ORIGINAL ARTICLE

Sensitivity and Specificity of Magnetic Resonance Enterography in the Clinical Management of Fistulizing Crohn's Disease

Cinzia Papadia, MD,*[†] Erica Maffei, MD,[‡] Paolo Del Rio, MD,[§] Stuart Taylor, MD,[||] Saverio Caini, MD,[¶] Chiara Montana, MD,[†] Alessandro Coruzzi, MD,[†] Angelo Franzè, MD,[†] Filippo Cademartiri, MD,[‡,**] and Alastair Forbes, MD*

Background: High diagnostic accuracy is reported for magnetic resonance enterography (MRE) in Crohn's disease (CD), but few studies have evaluated its role in abdominal fistulae. The primary aim of this study was to assess the reliability of MRE in the identification of internal fistulae in CD.

Methods: One hundred and eighty-six patients with moderate CD (CD Activity Index : 250–400) were prospectively selected from the inflammatory bowel disease clinic of Parma University Hospital. Eligible patients had already undergone nutritional screening, pancolonoscopy, and computed tomography enterography (CTE) in the month before enrollment. MRE was performed according to the study protocol. Additional fluoroscopic contrast-enhanced studies or surgical evaluation were used for discordance between CTE and MRE results. A consensus committee resolved equivocal findings. Surgical findings and/or fluoroscopic contrast-enhanced studies together with the clinical data were considered the composite "reference standard" to which the results of MRE were compared.

Results: MRE identified 22 internal fistulae in 21 patients (11%), of whom 4 (19%) also had perianal fistulae and found 7 abscesses (33%). Forty-one (22%) additional patients with perianal fistulae were identified. Thirteen patients (57%) with internal fistulae required enteral nutrition support. No statistically significant differences were found between MRE and CTE in fistula detection. There was also no significant difference between MRE and the composite diagnosis in those who underwent surgery (n = 8) and/or contrast-enhanced studies (n = 7).

Conclusions: CTE and MRE accurately detect internal fistulae in CD. MRE is preferable because it avoids radiation. Reliable identification of internal fistulae by MRE should permit earlier and improved treatment.

Gastrointestinal (GI) fistulae are abnormal duct-like communications between the gut and another epithelial-lined surface, such as another organ, the skin surface, or elsewhere along the GI tract itself. The development of a GI fistula can markedly increase morbidity and mortality, rendering detection of the fistula critical. Fistulae are frequent problems in patients with Crohn's disease (CD). The reported incidence ranges from 17% up to 50%,[1–4] and population-based studies support the higher figures.[5] Internal fistulae have been classified clinically into 2 types: those which form an internal connection between 2 bowel segments and those that occur between the intestine and other organs, such as the bladder (enterovesical) or abdominal wall (enterocutaneous).[6]

The identification of complications of CD, and in particular fistulae, is vital to facilitate optimal clinical management. Internal fistulae are, for example, relatively common causes of malabsorption and intestinal failure in patients with CD, even though these enteroenteric fistulae are often difficult to diagnose.[7] Indeed, it is possible that much subclinical malnutrition and dietetic deficiency in CD is related to undiagnosed internal fistulae. It is logical and potentially very important to identify such patients and accurately stage their disease, so that the correct medical or surgical treatment can be initiated. Furthermore, the accurate detection of internal fistulae allows better classification of patients (those with penetrating versus nonpenetrating CD according to the Vienna and Montreal Classifications) and therefore better prognostic assessment and more accurate selection for clinical trials.[8] Another important consideration is that an increased risk of cancer is reported in patients with CD who have bowel segments bypassed by internal fistulae.[9] A recent meta-analysis[10] demonstrated an increased risk of small bowel, colonic, and extraintestinal carcinoma and of lymphoma in patients with CD, which may be accounted for in part by this phenomenon.

Imaging plays a pivotal role in the diagnosis and management of GI fistulae. Fluoroscopic contrast-enhanced studies have served as the traditional first-line investigation, but the emergence of cross-sectional imaging techniques has already substantially modified the radiological approach to diagnosis and classification.

There is, however, ongoing debate about the optimal imaging for complications and fistulae. Currently, barium enteroclysis and abdominal computed tomography (CT) scan represent the standard diagnostic procedures in most institutions, despite the fact that they may miss >30% of internal fistulae detected at surgical intervention.[11–13] Furthermore, they both deliver non-negligible amounts of ionizing radiation to a generally young population potentially requiring lifelong repeated imaging. The effective dose of a single abdominal–pelvic CT scan is, for example, over 10 mSv, and the hazards of ionizing radiation are thought to be cumulative with repeated examinations.[14] Modeling suggests that in the United States, >1% of all malignancies are now invoked by diagnostic medical irradiation, and the patient with CD would seem to be at particular risk.

Despite several studies reporting promising results in the detection and classification of internal fistulae, very few have prospectively evaluated the accuracy of magnetic resonance enterography (MRE) in detecting small bowel fistulae in CD. Our primary end point was therefore to assess the reliability of MRE in the precise identification of fistulae in CD. A key secondary end point was to evaluate the impact of internal fistulae on the nutritional and clinical status of patients with CD. We also aimed to seek and evaluate potential neoplastic changes in intestinal segments bypassed by internal fistulae.

MATERIALS AND METHODS

Patients

Patients with moderate CD (CD Activity Index [CDAI]: 250–400)[15,16] were prospectively selected from those attending the inflammatory bowel disease (IBD) clinic of Parma University Hospital between May 2008 and May 2010. Patients with moderate CD, only, were included to obtain adequate statistical power based on the prevalence data for fistulising CD (30%, see power calculation below).

Inclusion criteria were a staging colonoscopy, CT enterography (CTE), and/or fluoroscopic small bowel imaging within the past month, and diary data to permit the calculation of the CDAI. In each case, CD had been defined using the standard criteria of a characteristic history and at least 2 among typical endoscopic findings, characteristic radiology, supportive histology, or typical surgical findings.[15,16]

Patients were excluded from the study if they had fulminant CD requiring parenteral steroids and hospitalization or were in need of imminent surgery. Patients with serious infections in the preceding 3 months, opportunistic infections within 1 month, or current signs or symptoms of severe, progressive or uncontrolled renal, hepatic, hematological, endocrine, pulmonary, cardiac, neurological, or cerebral disease were excluded. Patients were excluded if they had a history of seizure, epilepsy, current central nervous system tumor, or of anorexia nervosa or bulimia. Patients were excluded if they were abusing alcohol or had alcohol dependence. Patients in whom a delay of >1 month had occurred between diagnostic evaluation and/or surgery, and patients presenting with severe biochemical abnormalities suggestive of major metabolic complications, were excluded. Those younger than 18 years and pregnant and lactating females were also excluded.

The aim was to recruit 186 patients with moderate CD, this sample size having been calculated from published prevalence data on fistulae in CD, hypothesizing that MRE has a high diagnostic accuracy for penetrating disease (sensitivity 0.76 and specificity 0.96). The statistical significance of the differences in sensitivities between MRE and reference standards were assessed by means of a test for difference in proportions ($P < 0.05$ was considered significant). A statistical power of 90% with an alpha of 10% was fixed to detect fistulae at a prevalence of 30%.[17–19]

The study protocol was devised in line with the Helsinki Declaration of 1964, as revised in 1989, and underwent review and approval by the Parma Local Research Ethics Committee. Written informed consent was obtained from all participants.

Initial Non-study Investigations

Before recruitment, and necessarily so for eligibility, all patients to be enrolled had already undergone pan-colonoscopy and CT enteroclysis (CTE), as part of their routine clinical investigation in the IBD unit of Parma University Hospital. Only a small proportion (32%; n = 59) had undergone double contrast small bowel radiography (12%; n = 21) or barium follow through (20%; n = 38). These investigations formed part of the patients' standard clinical care in the assessment of presumed mild-to-moderate CD and were in that respect independent of their subsequent participation in the study. Colonoscopy was performed according to the suggested standards for colorectal cancer screening in accordance with the American Society for GI Endoscopy Guidelines.[20]

The CT enterography protocol included administration of a total of 1.35 L O.1% wt/vol barium sulfate suspension (VoLumen, Bracco Diagnostics; Princeton, NJ) as a negative oral contrast agent. A bolus of intravenous contrast material (125 mL, Isovue 370; Bracco Diagnostics) followed by 50 mL of saline solution was then administered with a power injector at a rate of 4 mL/seconds. Helical scanning was performed from the diaphragm to the symphysis pubis, beginning 65 seconds after the administration of intravenous contrast material including a single (venous) phase. Scanning parameters included a section thickness of 0.625 mm and interval of 0.625 mm. Postprocessing techniques included axial image reconstruction with a section thickness of 2.5 mm and an interval of 2.5 mm, reformatting of axial image data for coronal and bilateral oblique (30-degree angulation) maximum intensity projections, and volume rendering. Multiplanar reformatting of axial image data allowed excellent demonstration and characterization of enteric and extraenteric abnormalities.

Interventions

All previous abdominal CT scans and small bowel enteroclysis/barium examinations were reviewed by the gastroenterologists of the Parma IBD team in conjunction with the consultant GI radiologist. Only patients who had undergone their most recent procedures in the 4 weeks preceding the enrollment date were considered eligible for the study. The IBD team reviewed the

technical quality of all clinical scans and if diagnostic quality was deemed unacceptable, they were repeated.

Nutrition screening was performed with the malnutrition universal screening tool and subjective global assessment. This approach identifies undernourished patients and those who are at increased risk of malnutrition. Those with confirmed malnutrition are at higher risk of medical complications and are thought to benefit from specific nutritional therapy.[21]

Patients underwent MRE according to the study protocol. An antiperistaltic agent (hyoscine butylbromide 20 mg intravenously) was injected to minimize potential artifacts caused by bowel movement or contraction. Imaging (Achieva, 1.5T; Philips, Ann Arbor, MI) was performed with the patient in the prone position. A biphasic contrast agent (polyethylene glycol) was administered orally in the magnetic resonance (MR) suite. Once bowel distension was deemed adequate, through rapid and sequential axial sequences True-FISP (fast imaging with steady-state precession), MRE was performed as follows: axial and coronal T2-weighted imaging employing HASTE and SSFP sequences with and without fat saturation, in combination with parallel imaging, and dynamic 3D T1-weighted imaging using a post-gadolinium (gadolinium dose 0.1 mmol/kg and 3 mL/sec infusion rate; MultiHance; Bracco Diagnostics) image acquisition at 30, 60, and 90 seconds in the axial plane. MRE reporting was carried out by 2 experienced consultant radiologists working in consensus. At this stage, radiologists were blinded to initial nonstudy investigation results.

Confirmatory tests were performed in patients in whom MRE suggested a fistula but prestudy CTE, colonoscopy, and barium follow through (BaFT) were negative. In the case of MRE-diagnosed enteroenteric fistula, the BaFT or CTE (depending on the negative procedure) was repeated if the consensus panel (see below for full description of the consensus panel) thought MRE was convincing. If the MRE, CTE, colonoscopy, and BaFT were negative, but the gastroenterologists still suspected a fistula, for example, due to the persistence of external discharge or watery diarrhea and malabsorption, then consensus panel review with 6 months clinical follow-up was carried out and a further and final consensus opinion as to whether the MRE was a true or false negative had to be expressed. The quality of all examinations were deemed sufficient by the performing/reporting radiologists, such that none needed to be repeated. However, a formal quality grading score was not applied.

In clinically hypothesized fistula (defined as 1 visualized on a single imaging modality—MRE, prestudy CTE, BaFT—or high clinical suspicion despite negative imaging), patients were selected for fluoroscopic contrast-enhanced studies and/or surgery as follows.

Enterovesical Fistulae

Cystography was performed with a standard technique as follows: a Foley urinary catheter was placed and the bladder emptied. A 300-mL bottle of diatrizoate meglumine with 30% ionic contrast (150 mg/mL) (Reno-Dip; Bracco Diagnostics) was connected to the Foley catheter and instilled into the bladder. At bladder filling, oblique radiographs were obtained if the patient

could be safely turned, followed by an anterior posterior radiograph after draining the contrast from the bladder.

Rectovaginal Fistulae

Clinical and unsedated speculum examination was carried out in an attempt to document a suspected fistula and to define its tract. The integrity of the anal sphincter was assessed by digital examination, with manometry, and/or endoanal ultrasound. The surrounding tissues were assessed by digital examination, anoscopy, and proctoscopy. When examination in the office setting proved inadequate, an examination under anesthesia was arranged. Patients were allocated to one of 3 possible outcome groups and future planning was defined. If a simple rectovaginal fistulae was identified, the evaluation was considered complete and planning for surgical repair of the fistula began. If a complex rectovaginal fistulae was identified, further evaluation was sometimes necessary depending on the site and etiology. In some cases, after completion of examination under anesthesia, it was not possible to identify the potential fistula tract. In this case, a vaginogram with water-soluble contrast followed by a barium enema was considered in an attempt to disclose the fistula tract.

Enterocutaneous Fistula

Anatomical definition of the tracts in enterocutaneous fistula, with their secondary and internal openings, is difficult. At present, conventional radiographic fistulography has the most professional support, in our experience[22], and this was the investigation adopted as "standard" in the study. However, it cannot be easily or frequently repeated and has been reported to be associated with dissemination of septic fistulous content.[23] Moreover, it provides very little information on the affected bowel segments, thus making it necessary to perform additional diagnostic examinations, such as small bowel enteroclysis and/or barium enema to plan treatment.

Enteroenteral (Internal GI) Fistula

For internal intestinal (gut-to-gut) fistulae, enteric contrast-enhanced studies were considered "standard" for this study. A water-soluble iodinated contrast agent was used when frank perforation was suspected or pneumoperitoneum was present.[24,25] When no free communication was thought, likely barium imaging was used.[26,27] Negative water-soluble contrast studies were followed by a barium study when the index of suspicion remained high.

The consensus panel included consultant gastroenterologists, radiologists, and surgeons not otherwise involved in the study, to evaluate contradictory results independently and to judge the diagnostic performance of MRE in CD fistulae. The panel members were 2 gastroenterologists, 2 colorectal surgeons with an interest in IBD, and 2 consultant radiologists with longstanding experience in GI imaging. When MRE suggested a fistula not recorded by conventional imaging tests or colonoscopy, the panel reviewed the full clinical notes (including findings at surgery and all imaging/endoscopic investigations) with at least 6-month follow-up. A consensus decision was then made on the absence

or presence and location of any internal fistulae. During the consensus deliberations, appropriate weight was placed on the known diagnostic performance of each investigation, other than the MRE, to reduce the risk of introducing bias. Radiologists interpreting CTE, MRE, and contrast-enhanced studies were experienced consultants with at least 10 years of relevant practice.

Surgical findings and/or fluoroscopic contrast-enhanced studies together with the clinical data were therefore considered the composite "reference standard" to which the results of MRE were compared. The reference standards were considered on a per-patient basis to analyze data against the different references at the end of the study.

A result was considered to be a true positive when at least 1 fistula identified at MRE, barium radiology, or CT scan matched a lesion observed intraoperatively or by fluoroscopic contrast-enhanced studies. The presence of cancer or suspected neoplasm in the bypassed bowel loops of the internal fistula was also to be reported.

The original data were recorded onto anonymized CD-ROMs to aid data protection and assigned to the consensus panel for storage. The consensus panel also supervised data collection and statistical analysis. Results of the diagnostic procedures were analyzed on a per-patient basis, in accordance with other studies[17,28] with the intent of identifying the CD behavior type (fistulising versus no fistulising).

A Fisher's exact test was used for comparing sensitivity and specificity of different procedures ($P < 0.05$ was considered significant). Statistical analysis was performed with commercially available software (Stata 11 for Windows, College Station, TX).

RESULTS

There were 25 patients (of 194 considered eligible for the study) with a diagnosis of moderate CD and a finding of internal fistula in the radiology reports, as confirmed by the consensus panel. Of these, 2 were excluded because the final diagnosis was revised from CD to diverticulitis. Internal fistulae were therefore present in 11.2% of the patients with CD. One patient had 2 internal fistulae. The fistulae were distributed as follows: 15 between different segments of the intestinal tract, 4 enterovaginal, 2 enterovesical, and 2 enterocutaneous. Of these 23 patients, 6 (28%) also had perianal fistula and 7 (33%) had a current abdominal abscess.

Forty-one patients (22%) with CD and perianal fistulae were identified by T_2-weighted magnetic resonance imaging with fat suppression (Table 1). In 1 patient with perianal fistula, the identification of a clinically suspected enterovesical fistula required a contrast-enhanced study, and this patient therefore had perianal and enterovesical fistula (Fig. 1). There was no significant ($P = 0.49$) difference in the diagnostic yield for internal fistulae between MRE and the composite gold standard. In fact, MRE detected 22 of 23 fistulae (sensitivity = 0.91). Only 1 fistula needed fluoroscopically enhanced study for detection, prompted by previous review of the previous 6-month clinical notes.

No statistically or clinically significant differences were found in diagnostic efficacy between MR examinations and CT scan for the detection of internal fistulae. Conventional contrast-enhanced studies detected only 16 internal fistulae (sensitivity = 0.73), this constituting a numerical deficiency in comparison with CT scan and MR ($P = 0.11$). Most of the fistulating patients with CD had a normal C reactive protein (n = 12), and half (n = 11) of the patients showed no obvious clinical signs of penetrating disease.

Thirteen patients (57%) with CD and internal fistulae required nutritional support. Of these 13 patients, 6 were severely malnourished (malnutrition universal screening tool score = 2; subjective global assessment = 3) and 7 had mild-to-moderate malnutrition (malnutrition universal screening tool score = 1; subjective global assessment = 2). All 13 patients were started on enteral nutrition support according to standard practice. None needed parenteral nutrition. No small bowel cancers or suspicious areas were identified in loops by-passed by fistulizing small bowel.

DISCUSSION

In our study, we found that MR is as reliable as CT scan in precise identification of fistulising CD. Because clinical signs and symptoms of fistulising CD are subtle and do not always predict penetrating disease, the application of MR should be encouraged in all patients with CD with mild-to-moderate disease.

CT scan and more conventional diagnostic radiographic procedures impart significant quantities of ionizing radiation to a predominantly young patient population requiring lifelong

TABLE 1. Patient Characteristics at Entry into the Study

Age, yr				
Median	48	47	53	51
Range	32–74	42–69	31–71	42–72
Body mass index				
Median	21	21	22	23
Range	18–26	19–25	20–24	21–27
N	21	(21)	41	124
Women	14	3	26	63
Fistulae	22	4	41	—
CDAI	350	310	300	250
Nutritional risk				
Overall	1	1	1	—
Range	1–2	1	1	—
Medications				
Mesalazine	18	(18)	21	68
Azathioprine	14	(4)	24	31
6-MP	4	—		6
MTX	2	—	—	—
ADA or IFX	12	4	−13	8

ADA, adalimumab; BMI, body mass index; IFX, infliximab; 6-MP, 6-mercaptopurine; MTX, methotrexate; N, number (Brackets stand for number duplication).
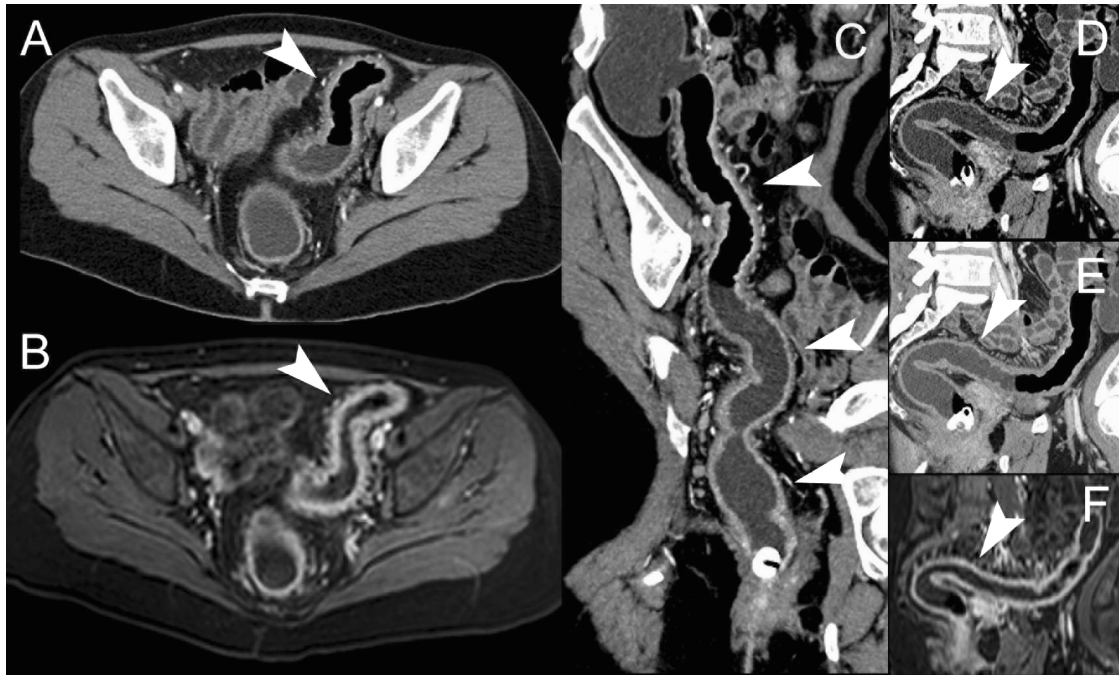
FIGURE 1. The figure shows contrast-enhanced CTE and MRE of a patient with colonic localization of CD. Axial CT and MR images show the sigmoid concentric involvement (A, B: arrowheads) characterized by homogeneously thickened visceral wall with blurring of the edges between the outer wall of the colon and the surrounding fat. Multiple hyperhemic vessels are also easily depicted. To show the extensive longitudinal involvement, a curved multiplanar reformation can be performed on CTE datasets to display in one single image the entire segment (C: arrowhead); from the image, it is clear that the involvement of the colonic wall is extending from lower rectum up to mid descending colon. There is no evidence of significant stenosis or fistula in this tract. Another curved multiplanar reformat shows the potential of CTE and MRE for visualization of disease extension (D, E, F: arrowhead). The 2 modalities can basically provide similar information in this context (CTE = D, E; MRE = F).

imaging. Furthermore, standard diagnostic workup may include cycles of repeated testing due to the sometimes low diagnostic yield of standard procedures and the inability of conventional fluoroscopic contrast-enhanced studies to visualize extraenteric manifestations of the disease, such as abscess or fistula formation. Perianal enterovesical fistulae and rectovaginal fistulae may not always be well demonstrated at CT scan imaging. Although no difference was seen in this study, MR examination may be preferred for this reason (Fig. 2).

In our study, there was no clinical suspicion of penetrating disease in half of the patients with fistulae and abscess before CTE and MRE. Moreover, the C reactive protein was normal in most cases. As a result of modern comprehensive imaging, no fewer than 33% of patients underwent a change in nutritional therapy after the detection of fistulising CD.

Treatment of fistulae might also include drainage of acute suppurative lesions in combination with prompt antibiotic treatment. The therapeutic goals for fistulising CD are to close fistulae and maintain their closure, to reduce the incidence of infections and malnutrition in persisting fistulas, and to limit the need for surgical interventions. Clinical studies in fistulising CD should reflect this, and precise identification of fistulae is of key importance if maximal yield is to be accrued. However, using MR as first-line investigation in CD

is still a matter of debate, not least since it has been criticized for the high operating costs and the need for contrast injection.[17] Furthermore in 2005, Mackalski and Bernstein[18] compared MRE and small-bowel follow through in 30 patients with CD and found that small-bowel follow through allowed identification of 2 ileocolic fistulas that were missed by using MR enterographic images.[18]

In contrast, further studies have proven MR to be very effective in the assessment of small bowel abnormalities and to be particularly capable of providing tissue-specific information on CD at its various stages from acute inflammatory, regenerative, fistulising, and perforating disease to the fibrostenotic stage due to its excellent soft-tissue contrast. Maccioni et al[19] in a recent study including 59 patients with suspected CD found 12 internal fistulae, by using MRE. In this study, CT scan was not considered in the preclinical workup and CDAI was scored but not used as inclusion criteria, as in our study.

In 2009, Lee et al[29] included 30 patients with suspected CD, and magnetic resonance imaging was compared with other techniques for the diagnosis of CD. In this study, 19 extraenteric complications were found and the sensitivity and the specificity of MRE and CT enterography methods resulted higher than barium enema in demonstrating the small bowel involvement in CD. In this study too, CT scan was part of the study's workup.[30]
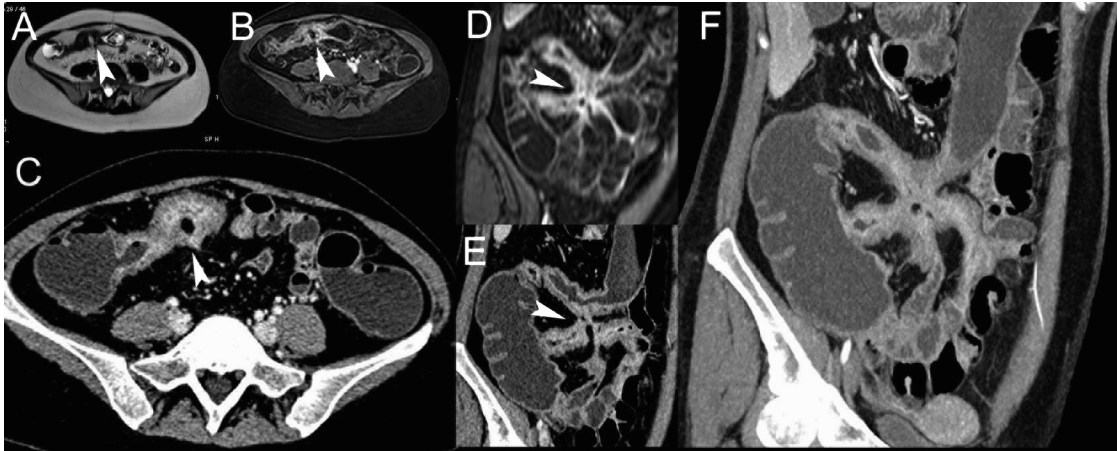
FIGURE 2. The figure shows contrast-enhanced CTE and MRE of a complex enteroenteric fistula involving colon. MRE (precontrast = A, post-contrast = B) and CTE (C) show the center of the fistula in the mesenteric fat (arrowheads). A coronal multiplanar reformat shows the extent and anatomy of the complex fistula (arrowheads) both with contrast enhance MRE (D) and CTE (E). A maximum intensity projection algorithm applied to coronal CTE (F) reformats perfectly shows the pattern of enhancement of the visceral wall (i.e., two-layer pattern with relatively hyper-enhanced inner layer). The figure easily allows defining an involvement of the distal ileal segment of the transverse colon and of the ileal loops.

The association of T2- and T1-weighted gadolinium-enhanced sequences has now to be considered of highest diagnostic accuracy, thus making MR imaging a powerful diagnostic tool in the complete examination of patients with CD. Magnetic resonance imaging can therefore be firmly recommended as the best technique for the detection of extramural complication in CD.[31]

The groups of both Masselli and Umschaden have reported high diagnostic accuracy in the clinical workup of CD, including the detection of internal fistulae.[12,13] Indeed, there are many theoretical reasons why MR may be especially sensitive and appropriate in the diagnosis of fistulae, given rapid high-contrast resolution image acquisition, encompassing both mural and extramural tissues. Importantly, the technique does not impart ionizing radiation.

Like CT scan, it is capable of multiplanar images, aiding the radiological interpretation. With modern hardware, very rapid high-resolution imaging sequences are now available (such as steady-state free precession sequences) permitting high-quality images to be obtained in a single breath-hold and in part overcoming artifacts generated by bowel peristalsis. Furthermore, MR not only depicts the enteric changes of CD such as mural thickening, stricturing, and inflammation but also provides important information about the extraenteric manifestations of the disease, such as abscess or fistula formation, vital for optimal patient management. Adequate bowel distension is important for accurate cross-sectional diagnosis in CD, and MR seems particularly successful in this. Furthermore, the application of MR to the study of
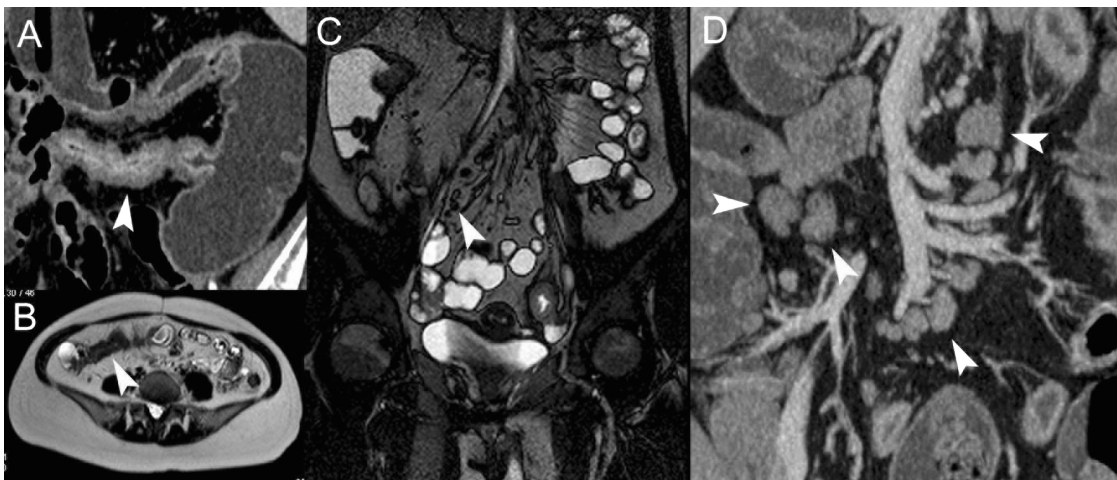

FIGURE 3. CTE and MRE of CD allow depicting several different aspects of disease anatomy, distribution, and activity. Beside the very important aspect of active disease (A, arrowhead: CTE of distal ileum with hyper-enhanced inner layer) or quiescent disease (B, arrowhead: distal ileum with thickened walls but without significant perivisceral fat stranding), it is possible and easy to depict, locate, and assess the nodal inflammation both with MRE (C, arrowhead) and CTE (D, arrowheads).

fistulae may help in the early identification of neoplasia in bypassed intestinal loops (Fig. 3).

Patients with CD have a recognized relative risk of developing small bowel adenocarcinoma. In a recent study, based on a hospital cohort of 1935 patients with small bowel involvement, the cumulative risk of small-bowel adenocarcinoma in CD (95% confidence interval) was estimated to be 2 (0–8) and 22 per 1000 patients (7–64) after 10 and 25 years of follow-up, respectively.[32]

In this study, no data have been displayed to corroborate the existing link between fistula and cancer development on the small bowel bypassed loops, but the possibility of this complication lends further support to the use of an axial imaging approach that is capable of showing disease outside the principal alimentary channel. Our study was, however, underpowered to detect small bower cancer, into the study's cohort.

A limitation of this study was the inclusion of patients with CD with moderate disease only (CDAI, 250–450), excluding patients with early-stage disease. This was a deliberate selection bias explaining the quite high rate of fistulising disease in our study population and potentially increasing the diagnostic performance of CTE and MRE.

Nevertheless, early disease manifestations such as superficial aphthous ulceration, mucosal nodularity, and erythema are beyond the resolution of MR imaging and are probably still better identified with endoscopic technique. Moreover, subtle wall thickening is not well demonstrated at MR imaging, even with full luminal distension. Moderately active disease instead and its complications are clearly identified, with MRE, for moderate disease being deliberated targeted in this study. It would perhaps

have been useful to assess the diagnostic capabilities of each of the individual MRE sequences in their ability to detect fistulae; however, the MR examination was interpreted as a whole.

The results of this study may not apply to all patients with CD. Incomplete luminal distension of the jejunal loops may occur in MRE. Therefore, enteroclysis may still be necessary in some patients with suspected jejunal disease. Complex enterocutaneous fistulae are sometimes not well defined by MR, notably due to compression or distortion caused by prone positioning or to field inhomogeneity caused by their localization. In this situation, imaging with the patient supine may be helpful when enterocutaneous fistulae are suspected clinically.[33]

Other studies in CD have also reported MR to seem similar to CT enterography/enteroclysis and superior to conventional contrast-enhanced studies in diagnosing and depicting fistulae and disease extent in CD,[34–37] and it should be acknowledged that reference standards in CD are evolving rapidly. In the general context of pelvic sepsis and anorectal fistulae complicating CD, anal endosonography has been reported as the best modality in 1 study.[38] However, state of the art comparative data is clearly warranted in CD. The lack of a need to introduce an endoluminal device, unlimited view and perfect comparison between different examinations, with less dependence on a specially skilled operator favors MR, anal endosonography being a good alternative.[39]

CONCLUSIONS

CT enterography and MRE are of undoubted clinical value in the diagnosis of all forms of fistulae in CD. MR is preferable
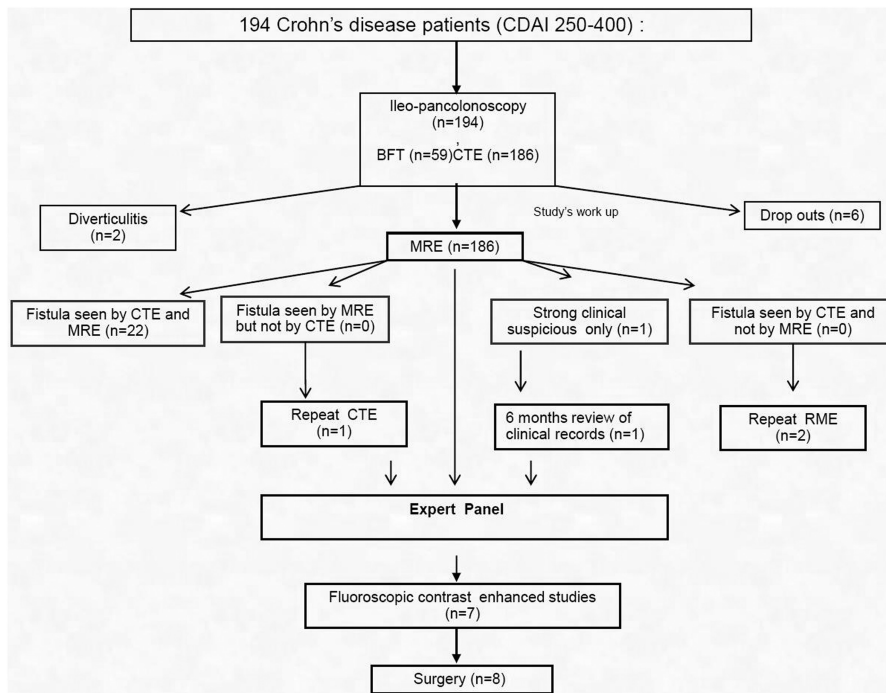

FIGURE 4. Summary of investigatory pathway.

given the avoidance of radiation burden. The better identification of internal fistulae should facilitate earlier effective treatment of fistulae-related malabsorption and malnutrition (Fig. 4).

ACKNOWLEDGMENTS

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