinale contrairement à la vidéocapsule et à l'entéroscopie à double ballonnet. Il est admis que l'entéros scanner est un examen performant qui doit remplacer le transit du grêle. Cependant il présente d'incontestables inconvénients : irradiation, difficultés et désagréments de la pose de sonde naso-jéjunale, faux positifs, interprétation longue et impossibilité d'explorer le versant endoluminal de la muqueuse intestinale. Tout radiologue doit donc se familiariser avec les difficultés et la sémologie de cette nouvelle technique qui est illustrée dans cette revue iconographique.

Mots-clés : Intestin grêle. Scanner volumique. Entérocluse. Distension intestinale. Tumeur.

Abstract

The objective of the CT-enteroclysis is to distend the entire small intestine equally and sufficiently using a nasojejunal probe and an enteroclysis catheter for administration of a neutral opacifying agent. Today this is the best radiological method available to explore the small intestine because of its good spatial resolution and the rapidity of the exam. It is a high-performance exam when searching for transmural and extramural pathologies, in particular small tumoral lesions. It remains less effective in the exploration of anomalies of the lumen's mucosal lining, contrary to videocapsule endoscopy and the double-balloon enteroscope. It has been recognized that the CT-enteroclysis is a high-performance examination that should replace the small-bowel follow-through exam. However, there are undeniable disadvantages: higher doses of radiation, patient discomfort during placement of the enteroclysis catheter, false-positive results, long interpretation time, and the impossibility of exploring the endoluminal aspect of the intestinal mucosal lining. All radiologists should therefore become familiar with the problems involved with this exam and its signs and patterns, which are illustrated in this pictorial review.

Key words: Small intestine. Volume CT. Enteroclysis. Intestinal distension. Tumor.

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The small intestine was the most difficult digestive segment to explore until the arrival of CT-enteroclysis. This is a CT technique requiring that the entire small intestine be distended equally as in the small-bowel follow-through examination to explore the entire abdominopelvic cavity and thus the walls and surroundings of the small intestine in a single breath hold. There are several techniques: with or without enteroclysis catheter, with or without enteroclysis pump, and with neutral opacifying agent (water \pm mannitol, methylcellulose, polyethylenglycol) or positive opacifying agent (iodine or diluted barium). The objective of the pictorial review is to illustrate the signs and patterns of the water-enhanced CT-enteroclysis with probe.

Technique

The CT-enteroclysis is a moderately reproducible examination because small-bowel distension is the major difficulty. It depends on the probe position, which is not always optimal, intestinal peristalsis, and reabsorption of the opacifying contrast agent. Furthermore, it is an irradiating exam that is uncomfortable for the patient (1, 2). For this reason, many teams perform CT-enteroclysis without a probe, which requires slow and progressive ingestion of the contrast agent, providing less complete distension, probably limiting the detection of small tumors.

Patient preparation

The patient should not have eaten solid food for 8 h. Water should be authorized so as to reduce the phenomenon of water reabsorption by the small intestine during intestinal infusion, which increases with dehydration.

No particular diet is necessary before fasting. Maglinte (1) recommends a diet poor

in fiber with abundant fluids a few days before the exam, administration of a laxative the day before the exam, and fasting beginning at midnight the day of the exam.

Premedication

A premedication can be given. Maglinte (3) advises IV administration of 10 mg of metoclopramide (Primperan®) immediately before nasojejunal intubation to facilitate its progression by favoring gastric and intestinal peristalsis. A sedative can also be administered to increase the patient's comfort. For example, Maglinte's team prescribes 25-50 mg of fentanyl (Fentanyl®) or 3-15 mg of diazepam (Valium®) intravenously as analgesic associated with a small dose (2-5 mg) of midazolam (Hypnovel®) intravenously as amnesic.

Inducing hypotonicity

Before CT acquisition, an antispasmodic agent can be administered intravenously to reduce the kinetic artifacts related to

peristalsis and false-positive results stemming from spasms or functional invaginations. The time between administration and beginning acquisition should be adapted to the half-life of the drug used.

The most frequently used drug in France was Tiemonium (Visceralgine®) until it was removed from the market. Therefore, with no intravenously injectable atropinic, glucagon can be used, a blood glucose-raising hormone with an inhibitory action on the digestive tract's motility. After IV injection of 0.2–0.05 mg, the drug takes action within 1 min and lasts between 5 and 20 min.

Enteroclysis catheter

An 8-French small-bowel probe is used (*fig. 1a*; Biosphere Medical, Louvres, France), 150 cm long, with 2.8-mm external diameter and 2.1-mm internal diameter. The catheter's distal end has a plastic olive-tip device measuring 3.5 mm in diameter where there are four lateral exit holes measuring 2 mm in diameter. This catheter is equipped with a radiopaque metallic guidewire in Teflon and has no distal balloon.

Maglinte (3) used a 13-F catheter with a distal balloon that prevents gastroduodenal reflux. The balloon is inflated with 20–25 ml of air and fixed in Treitz's angle. In case of occlusion, he uses a multipurpose catheter that provides continuous aspiration after the exam and inflates the balloon in the proximal jejunum.

Nasojejunal intubation

The catheter is placed with fluoroscopic guidance. Patients tolerate nasal passage in a seated position better than oral passage because the gag reflex is avoided, although pulling it out through the nose is sometimes more delicate because of the risk of blocking the distal olive tip at the posterior apertures of the nose. Passing the pylorus is easier in the decubitus position. The guidewire should not be advanced to the end of the catheter so as to leave enough flexibility at the distal end and to prevent perforations. The catheter should be placed downstream of Treitz's angle and it is preferable to have it follow the direction of the superior part of the duodenum and not the ascending part to avoid gastric reflux. To check its position, it is sometimes necessary to inject a bit of air. One must always verify that the catheter is not bent or kinked. To study the duo-

denum conjointly with the jejunum and the ileum, the distal olive tip must be more proximal.

Perfusion

Intestinal filling takes place with an electrical pump (*fig. 1*, 807NE enteroclysis catheter, Biosphere Medical, Louvres, France), which provides homogenous and good-quality opacification, a high and constant flow rate, and excellent safety because pressure and flow rate can be monitored and regulated permanently. The flow rate chosen should be from 180 to 200 mL/min, with 2 L of opacifying agent. The product should be administered before CT acquisition, checking that the last part is well distended, then it should continue to be administered continuously to obtain constant distension during the entire acquisition period.

Generally, a high flow rate abolishes peristalsis and produces hypotonia then atonia with a reflux toward the stomach. A low flow rate produces hyperperistalsis and therefore the absence of optimal distension. The infusion rate should be monitored and adapted to each patient. However, the technique's limits are more often related to placing the catheter (*fig. 2, 3*).

Contrast media

The goal of CT-enteroclysis is to obtain optimal and durable small-intestine distension (≥ 2.5 cm) so as to analyze the wall effectively during the entire duration of the examination. This requires filling the small intestine with a contrast product that meets two conditions: little reabsorption and a Hounsfield density contrasting sufficiently with the wall density so that it can be analyzed. Therefore, water is the ideal opacifying agent because it is a neutral liquid, contrary to positive agents, but water is usually substantially reabsorbed before reaching the last ileal loops and can therefore limit intestinal distension, the reason for associating it with an agent that reduces this reabsorption phenomenon: mannitol, polyethylenglycol, methylcellulose, or highly diluted barium (Volumen).

Maglinte recommends intestinal opacification using a positive opacifying agent if there is occlusion or fistula, but generally these diagnoses do not require CT-enteroclysis with a catheter. According to Parrish et al. (4), use of a low-density positive contrast agent (a mixture of 40 cc methylcellulose, 400 cc boiling water, 5 cc

barium, 40 cc iodine contrast, 20 cc air bubbles, and 2500 cc cold water) can more readily demonstrate endoluminal lesions than a neutral contrast medium.

In the literature, it appears that the best distension was obtained by Lauenstein et al. (5) with no catheter, with a 23.7 mm distension with a mannitol/carob flour mixture, and 21.3 mm with mannitol alone. More recently, Megibow et al. (6) reported that oral administration of Volumen (0.1% barium preparation) procured excellent distension and excellent visualization of wall lesions of the gastrointestinal tract. Boudiaf et al. (7) obtained 70% optimal distensions (>25 –30 mm) with a catheter and 28% acceptable distensions (15–25 mm) with water.

Our experience (8) with intestinal infusion using 2 L of a water-mannitol mixture through the enteroclysis catheter without drug-induced hypotonia showed that digestive tract distension was more complete because of better ileum distension and in particular of the last ileal loop (mean, 18 mm with mannitol versus 13 mm with pure water).

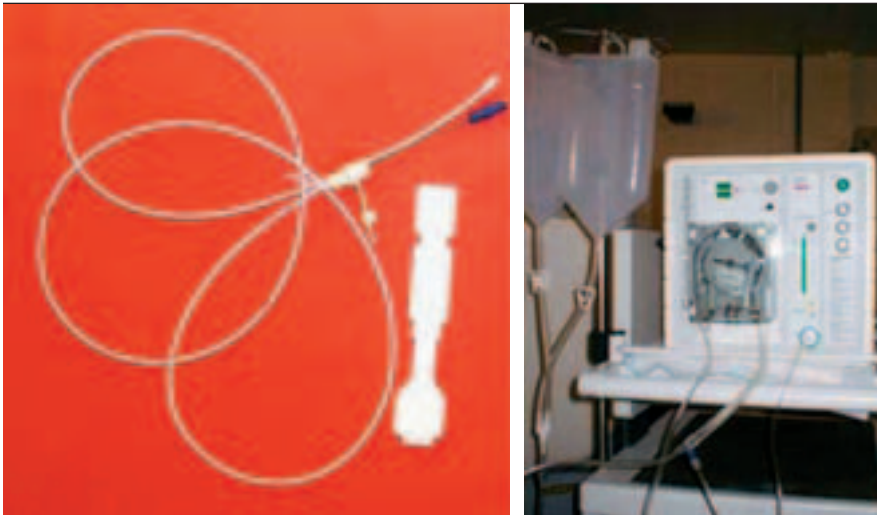
Finally, Borthme (9) et al. reported that the opacifying contrast agent concentration influences distension quality.

CT acquisition

CT acquisition with no injection of iodated contrast medium should be done after intestinal filling, unless perfusion has failed, in order to check the catheter position when monitoring irradiation. The number of acquisitions after injection and their timing depends on the indication and the patient's age. It is preferable to study the intestinal loops in the parenchymatous phase between 70 and 80 s. Earlier study is only warranted when looking for an arterial hypervascular lesion such as a carcinoid tumor or a stromal tumor. It is not useful in Crohn disease or in celiac disease. Optimal slice thickness is 1 mm, which favors good spatial resolution and therefore the quality of multiplanar reformations.

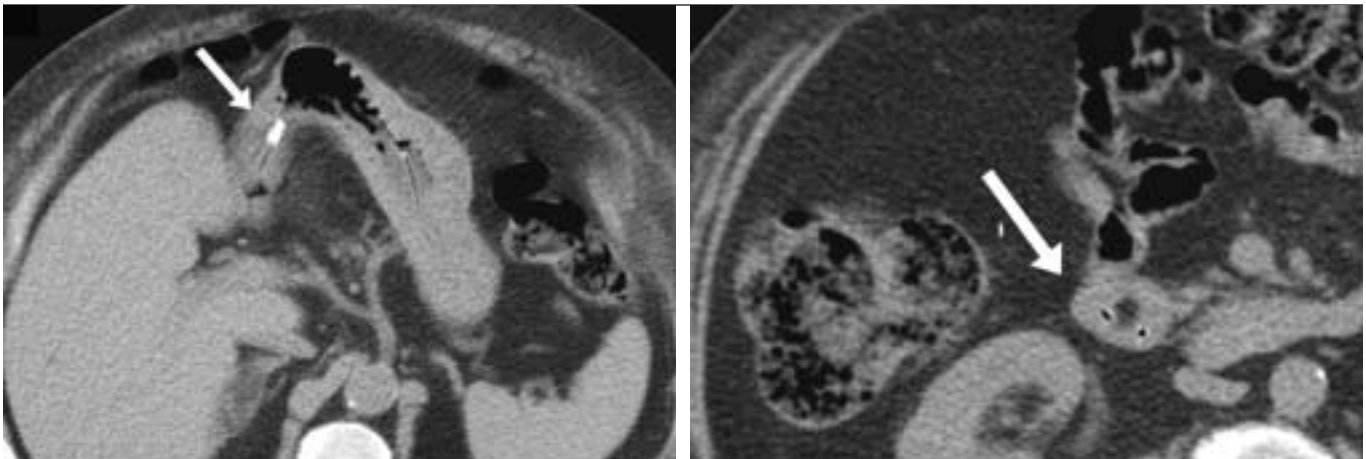
Interpretation

There is no standardized method for reading a CT-enteroclysis image. Nevertheless, the small intestine is long and is often difficult to follow continuously over its entire length. It is better to begin by analyzing axial and frontal views in the dynamic mode. If an anomaly is detected on



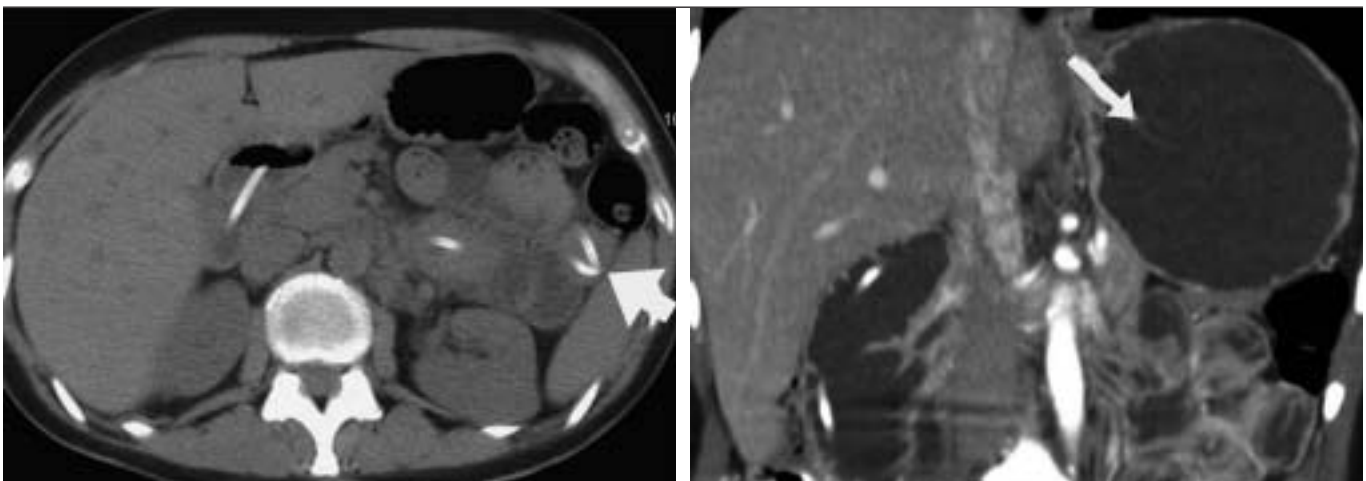
a|b

Fig. 1: *Eight-French enteroclysis catheter*
 a With metal guidewire
 b allowing intestinal filling using an electric enteroclysis catheter.



a|b

Fig. 2: *Example of intestinal filling destined for failure*
 a Because of a kink in the probe (arrow),
 b occurring on contact with two duodenal lipomas (arrow).



a|b

Fig. 3: *Another example.*
 a Kinked probe (arrow), in the jejunum this time,
 b with no favoring lesion responsible for substantial gastric reflux (arrow).

the axial views, oblique multiplanar reformations should be used to uncoil the length of the abnormal intestinal loop.

Limiting irradiation

CT-enteroclysis is an irradiating examination because the nasojejunal probe is placed with fluoroscopic guidance and CT acquisition during which the dose and the number of phases acquired after injection should be limited, particularly in young subjects and in women of child-bearing age.

Results

CT-enteroclysis is a high-performance examination that can provide multiplanar reformations to view the intestinal loops at their widest point and avoid false-positive results related to the folds and connivent valves and detect small tumors. However, it remains ineffective in superficial exploration of the intestinal mucosal lining, contrary to current endoscopic techniques such as videocapsule endoscopy and the double-balloon enteroscope. The small-bowel follow-through study is now obsolete, particularly because it presents a number of limitations related to digestive tract superimpositions, irradiation, the duration of the exam, and the problems involved in its interpretation. The performance of entero-MRI are equivalent to CT-enteroclysis, but its success requires drug-induced hypotonia as well as more prolonged hypotonia since the examination lasts longer.

Normal results

In general, CT-enteroclysis also extends the duodenum by reflux and, with good distension, the normal wall measures approximately 1 mm. The different normal layers of this wall are not visible. This wall hosts a great number of folds. The duodenal papillae and mucous anomalies (*fig. 4*) are not visualized by CT-enteroclysis.

The small bowel wall's normal thickness (*fig. 5*) varies greatly depending on the distension. The wall is sometimes barely visible or less than 1 or 2 mm if distension is substantial. It appears thicker (3–4 mm) when the intestine is flat or only slightly distended. The connivent valves (or Kerckring folds) are perpendicular to the wall's long axis. They occupy one-third to two-thirds of the intestinal circumference. There are

many of them at the jejunum and they become rare in the ileum, disappearing at 50 cm to 1 m from the ileocecal orifice. Their thickness is the same as the wall thickness and their mean height is 7–8 mm. The aspect of the mesentery is identical to the plain abdominal CT. However, when intestinal distension is substantial or in thin patients, it can be compressed and therefore difficult to study.

False-positive results

The excellent sensitivity and specificity of CT-enteroclysis have been widely reported in the literature on intestinal mural and transmural diseases, with very few false-negative results. However, the false-positive results continue to be too numerous. It is therefore indispensable to take multiplanar reformations to limit this pitfall (6, 10).

The false-positive results (*fig. 6–9*) generally correspond to partial volume effects of the connivent valves, intestinal spasms, and functional invaginations. It seems that invagination is very difficult to demonstrate because its analysis is highly subjective and there is no reference method to prove it. It can be confused with simple intestinal contraction or an intestinal fold (*fig. 8*), but not with organic invagination because it does not result in upstream distension.

Chronic intestinal bleeding

The performance of CT-enteroclysis in diagnosing obscure intestinal bleeding is poor because in this indication, the most frequently found causal lesions are, in decreasing order of frequency: arteriovenous malformations (or angiodysplasia) (*fig. 4*), very frequent after 50 years of age, ulcerations secondary to NSAIDs, and tumors. There is no precise consensus on the best diagnostic strategy in these situations of obscure chronic intestinal bleeding. However, age plays an important role in the diagnostic decision.

Chronic intestinal bleeding and tumors after 50 years of age

In patients over 50 years of age, it is recommended to begin with an esogastroduodenoscopy and a colonoscopy, then if these exams are negative, a videocapsule recording is indicated. If videocapsule endoscopy shows a lesion in the small bowel, it may be possible to treat it endoscopically and/or surgically. However, if it is negative, inves-

tigations should be pursued and directed toward other segments of the digestive tract depending on the clinical context because 42% of digestive tract lesions are diagnosed by repeating esogastroduodenoscopy and colonoscopy. The endoscopic examinations, and in particular videocapsule endoscopy, have a much poorer performance when they are done at a distance from the hemorrhagic episode (1% at 6 months). Yet angiodysplasias are lesions that bleed intermittently.

After the age of 50, CT-enteroclysis has a very minor place since angiodysplasia is frequently the cause of bleeding and this is not detected on CT. However, CT-enteroclysis is often done before videocapsule endoscopy because it can verify the absence of stenosis that may block the capsule (11).

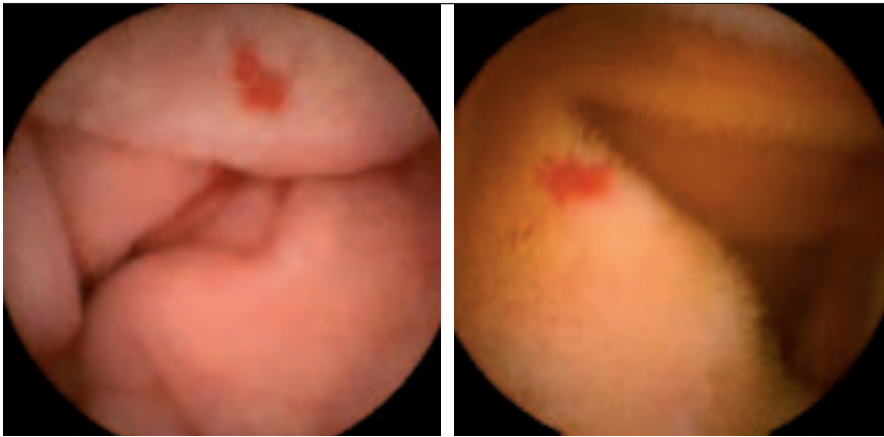
Chronic intestinal bleeding and tumors before 50 years of age

On the other hand, before the age of 50, CT-enteroclysis comes after gastroscopy and colonoscopy because a bowel tumor must be sought first and foremost, with angiodysplasia less frequent at this age. If the CT-enteroclysis does not find the source of bleeding, more invasive explorations such as enteroscopy or videocapsule endoscopy have a role to play (12).

The results from different series, and in particular the results from Orjellet et al. (12), Boudiaf et al. (7), and Romano et al. (13), agree in the observation that CT-enteroclysis is valuable for patients with a high clinical probability of presenting a small-bowel tumor. The best indications come from carcinoid syndromes and digestive tract hemorrhage syndromes recurring over several months with negative gastroscopy and colonoscopy. Our experience confirms this strategy since it appears that the CT-enteroclysis is a technique that can detect tumors less than 1 cm in size as long as optimal intestinal distension is obtained and sufficient time is taken to read the images.

Acute digestive tract bleeding

In an emergency situation, videocapsule endoscopy has no place because it lasts 8 h and its progression depends on peristalsis. In addition, if the patient is in hemorrhagic shock this exam is not indicated. Therefore, CT-enteroclysis and/or the double-balloon enteroscope are indicated. On the contrary, when the patient is doing well, videocapsule endoscopy can easily be performed.



a|b

Fig. 4: *Example of jejunal angiodysplasia. Normal CT-enteroclysis and sideropenic anemia in a 66-year-old patient who did not present exteriorized bleeding and in a 76-year-old patient with melena (false-negative).*

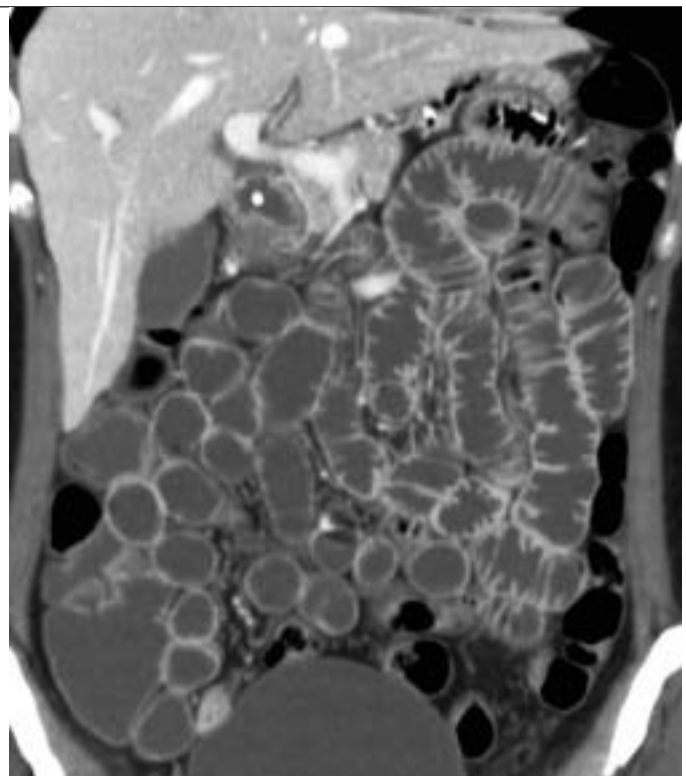
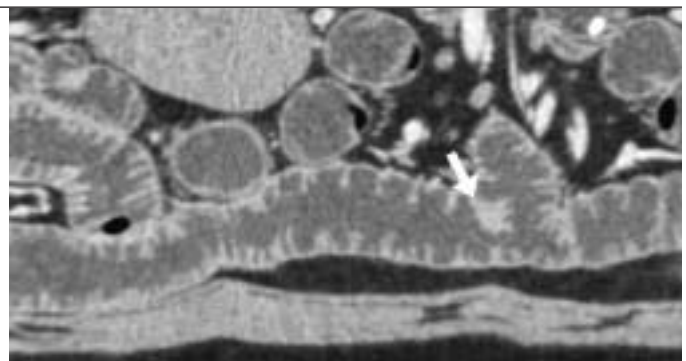
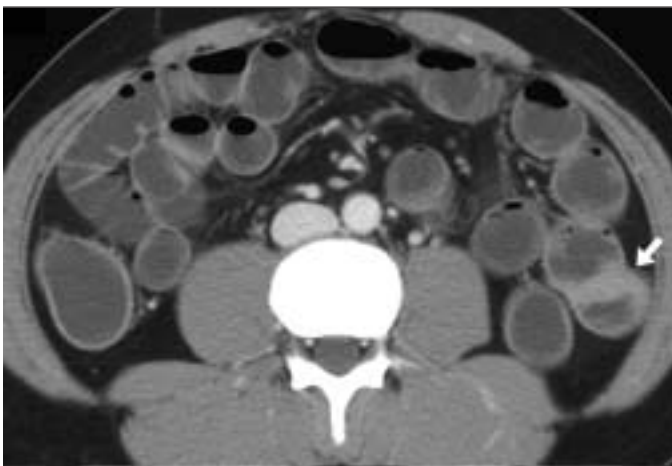


Fig. 5: *Successful normal CT-enteroclysis with probe properly placed at the beginning of the jejunum, with optimal and homogenous intestinal distension.*

Filling was done with a mannitol-based solution without drug-induced hypotonia. The jejunum measured 26 mm, the mid-ileum 23 mm, and the last ileal loop measured 20 mm.

a Axial view,
b coronal view.



a|b

Fig. 6: *Example of a false-positive result: pseudothickening of the wall at the left flank (arrow), actually corresponding to an intestinal-jejunal fold when the loop is uncoiled with multiplanar reformations (arrow).*

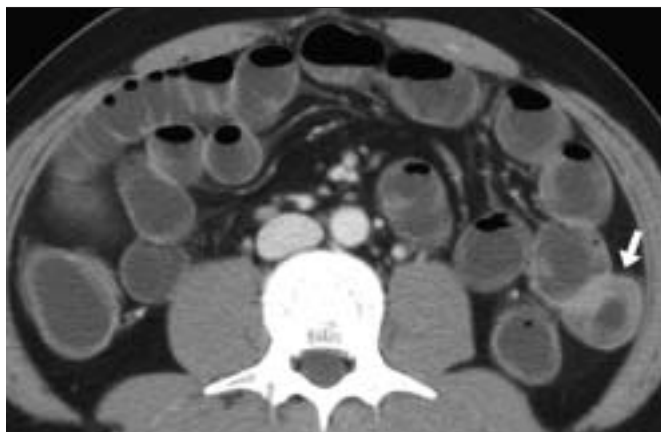
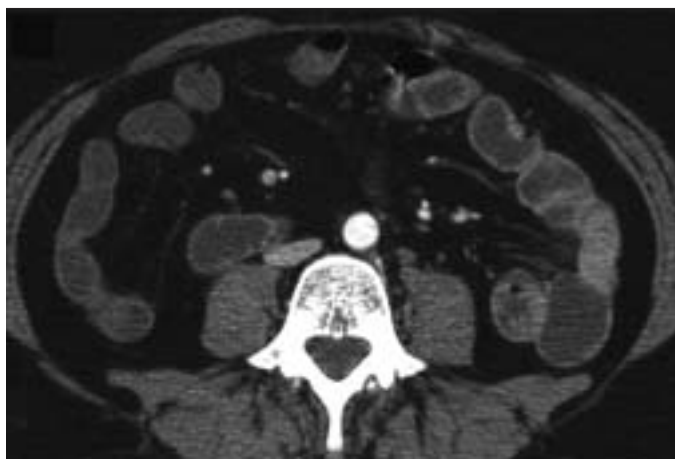


Fig. 7: *Example of a false-positive result: pseudotarget of a loop at the left flank (arrow) corresponding to a jejunal connivent valve.*

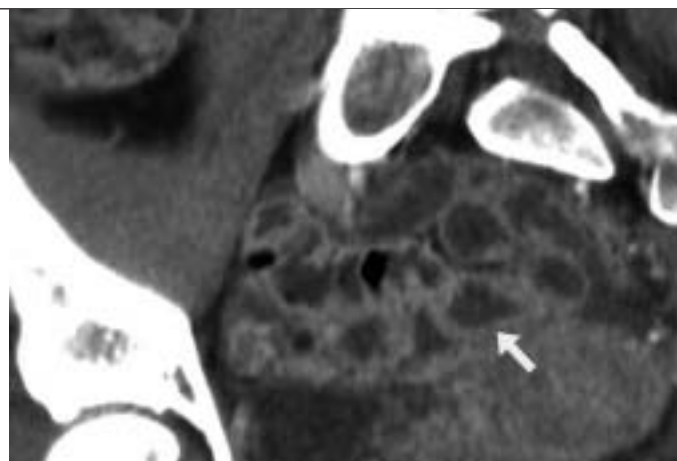
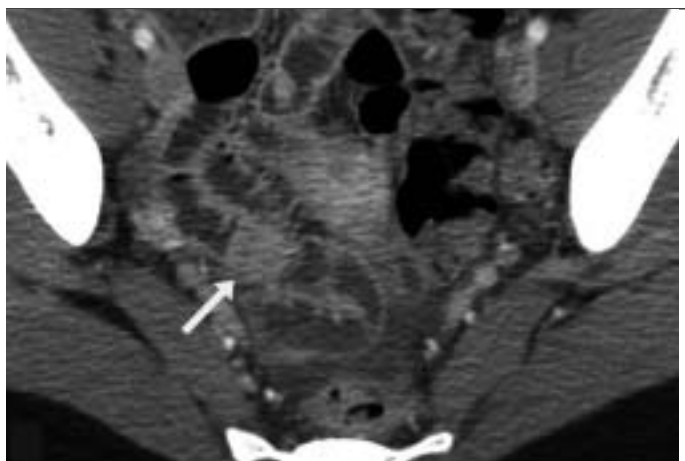


a|b

Fig. 8: *Example of a false-positive result.*

a *Example of functional jejunal invagination or intestinal spasm appearing as a stenosing wall thickening after injection of iodinated contrast product.*

b *Analysis of the other acquisition phases can eliminate the nonpathological aspect of this image because it disappears.*



a|b

Fig. 9: *Example of false-positive result for a tumor (arrow):*

a *axial view,*

b *oblique view.*

Small-bowel tumors

The first study on CT-enteroclysis exploration of small-bowel tumors was reported by Orjollet-Lecoanet et al. in 2000 (12) on 48 patients consulting for suspected small bowel tumor over a period of 23 months. At the end of this study, CT-enteroclysis seemed to be an indisputable, high-performance technique in detecting small-bowel tumors as long as optimal intestinal distension was obtained.

In November 2004, Boudiaf et al. (13) confirmed the results of Orjollet-Lecoanet et al. (12), and considered that water CT-enteroclysis can replace the usual combination of small-bowel exploration and abdominopelvic CT scan for small-bowel tumor workup. In June 2005, Romano et al. (13) also confirmed these results in a study on more than 400 patients. In staging tumors, small-bowel tumors present a diagnostic difficulty for both the clinician and the radiologist because they

are rare (<5% of tumors of the digestive tract), their nonspecific symptoms delay diagnosis, and in particular their small size at the initial evolving stage. However, their CT aspect is identical to the aspect classically described in CT without enteroclysis, and epithelial and conjunctive tumors can be distinguished.

Epithelial tumors are represented by adenocarcinomas (fig. 10, 11), adenomatous polyps (fig. 12), and solitary fibrous polyps (fig. 13).

Benign conjunctive tumors comprise the nonmalignant GISTs (gastrointestinal stromal tumors with a Cajal cell phenotype), leiomyomas, lipomas (fig. 14), hemangiomas, benign lymphoid hyperplasias, schwannomas, etc.

Malignant conjunctive tumors concern the GISTs with malignancy criteria (fig. 15, 16), leiomyosarcomas, hemangiosarcomas, Kaposi sarcomas, plexosarcomas, etc.

Type B (fig. 17) or T (fig. 18) lymphomas are born of lymphoid tissue, and carcinoid

tumors (fig. 19) are neuroendocrine tumors. Metastases appear either from intrinsic involvement (peritoneal carcinomatosis) or hematogenic involvement (fig. 20, 21).

In our experience, the most frequent malignant tumors are stromal tumors (GISTs), adenocarcinomas and lymphomas. Lipomas are the most frequent benign tumors. Hypervascular lesions generally correspond to carcinoid tumors, stromal tumors, or certain metastases. The adenocarcinomas enhance less intensely and are often stenosing. Lymphomas, on the other hand, enhance very little and are associated with multiple adenopathies. Lipomas are very easy to identify on CT because of their characteristic hypodensity.

Inflammatory disease

The most frequent inflammatory involvement of the small bowel is Crohn disease: chronic ulcerous and stenosing granulomatous progression in the young

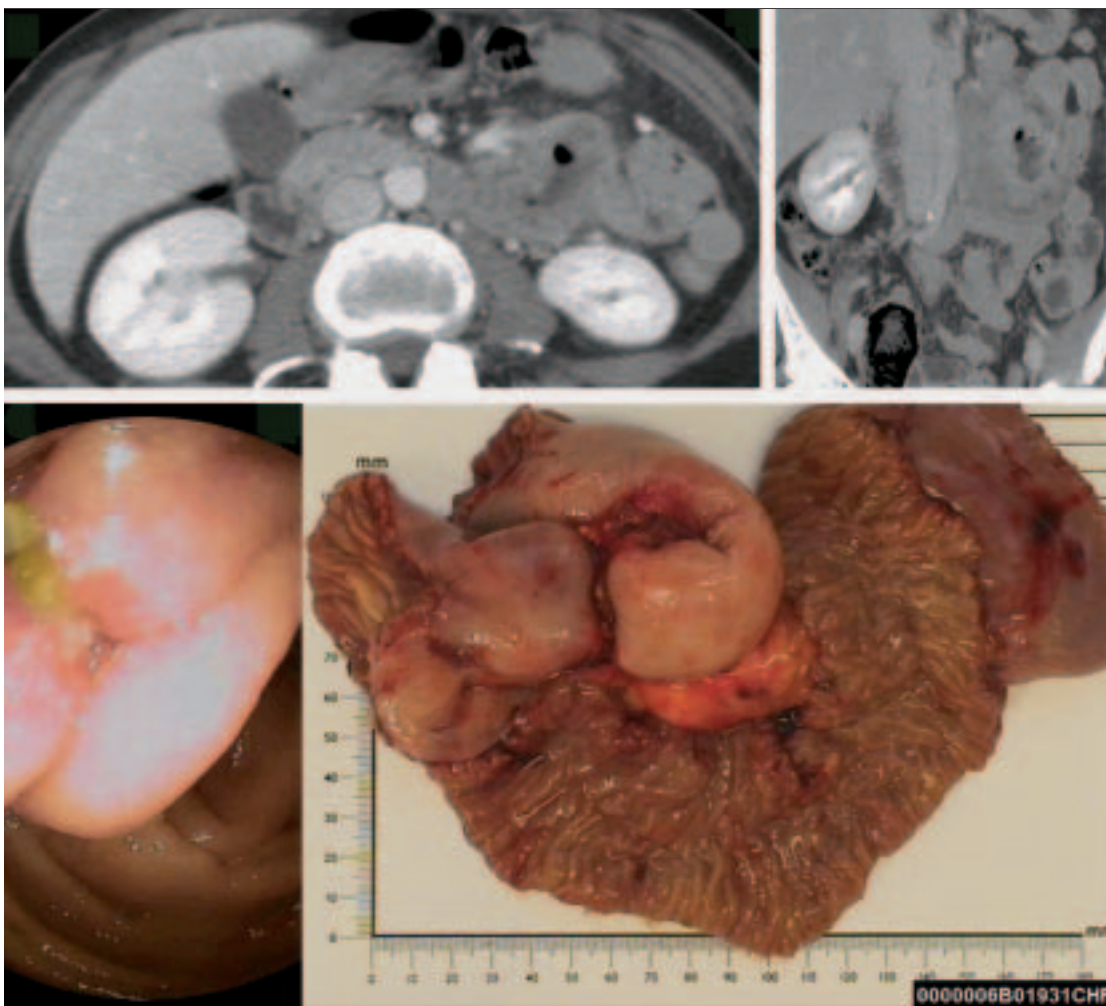


Fig. 10: *Circumferential thickening of the jejunum with aneurysmal dilatation and low enhancement after injection and therefore highly suggestive of lymphoma. The double-balloon enteroscope and the pathological report nevertheless diagnosed mucinous adenocarcinoma.*

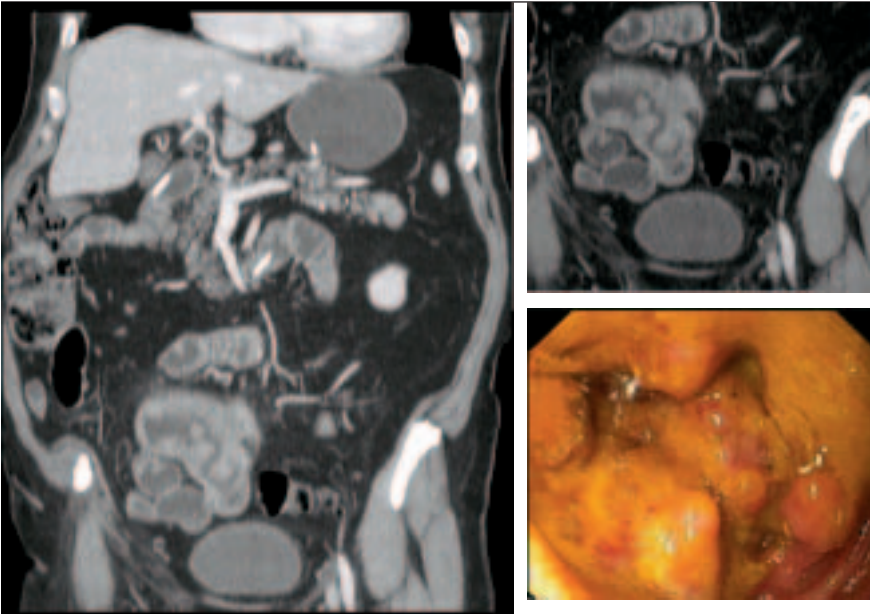


Fig. 11: *CT and endoscopic aspect (videocapsule) of an adenocarcinoma of the jejunum appearing as budding and circumferential thickening.*

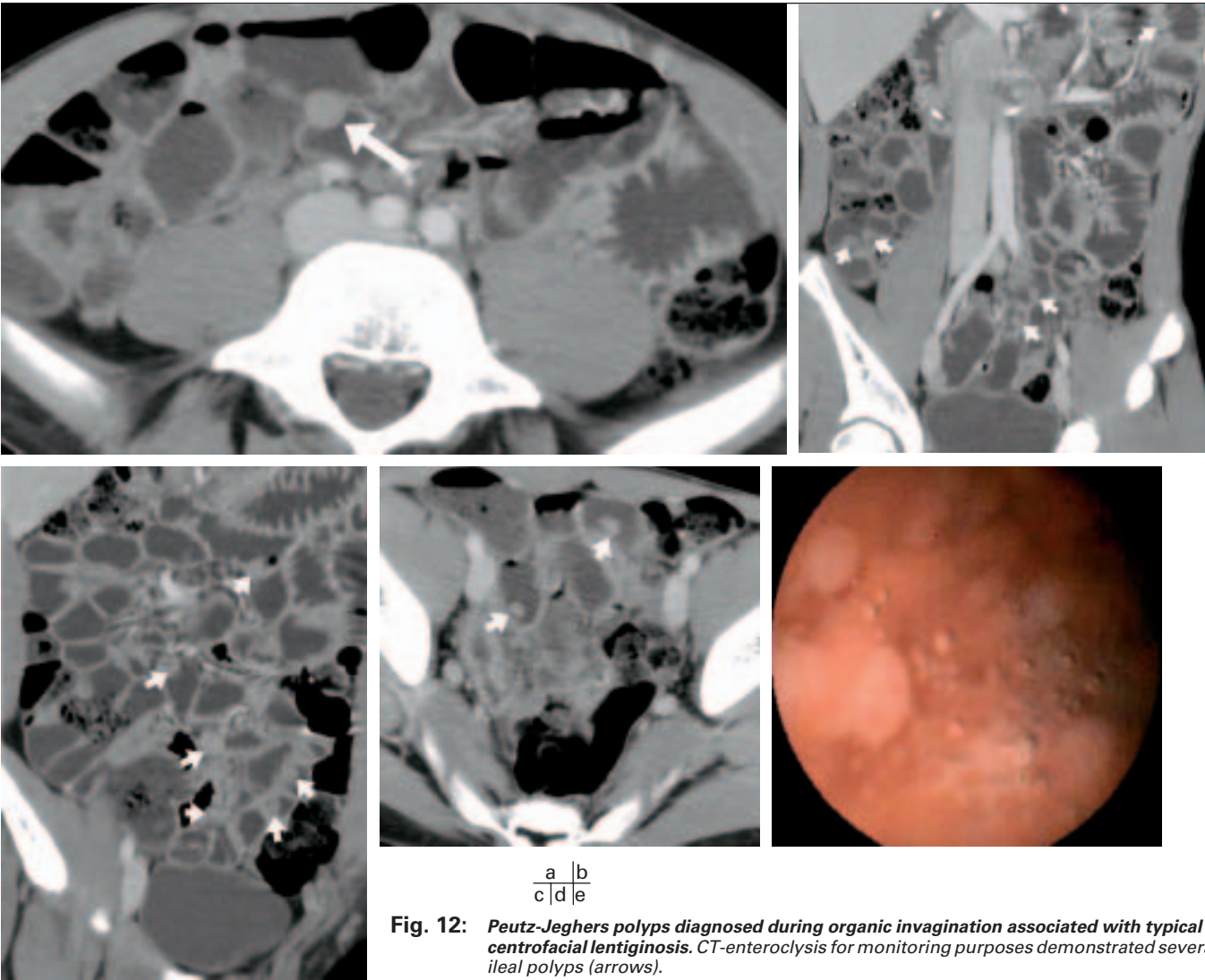


Fig. 12: *Peutz-Jeghers polyps diagnosed during organic invagination associated with typical centrofacial lentiginosis. CT-enteroclysis for monitoring purposes demonstrated several ileal polyps (arrows).*

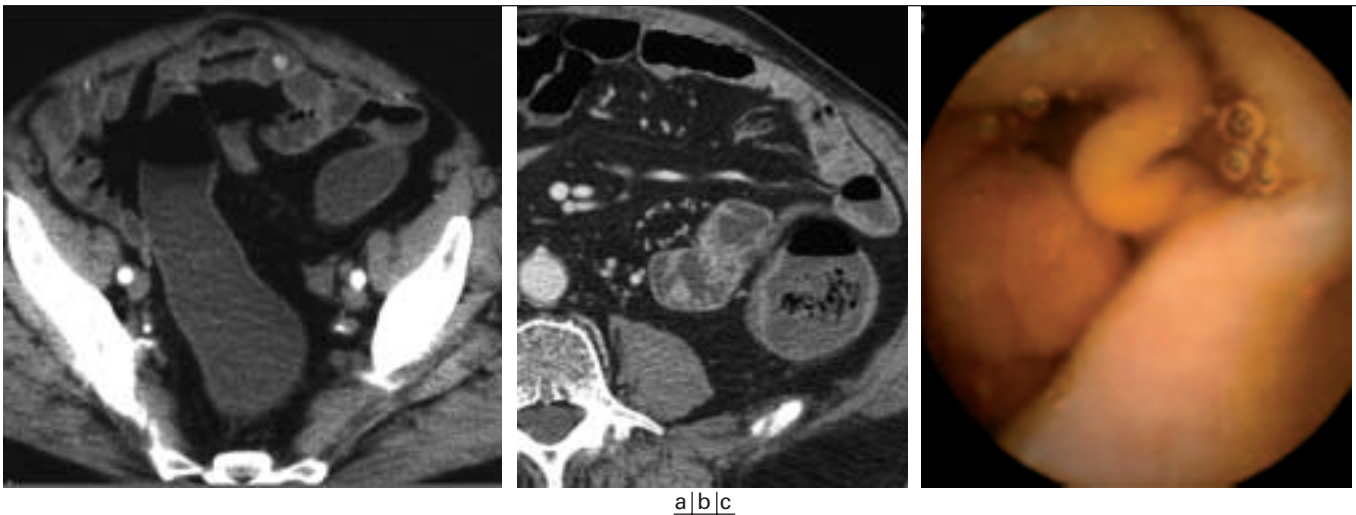
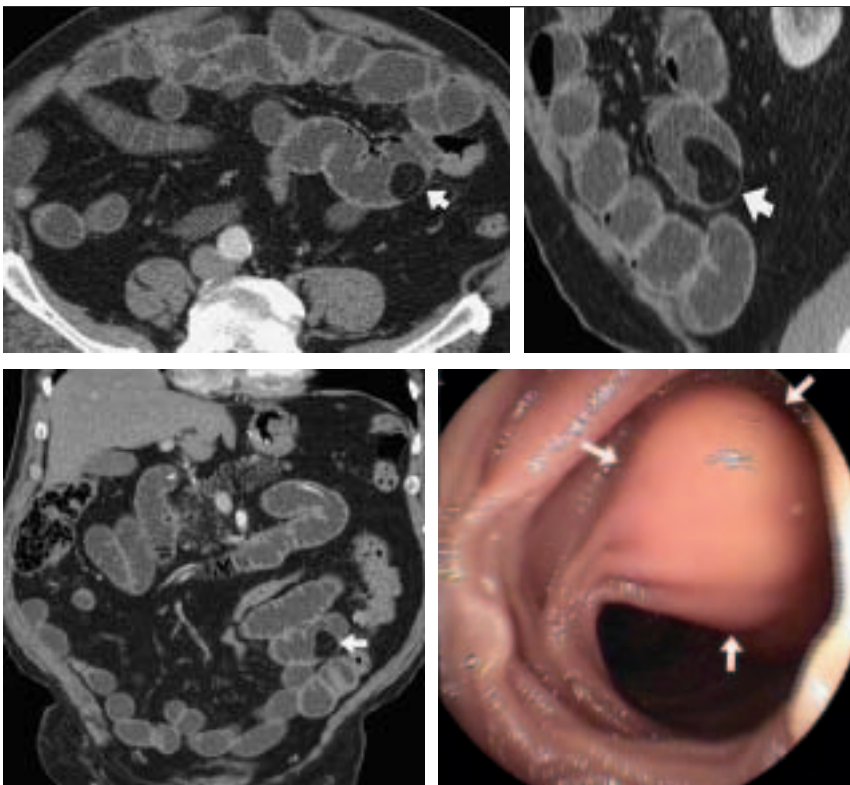


Fig. 13: Examples of a single fibrous polyp on CT-enteroclysis and endoscopic videocapsule.



a | b
c | d

Fig. 14: Lipoma of the distal jejunum diagnosed on videocapsule endoscopy and double-balloon endoscope in a digestive tract duplication (arrows).

adult most often found in the terminal ileum. CT is a reference technique to study wall thickening, abdominal fat, and the complications of inflammatory disease of the small bowel with a strong impact on patient management. High-resolution sonography and MRI (14, 15) are nonirradiating alternatives that should be favored in young patients. The objective of morphological exploration depends on disease stage. During initial diagnostic workup, with no irradiation, MRI can map the abdominal lesions. During sta-

ging for exacerbation and to evaluate complications, high-resolution sonography provides a preliminary evaluation of the lesions, but should generally be completed by MRI if it is available (fig. 22). Aphthoid ulcerations are not visualized on imaging studies, whereas they are clearly seen on double-balloon videocapsule endoscopy.

Diverticular disease

On CT, diverticulum generally corresponds to an extraluminal image, rounded, with a fluid, gas, or fluid-gas content,

communicating with the intestinal lumen. On CT-enteroclysis, diverticula more often appear as fluid since they fill simultaneously with the intestinal loops. Congenital diverticula are more frequently found on the antimesenteric edge than acquired diverticula found on the mesenteric edge where the vessel penetrates (fig. 23-25).

Meckel diverticulum

Meckel diverticulum is inconstant and rare since it is found in only 2% of autopsies.

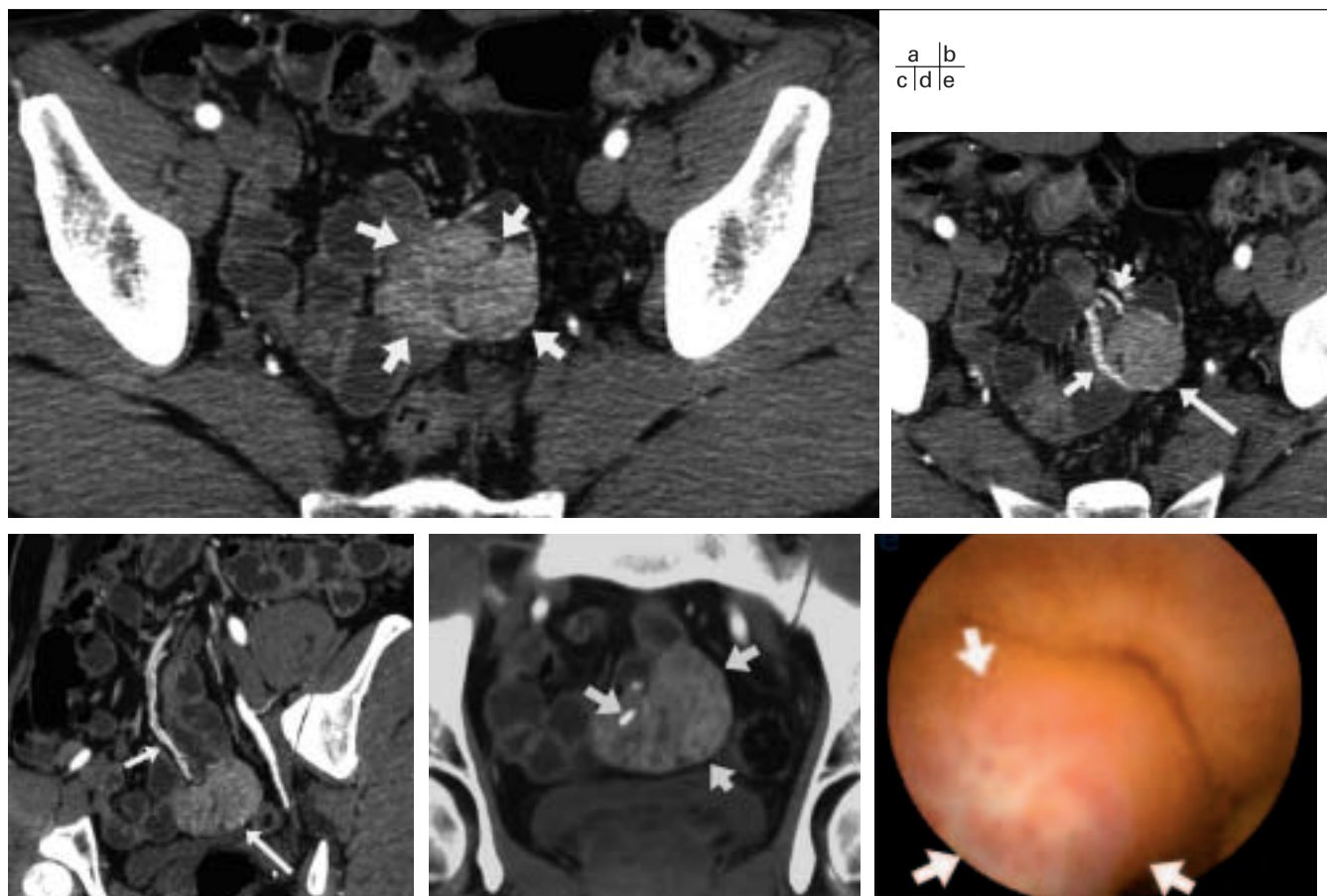


Fig. 15: *Ileal stromal tumor revealed by abdominal pain. The tumor's characteristics are seen clearly:*
a budding endoluminal mass,
b-c hypervascular heterogeneous mass with large feeding artery,
d a few necrotic areas and intralesional calcification.

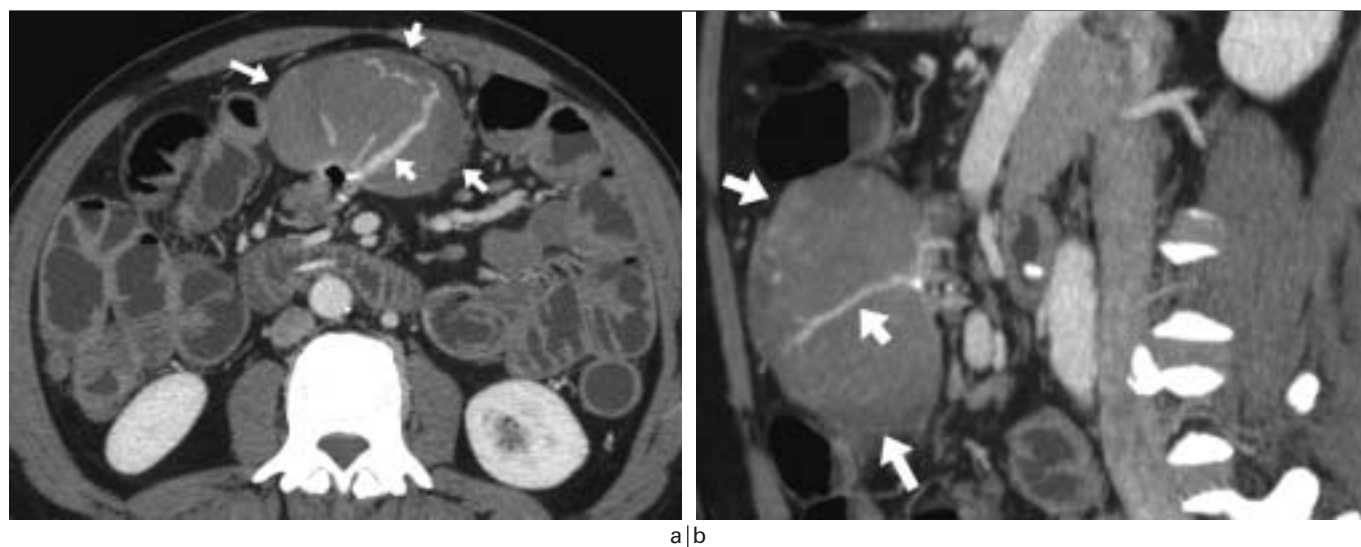


Fig. 16: *Voluminous ileal stromal tumor on CT-enteroclysis: budding endoluminal mass, hypervascular heterogeneous mass with large feeding artery.*

It is most often asymptomatic and is manifested by its hemorrhagic, inflammatory, occlusive, and tumoral complications (16). Beyond cases of tumoral or infectious complication of this malformation, CT-enteroclysis should provide a diagno-

sis more often than the plain CT. Indeed, abundant filling of the small intestine loops by enteroclysis theoretically easily distinguishes between diverticulum and intestinal loop. However, it can also be imagined that the distension of the origi-

nal loop creates a compression of the diverticulum, which is therefore not visible. We have observed ulcerated Meckel diverticulum responsible for sideropenic chronic anemia on CT-enteroclysis (videocapsule endoscopy and the double-

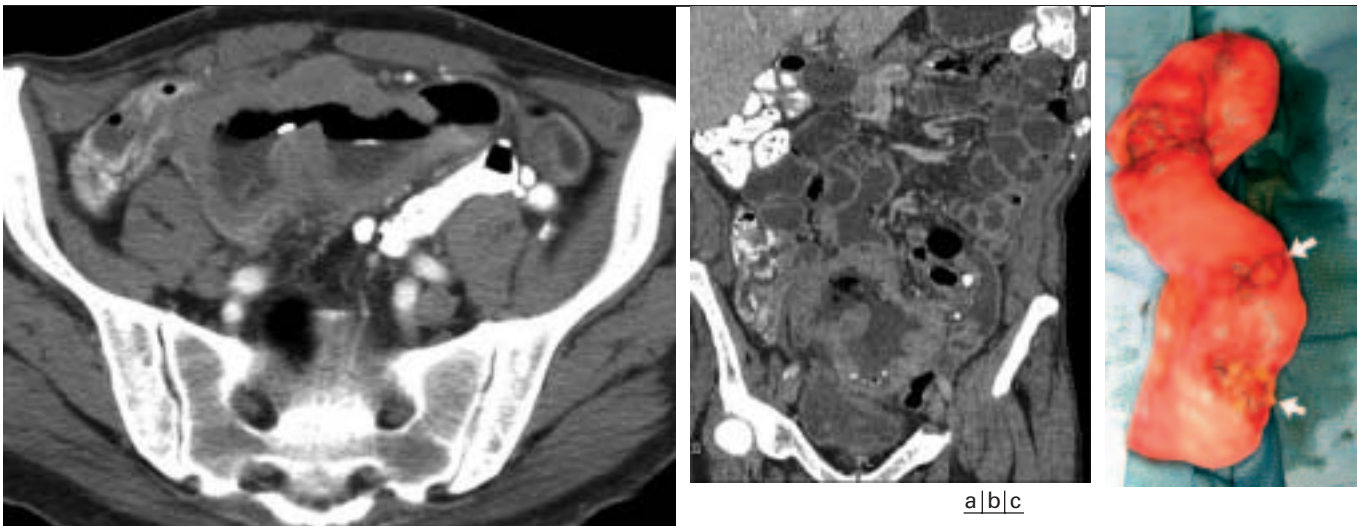


Fig. 17: *Type B ileal lymphoma seen as a homogenous thickening of the wall with regular contours and little enhancement, confirmed by surgery (arrows).*

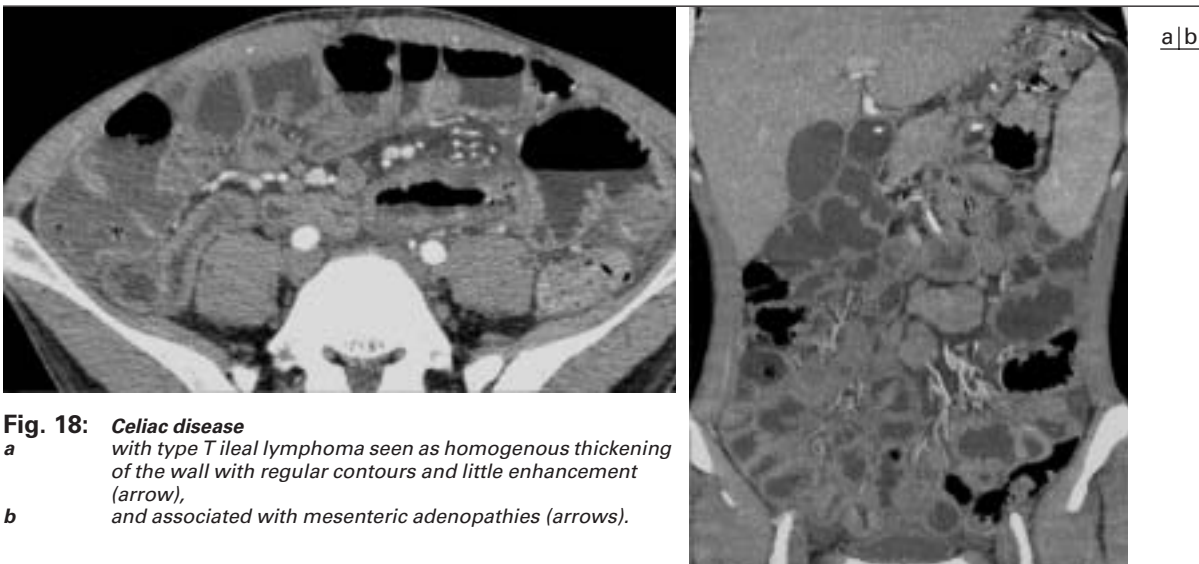


Fig. 18: *Celiac disease with type T ileal lymphoma seen as homogenous thickening of the wall with regular contours and little enhancement (arrow), and associated with mesenteric adenopathies (arrows).*

balloon endoscope) and at surgery. This diverticulum had not been initially diagnosed, but was discovered a few months later upon exteriorized bleeding on a new endoscopic workup (fig. 20, 21). A similar case was described by Mathon et al. (17) in an example of hemorrhagic shock.

Malabsorption syndrome

In malabsorption syndromes, CT-enteroclysis has no place in typical situations of celiac disease (reversed appearance of the small bowel, adenopathies, hyposplenism), since duodenal biopsy remains the key examination showing villous atrophy. On the other hand, in refractory sprue, CT-enteroclysis is the choice exam when looking for a lymphoma-type tumor complication.

According to Boudiaf et al. (7), who report their experience with refractory celiac disease, CT-enteroclysis demonstrated a partial villous atrophy, an reversed small bowel (fig. 26, 27), a T-type lymphoma (fig. 18), an adenocarcinoma, an ulcerous jejunoileitis, and several functional invaginations.

Waldmann disease, congenital primary lymphangiectasia, is responsible for jejunal lymphatic and major ileal stases with ectasia and cystic cavities that are manifested by a thickening and multiplication of the jejunoileal valves on CT (fig. 28).

Small-bowel occlusion

In cases of low-grade occlusion (bridle, adhesions, radiation enteritis, carcinosis, Crohn disease), the ingestion of contrast product or its injection in the nasogastric

catheter before the CT examination makes it possible to differentiate incomplete occlusions that can be treated medically from complete surgical occlusions. Maglinte et al. (18) encourage this exam with a double-function catheter (infusion and aspiration) to avoid any problems. However, this practice is debatable since it increases endoluminal hyperpressure in a stasis intestine with possible microbial proliferation and a consequential risk of septic discharge.

Conclusion

Imaging the small bowel plays a major role in the diagnosis and therapeutic management of these patients. It has been established that slice imaging

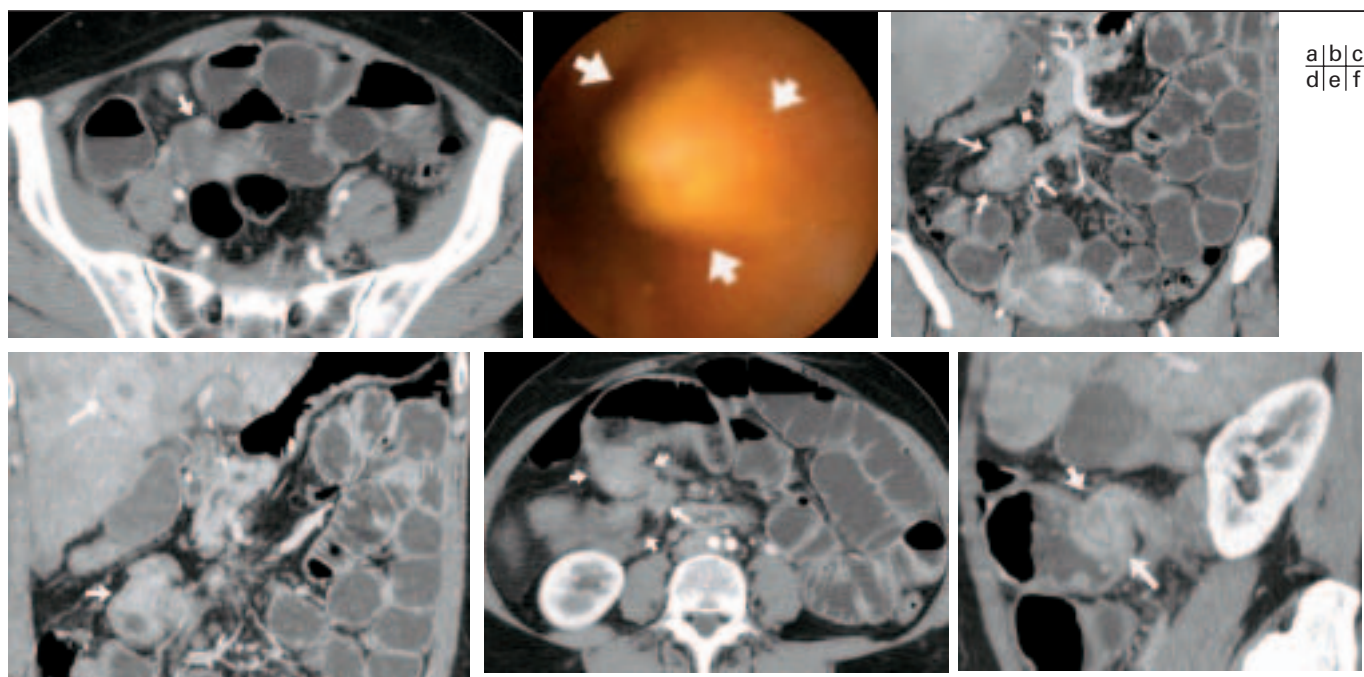


Fig. 19: *Ileal endoluminal carcinoid tumor (arrows) corresponding to stenosing hypervascular wall thickening with retraction and fixity at the antimesenteric edge of neighboring loops, liver metastases (long arrow) and hypervascular ileal and peritoneal nodules.*
d-f
c
a
b Videocapsule endoscopy found an oval submucous ileal nodule.

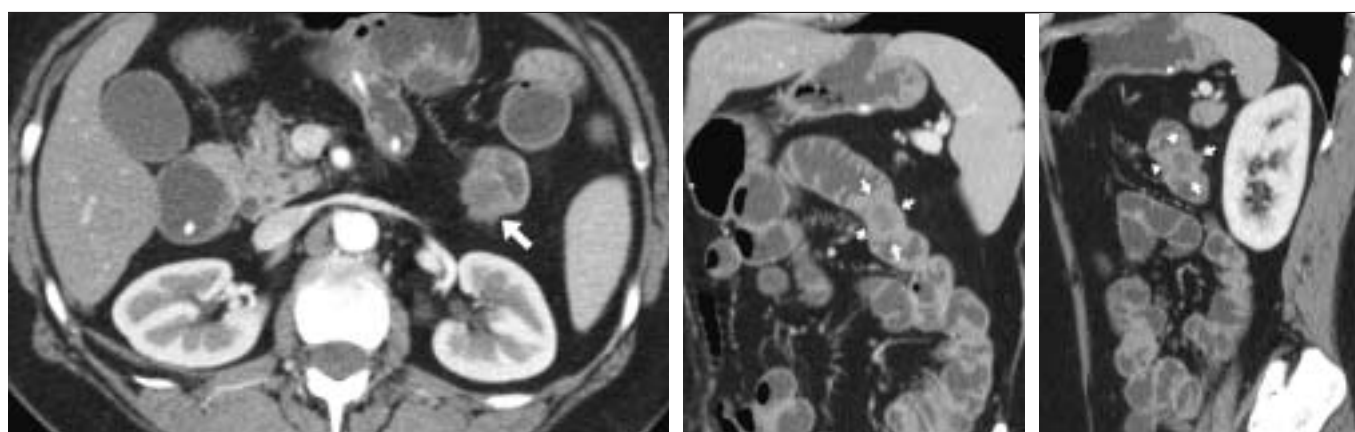


Fig. 20: *Rectal adenocarcinoma metastasized to the jejunum (arrows): spiculated tumor, slightly vascularized, extraluminal and endoluminal, of the proximal jejunum.*
a|b|c



Fig. 21: *Ileal metastasis of melanoma (arrows).*
a|b

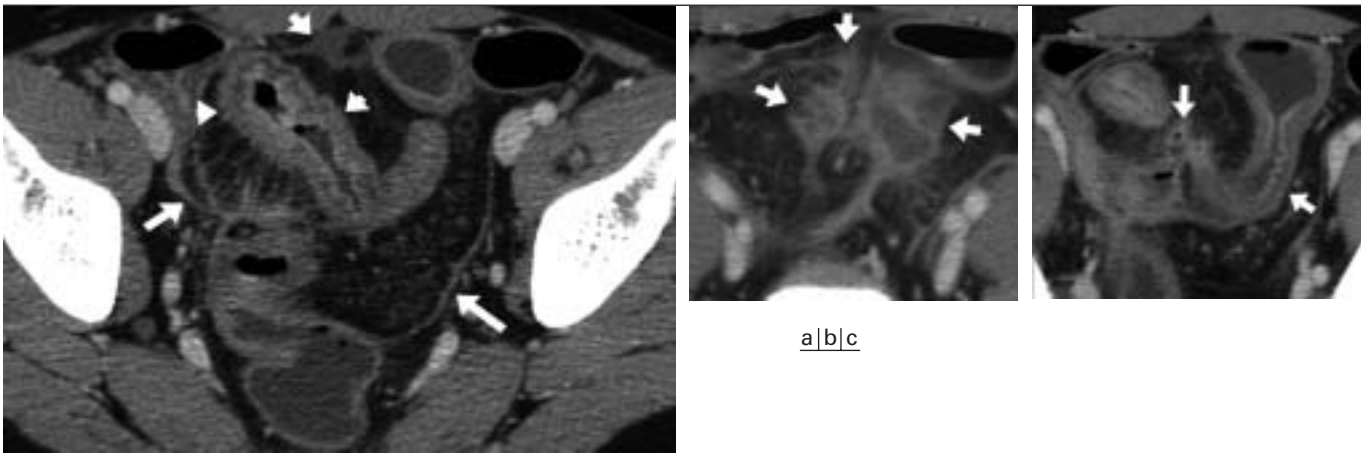


Fig. 22: *Crohn disease complicated with terminal ileitis:*
a-c *submucous edema and mucous uptake of contrast medium responsible for the target aspect, sclerolipomatosis, combed aspect, abscesses and associated fistulae.*

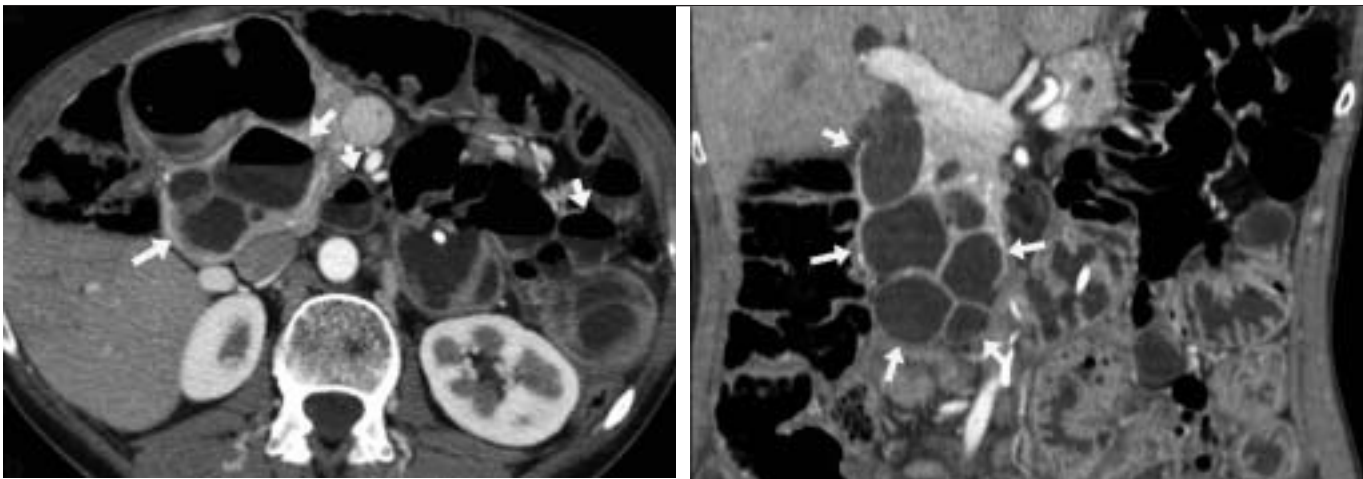


Fig. 23: *Duodenojejunal diverticulosis*
a *axial view,*
b *coronal view.*

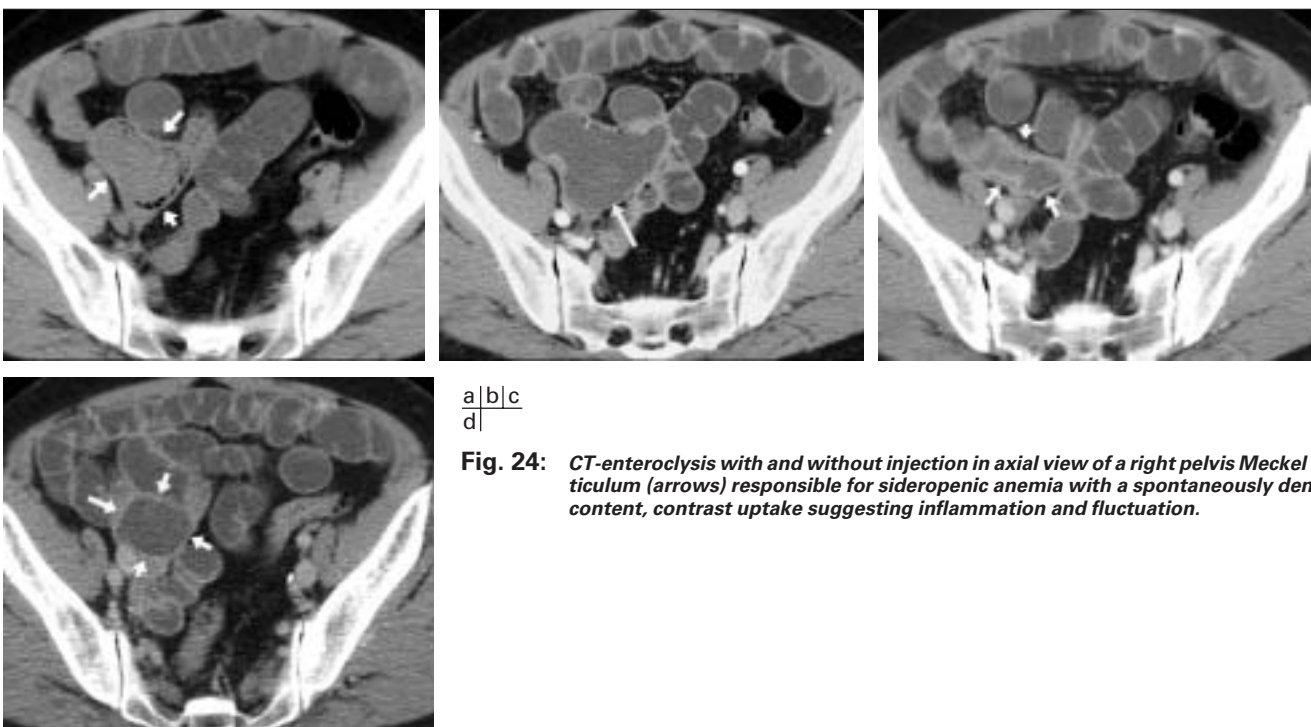
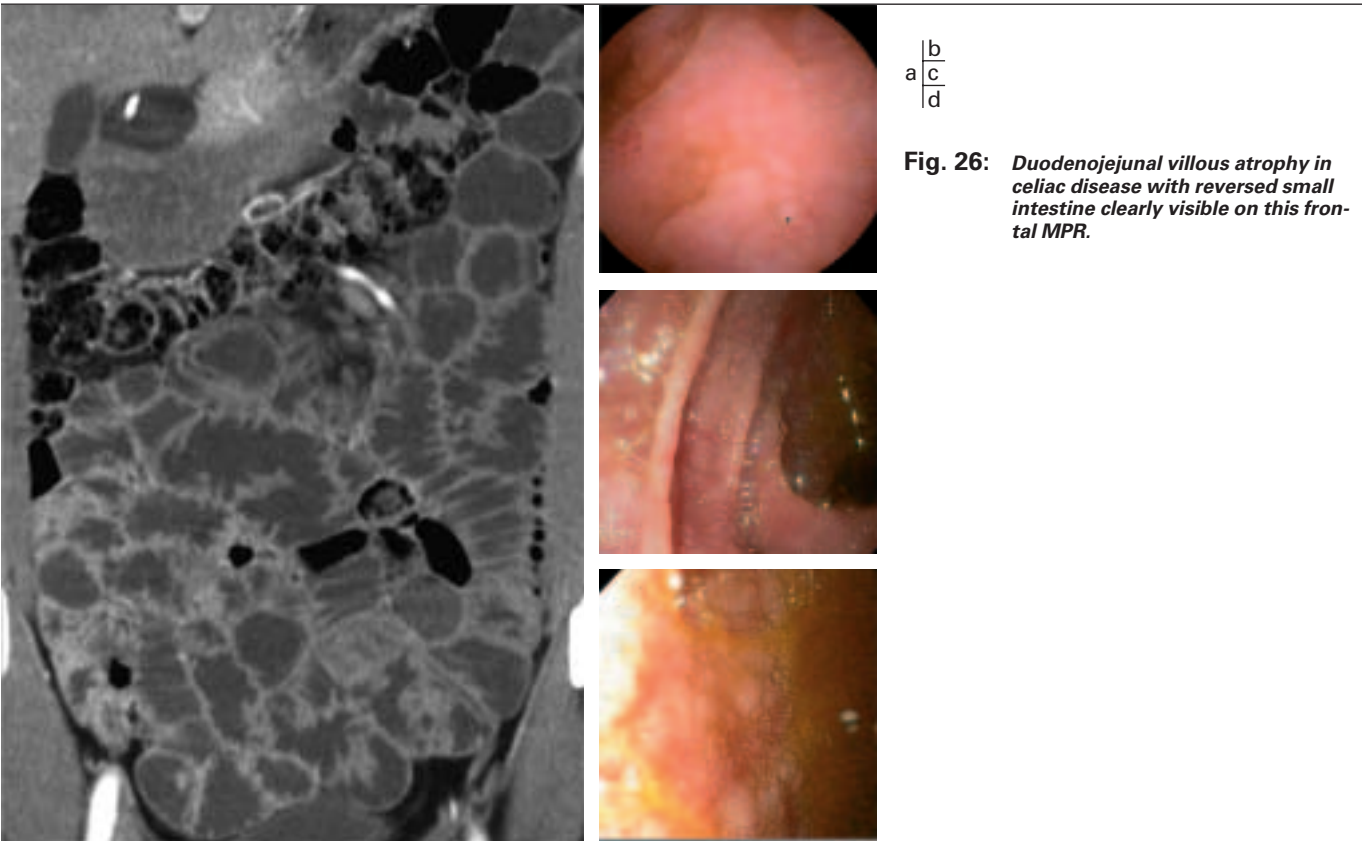
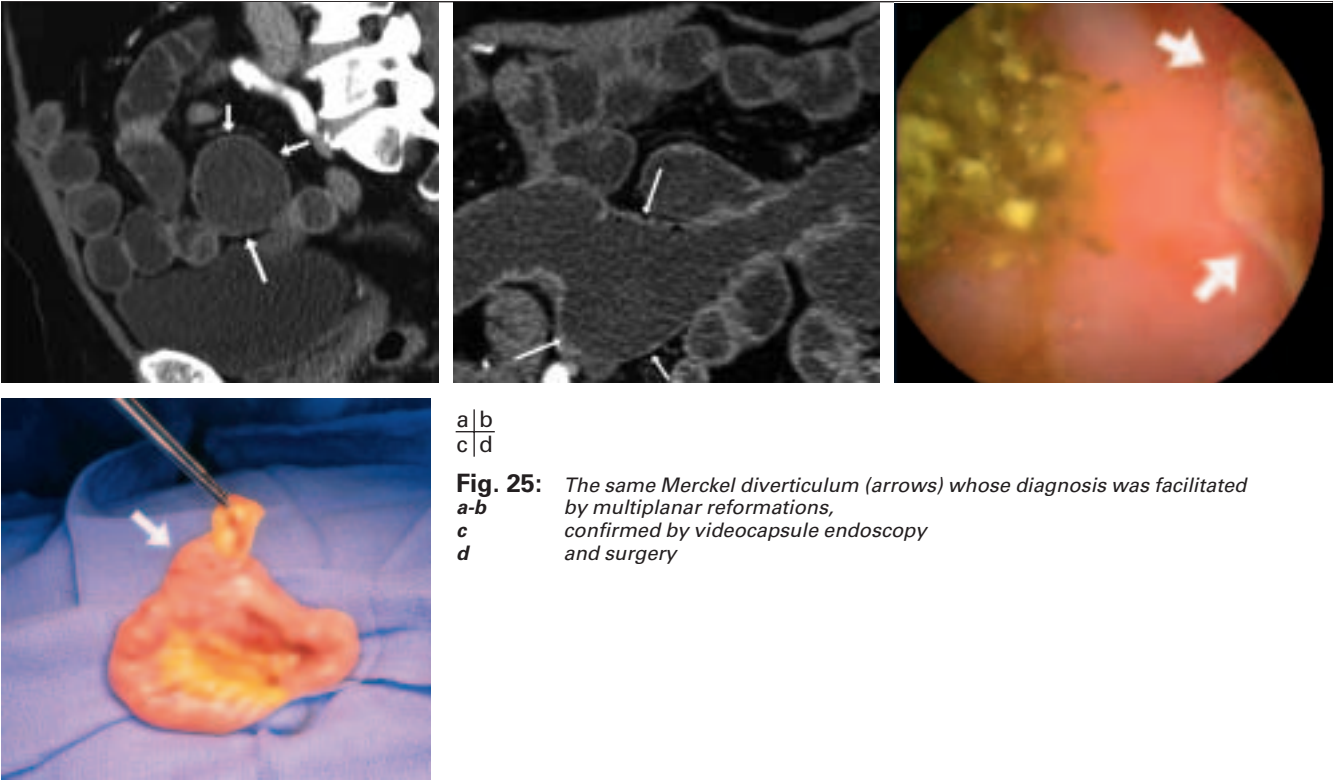
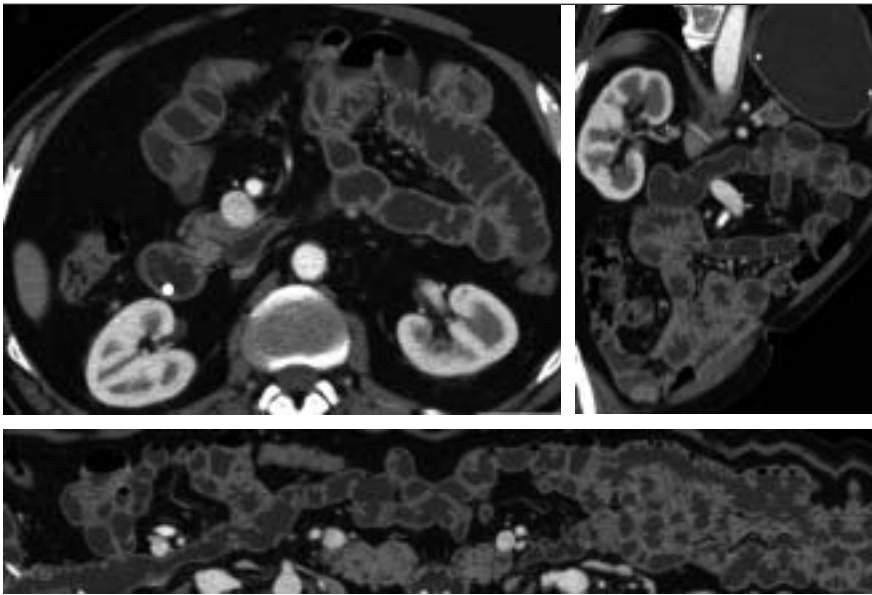


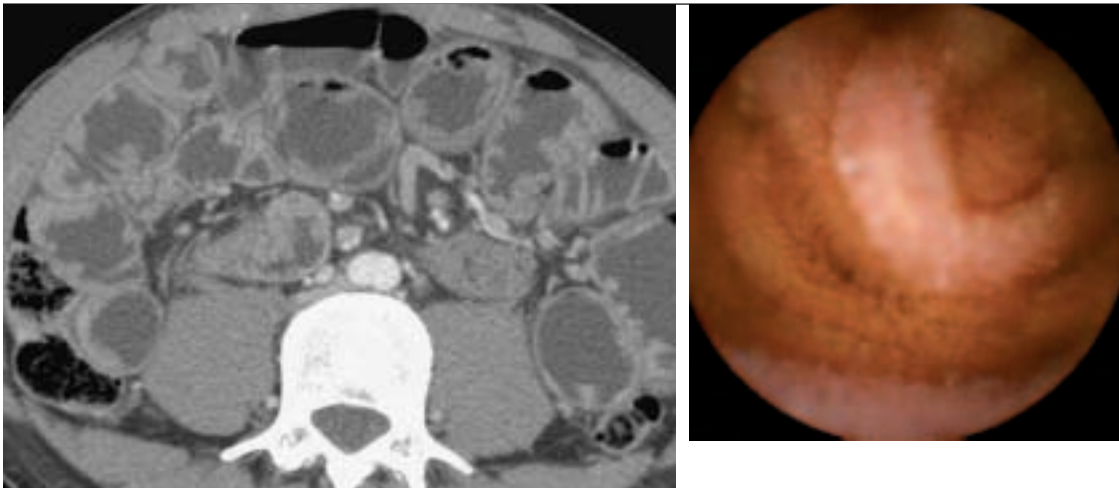
Fig. 24: *CT-enteroclysis with and without injection in axial view of a right pelvis Meckel diverticulum (arrows) responsible for sideropenic anemia with a spontaneously dense content, contrast uptake suggesting inflammation and fluctuation.*





a|b
c

Fig. 27: Duodenojejunal villous atrophy secondary to substantial exogenous intoxicification with 80 g of alcohol per day. The inverted small-bowel aspect is very clear on this CT with poorly visible duodenal and jejunal connivent valves as well as multiplication and ileal valve hypertrophy on axial view, oblique views and curved views



a|b

Fig. 28: Waldmann disease characterized by large fold and diffuse thickening of intestinal walls as seen on CT-enteroclysis and videocapsule endoscopy.

(CT-enteroclysis, entero-MRI, high-resolution sonography) presents a high diagnostic value in terms of sensitivity and specificity in detecting transmural and extramural pathologies, in particular tumors of the small bowel. However, the quality of the CT-enteroclysis (catheter placement, intestinal distension, injection of iodinated contrast medium, spatial resolution) as well as the duration of image interpretation modifies its diagnostic power quite significantly. Finally, one must know how to use the superiority of oblique multiplanar reformations to avoid false-positive results (pseudothickening, pseudo-tumors) because they make it possible to proceed through the intestinal

loops and in particular to differentiate the folds, the connivent valves, and the intestinal curves. Currently, CT-enteroclysis is reserved more for specialized imaging departments and for exploring tumors while we await better contrast agents.

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