# Crohn's disease: value of diagnostic imaging in the evaluation of anastomotic recurrence



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Crohn's disease: value of diagnostic imaging in the evaluation of anastomotic recurrence

In patients who had previously undergone ileocolic resection due to Crohn's disease (CD) complications, anastomotic recurrence is a frequent event, which may lead to further surgical interventions. Optical colonoscopy with retrograde ileoscopy is currently the reference standard technique to confirm the clinical suspicion of anastomotic recurrence; however, the ileal side of ileocolic anastomoses may not be assessed due to technical complexities in approximately 1/3 of cases. Moreover, endoscopy allows for an investigation limited to the mucosal surface without demonstrating trans-mural involvement and/or penetrating complications (i.e. fistulas and abscesses). Imaging plays an important role in the assessment of both ileocolic and entero-enteric anastomoses in patients with CD. Conventional radiological methods (i.e. small bowel enteroclysis and small bowel follow through) can effectively depict the presence of aphthous ulcers and other mild and subtle mucosal abnormalities, but they are not precise for the diagnosis of transmural and extramural disease. CT - and MRenterography accurately demonstrate both the extent of bowel wall involvement and the presence of penetrating complications. The main cross-sectional imaging findings observed in CD (including anastomotic recurrence) are small bowel wall thickening with bilaminar or trilaminar stratification, hyperdensity and oedema of the mesenteric fat, engorged mesenteric vasa recta ("comb sign"), sub-mucosal fibro-fatty infiltration and mesenteric adenopathy. Ultrasonography performed after distension of small bowel loops with anechoic contrast agents (Small Intestine Contrast Ultrasonography – SICUS –) is a non-invasive imaging technique which can detect early inflammatory alterations of the anastomosis. On the other hand ultrasor ography is an operator-dependent technique and it lacks of a large anatomic field of view.

KEY WORDS: Computed Tomography enterography, Crohn's disease, Ileocolic anastomosis, Magnetic Resonance Imaging

## Introduction

Crohn's disease (CD) is a chronic inflammatory disease which can affect any segment of the digestive tract, with a marked predilection for the terminal ileum <sup>1</sup>. Patients with CD are classified according to the distribution of

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inflammatory lesions (ileal, ileocolic, colic, upper gastrointestinal, perianal) and their behavior (inflammatory, stricturing, penetrating)<sup>2</sup>. The majority of patients with ileal or ileocolic localization (up to 80% <sup>3,4</sup>) has to undergo at least one surgical resection of the bowel in the course of their disease, due to stricturing or penetrating complications (fistulas, abscesses) which may occur.

CD recurrence in correspondence to the ileocolic anastomosis is very frequent (up to 75% <sup>5-7</sup>), and, in relation to its severity, immunosuppressive therapy or further surgery may be needed <sup>7-9</sup>. Endoscopic studies have shown that, one year after ileocolic resection, 75% of CD patients have new inflammatory lesions at the ileal side of anastomosis (i.e. neoterminal ileum) <sup>5,10,11</sup>.

These lesions, which may also be found within a few weeks after resection, represent a real sign of recurrent inflammation, not of residual or persistent disease, nor even of incomplete healing of the intestinal mucosa at the anastomotic site after surgery <sup>9,10,12</sup>.

Three years after the ileocolic resection, the prevalence of post-operative endoscopic recurrence increases up to 83-100% <sup>1,2,10</sup>. Relevant endoscopic lesions may be found even in the absence of clinical symptoms (i.e. morphologic recurrence), and the prognosis of the disease seems to be influenced by the severity and early onset of post-operative endoscopic inflammatory lesions <sup>1,10</sup>. During the first year after ileal or ileocolic resection, clinically manifest recurrence occurs in variable percentages of patients up to 30%, with a cumulative 10% increased risk for each subsequent year <sup>10</sup>. Further surgery occurs in 5% of patients at 1 year, 15-45% at 3 years and 26-65% at 10 years after the first surgical intervention <sup>10-14</sup>.

Recurrent lesions are supposed to be triggered by factors which act directly on the intestinal mucosa. If the ileocolic anastomosis is protected from contact with the feces by means of a proximal ileostomy, new inflammatory lesions do not arise <sup>5,10,15</sup>. Other risk factors for CD anastomotic recurrence, in addition to the duration of post-operative follow-up and cigarette smoking, are the colic localization of disease, its extension (> 100 cm) and the absence of post-operative pharmacological prophylaxis<sup>3</sup>.

The distribution of CD seems to be relatively constant over time, even after intestinal resection; in fact, CD recurrence frequently affects the neoterminal ileum of ileocolic anastomoses and ileostomies <sup>14,16</sup>. On the contrary, the behavior of the disease (inflammatory, stenosing, penetrating), tends to progress over time <sup>10</sup>.

Optical colonoscopy with retrograde ileoscopy is the method of choice to confirm the clinical suspicion of anastomotic recurrence. Rutgeerts et al. have proposed a simple semi-quantitative endoscopic scoring system to classify the severity of anastomotic recurrence 5,8,19. The Rutgeerts' score is made up of 5 increasing grades (from 0 to 4) defined by the presence, type and number of inflammatory lesions which can be observed in correspondence to the ileocolic anastomosis. Grade 0 is char-

acterized by the absence of lesions, while grade 4 is defined by the presence of widespread inflammation complicated by deep ulcerations, nodular appearance of the mucosal surface and/or narrowing of the intestinal lumen. Hyperemia and edema of the mucosal surface of ileocolic anastomoses are not considered endoscopic findings suggestive of recurrent disease. The Rutgeerts' score has been recently modified by the introduction of two additional grades (0b and 5) to identify patients with endoscopic findings suspicious for a fibrostenosis (substenosis and anastomotic stenosis in the absence of mucosal ulcers) 17. As a matter of fact, both inflammatory and fibrotic stenosis (fibrostenosis) can develop in correspondence to the surgical anastomosis in CD patients. For a correct clinical management of patients, it is crucial to distinguish these two forms of stenosis, which require a different therapeutic approach: medical and conservative in the first case, surgical in the second one. Currently, histopathological analysis of endoscopic biopsies with quantification of fibrosis degree is the gold standard technique to differentiate between fibrostenosis recurrent inflammation. and However, optical colonoscopy with retrograde ileoscopy is an invasive and poorly tolerated diagnostic procedure. The risk of bowel perforation is not completely negligible<sup>17,18</sup>. Narrowing of the lumen of the ileocolic anastomosis can hinder the progression of the endoscope and the intubation of the neoterminal ileum in approximately 1/3 of cases, thus preventing its evaluation <sup>7,17,19</sup>. Diagnostic imaging plays therefore an important role in the evaluation of ileocolic anastomosis in relation to the limitations of endoscopy in this field, and represents the method of choice for the evaluation of entero-enteric anastomoses. Barium small bowel follow-through and enteroclysis have been the only radiographic techniques suitable for these purposes for a long time. Over the years, the most commonly used imaging modalities in the abdominal pathology (Computed Tomography enterography - CT -, Magnetic Resonance Imaging - MRI -, Ultrasonography - US -) have been modified and optimized for the study of the small bowel (CT- and MR-enterography and – Small Intestine SICUS enteroclysis, Contrast Ultrasonography –).

In daily clinical practice, the choice of the most appropriate imaging technique is based on multiple parameters; each of them is characterized by peculiar advantages and disadvantages (availability, cost, safety, use of ionizing radiation, higher or lower spatial and contrast resolution), and a different profile of diagnostic accuracy. In some circumstances different modalities may be used to complement each other <sup>20</sup>.

# Conventional radiology

Enteroclysis and barium small bowel follow-through have been widely used until the recent past. They enable the



Fig. 1: Small bowel follow-through images in a CD patient with ileotransverse anastomosis (A) and in a second CD patient with ileocolic anastomosis (B). Both in a) and b) ulceronodular appearance of the ileal side of the anastomosis (arrows) with substenosis of its lumen can be observed. These findings are well compatible with CD recurrence. Legend: c = colic side of the anastomosis.

definition of the location and morphology of the anastomosis, and the presence of radiological signs of recurrence (Fig. 1).

However, small bowel follow-through and enteroclysis give a limited amount of information (lower than that provided by cross-sectional imaging methods, such as CT– and MR– enterography) with regard to transmural CD involvement and penetrating complications.

Enteroclysis requires the preliminary placement of a nasojejunal tube, through which a radiopaque barium sulfate suspension is infused, resulting in the distension of the intestinal lumen. A fluoroscopic control of the distension of the intestinal lumen can be performed during enteroclysis and, by adjusting the infusion of contrast medium, a better visualization of the anastomotic site may be achieved. The small bowel follow-through is a less invasive and more easy to perform examination, which does not require nasojejunal intubation, but the simple oral administration of a contrast medium containing barium sulphate <sup>20-25</sup>.

The radiological signs of CD (including CD anastomotic recurrence) which can be demonstrated with these methods are as follows:

- the irregular thickening and distortion of the normal structure of valvulae conniventes;

- the nodular appearance of the mucosa with millimetric (1-3 mm) filling defects generated by the hyperplasia of submucosal lymphoid tissue;

- small aphthous target-shaped ulcers (i.e. small superficial collections of barium contrast medium surrounded by a halo of periulcer radiolucent edema);

- the cobblestone appearance of the intestinal mucosa, resulting from the convergence of deep longitudinal and transverse ulcers, surrounding islands of intact mucosa; the typical skip lesions;

- the reduction of intestinal peristalsis in correspondence to stenotic bowel segments;

- adhesions between adjacent bowel loops, or, on the

contrary, a greater separation of neighboring loops, determined by wall thickening and fibro-fatty proliferation of the mesentery.

Both enteroclysis and small bowel follow-through have the same sensitivity (85%-95%) and specificity (89-94%) in the detection of the typical CD lesions when performed by experienced radiologists <sup>25,26</sup>. The choice of a technique over the other varies according to its availability, and enteroclysis is more invasive and less tolerated by patients. In addition, small bowel follow-through implies a lower radiation dose, avoiding the nasojejunal tube positioning under fluoroscopic guidance <sup>27</sup>.

In 2005, Zalev et al. <sup>26</sup> retrospectively reviewed the small bowel x-ray examinations (i.e. small bowel followthrough and enteroclysis) of 105 CD patients, including 47 patients who did not undergo an intestinal resection and 58 patients who had already undergone resection surgery. 56 out of the 58 patients who had undergo surgery (97%) had radiographic signs of CD postoperative recurrence. Stenosis at the anastomotic site resulted to be the most common and characteristic radiographic sign of disease recurrence in the group of surgical patients, in which, on the contrary, a lower frequency of other radiographic CD findings (i.e. ulcerative and/or nodular appearance of the mucosa and increased distance between adjacent intestinal loops -"loop separation"-) was found.

These radiographic techniques have represented for many years the main diagnostic modalities in patients with small bowel CD, in particular before the introduction in the clinical practice of videocapsule endoscopy and newer endoscopic techniques (i.e. "push enteroscopy" and "double balloon enteroscopy") <sup>20</sup>. Currently, the diagnostic performance of enteroclysis and small bowel follow-through has been exceeded by that of CT– and MR– enterography, in particular with regard to the detection of penetrating complications (abscesses and fistulas)<sup>28-30</sup> (Fig. 2).



Fig. 2: Penetrating recurrence on ileocolic anastomosis demonstrated with small bowel follow-through (a) and CT-enterography (image reconstructed in the coronal plane) (b). In a the recurrence determines a stenotic appearance of the ileal side of the anastomosis (thick arrows); a short fistulous tract in relation to the lower aspect of the ileocolic anastomosis is also appreciable (thin arrow). In b) the real extension of the fistulous tract (thin arrow) and the presence of an abscess (asterisk) in relation to the posterior aspect of the anastomosis (which was not appreciable in the small bowel follow-through examination) can be observed.

Computed tomography of the small intestine

CT techniques dedicated to the study of the small intestine have been widely used to assess the presence, extent and complications of CD, showing a high sensitivity and specificity in the detection of inflammatory lesions, with an overall diagnostic accuracy higher than that of traditional x-ray techniques with barium contrast medium (small bowel follow-through, single and double-contrast small bowel enteroclysis) <sup>31</sup>.

CT examination of the small intestine can be performed in two ways:

– administration of neutral (radiolucent) enteral contrast medium (methylcellulose or non-absorbable isotonic solutions containing polyethylene glycol) through a nasojejunal tube (CT enteroclysis <sup>32</sup>) or per os (CT enterography <sup>29</sup>), in association with intravenous injection of iodinated contrast medium at the time of the examination and image acquisition in the portal contrastographic phase;

- administration of radiopaque positive contrast medium (water soluble iodinated contrast media) through a nasojejunal tube without intravenous injection of iodinated contrast medium <sup>32,33</sup>.

The trans-rectal introduction of a water enema (up to 2 liters), together with the assumption of neutral oral contrast medium, produces a simultaneous distension of both large and small intestine, which is particularly useful to properly visualise the two sides of ileocolic anastomoses <sup>34</sup>. The use of neutral radiolucent endoluminal contrast medium has shown more advantages than the radiopaque contrast medium in the detection of inflammatory changes in the intestinal mucosa, while no significant differences in the degree of distension of the intestinal loops have been found between CT-enterography and -enteroclysis <sup>29,35-37</sup>. Many characteristic CT

findings of CD have been described, and they showed a good correlation with macro- and microscopic features derived from pathoanatomical analysis of surgical specimens <sup>33</sup>. In normal conditions the intestinal wall measures 2.5 mm in the small intestine, and 3 mm in the colon. Bowel wall thickening of more than 4-5 mm (usually about 1-2 cm) is a typical and constant CT sign of CD. Further CT findings include:

- mural stratification, characterized by mucosal hyperemia associated to hypodense edematous thickening of the submucosa;

- increased density of the mesentery of affected loops in relation to inflammation and/or fibrosis (fibro-fatty proliferation);

- enlarged vasa recta of affected loops related to hyperemia and inflammatory vasodilation ("comb sign");

the presence of reactive inflammatory lymphadenopathies in the mesentery (usually = 3–8 mm and <10 mm).

The panoramic view of this imaging modality enables an accurate demonstration of inflamed bowel segments, skip lesions, stenosis and pre-stenotic dilatation (under normal conditions the maximum caliber of the lumen of the small intestine does not exceed 2.5 cm).

CT-enterography of the small intestine provides a complete evaluation of all layers of the bowel wall, without being limited to the mucosal surface, as in the case of videocapsule endoscopy or optical ileocolonoscopy <sup>31,38,39</sup>. This advantage of CT is of great value, because pathoanatomical studies have demonstrated that CD inflammatory lesions are more early and severe in correspondence to the submucosal layer <sup>40</sup>.

CT-enterography of the small intestine is characterized by high diagnostic accuracy in the detection of recurrences after surgical treatment and penetrating complications of CD (abscesses and fistulas) <sup>28</sup> (Fig. 3).

In a recent work Soyer et al. assessed the diagnostic val-



Fig. 3: Coronal CT-enterography reconstructions [a) and b)] in two different patients with CD recurrence involving the ileocolic anastomosis. The first coronal CTenterography reconstruction (a) shows wall thickening with mucosal enhancement of the ileal side of the anastomosis (thick arrow). The exact location of the anastomosis is detectable due to the presence of surgical staples (thin arrows). In b) two typical "skip" lesions (thick arrows) affecting the ileal side of the anastomosis can be observed. The mesentery of the affected loop is thickened and its vasa recta are engorged and more prominent (asterisk). Legend: c = colic side of the anastomosis;  $i \Rightarrow$  ileal side of the anastomosis.

ue of CT-enteroclysis to determine the status of ileocolic anastomosis (i.e. recurrent inflammation vs fibrostenosis) in CD patients after ileocolic resection <sup>17</sup>, proposing some CT criteria to distinguish inflammatory stenosis from fibrostenosis. Some CT findings (i.e. mural stratification, high contrast enhancement of the mucosa, "comb sign", and mesenteric lymphadenopathy <10 mm) resulted to be more significantly associated with inflammatory recurrence rather than anastomotic fibrostenosis. Mural stratification and "comb sign" represent the two most indicative CT signs of inflammatory recurrence. The isolated presence of anastomotic stenosis with preanastomotic dilatation does not help in distinguishing between fibrostenosis and inflammatory recurrence, as it can be observed in both conditions <sup>17</sup>.

Minordi et al. <sup>36</sup> compared the two different CT techniques dedicated to the examination of the small intestine (i.e. CT-enteroclysis and CT-enterography after oral administration of neutral enteral contrast medium) in assessing the status of ileocolic anastomosis in CD patients who have undergone surgery. The Authors did not find significant differences in the degree of distension of the anastomosis obtained by these two CT techniques.

The main advantages of CT include its wide availability, low cost, speed of acquisition, and a very high spatial resolution. With new multidetector CT scanners and post-processing softwares, it is possible to obtain reconstructed sagittal, coronal and oblique images, characterized by the same spatial resolution of the axial scans. The high diagnostic accuracy of CT-enterography in detecting penetrating complications of CD is accompanied by a comprehensive evaluation of the whole abdominal cavity, thus allowing the detection of extra-intestinal findings of clinical relevance <sup>41</sup>. The main disadvantage of CT is related to the radiation dose, which is a topic of great importance in relation to the young age of patients suffering from CD and the need to perform more examinations close in time to each other to monitor CD progression and its response to therapy. With this regard, technological advances to improve the efficiency of CT detectors are being recorded, and new CT scanners are equipped with softwares for modulation and optimization of the radiation dose  $^{42}$ .

Magnetic Resonance Imaging of the small bowel

The crucial elements to obtain a good quality MRI examination of the small intestine are the optimal distension of bowel loops, the use of ultrafast sequences to reduce motion artifacts, and the intravenous administration of paramagnetic contrast medium <sup>43,44</sup>. MR-enterography of the small bowel is a noninvasive technique that, in the absence of ionizing radiations, provides diagnostic information about the presence, extent and extra-parietal involvement of CD, providing multiplanar and multiparametric images characterized by high contrast resolution.

To obtain a good distension of bowel loops and improve the contrast resolution between lumen, intestinal wall and extra-intestinal structures, it is necessary to administer a large volume (1.5-2 liters) of non-absorbable isoosmotic endoluminal contrast medium per os or through a nasojejunal tube <sup>43,44</sup>. Contrary to what happens with CT, the route of administration of the endoluminal contrast medium seems to be a factor affecting the diagnostic sensitivity of MRI in the detection of CD inflammatory lesions. In a recent meta-analysis <sup>45</sup>, the diagnostic sensitivity of MRI with oral administration of contrast medium (i.e. MR-enterography) (83.7%) resulted significantly lower than that of MRI performed after injection of contrast medium by a nasojejunal tube (i.e. MR enteroclysis) (95.9%).

MRI also allows to study the bowel peristalsis and motility by means of cinematic sequences, which can give an effect similar to traditional fluoroscopy (i.e. MR-fluoroscopy). This "fluoroscopic-like" technique can help to detect peristaltic abnormalities and to differentiate fibrostenosis from functional bowel spasms. In order to minimize peristaltic movements and reduce motion artifacts, a hypotonic drug (usually 2 ml of Hyoscine-N-butylbromide 20 mg/ml) is administered intravenously immediately before the acquisition of contrastographic sequences <sup>43</sup>. Active inflammation is associated to hyperemia, which causes an increase in the contrast ("contrast enhancement") of the intestinal wall after intravenous administration of paramagnetic contrast medium. A good correlation between the peak signal intensity of the wall enhancement profile and the clinical CDAI (Crohn's Disease Activity Index) has been demonstrated <sup>43,46,47</sup>, while the parietal enhancement with layered pattern showed a significant correlation to the clinical indices of active inflammation <sup>48,49</sup>. In the short axis scans of affected loops, the appearance of parietal stratification is determined by the presence of an enhancing inner ring of mucosal hyperemia, an enhancing outer ring produced by hyperemia of both muscular and serosal layers and an intermediate ring of low signal intensity due to the edematous thickening of the submucosa <sup>50,51</sup>. In a recent prospective study comparing CT-enteroclysis and MR-enteroclysis in CD patients, Siddiki et al. 52 found high sensitivity values for both these two imaging modalities (i.e. 95% and 90.5%, respectively) in the detection of inflammatory bowel

lesions. MR-enteroclysis showed a lower specificity than CT (82% vs 66.7%), but this difference did not reach statistical significance. In a previous study, Schmidt et al. observed higher degrees of sensitivity for the diagnosis of small-bowel thickening, enhancement, and stenosis and better interobserver agreement with CT enteroclysis than with MR enteroclysis <sup>53</sup>. The diagnostic performance of MRI in the detection of entero-enteric and entero-colic fistulas has been object of a few studies, but it would seem superior not only to small bowel follow-through, but also to CT enteroclysis <sup>30,34</sup> (Fig. 4). In 2008, Sailer et al. <sup>19</sup> examined 30 patients with sus-

pected CD recurrence after ileocolic resection using MRenteroclysis and ileocolonoscopy. The Authors developed an original semi-quantitative MRI scoring system based on the presence of morphological and signal intensity alterations in the inflamed bowel segments (from MR0 to MR3), which was characterized by high interobserver reproducibility (k=0.865) and a good correlation with the Rutgeerts' endoscopic score (k=0,673) (Fig. 5). This new MRI scoring system was also used in a further work <sup>54</sup>, which demonstrated that MR-enteroclysis and ileocolonoscopy have a similar diagnostic value in predicting clinical recurrence of CD at the ileocolic anastomosis. However, using MR-enterography in patients with ileocolic anastomosis, the surgical clips can produce artifacts and hinder the assessment of the anastomotic site in about 10% of cases 17. The most significant advantage of MR-enterography over CT-enterography is represented by the absence of ionizing radiation, which is particularly important in women of childbearing age and pediatric patients.



Fig. 4: Penetrating anastomotic recurrence involving an entero-enteric anastomosis in a CD patient who had undergone segmental resection of the preterminal ileum. The coronal CT-enterography reconstruction (a) shows marked wall thickening of the preanastomotic ileal loop (arrow) and a fluid collection within its mesentery (asterisk). The coronal fat suppressed T2-weighted FIESTA sequence (b) of an MRI examination performed after two weeks demonstrates the appearance of a second extra-parietal fluid collection in correspondence to the antimesenteric side of the preanastomotic ileal loop (asterisk). The coronal LAVA MRI sequence after intravenous injection of paramagnetic contrast medium (c) shows marked enhancement of the affected loop (arrow) and confirms the presence of two fluid collections in relation to its mesenteric and antimesenteric sides (stars).



Fig. 5: Inflammatory CD recurrence in a patient with ileocolic anastomosis. The anterior-posterior plain-film radiograph of the abdomen (a) shows the presence of surgical clips in the right upper quadrant (thin arrow) in correspondence to the site of the ileocolic anastomosis. In the coronal fat suppressed T2-weighted FIESTA MRI sequence (b) marked thickening of the ileal side of the ileocolic anastomosis (thick arrow) can be appreciated; it is characterized by significant enhancement in the coronal LAVA MRI sequence performed after intravenous injection of paramagnetic contrast medium (thick arrow in c). The axial fat suppressed T2-weighted FIESTA MRI sequence (D) confirms thickening and parietal stratification of the neoterminal ileum (thick arrow).



Fig. 6: Two SICUS images with (a) and without color-Doppler module (b) in a patient with stricturing recurrence involving the ileocolic anastomosis. The short axis scan of the ileal side of the ileocolic anastomosis (a) shows marked asymmetrical circumferential thickening of the bowel walls with clear stratification. The external muscular (hypoechoic, thick arrow), submucosal (hyperechoic, star) and mucosal (hypoechoic, thin arrow) layers are well dissociable, while the intestinal lumen is almost virtual due to the stricturing behavior of CD recurrence. The color-Doppler module (b) was used to detect hyper-vascularity of the inflamed small bowel loop.

#### Ultrasonography

The first studies concerning ultrasonography in CD were published in the early eighties <sup>20</sup>. Recently, due to technological advances in ultrasound equipment, the study of the intestinal wall and its abnormalities has become more and more detailed. Using high-frequency linear probes (7-14 MHz) it is possible to obtain ultrasound images of the bowel segments affected by CD with excellent spatial resolution. Trans-abdominal ultrasonography has been proposed as a non-invasive imaging method to detect inflammatory bowel lesions in patients with known or suspected CD, showing sensitivity values of 67% -84% and 81% -95%, respectively <sup>55-57</sup>. The oral administration of enteral contrast medium (i.e. SICUS, Small Intestine Contrast Ultrasonography) is able to increase the sensitivity of ultra-

sonography in the detection of small bowel inflammatory lesions up to more than 95% 24-26,58. In particular, SICUS performed by an experienced sonographer may allow to visualize not only advanced inflammatory lesions, such as a stenosis with pre-stenotic dilatation, but also more tiny alterations, such as the early thickening of the bowel wall <sup>26-28,59</sup>. In experienced hands, SICUS can demonstrate inflammatory lesions in patients with suspected small bowel CD with a diagnostic accuracy higher than that of small bowel follow-through and enteroclysis 58. SICUS represents therefore a more accurate technique than trans-abdominal ultrasonography in the detection of small bowel inflammatory lesions, despite the operator's experience is likely to significantly affect the diagnostic accuracy of both techniques, in particular trans-abdominal ultrasonography 58 (Fig. 6).

The typical parietal and extraparietal CD alterations detectable by SICUS include:

- thickening of the bowel wall greater than 3 mm, with increased mural stratification and signs of hypervascularization at the examination with color-Doppler module;

narrowing and stenosis of the small bowel lumen (<1 cm) with impossible distension by the endoluminal contrast medium;</li>

- pre-stenotic dilatation (>2.5 cm);

– peristaltic abnormalities;

- presence of penetrating complications (abscesses, fistulas);

- inflammatory changes in the mesentery (hyperechogenicity of the mesenteric fat tissue and inflammatory-reactive lymphadenopathies) <sup>61,62</sup>.

In the detection of CD recurrence after ileocolic resection determined by measuring the peri-anastomotic bowel wall (normal/pathological cut-off > 3 mm), the sensitivity of trans-abdominal ultrasonography has been proven to be 82%, using ileo-colonoscopy as reference standard  $^{29, 30.57}$ .

In a recent study<sup>63</sup> based on the assessment of CD anastomotic recurrence using trans-abdominal ultrasonography, sensitivity, specificity, positive and negative predictive values turned out to be 79%, 95%, 95%, and 80% respectively; in the diagnosis of high grade recurrence (grades 3 and 4 of the Rutgeerts' score) the sensitivity was 93%. Even in the case of ileocolic anastomosis, the oral administration of non-absorbable iso-osmotic endoluminal contrast medium significantly improves the diagnostic value of this imaging modality with sensitivity, specificity and diagnostic accuracy of 92.5%, 94% and 87.5%, respectively<sup>64</sup>. There is a significant correlation between the perianastomotic bowel wall thickening and endoscopic Rutgeerts' score (P=0,0001; r=0,67) <sup>57</sup>.

According to the results of a recent meta-analysis <sup>45</sup>, a threshold value of 4 mm between the normal and abnormal wall thickness is the most accurate ultrasound parameter in the diagnosis of CD (sensitivity 94.1%; specificity 98.9%).

Bowel ultrasound, in relation to its availability, repeatability and accuracy, may replace endoscopy for the diagnosis and grading of anastomotic recurrence in patients with poor compliance to the endoscopic examination <sup>20</sup>. The advantages of ultrasonography are non-invasiveness, absence of ionizing radiation, and high diagnostic sensitivity in the detection of parietal inflammation. However, ultrasonography is often difficult to use in obese patients and in presence of significant intestinal meteorism.

Further disadvantages are related to the limited panoramic view; in particular, with ultrasonography it is impossible to precisely explore each segment of the small intestine, being sure not to generate false negatives. As previously mentioned, the operator's experience represents a crucial requisite for a diagnostic examination. Conflicting and not satisfactory data regarding the diagnostic per-

formance of SICUS in the determination of CD fistulas are currently available in the literature, with sensitivity values ranging from 50 to 87% and specificity values of 90-95%. On the contrary, concerning the determination of abscesses, sensitivity and specificity values of SICUS are higher (83-100% and 87-94%, respectively)<sup>65,66</sup>. No studies comparing SICUS with CT- and MRenterography in the assessment of CD penetrating complications are currently available, and the real diagnostic ability of SICUS for the detection and anatomical characterization of complex fistulas and deep abscess collections is still under discussion. In conclusion, SICUS has shown high diagnostic accuracy in the diagnosis and grading of CD postoperative recurrence in patients with ileocolic anastomosis.

# Conclusions

Post-operative anastomotic recurrence is a frequent event in patients with CD, which has a negative impact on the disease prognosis. The neoterminal ileum is the most affected site in both entero-enteric and ileocolic anastomoses, as well as in ileostomies. The type of surgical anastomosis (i.e. manual or mechanical; side-to-side, endto-end, end-to-side; in single or double layer), does not seem to be a predictor of early symptomatic recurrence. Some Authors suggest that a wide-lumen anastomosis (stapled side-to-side anastomosis) could lead to a lower rate of CD recurrence <sup>60-69</sup>.

Currently, in the effort to reduce surgical demolition, segmental resection and stricturoplasty are often performed, but ileocolic resection (with ileocolic anastomosis) remains the most frequently performed intervention in patients with CD. Evaluation of the ileocolic anastomosis by endoscopy is often not easy, and the ileal side of the anastomosis cannot be explored (due to impossible intubation of the neoterminal ileum) in about 1/3of the patients. The main technical limitations of endoscopy are determined by the narrowing of the intestinal lumen and the modification of normal anatomy that occur at the anastomotic site. In the evaluation of suspected CD recurrence on a entero-enteric anastomosis after segmental ileum resection, there are significant technical complexities to perform endoscopy, proportionally increasing with the distance of the anastomosis from the ileocecal valve. The application of new endoscopic techniques (such as the "double-balloon enteroscopy") is not always feasible, and imaging plays a role of primary importance in this concern.

Endoscopy provides an evaluation of CD confined to the intestinal mucosa, without the ability to demonstrate the transmural involvement of the disease and its penetrating complications. Even with conventional fluoroscopic techniques with barium, the evaluation is mainly limited to the inner mucosal surface. On the other hand, both CT- and MR-enterography allow a direct demon-

stration of the real extent of parietal involvement and the presence of extra-parietal penetrating complications. Moreover, conventional radiological techniques do not enable a characterization of the anastomosis, nor a distinction between fibrostenosis and inflammatory recurrence. Recently, some CT-enterography findings have been proposed to differentiate these two types of anastomotic stenosis, which require a different therapeutic approach. Despite the great interest on this topic, in the daily clinical practice the distinction between fibrostenosis and inflammatory stenosis relies mainly on the response to medical therapy. Penetrating complications, which may occur in severe anastomotic recurrence, can be detected by CT- and MR-enterography with a diagnostic accuracy higher than conventional radiographic techniques 70.

Ultrasonography dedicated to the study of the small intestine (SICUS) and MR- enterography are safe techniques, with no radiation exposure, and therefore to be preferred in the examination of young patients and in women of childbearing age. SICUS has a high diagnostic accuracy and can detect early alterations of the intestinal wall. The reduced panoramic view of ultrasound, which is also not feasible in all patients, may be easily overcome by MRI. However, the high contrast resolution and great power of tissue characterization of MRI is accompanied by significant cost and long examination times. CT-enterography is a very suitable imaging technique in elderly patients which can provide a comprehensive and panoramic view of the entire abdominal cavity, enabling the detection of clinically important extraintestinal findings.

# Riassunto

La resezione ileocolica rimane l'intervento più frequentemente eseguito nei pazienti con MC. La valutazione dell'anastomosi ileocolica mediante endoscopia spesso non è agevole, ed il versante ileale dell'anastomosi non è esplorabile per difficoltosa intubazione del versante ileale (ileo neoterminale) in 1/3 circa dei pazienti. Il più evidente limite delle tecniche endoscopiche è quello di una valutazione confinata alla mucosa intestinale, senza la possibilità di apprezzare l'interessamento transmurale della malattia e le sue complicanze penetranti. Anche mediante le tecniche fluoroscopiche tradizionali con Bario la visualizzazione è prevalentemente limitata alla superficie mucosa. L'entero-TC e l'entero-RM, al contrario, permettono di apprezzare direttamente l'entità del coinvolgimento parietale e la presenza di complicanze penetranti extra-parietali (ascessi e fistole). L'ecografia dedicata allo studio del tenue (SICUS) è dotata di elevata accuratezza diagnostica e può rilevare l'iniziale ispessimento della parete intestinale, segno precoce di recidiva anastomotica. La ridotta panoramicità dell'ecografia, che inoltre non è applicabile in pazienti obesi o non collaboranti,

limita il valore della metodica nella rilevazione e nella caratterizzazione anatomica dei tragitti fistolosi complessi e delle raccolte ascessuali in sede profonda.

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