REVIEW

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The Role of Colonoscopy in Managing Diverticular Disease of the Colon

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ABSTRACT

Diverticulosis of the colon is frequently found on routine colonoscopy, and the incidence of diverticular disease and its complications appears to be increasing. The role of colonoscopy in managing this disease is still controversial.

Colonoscopy plays a key role in managing diverticular bleeding. Several techniques have been effectively used in this field, but band ligation seems to be the best in preventing rebleeding. Colonoscopy is also effective in posing a correct differential diagnosis with other forms of chronic colitis involving colon harbouring diverticula (in particular with Crohn's disease or Segmental Colitis Associated with Diverticulosis). The role of colonoscopy to confirm diagnosis of uncomplicated diverticulitis is still under debate, since the risk of advanced colonic neoplasia in patients admitted for acute uncomplicated diverticulitis is not increased as compared to the average-risk population. On the contrary, colonoscopy is mandatory if patients complain of persistent symptoms or after resolution of an episode of complicated diverticulitis. Finally, a recent endoscopic classification, called Diverticular Inflammation and Complications Assessment (DICA), has been developed and validated. This classification seems to be a promising tool for predicting the outcome of the colon harboring diverticula, but further, prospective studies have to confirm its predictive role on the outcome of the disease.

Key words: acute diverticulitis – colonoscopy – diverticulosis – diverticular disease – diverticular bleeding – Segmental Colitis Associated with Diverticulosis – Diverticular Inflammation and Complications Assessment (DICA) classification.

Abbreviations: AUD: acute uncomplicated diverticulitis; CD: Crohn's disease; CRC: colorectal cancer; DICA: diverticular inflammation and complications assessment; IBD: inflammatory bowel disease; LGIB: lower gastro-intestinal bleeding; SCAD: segmental colitis associated with diverticulosis; UC: ulcerative colitis.

INTRODUCTION

Colonic diverticulosis is characterized by the presence of sac-like protrusions called "diverticula", which occur when colonic mucosa and submucosa herniate through defects in the muscle layer of the colon wall (pseudo-diverticula) [1]. It is highly prevalent in western countries, where diverticula are mainly located in the sigmoid-descending colon [1], while Asian people generally have right diverticulosis (represented by real diverticula) [1]. This different location of colonic diverticulosis leads to different complications: left diverticulosis shows higher risk of inflammatory complications (mainly diverticulitis), that occur in about 5% of those patients [2]; right diverticulosis shows higher risk of bleeding, that occurs in >50% of those patients [3].

In the western world, prevalence of diverticular disease of the colon increases with age. This anatomic alteration generally affects the elderly. However, the large majority of those people will remain entirely asymptomatic, and only one fifth of them may manifest clinical illness [1].

Diverticular disease imposes a significant burden on western National Health Systems [4–6]. In the United States, its prevalence increases with age, and about 70 % of people ≥80 years show diverticulosis [5, 7-9]. In the United States, every year these complications account for more than 300,000 hospital admissions, 1.5 million inpatient care days, and

2.4 billion dollars in direct costs [3, 10, 11]. The incidence of diverticular disease and its complications appears to be increasing, and the number of patients suffering from diverticular disease is expected to expand in the following years according to the continuing rise of ages in the population [12]. Every endoscopist knows these epidemiologic trends, as diverticulosis is the most commonly reported colonic lesion found on routine colonoscopy [3].

To know colonic diverticulosis location and its extension is important for clinical practice. For example, a computed tomography (CT) scan may generate confusion between right-sided diverticulitis and carcinoma or severe ischemic colitis [13]. In those patients, the knowledge of right-sided diverticula helps to avoid unnecessary medical and/or surgical approach [13]. Diverticulosis of the left colon is much more frequent, and the risk of acute diverticulitis occurrence in those patients is about 1/1000 lifetime [8]. Endoscopic diagnosis of diverticulosis is generally incidental and does not affect the safety or accuracy of colonoscopy. However, detection of massive diverticulosis, especially in the sigmoid, may increase the risk of perforation, because of the rigidity of the colon and potential confusion between the diverticular lumen and true colonic lumen when multiple large diverticular openings are detected [14-16]. Circular muscular hypertrophy may also create crevices during colonoscopy, affecting the endoscopic accuracy in detecting polyps.

Despite these general contraindications, colonoscopy has today several indications in managing diverticular disease of the colon, ranging from treatment of diverticular bleeding to diagnosis of Segmental Colitis Associated with Diverticulosis (SCAD) [1] (Table I).

Table I. Current indication for colonoscopy in diverticular disease

	Timing
Diverticular bleeding	Urgent
Acute diverticulitis	Only if symptoms persist after 5-7 days of treatment
Following acute diverticulitis	After 4-6 weeks following resolution of acute episode
Segmental Colitis Associated with Diverticulosis	No evidence. Probably the same as IBD, in order to monitor the outcome of the disease

COLONOSCOPY AND DIVERTICULAR BLEEDING

Diverticular bleeding is the most common cause of lower gastrointestinal bleeding (LGIB) [17]. Suzuki et al. found recently that the percentage of patients with diverticula on both the right and left colon was significantly higher in the diverticular than in the non-diverticular bleeding group (p=0.0011). Multiple regression analysis identified only the diverticular location as being significantly linked to the risk of diverticular bleeding (p= 0.0021) [18].

A recent study investigated the risk factors of diverticular bleeding. Independent risk factors were alcohol consumption [light drinker, adjusted Odds Ratio (aOR) 3.4; moderate drinker, aOR 3.3], smoking index (aOR 2.0), NSAIDs (aOR 4.6), low-dose aspirin (aOR 1.9), and non-aspirin antiplatelet drugs (aOR 2.2). The drugs significantly associated with bleeding were loxoprofen (aOR 5.0), diclofenac (aOR 3.1), diclofenac suppository (aOR 8.0), etodolac (aOR 4.9), enteric-coated aspirin (aOR 3.9), buffered aspirin (aOR 9.9), clopidogrel (aOR 2.5), and cilostazol (aOR 7.3). Dual therapy carried a higher risk than monotherapy (single NSAID, aOR 3.6, p<0.01; dual, aOR 23, p<0.01; single antiplatelet drug, aOR 2.0, p<0.01; dual, aOR 4.1, p<0.01) [19]. Those patients taking one or more NSAIDS or antiplatelet drugs should be therefore carefully monitored for diverticular hemorrhage if having diverticulosis.

When and how to perform colonoscopy in managing acute diverticular bleeding is still under debate. Acute LGIB is generally evaluated with CT angiography or with technetium-tagged red blood cell scans, which have a different accuracy in detecting bleeding and its anatomic location [20–22]. Radiological hemostasis with either vasopressin infusion or coil embolization is generally carried out when bleeding is detected by angiography, while surgery is reserved for uncontrolled bleeding [23, 24]. Colonoscopy is generally performed electively when bleeding has stopped spontaneously. This is because it is often performed in order to exclude other causes of LGIB, such as vascular ectasia, Dieulafoy lesions, acute colitis, and colonic neoplasia, rather than to identify stigmata of recent bleeding. However, colonoscopy often replaces radiology as a primary imaging modality in managing LGIB. This is also because the prevalence of right-sided colonic diverticula has increased in those patients over 75 years of age, and the right-sided involvement is associated with a significant risk of bleeding not linked to the patients‘ age [3].

Several hemostasis procedures, ranging from epinephrine injection and bipolar cautery to endoclip placement and band ligation have been reported as being effective in controlling active bleeding and preventing both early and late rebleeding [25–29] (Table II). However, some techniques seem to be better than others at least in preventing rebleeding. For example, Setoyama et al. found that endoscopic band ligation was superior to endoscopic clipping in reducing rebleeding rate (p=0.018) [30].

Table II. Endoscopic techniques for treating diverticular bleeding

Epinephrine injection
Bipolar cautery
Endoclip placement
Band ligation

It is worth noting that these techniques do not seem effective in all diverticular locations. For example, Ishii et al. found recently that location in the ascending colon is a significant predictor of refractory colonic diverticular hemorrhage after endoscopic clipping, a technique that is often ineffective in this colonic district [31].

Urgent colonoscopy has been claimed to be very effective in managing diverticular bleeding. Jensen et al. recommend colonoscopy between 6 and 12 hours after hospital admission. Urgent colonoscopy is able to find signs of diverticular bleeding

(active bleeding, visible vessel without active bleeding, adherent clot) in about 20% of the patients with severe bleeding [32]. Every type of endoscopic hemostasis (epinephrine injection and/or bipolar electrocoagulation) was able to prevent early rebleeding [32]. It is also reported that urgent colonoscopy, after adequate colon cleansing and performed by an experienced endoscopist, is able to decrease direct costs and shorten hospital stay in these patients [33, 34]. However, impact of urgent colonoscopy in improving outcomes in LGIB is under debate [35-37]. Smoot et al. did not find a significant impact of the timing of urgent colonoscopy on the detection of active bleeding or non-bleeding signs in acute diverticular bleeding [36]. Similarly, Green et al. randomized patients with LGIB to receive either urgent diagnostic and therapeutic colonoscopy or standard care involving labelled red blood cell scans and visceral angiography with vasopressin infusion [38]. The main outcomes analyzed by the study were mortality, length of hospital stay, length of intensive care unit stay, transfusion requirements, early and late rebleeding rates, and surgery, but no significant difference between the two groups was found. However, the accompanying editorial [39] underlined that several items, ranging from the inadequacy of colon cleansing to the high overall rebleeding rate in the study group, and the steep learning curve required from endoscopists to obtain successful diagnosis and hemostasis in severe colon bleeding, affected the interpretation of this study.

Despite the fact that colonoscopy has been reported as being accurate both in localizing bleeding sites and in treating acute bleeding with lower rebleeding rates following endoscopic therapy, this approach has not been widely adopted in the management of acute LGIB. This is due to several practice considerations. First, because adequate cleansing of the colon, a key to successful localization of bleeding signs, is difficult to obtain, requiring a rapid infusion of 6 to 8 litres of polyethylene glycole (PEG) to obtain colon cleansing [39]. Procedure times are often prolonged (from 45 to 140 min) because of the carefully endoscopic colonic evaluation required to accurately identify a source of colonic bleeding [40]. The second is that diverticular bleeding is mainly well tolerated, despite the fact that it mainly occurs in the elderly population suffering from several comorbidities [41]. In fact spontaneous resolution of bleeding occurs in 76% of all patients and, significantly, in 98.5% of those patients it requires transfusion of ≤3 units [42]. Third, CT angiography is widely available, does not require intestinal cleansing, and can be performed immediately, repeating the procedure if the patients complain of signs of early rebleeding. Moreover, super-selective angiographic embolization seems to be safer and more effective than older methods in controlling bleeding.

Thus, urgent colonoscopy is likely to be used primarily in those patients with recurrent episodes of LGIB and in whom CT angiography was non-diagnostic at the first episode of bleeding. In this situation, identifying stigmata of recent colonic bleeding may permit the treatment of lesions with one of the endoscopic hemostasis techniques currently available or to tattoo precisely the bleeding site in order to facilitate later surgical resection.

COLONOSCOPY AND ACUTE DIVERTICULITIS

Contrast-enhanced CT scan is generally considered the gold standard, together with the clinical picture, in diagnosing acute diverticulitis and its complications [43, 44]. Colonoscopy is usually avoided in those patients because air inflation and instrumental manipulation are considered as a high risk of perforation [17]. However, when imaging is not conclusive, colonoscopy helps to pose a correct differential diagnosis between acute diverticulitis and several other colonic pathologies occurring in association with diverticulosis, ranging from Crohn's disease (CD) and SCAD, to bacterial infection, *Clostridium difficile* colitis, ischemic colitis, and colon cancer. When colonoscopy is performed in this setting, gentle instrumental manipulations with minimal air inflation can be performed with low risks and, if a diagnosis of acute diverticulitis is confirmed, the procedure may be stopped at that point.

Unsuspected asymptomatic Acute Uncomplicated Diverticulitis (AUD) may often be diagnosed during elective screening colonoscopy. Ghorai et al. found endoscopic signs of acute diverticulitis in 0.48% of patients consecutively undergoing non-urgent colonoscopy [45]. The most common endoscopic findings were granulation tissue protruding from a diverticular opening, erythema and edema of a single diverticular opening or pus coming from a diverticulum. Significantly, no patients complained of signs or symptoms of acute diverticulitis at the time of colonoscopy [45]. A more recent study conducted on 8525 consecutive colonoscopies found that AUD and SCAD were diagnosed in 2%, and ulcerative colitis (UC) with diverticulosis was diagnosed in only 0.3% of the overall population analyzed. Endoscopic findings of inflammation occur in different patterns: in AUD, inflammation affects mainly the diverticular opening and peri-diverticular mucosa; in UC with diverticulosis, inflammation always affects the overall colonic mucosa, including the diverticular orifices; in SCAD, inflammation is mainly detected in the inter-diverticular mucosa with sparing of the diverticular openings [46].

With an incidence ranging from 0.81 to 2%, it is likely that endoscopic diagnosis of oligo/asymptomatic acute diverticulitis may be frequently made in clinical practice. But is it always necessary to perform colonoscopy in acute diverticulitis? And what is the correct timing?

Performing colonoscopy in acute diverticulitis is still controversial due to the risk of perforation or bleeding [47, 48], and safe colonoscopy is advised at least 6 weeks after an episode of acute diverticulitis [47,48]. However, early colonoscopy (namely performed 3-11 days after the hospital admission) was found as safe and effective as late colonoscopy (namely performed 6-19 weeks following hospital admission), without any different rate of early or late complication [48]. Thus, an early colonoscopy (for example, 7-10 days after an episode of uncomplicated diverticulitis) seems to be safe and more effective than late colonoscopy (4-6 weeks after hospital discharge). This approach may be particularly useful in patients with persistent complaints. We know that diverticulitis generally resolves in a

few days, especially when uncomplicated [1]. If 7-10 days have passed without resolution (or without a significant clinical improvement), colonoscopy should be mandatory in order to exclude other diseases explaining the symptoms' persistence. For example, Lahat et al. performed early colonoscopy in patients with persisting complaints after an episode of acute diverticulitis, finding other significant pathology in 17% of those patients [49]. Thus, early colonoscopy should be taken into account in the clinical management of this subset of patients.

COLONOSCOPY FOLLOWING ACUTE DIVERTICULITIS

Recently, several studies evaluated the role of colonoscopy in assessing the colon after an episode of acute diverticulitis and in predicting the outcome of the disease.

The main indication for a colonoscopy following acute diverticulitis is to exclude colonic polyps and/or malignancy. This is because a higher risk of colonic polyps and carcinoma in diverticular disease has been hypothesized [50], probably because an increased cell proliferation rate was found in these patients [51, 52]. However, recent data are still controversial. Huang et al. found that the risk of colorectal cancer (CRC) was significantly higher in the cohort with diverticulosis than in the control cohort (Hazard Ratio - HR, adjusted for age, sex, and comorbidities, 4.54; 95% confidence interval (CI) 4.19-4.91; p<0.0001) [53]. However, a sensitivity analysis excluding the first 12 months of follow-up evaluation after a diagnosis of colonic diverticular disease found that subsequent incidence rates for CRC in the study and comparison cohorts were 15.13 and 15.74 per 10,000 person-years, respectively (adjusted HR, 0.96; 95% CI 0.83-1.11). The authors explain the increased CRC risk in the first year as due to misclassification and screening effects. Finally, Muhammad et al. found that the prevalence of colorectal polyps in patients with diverticulosis was significantly higher than in those without diverticulosis [odds ratio (OR) 1.54; 95 % CI 1.27-1.80, p=0.001], with a statistically significant association between age, presence of diverticulosis, and colorectal polyps (OR 1.03; 95 % CI 1.02-1.04), but there was no association between diverticulitis and colon polyps (54).

Regarding the role of colonoscopy after an episode of radiologically-confirmed acute diverticulitis in excluding malignancy, the literature results are conflicting. The vast majority of the studies draw the conclusion that colonoscopy after radiologically-confirmed uncomplicated diverticulitis is unnecessary to exclude malignancy [55-60], while it seems to be necessary after radiologically-confirmed complicated diverticulitis because the risk of malignancy in those patients is higher [61].

For example, Sallinen et al. [55] recently claimed that routine colonoscopy after CT-proven uncomplicated diverticulitis seems to be unnecessary, but colonoscopy should be performed after an attack of complicated diverticulitis; Schmilovitz-Weiss et al. [57] and Westwood at al. [58[claimed that colonoscopy may not be required to confirm diagnosis of diverticulitis, since the overall incidence of advanced colonic neoplasia in these patients is not increased. Granlund et al. found an increased risk of colonic neoplasia (especially in the left colon) at 12 months but not in the long-term, recommending colonoscopy after an episode of diverticulitis [60]. Lau et al. advised routine colonoscopy after an attack of diverticulitis in patients who have not had recent colonic evaluation, since the rate of colonic carcinoma is increased in those patients, especially in patients complaining for complicated diverticulitis [59]. Choi et al. found that the yield of advanced colonic neoplasia was substantially higher in patients with acute diverticulitis than in asymptomatic, average-risk individuals. Colonoscopy verification should be warranted in patients with diverticulitis detected on CT, especially in those aged 50 years or older [62]. Sharma et al. found that the pooled proportional estimate of malignancy was 1.6% (95% CI, 0.9%-2.8%) after an attack of acute diverticulitis, with a proportional estimate of risk 0.7% (CI, 0.3%-1.4%) in AUD and 10.8% (CI, 5.2%-21.0%) in complicated diverticulitis [61]. Finally, two recent systematic reviews [63, 64] conclude (not surprisingly, because both include roughly the same papers) that broadly speaking, colonoscopy is not necessary to rule out CRC after an episode of AUD.

Despite these conflicting literature results, to take a look at the colon appears to be strongly advisable after an acute episode of colonic diverticulitis. Firstly, because it is mandatory to exclude other diseases often sharing the same symptoms, not only CRC, but also SCAD or CD. This is particularly true for patients who have not had recent colonic luminal evaluation [17] or have a wall thickness more than 6 mm, abscess, obstruction, or lymph nodes seen on contrast-enhanced CT [65].

Secondly, it is necessary because the detection of persisting signs of endoscopic and/or histological inflammation after colonoscopy may influence the outcome of the disease [66]. Thus, the knowledge of what the condition of the colon is after an episode of diverticulitis is essential to decide how it should be treated in order to prevent diverticulitis recurrence. However, larger sample sizes should be included in a prospective study aimed at confirming the predictive role of these endoscopic factors.

COLONOSCOPY AND SEGMENTAL COLITIS ASSOCIATED WITH DIVERTICULOSIS

Colonoscopy is also essential in establishing the diagnosis of SCAD. It is chronic colitis occurring only in the left colon harbouring diverticula. Rather than a complication of diverticular disease, SCAD is currently thought to be an independent clinical disease falling in the set of IBD [68].

The following characteristics support the hypothesis that SCAD may be a type of IBD rather than a DD complication: 1) mucosal tumour necrosis factor-alpha (TNF-α) expression is higher in SCAD than in control population (matched patients with irritable bowel syndrome), similarly to that occurring in inflammatory bowel disease (IBD) [68, 69]; 2) Infliximab is able to reduce the TNF-α levels and to reach remission in SCAD patients in whom steroids and immunosuppressors have failed [70]. This behaviour is absolutely similar to the one observed in UC and in CD, supporting the hypothesis that SCAD falls within IBD.

The endoscopic findings of SCAD are erythema, granularity and fragility of the mucosa, erosions, with diffuse or "patched" involvement. These findings are limited to the colonic area harbouring diverticulosis, mostly in the sigmoid region, and the rectum is always spared from inflammation.

The first reports on SCAD are conflicting, probably because of the retrospective design of the studies and the small sample of patients described [71-75].

A recent, large prospective study on more than 6000 colonoscopies claims that the specific endoscopic characteristics of SCAD were no inflammation of the diverticular orifice and involvement of the inter-diverticular area. According to this basic definition, the authors classified SCAD within 4 different endoscopic pictures [76]:

A. "Crescentic fold disease": red round lesions are generally detected at the top of the colonic fold, the lesions are generally small (diameter 0,5-1,5 cm), without ulcer and no sign of bleeding;

B. "Mild to moderate UC-like": lesions indistinguishable from those occurring in UC (loss of vascular pattern, edema of the mucosa, hyperaemia, fragility and diffuse erosions), but involving only inter-diverticular mucosa;

C. "Crohn-colitis-like": small isolated aphtous ulcers are detected at the top of colonic fold, surrounded by non-inflamed mucosa ;

D. "Severe UC-like": lesions indistinguishable from those occurring in severe UC (loss of vascular pattern, intense hyperaemia, diffuse ulcerations and reduced calibre of the colonic lumen).

This endoscopic classification seems to have also a predictive value. It has been recently shown that more severe SCAD features (grades B and D) have higher recurrence rate than milder features (grades A and C) [77].

These endoscopic criteria permit not only a correct diagnosis of SCAD but also the ability to differentiate it from other diseases occurring in a colon harbouring diverticulosis. In acute diverticulitis, the inflammation affects mainly the diverticular orifice and successively expands to the inter-diverticular mucosa only when the disease becomes severe; in SCAD, the inflammation affects mainly the inter-diverticular mucosa, and involvement of the diverticular orifice occurs only in severe forms of disease; in UC with diverticulosis, the inflammation affects the whole colonic mucosa, including diverticular orifices. In these last two groups of patients differential diagnosis may be difficult. However, endoscopic and histological sparing of the rectum, which is typical of SCAD and by definition improbable in UC, helps to pose a correct diagnosis.

Some difficulty in the differential diagnosis may come from the artefact of bowel preparation. In fact non-specific rectal inflammation associated with bowel preparation is frequently detected [78], and it is generally considered as a normal variant, not even requiring comments in a colonoscopy report. However, in-depth analysis of endoscopic findings helps to pose a correct differential diagnosis. Firstly, artefact lesions due to bowel preparation are generally located in the rectum which, by definition, is spared in SCAD. Secondly, chemical colitis due to disinfecting/sterilizing products [79] may sometimes occur when the water button of the colonoscope is pushed, with subsequent immediate effervescence and blanching. But these lesions differ substantially from those of SCAD, when lesions are evenly located in the sigmoid region despite water instillation. Thirdly, chemical injury causes white lesions, whilst SCAD shows red lesions resembling IBD. Fourth, histological damage is completely different (acute-chronic inflammatory infiltrate in SCAD, the so called "pseudolipomatosis" in chemical injury) [80]. Thus, a complete endoscopic-histological differential diagnosis leads to the correct diagnosis.

COLONOSCOPY AS A PREDICTIVE TOOL FOR DIVERTICULAR DISEASE OUTCOME

Current classifications of diverticular disease are based on imaging, in particular on the appearance of the disease by abdominal CT [81-83]. On the other hand, there are some clinical classifications that look at the clinical appearance of the disease [84-86]. However, most of them have focused attention on the severity of diverticulitis rather than on the overall spectrum of diverticular disease.

Surprisingly, an endoscopic classification of the disease is still lacking. This is more surprising, if we consider the high number of colonoscopies performed in our centres [4], and that endoscopic signs of diverticular inflammation may be recognized in 0.48-1.75% of patients undergoing a colonoscopy [45, 46]. For many years we did not know whether anatomical and/or endoscopic appearance of the diverticular colon could influence the disease outcome. It is hypothesized that patients differ from each other. For example, it is hypothesized that a patient having only scattered diverticula in the sigmoid colon may differ from a patient having diffuse diverticulosis and rigidity of the colon at the inflation, but we do not know if these differences might have a prognostic significance. Moreover, the meaning of several endoscopic descriptions of the colon harbouring diverticula, for example "scattered diverticulosis", or "diffuse diverticulosis", or "diverticular inflammation" was unclear, considering that a classification of the colon harbouring diverticula based on endoscopic appearance, was lacking.

For these reasons, a recent endoscopic classification of diverticular disease, called Diverticular Inflammation and Complications Assessment (DICA) has been developed and validated [87] (Table III). This classification considers four items on which it has been built: diverticulosis extension, number of diverticula, presence of inflammatory signs, presence of complications. The DICA classification comprises therefore the following items:

a. Diverticulosis extent: left colon; right colon;

b. Number of diverticula (in each district): up to 15: grade I; >15: grade II;

c. Presence of inflammation: edema/hyperemia; erosions; SCAD. Since contemporary presence of different severity of inflammation may be detected during colonoscopy in the same district (e.g. some diverticula with hyperemia and other with erosions), the most severe grade of inflammation is reported.

d. Presence of complications: rigidity of the colon; scarce distension of the diverticular district to inflation, and comprising also mild stenoses in which the standard

Table III. Diverticular Inflammation and Complication Assessment (DICA) Classification

Items	Points
Diverticulosis extension	
left colon	2
right colon	1
Number of diverticula (in each district)	
up to 15: grade I	0
>15: grade II	1
Presence of inflammatory signs	
Edema/Hyperemia	1
Erosions	2
SCAD	3
Presence of complications	
Rigidity of the colon	4
Stenosis	4
Pus	4
Bleeding	4
	Total: ….

SCAD: Segmental Colitis Associated with Diverticulosis.
DICA 1: 1 to 3 points; DICA 2: 4 to 7 points; DICA 3: >7 points.
For a complete description and explanation of this classification, please read the text.

colonoscope could be passed through the narrowed lumen; stenosis: not passing stenosis or narrowed lumen with elevated risk of perforation due to presence of some anatomical characteristics (e.g. a lot of diverticula at the splenic flexure); pus: purulent material coming from diverticular opening; bleeding.

Points in constructing the final DICA are assigned according to the severity of the anatomical/inflammatory findings. Two points are assigned to diverticulosis located in the left colon because in the western world diverticulosis (and therefore diverticulitis) occurs more frequently in the left than in the right colon. The DICA score is therefore constructed as follows:

DICA 1: when the sum of the points is up to 3. This is a simple diverticulosis, probably without risk of complications;

DICA 2: when the sum of the points is 4 to 7. This is a mild diverticular disease, probably with a lower risk of complications;

DICA 3: when the sum of the points is over 7. This is a severe diverticular disease, probably with a higher risk of complications.

The validation process was carried out by estimating the correlation between the calculated index and inflammatory indices: erythro-sedimentation rate (ESR) and C-reactive protein (CRP) expression, that were selected because ESR and CRP correlated with the severity of the diverticular disease [88]. Correlation between the calculated index and the symptoms experienced by patients at the time of colonoscopy was assessed, too. In this way, four main symptoms were assessed: abdominal pain, bleeding, constipation, diarrhea. In particular, abdominal pain was considered the main symptom characterising diverticular disease [89].

In order to have a first step in assessing the predictive value of DICA classification, DICA classification was applied to the videos of 50 patients enrolled in the placebo-arm of a previous double-blind placebo-controlled trial on symptomatic uncomplicated diverticular disease [90]. Finally, the 1-year clinical follow-up of that group was reassessed according to the DICA score at the beginning of the follow-up.

Overall Fleiss' kappa for inter-rater reliability was 0.847 (95% CI 0.812 to 0.893): for grade 1, Fleiss' kappa was 0.878 (95% CI 0.832 to 0.895); for grade 2, 0.765 (95% CI 0.735 to 0.786); for grade 3, 0.891 (95% CI 0.845 to 0.7923). Intra-observer agreement kappa was 0.91 (95% CI 0.886 to 0.947).

A significant correlation with DICA classification was found both for ESR and CRP values (ESR vs DICA p=0.0001; CRP vs DICA p=0.0001). A significant correlation was found between pain score and DICA classification (p=0.0001).

With respect to the 50 patients retrospectively reassessed, 30 (68%) patients were classified as DICA 1 and 20 (32%) were classified as DICA 2. Overall, recurrence or occurrence of disease complications were recorded in 29 (58%) patients. Regarding these 29 patients, 10 (34.5%) were classified as DICA 1 and 19 (65.5%) as DICA 2 patients (p=0.036). In particular, symptomatic uncomplicated diverticular disease recurred in 23 patients: 9 (39.1%) patients were classified as DICA 1 and 14 (60.9%) patients were classified as DICA 2 at the beginning of the study (p=0.238). Acute diverticulitis occurred in 6 patients: 1 (16.7%) patient was classified as DICA 1 and 5 (83.3%) patients were classified as DICA 2 at the beginning of the study (p=0.083).

DICA classification is a new and practical instrument that can be used by clinicians for the objective description of colon harbouring diverticula. The simplicity of this classification, its excellent reproducibility, and its correlation with biochemical and clinical disease markers makes it very attractive in clinical practice. Of course, further studies are needed in order to validate this classification and to assess its reproducibility in clinical trials, as well as to assess whether its use may impact the natural history of diverticular disease.

CONCLUSIONS

The role of colonoscopy in managing diverticular disease is now changing. It is the mainstay tool in managing diverticular bleeding, where band ligation seems to be the most effective technique. Colonoscopy seems to be important also in managing patients with acute diverticulitis experiencing persistent symptoms, while its role in assessing the colon after an acute episode of uncomplicated diverticulitis is still under debate. Finally, colonoscopy may have also a prognostic role on the outcome the disease. The recently developed and validated endoscopic classification of diverticular disease, named DICA, has given us the first endoscopic tool with the ability to classify colon harbouring diverticula. Further, prospective studies have to confirm the role of this classification in predicting the outcome of the disease.

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