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An update based on our experience and literature data.

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BACKGROUND: *The treatment of acute diverticulitis is a matter of debate and has undergone significant changes. Currently the main focus of surgical treatment is a more conservative and less invasive management.*
AIMS AND METHODS: *To focus the role of surgery in the treatment of acute diverticulitis, the Authors have conducted a review of the literature of the last two decades and have revised critically their own experience.*
RESULTS: *The indications for elective surgery based on the number of episodes, the young age at diagnosis and the presence of risk factors such as immunosuppression, have to be overcome in favour of a more individual approach based on the severity of the disease. Similarly the presence of pneumoperitoneum is no longer a compelling indication for urgent surgery just as it was in the past. In the treatment of complicated diverticulitis with abscess (Hinchey I-II) is used more and more conservative treatments consisting of guided percutaneous drainage combined with antibiotics. Resection with primary anastomosis with or without diverting ileostomy is preferable to Hartmann's procedure in case of perforated diverticulitis with peritonitis (Hinchey III-IV), using the latter only in the case of comorbidities, severe sepsis, hemodynamic instability or longtime feculent peritonitis (Hinchey IV). Recently, laparoscopic peritoneal lavage was introduced in the treatment of diverticulitis.*
CONCLUSIONS: *Thanks to the progress made in conservative and interventional treatment and laparoscopic surgery, an increasingly less invasive treatment is proposed in the management of acute diverticulitis.*

KEY WORDS: Acute diverticulitis, Laparoscopic surgery, Surgical treatment

Introduction

Diverticulosis is a common condition. More recent data suggest that up to 50% of individuals older than 60 years of age have colonic diverticula, with 10% to 25% developing complications such as diverticulitis [1]. Acute diverticulitis is the third most common inpatient gastrointestinal diagnosis in the United States, costing more than $2 billion annually, and is a common outpatient and emergency department diagnosis as well [2]. The prevalence of diverticular disease is as high as 65% by 85 years of age and estimated to be as low as 5% in those 40 years of age or younger [3]. More recent literature has reported an increase in the incidence of diverticular disease among younger patients [4]. The Hinchey classification, developed before the advent of routine computed tomography (CT) imaging, remains the most widely used classification for acute complicated diverticulitis. The original Hinchey classification divided acute complicated diverticulitis into pericolic abscess confined to the mesentery of the colon (stage I), pelvic abscess resulting from a local perforation of a pericolic abscess (stage II), generalized peritonitis resulting from rupture of pericolic/pelvic abscess into the peritoneal cavity (stage III), and fecaloid peritonitis resulting from the free perforation of a diverticulum (stage IV) [5]. Currently, the most commonly used classification of acute colonic diverticulitis is the modified Hinchey classification, which corresponds to a slightly more complex classification by comparison with the original description. This modified

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TABLE I - *Hinchey Classification.*

Hinchey classification	Modified Hinchey classification
0 diverticulitis no complicated	0 diverticulitis no complicated
I abscess or phlegmon pericolic	Ia confined pericolic inflammation-phlegmon Ib confined pericolic abscess
II pelvic, intra-abdominal or retroperitoneal abscess	II pelvic, intra-abdominal or retroperitoneal abscess
III generalized purulent peritonitis	III generalized purulent peritonitis
IV fecaloid peritonitis	IV fecaloid peritonitis

TABLE II - Management of diverticulitis of the colon.

Hinchey classification	Management
Diverticulitis no complicated	Observation and restriction of oral intake. The use of antibiotics is justified by septicemia, affected general condition, pregnancy or immunosuppression.
Confined pericolic abscess, pelvic, intra-abdominal or retroperitoneal	Abscesses <3 cm in diameter: antibiotics alone. Abscesses > 4 cm in diameter: guided percutaneous drainage combined with antibiotics. Abscesses that are not drainable or that do not respond to percutaneous treatment: surgery.
Generalized purulent peritonitis	Primary resection and anastomosis, preferably with diverting ileostomy. Hartmann's procedure in case of comorbidities (ASA III or IV), severe sepsis, or long-standing feculent peritonitis. Laparoscopic peritoneal lavage like definitive treatment or "bridge" to surgery.
Fecaloid peritonitis	Primary resection and anastomosis with diverting ileostomy. Hartmann's resection is preferable in case of comorbidities (ASA III or IV), severe sepsis, hemodynamic instability or long-standing feculent peritonitis.

classification allows to categorize patients with acute colonic diverticulitis into four major categories (I, II, III, IV) and two additional subcategories (Ia and Ib), depending on the severity of the disease [6]. (Table I) Recent advances in the understanding of the disease's pathophysiology and natural history have led to substantial changes in diverticulitis treatment guidelines: complicated diverticulitis (ie, with perforation, abscess, or phlegmon) is now reliably distinguished from uncomplicated disease by computed tomography (CT); large clinical and administrative databases have facilitated more complete follow-up of large populations, resulting in changes in the understanding of the natural history of diverticulitis, clinical and behavioral risk factors for the disease, and what are the indications and outcomes of its treatments. Surgeons now pursue less invasive intervention, increasing the use of percutaneous drainage, intraperitoneal lavage, and minimally invasive surgical techniques.

Methods

A extensive literature analysis was performed using the PubMed database. The following "MeSH" terms were used during the first PubMed search: diverticulitis, classification, surgical management, abscess, complicated, uncomplicated, percutaneous drainage, laparoscopic lavage, and colectomy. An review of the most recent international guidelines has been performed. The inclusion criteria used were national and international guidelines, clear recommendations based on levels of evidence or grades of recommendation, a publication date within the past 5 years and the availability of a full-text version in English. A careful analysis was conducted in literature on the treatment of acute diverticulitis in urgent surgery and election. The definition of urgent surgery is a situation that requires immediate and rapid action. It can be immediate if within 3-4 hours, deferred within 6 hours and scheduled within 24 hours. A literature review was also conducted on the treatment of uncomplicated and complicated diverticulitis. In the latter case, we divided the discussion on the basis of modified Hinchey's classification. The purpose of this review is to describe the treatment of acute diverticulitis in accordance with the most recent international guidelines.

Results and Discussion

Indications for Elective Surgery

Indications to elective surgery must be evaluated balancing severity of symptoms, risks of severe recurrences,

and morbidity due to surgery. After successful nonsurgical treatment of complicated diverticulitis, elective resection should be performed. Patients with a history of complicated diverticulitis are likely to develop further complications or recurrence at the rate of up 47% within 4-5 years [7,8]. Until a decade ago, two episodes of recurrence, especially in combination with elevated markers of inflammation, prompted the recommendation of elective sigmoid resection to prevent severe complications.[7] The practice of recommending elective colectomy to prevent a future recurrence requiring stoma formation is not supported by the literature and should be discouraged [9]. Chapman et al, in a study of 150 patients with prior episodes of diverticulitis who were hospitalized with complicated diverticulitis, showed that patients with multiple (> 2) episodes of diverticulitis are not at increased risk for poor outcomes if they develop complicated diverticulitis. The morbidity and mortality rates are not significantly different between patients with multiple episodes of diverticulitis compared with those with 1 or 2 prior attacks [10]. Salem et al has also demonstrated that elective resection following the fourth episode is not associated with an increased colostomy or mortality rate compared with the performance of surgery after the first episode [11]. As regards the un-complicated diverticulitis the recurrence is rare and is a relatively benign process for the substantial majority of patients [12]. Broderick-Villa et al reported on 2366 of 3165 patients (75%) hospitalized with acute diverticulitis and treated nonoperatively. 86% of those patients required no further inpatient care for diverticulitis over the 8.9 years of follow-up. Recurrence occurred in only 13.3% of patients and only 3.9% had a second recurrence. No patient with a second recurrence required an operation, and repeat recurrences plateaued after 4 episodes. Although the risk for a second recurrence increased to 29% among those with a first recurrence, the authors concluded that overall recurrence is rare and therefore does not warrant elective colectomy [13]. The general recommendation of elective sigmoid resection after two attacks of diverticulitis has been abandoned in favor of a more individual approach based on patient's risk level and medical conditions [7]. It is still controversial whether young age, generally defined as below 50 years, represents an independent risk factor of acute diverticulitis recurrence. In young people, the initial attack of colonic diverticulitis is frequently severe, often requiring an urgent operation for complications [14,15]. Diverticulitis in patients younger than 40 years seems to have a particularly aggressive and fulminant course and requires early surgical procedures for complications (associated abscess, colonic perforation) in 40 % of cases. The use of "major procedure" (i.e., stoma) is more frequent in these patients [16]. In contrast, in many recent studies, the course of diverticulitis in young patient is not more severe than that in elderly patients; however, the disease tends to recur more often [17]. According to Biondo, acute diverticulitis in young patients does not have a particularly aggressive course and the risk of recurrence is similar to that of older patients [18]. Nelson adds that younger patients with uncomplicated diverticulitis by CT criteria respond well to medical management and seldom required an emergent operation and colostomy. Young patients with diverticulitis should be treated according to the same criteria used for older patients [19]. In another study young age is not a predictive factor of poor outcome in the management of first or recurrent episodes of acute diverticulitis. Patients older than 50 years more frequently need emergency surgical treatment [20]. In conclusion diverticulitis management should be based on the severity of the disease rather than on the patient's age. Immunocompromised patients or patients on immunosuppressive therapy, patients with chronic renal failure or with collagen vascular disease had a greater risk of perforation in a recurrent episode of acute diverticulitis [21]. A recent study confirms that immunocompromised patients have a higher probability of perforation and a more serious course of the illness but the problem is that complicated diverticulitis is often the initial clinical presentation of the disease. Surgical treatment is more effective than conservative therapy in the prophylaxis of recurrent diverticulitis, but, according to the study, the relapse of diverticulitis occurs in a minority of patients (14%) and the recurrence tends to have a relatively benign course. These findings should be taken into consideration when counselling patients regarding potential benefits of prophylactic colectomy [22]. According to Biondo et al, in a study of 931 patients divided into 2 groups (group 1, 166 immunosuppressed patients, and group 2, 765 non-immunosuppressed patients) the overall recurrence rate was similar in both groups. Patients in group 1 with a severe first episode presented significantly higher rates of recurrence and severity without needing more emergency surgery. Mortality after emergency surgery was 33.3% in group 1 and 15.9% in group 2 (P = .004). The author concluded that after successful medical treatment of acute diverticulitis, patients with immunosuppression need not be advised to have an elective sigmoidectomy [23]. In conclusion, there is no clear evidence that one single risk factor could be considered an independent indication for elective surgery for diverticulitis disease.

Indications for Urgent Surgery

The SICCR Italian guideline suggests urgent surgery for patients with diffuse peritonitis and for those who fail to improve despite appropriate medical therapy [24,25]. Patients with multi-quadrant peritonitis or overwhelming infection due to purulent or feculent peritonitis are typically acutely ill or appear toxic and require expedited fluid resuscitation, antibiotic administration, and operation without delay. A subset of patients in whom

non-operative management fails do not present as dramatically; rather, these patients simply do not improve clinically and continue with abdominal pain or the inability to tolerate enteral nutrition owing to infection-related ileus or bowel obstruction. Although repeat imaging to evaluate possible abscess formation or to otherwise guide management of antibiotic coverage and parenteral nutrition may be useful, clinical judgment determines the need for definitive surgical treatment [9,26]. The majority of patients have symptoms and signs of complicated diverticulitis like pneumoperitoneum at admission without evident peritonitis. In a study of 136 patients identified with perforated diverticulitis 19 had localized free air, 45 had abscess <4 cm or distant free air measuring <2 cm, 66 had abscess >4 cm or distant free air >2 cm, and 6 had distant free air with free fluid. Only 5 patients (3.7%) required urgent surgery at the time of admission, and 7 (5%) required urgent surgery for failed non-operative management failure. Thus, the overall success rate of non-operative management was 91% [27]. In a Finland study, patients with a small amount of distant intraperitoneal air (<1×1 cm or 2 cm in any direction) in the absence of clinical diffuse peritonitis or fluid in the pouch of Douglas was safely treated non-operatively with an 86% success rate and 0% mortality. On the other hand, patients with a large amount of distant intraperitoneal air (>1×1 cm or 2 cm in any direction) or distant retroperitoneal air even in the absence of clinical diffuse peritonitis had a relatively high failure rate (57%–60%) of non-operative management. Patients with perforated diverticulitis and pericolic air in the absence of abscess could almost always be treated non-operatively with a high success rate (99%) [28]. In conclusion, we resort to urgent surgery in patients presenting clinical signs and symptoms of diffuse peritonitis and in those where medical therapy fails. The presence of pneumoperitoneum is no longer a compelling indication for urgent surgery just as it was in the past. Several surgical options may be appropriate, but the choice mostly depends on the severity of peritonitis. Laparoscopic peritoneal lavage should be considered as an alternative to primary resection and anastomosis in purulent peritonitis.

Treatment of Acute Uncomplicated Diverticulitis

We suggest avoiding antibiotic in acute uncomplicated diverticulitis since may not improve short- or long-term outcomes. Use on a case-by-case basis should possibly be considered. Use of antibiotics in uncomplicated diverticulitis is justified by septicemia, affected general condition, pregnancy or immunosuppression [24,29,30]. In a retrospective audit of 311 patients (64% F, mean age 60 years) hospitalized for acute diverticulitis, all patients were initially treated conservatively with observation and restriction of oral intake. Patients receiving antibiotics (n=118) were compared with patients treated with observation and restriction of oral intake only (n=193). Mean follow-up time was 30 months. It was observed that antibiotic or conservative treatment yielded the same clinical outcome, with an overlapping rate of recurrence [31]. In a study of 155 patients, the majority of the patients (97.4%) was managed successfully as outpatients without antibiotics, admissions, or complications. In only 4 (2.6%) patients, the management failed because of complications in 3 and deterioration in 1. These patients were all treated successfully as inpatients without surgery. 5 patients had recurrences and were treated as outpatients without antibiotics [32]. In a multicenter randomized trial involving 10 surgical departments in Sweden and 1 in Iceland were recruited 623 patients with CT-verified acute uncomplicated left-sided diverticulitis. Patients were randomized to treatment with (314 patients) or without (309 patients) antibiotic. The authors concluded that the antibiotic treatment for acute uncomplicated diverticulitis neither accelerates recovery nor prevents complications or recurrence. It should be reserved for the treatment of complicated diverticulitis [33]. A recent Cochrane review including 3 randomized trials similarly found no significant difference between antibiotics and no antibiotics for the treatment of uncomplicated diverticulitis [34]. The literature shows a rational use of antibiotics limited to cases of complicated diverticulitis in order to reduce the antibiotic resistance and the costs in health care. According to the so-called "diabolo trial" the liberal strategy without antibiotics and without the strict requirement for hospital admission is anticipated to be a more cost-effective approach [35]. In addition no evidence exists for a beneficial effect of bowel rest. Fewer postprandial contractions could equate to less pain. However, spasmolytic should yield the same effect.

Treatment of Abscesses (Hinchey Stages 1 And 2)

Most of the international guidelines recommend conservative management of small mesocolic abscesses (Hinchey 1b) with antibiotics and recommend percutaneous drainage and antibiotics for larger abscesses [8]. The definition of a large abscess was one that ranged in size from 2 to 5 cm. Pelvic abscesses (Hinchey 2) require more aggressive therapy compared with mesocolic abscesses, with percutaneous drainage and elective surgery if unsuccessful [36]. Conservative treatment with antibiotics is successful in up to 73% (95% CI: 66.3–78.9) of patients presenting with an abscess of less than 4-5 cm in diameter. When conservative treatment fails, percutaneous drainage should be performed, which is successful in up to 81% (95% CI: 73.7-89.1) of patients. The risk of failure of conservative treatment is higher in patients with abscesses larger than 4-5 cm than in patients with smaller abscesses[30]. Siewert et al. assessed

30/181 patients with CT verified diverticulitis with an abscess (17 %) of which 22 cases (73 %) were classified as small (3 cm or less) and treated solely with antibiotics. The 8 patients with abscesses larger than 3 cm were in 4 cases treated with antibiotics and in 4 cases with CT-guided drainage. 5/8 patients (62.5 %) underwent resection. The author concluded that patients with abscesses smaller than 3 cm in size can be treated with antibiotics alone and, in some cases, as outpatients, and may not uniformly require surgery. Patients with abscesses larger than or equal to 4 cm can be managed with CT-guided abscess drainage followed by referral for surgical treatment[37]. In a study of Bahadursingh et al, 192 patients were admitted with a diagnosis of colonic diverticulitis. Of the investigations performed 128 of 192 (66.7%) had a CT scan of the abdomen and pelvis and 16% had a diverticular abscess. Preoperative abscess drainage occurred in 10 of 192 (5%), which were either percutaneous, 6 of 192 (3%), or transrectal, 4 of 192 (2%).[38] Durmishi et al. has published a series of 34 patients with Hinchey stage 2 diverticulitis. The median abscess size was 6 cm (range, 3-18 cm), and the median duration of drainage was 8 days (range, 1-18 days). Drainage was considered successful for 23 patients (67%). The causes of failure for the remaining 11 patients included continuing sepsis (n = 5), abscess recurrence (n = 5), and fistula formation (n = 1). 10 patients who failed percutaneous abscess drainage underwent an emergency Hartmann procedure. Among the 23 patients successfully drained, 12 underwent elective sigmoid resection with a primary anastomosis. The author concluded that the drainage of Hinchey II diverticulitis guided by CT scan was successful in 2/3 of the cases, and 35% of the patients eventually underwent a safe elective sigmoid resection with primary anastomosis [39,40]. We are agree with SICCR Italian guidelines and recommend the guided percutaneous drainage combined with antibiotics as the preferable treatment for > 4 cm diverticular abscesses. Those abscesses not responding to or not amenable to non-operative management should be treated surgically. Most abscesses <3 cm in diameter can be treated safely and successfully with antibiotics alone, while larger abscesses most often require combined percutaneous drainage and antibiotics. Patients with diverticulitis-related abscesses that are not drainable or who do not respond to percutaneous treatment should undergo urgent surgery [24,8].

Treatment of Hinchey Stages 3 And 4

Several surgical options may be appropriate in purulent peritonitis (Hinchey III). Laparoscopic peritoneal lavage should be considered as an alternative to primary resection and anastomosis or to Hartmann's procedure. Many studies have indicated that resection and primary anastomosis with or without proximal faecal diversion is not inferior to non-restorative resection (Hartmann's procedure) in terms of surgical efficacy and safety. A multicenter randomized clinical trial favors primary anastomosis with diverting ileostomy over Hartmann's procedure in patients with perforated diverticulitis. In particular the overall complication rate for both resection and stoma reversal operations was comparable (80% vs 84%, P = 0.813) and the study did not show any significant differences in mortality (13% vs 9%) and morbidity (67% vs 75%) in Hartmann's procedure vs primary anastomosis with diverting ileostomy. In contrast the stoma reversal rate after primary anastomosis with diverting ileostomy was higher (90% vs 57%, P = 0.005) and serious complications (Grades IIIb-IV: 0% vs 20%, P = 0.046), operating time (73 minutes vs 183 minutes, P < 0.001), hospital stay (6 days vs 9 days, P = 0.016), and lower in-hospital costs (US $16,717 vs US $24,014) were significantly reduced in the primary anastomosis with diverting ileostomy group.[41] Several studies have demonstrated similar mortality and morbidity after resection with primary anastomosis and non-restorative procedures [7,42,43]. According to another study the overall mortality was significantly reduced with primary resection and anastomosis (4.9 vs. 15.1 percent; odds ratio = 0.41) and subgroup analysis of trials matched for emergency operations showed significantly decreased mortality with primary resection and anastomosis (7.4 vs. 15.6 percent; odds ratio = 0.44) [44]. In a review of 98 series, mortality rate following resection with primary anastomosis (n=559) were found to be lower (10 %) when compared with Hartmann's procedure (19 %) (n=1051) [45]. The restoration of the bowel continuity after Hartmann procedure was performed in only 61% of the patients [46], and however, it is not performed in up to 55% of patients due to operative risks [47]. Reversal ileostomy was carried out significantly more often than reversal of Hartmann's procedure (90 vs. 57%; p = 0.005). Reversal ileostomy had a lower complication rate, shorter duration of operation, shorter hospital stay, as well as lower costs [41]. It has been stated previously that patients with a stoma may face many difficulties both physical and psychological [48]. It is known that patients with direct intestinal continuity after surgery for colon cancer showed better QOL scores than those who received an end colostomy [49]. Also, when having a stoma, reversal of it can result in significant improvements in global QOL and physical and social function [50]. In conclusion Hartmann's discontinuity resection is preferable in case of comorbidities (ASA III or IV), severe sepsis, or longstanding feculent peritonitis [51]. If the patient is in a relatively good general state and there is peritonitis of recent onset and only a mild septic reaction, creation of a primary anastomosis, possibly with a protective stoma, can be considered [52,53]. Laparoscopic lavage and drainage associated with antibiotics may be an alternative to resective procedures in diverticular perforation with purulent peritonitis. Many studies have reported that laparoscop-

ic lavage is not inferior to either primary resection/anastomosis or Hartmann's procedure in terms of feasibility, safety and efficacy. In a recent study 83 patients were randomized, out of whom 39 patients in laparoscopic lavage and 36 patients in the Hartmann procedure groups were available for analysis. Morbidity and mortality after laparoscopic lavage did not differ when compared with the Hartmann procedure. Laparoscopic lavage resulted in shorter operating time, shorter time in the recovery unit, and shorter hospital stay [54,55]. In another study 2455 patients underwent surgery for diverticulitis, of whom 427 underwent laparoscopic lavage. Patients selected for laparoscopic lavage had lower mortality (4.0% vs 10.4%, p < 0.001), complications (14.1% vs 25.0%, p < 0.001), and length of stay (10 days vs 20 days, p < 0.001) than those requiring laparotomy/resection [56]. Laparoscopic lavage for perforated diverticulitis is more cost-effective than sigmoid resection.[57] Recent studies show that in acute perforated diverticulitis with purulent peritonitis laparoscopic lavage is comparable to sigmoid resection in term of mortality but it is associated with a significantly higher rate of reoperations and a higher rate of intra-abdominal abscess. In a meta-analysis including 315 patents laparoscopic lavage versus resection was associated with significantly more reoperations (OR 3.75, p = 0.006) and more intra-abdominal abscesses (OR 3.50, p = 0.0003) with no differences in mortality (OR 0.93, p = 0.92) [58]. In a prospective study aimed to compare outcomes after laparoscopic peritoneal lavage and sigmoid resection with primary colorectal anastomosis, 25 patients underwent sigmoid resection with primary anastomosis and 15 laparoscopic peritoneal lavage. Overall postoperative morbidity and mortality rates were not significantly different after sigmoid resection with primary anastomosis and laparoscopic peritoneal lavage (40 vs 67 %, p = 0.19; 4 vs 6.7 %, p = 1, respectively). Intra-abdominal morbidity and reoperation rates were significantly higher after laparoscopic peritoneal lavage compared to sigmoid resection with primary anastomosis (53 vs 12 %, p < 0.01; 40 vs 4 %, p = 0.02, respectively). Multivariate analysis showed that laparoscopic peritoneal lavage (p = 0.028, HR = 18.936, CI 95 % = 1.369-261.886) was associated with an increased risk of postoperative intra-abdominal septic morbidity. Among 6 patients who underwent reoperation after laparoscopic peritoneal lavage, 4 had a Hartmann procedure. All surviving patients who had a procedure requiring stoma creation underwent stoma reversal after a median delay of 92 days after laparoscopic peritoneal lavage and 72 days after sigmoid resection with primary anastomosis (p = 0.07) [59]. In a multicenter randomized clinical superiority trial recruiting participants from 21 centers in Sweden and Norway from February 2010 to June 2014, 199 patients with suspected perforated diverticulitis were enrolled. Patients were assigned to undergo laparoscopic peritoneal lavage (n = 101) or colon resection (n = 98). Severe postoperative complications (Clavien-Dindo score >IIIa) within 90 days was observed in 31 of 101 patients (30.7%) in the laparoscopic lavage group and 25 of 96 patients (26.0%) in the colon resection group (difference, 4.7% [95% CI, -7.9% to 17.0%]; P = .53). Mortality at 90 days did not significantly differ between the laparoscopic lavage group (14 patients [13.9%]) and the colonic resection group (11 patients [11.5%]; difference, 2.4% [95% CI, -7.2% to 11.9%]; P = .67). The reoperation rate was significantly higher in the laparoscopic lavage group (15 of 74 patients [20.3%]) than in the colonic resection group (4 of 70 patients [5.7%]; difference, 14.6% [95% CI, 3.5% to 25.6%]; P = .01) for patients who did not have fecal peritonitis. 4 sigmoid carcinomas were missed with laparoscopic lavage.

The authors concluded that among patients with likely perforated diverticulitis and undergoing emergency surgery, the use of laparoscopic lavage vs primary resection did not reduce severe postoperative complications and led to worst outcomes in secondary end points [60]. A recent study published in "The Lancet" included 90 patients. The trial had to be ended as the safety of the participants in the lavage group was at risk considering the high rate of surgical in hospital reoperation after lavage (18 patients (39%) in the lavage group vs 2 patients (5%) in the sigmoidectomy group). By 12 months, 4 patients had died after lavage and 6 patients had died after sigmoidectomy.

The authors concluded that laparoscopic lavage is not superior to sigmoidectomy for the treatment of purulent perforated diverticulitis [61]. These controversial results do not bring a clear light about indications and identification of patients who would benefit from laparoscopic lavage and drainage for perforated diverticulitis with purulent peritonitis [55]. For this reason, according to some authors, laparoscopic peritoneal lavage can be performed as a "bridge" procedure with the intent to avoid the Hartmann procedure. In fact, after an initial "damage control" surgery (laparoscopic peritoneal lavage/drainage), these patients may undergo an elective laparoscopic sigmoid resection [62]. This concept can be especially important in elderly patients who must undergo surgery in emergency. The urgent surgery in elderly patients is characterized by values of mortality and morbidity higher than in the young. The greater frequency of complications is most likely attributed to the metabolic balance elderly precarious, the type of operation performed and the highest rate of associated diseases in this group of patients [63]. In a study examining the urgent surgery in elderly patients, Fornaro et al reported a intraoperative mortality rate of 0.27% and post-operative mortality rate of 12.1%. The overall incidence of postoperative complications was 25.7%. The elective surgery in elderly patients allows better patient preparation to surgical stress and therefore a lower mortality and morbidity rate [64]. In another study comparing the mortality and morbidity in emergency surgery versus election of diverticulitis,

Fornaro et al reported an incidence of increased mortality in patients operated in emergency (2 of 26 (7.7%)) compared to those operated electively (1 of 25 (4%)). The incidence of complications was higher in patients operated in emergency (7 of 26 (26.9%)) compared to those operated in the election (2 of 25 (8%)) [53]. In our opinion, laparoscopic peritoneal lavage should not only be considered a "bridge" to another surgical intervention. In fact, there is evidence that laparoscopic peritoneal lavage could be a definitive treatment for most patients. In a systematic review reporting 231 patients, most of them (77%) had purulent peritonitis (Hinchey III). Laparoscopic peritoneal lavage successfully controlled abdominal and systemic sepsis in 95.7% of patients. Mortality was 1.7%, morbidity 10.4% and only 4 (1.7%) of the 231 patients received a colostomy [65]. In a retrospective analysis of 63 patients treated with laparoscopic peritoneal lavage, 6 patients (9.5 %) had Hinchey II diverticulitis; 54 patients (85.7 %) had Hinchey III; and 3 patients (4.8 %) had Hinchey IV. 1 patient died because of pulmonary embolism, and there were 6 early reinterventions because of treatment failure. Delayed colonic resection was performed in 4 of the remaining 57 patients (7 %) because of recurrent diverticulitis. In the other 53 patients (93%), no recurrence of diverticulitis and no intervention was performed after a median follow-up period of 54 months (interquartile range 27–98 months) [66]. The European association for endoscopic surgery has suggested in a consensus statement that the laparoscopic peritoneal lavage might be particular advantageous for high-risk patients who would probably not survive Hartmann procedure [67]. Patients who have faecal peritonitis (Hinchey IV), or a large perforation site, and those who fail to improve after lavage should undergo prompt resection. In case of long-time faecal peritonitis and patients who are hemodynamically unstable, or have high-risk Hartmann procedure[68] comorbidities was generally considered. Resection with primary anastomosis is safe for haemodynamically stable patients with Hinchey IV diverticulitis [32]. Fecal contamination of the abdominal cavity is not thought to be a contraindication for construction of a primary anastomosis with diverting ileostomy [69]. Table II summarizes our current orientation in diverticulitis management.

In patients operated for acute dicerticulitis there is a quite high incidence of incisional hernias. This kind of patients has to be considered at quite high risk population, mainly in diabetic or smoking subjects. For this patiens, the prophylactic placement of mesh during closing of abdominal wall incision has been investigated in several prospective studies [70,71].

Conclusions

Acute diverticulitis is conveniently divided into uncomplicated and complicated diverticulitis. Complicated diverticulitis is staged by the Hinchey classification 1-4. Uncomplicated diverticulitis is treated by conservative means. Abscess formation is best treated by US- or CT-guided drainage in combination with antibiotics. The surgical treatment of acute perforated diverticulitis has interchanged between resection (Hartmann procedure or resection of the colon with primary anastomosis) and non-resection strategies. Recently a non-resection strategy consisting of laparoscopy with peritoneal lavage and drainage has been introduced in the treatment of Hinchey stage 3 disease. Thanks to the progress made in interventional and laparoscopic surgery, an increasingly conservative and less invasive treatment is proposed in the management of acute diverticulitis.

Riassunto

Negli ultimi anni si è assistito ad un notevole cambiamento nel trattamento della diverticolite acuta. Vengono riportati indicazioni e tipo di intervento nei pazienti affetti da diverticolite acuta complicata alla luce dei dati della letteratura più recente e dell'esperienza maturata nell'ultimo decennio. L'indicazione alla chirurgia di elezione basata su numero di episodi, età del paziente, presenza di fattori di rischio come l'immunosoppressione, è venuta meno in favore di un approccio personalizzato, differente nel singolo paziente, in funzione della gravità del quadro clinico. Inoltre anche la presenza di pneumoperitoneo non è più da considerare una indicazione alla chirurgia d'urgenza. Nel trattamento della diverticolite acuta complicata da ascesso (Hinchey I-II) oggi si fa ricorso ad un approccio più conservativo: drenaggio percutaneo ed antibioticoterapia. Nei casi di perforazione con peritonite (Hinchey III-IV) la resezione intestinale con o senza ileostomia di protezione è da preferire all'intervento secondo Hartmann, che trova invece indicazione solo nei pazienti con malattie intercorrenti gravi, sepsi severa, instabilità emodinamica, peritonite fecaloide (Hinchey IV) datante da più di 8-12 ore. Recentemente nel trattamento della diverticolite è stato introdotto il lavaggio peritoneale laparoscopico, ma i risultati non consentono di trarre conclusioni certe. In conclusione, grazie ai progressi della terapia conservativa e all'introduzione della laparoscopia, oggi nel trattamento della diverticolite complicata si può proporre sempre di più un atteggiamento più conservativo.

References

1. Weizman AV, Nguyen GC.: *Diverticular disease: epidemiology and management*. Can J Gastroenterol, 2011; 25(7):385-89.

2. Stollman N, Smalley W, Hirano I: *American gastroenterological association institute guideline on the management of acute diverticulitis*. Gastroenterology, 2015; 149(7):1944-949.

3. Painter, NS, Burkitt, DP: *Diverticular disease of the colon, a 20th century problem*. Clin Gastroenterol, 1975; 4(1):3-21.

4. Etzioni DA, Mack TM, Beart RW Jr, Kaiser AM: *Diverticulitis in the United States: 1998-2005: Changing patterns of disease and treatment*. Ann Surg, 2009; 249(2):210-17.

5. Hinchey EJ, Schaal PG, Richards GK: *Treatment of perforated diverticular disease of the colon*. Adv Surg, 1978; 12: 85-109.

6. Barat M, Dohan A, Pautrat K, et al.: *Acute colonic diverticulitis: an update on clinical classification and management with MDCT correlation*. Abdom Radiol (NY), 2016; 41(9):1842-850.

7. Pfützer RH, Kruis W: *Management of diverticular disease*. Nat Rev Gastroenterol Hepatol, 2015; 12(11):629-38.

8. Mastrorilli M, Mastrorilli G, Martini A, Santo C, Maresca M: *Surgical management of acute sigmoid diverticulitis*. Ann Ital Chir, 2008; 79(5):311-20.

9. Feingold D, Steele SR, Lee S, Kaiser A, et al.: *Practice parameters for the treatment of sigmoid diverticulitis*. Dis Colon Rectum, 2014; 57(3):284-94

10. Chapman JR, Dozois EJ, Wolff BG, et al.: *Diverticulitis: A progressive disease? Do multiple recurrences predict less favorable outcomes?* Ann Surg. 2006; 243(6):876-830; discussion 880-3.

11. Salem L, Veenstra DL, Sullivan SD, et al: *The timing of elective colectomy in diverticulitis: A decision analysis*. J Am Coll Surg. 2004; 199(6):904-12.

12. Morris AM,. Regenbogen SE: Sigmoid D*iverticulitis A Systematic Review*. JAMA, 2014; 311(3):287-97.

13. Broderick-Villa G, Burchette RJ, Collins JC, Abbas MA, Haigh PI: *Hospitalization for acute diverticulitis does not mandate routine elective colectomy*. Arch Surg, 2005; 140(6):576-81.

14. Freischlag J, Bennion RS, Thompson JE Jr.: *Complications of diverticular disease of the colon in young people*. Dis Colon Rectum, 1986; 29(10):639-43.

15. Pappalardo G, Frattaroli FM, Coiro S, Spolentini D, Nunziale A, Favella L, Vestri AR, Gualdi GF, Casciani E, Mobarhan S: *Effectiveness of clinical guidelines in the management of acute sigmoid diverticulitis. Results of a prospective diagnostic and therapeutic clinical trial.* Ann Ital Chir, 2013; 84(2):171-77.

16. Pautrat K, Bretagnol F, Huten N, et al.: *Acute diverticulitis in very young patients: A frequent surgical management*. Dis Colon Rectum, 2007; 50: 472-77.

17. Katz LH1, Guy DD, Lahat A, et al.: *Diverticulitis in the young is not more aggressive than in the elderly, but it tends to recur more often: Systematic review and meta-analysis*. J Gastroenterol Hepatol, 2013; 28(8):1274-281.

18. Biondo S1, Parés D, Martí Ragué J, et al.: *Acute colonic diverticulitis in patients under 50 years of age*. Br J Surg, 2002; 89(9):1137-141.

19. Nelson RS, Velasco A, Mukesh BN: *Management of diverticulitis in younger patients*. Dis Colon Rectum, 2006; 49(9):1341-345.

20. Kotzampassakis N, Pittet O, Schmidt S, et al.: *Presentation and treatment outcome of diverticulitis in younger adults: A different disease than in older patients?* Dis Colon Rectum, 2010; 53: 333-38.

21. Tyau ES1, Prystowsky JB, Joehl RJ, et al.: *Acute diverticulitis. A complicated problem in the immunocompromised patient.* Arch Surg, 1991; 126(7):855-8; discussion 858-9.

22. Adamová Z, Slováček R, Sankot J: *Recurrent diverticulitis. Risk factors.* Rozhl Chir, 2013; 92(10):563-68.

23. Biondo S, Borao JL, Kreisler E: *Recurrence and virulence of colonic diverticulitis in immunocompromised patients.* Am J Surg, 2012; 204(2):172-79.

24. Binda GA, Cuomo R, Laghi A, et.: *Practice parameters for the treatment of colonic diverticular disease: Italian Society of Colon and Rectal Surgery (SICCR) guidelines.* Tech Coloproctol, 2015; 19(10):615-26.

25. Miccini M, Borghese O, Scarpini M, Cassini D, Gregori M, Amore Bonapasta S, Tocchi A: *Urgent surgery for sigmoid diverticulitis. Retrospective study of 118 patients*. Ann Ital Chir, 2011; 82(1):41-8.

26. Del Rio P, Dell'Abate P, Soliani P, Ziegler S, Arcuri MF, Sianesi M: *The changes in the emergency surgical treatment of diverticulitis in the last thirty-years*. Ann Ital Chir, 2005; 76(6):529-32; discussion 532-33. Italian.

27. Dharmarajan S, Hunt SR, Birnbaum EH, et al.: *The efficacy of nonoperative management of acute complicated diverticulitis*. Dis Colon Rectum, 2011; 54(6):663-71.

28. Sallinen VJ1, Mentula PJ, Leppäniemi AK: *Nonoperative management of perforated diverticulitis with extraluminal air is safe and effective in selected patients*. Dis Colon Rectum, 2014; 57(7):875-81.

29. Andersen JC, Bundgaard L, Elbrønd H et al.: *Danish national guidelines for treatment of diverticular disease.* Dan Med J, 2012; 59(5):C4453.

30. Andeweg CS, Mulder IM, Felt-Bersma RJ, et al.: *Guidelines of diagnostics and treatment of acute left-sided colonic diverticulitis*. Dig Surg, 2013; 30(4-6):278-92.

31. Hjern F, Josephson T, Altman D et al: *Conservative treatment of acute colonic diverticulitis: Are antibiotics always mandatory*? Scand J Gastroenterol, 2007: 42:41-44.

32. Isacson D1, Thorisson A, Andreasson K,et al.: *Outpatient, non-antibiotic management in acute uncomplicated diverticulitis: A prospective st*udy. Int J Colorectal Dis, 2015; 30(9):1229-234.

33. Chabok A, Påhlman L, Hjern F: *Randomized clinical trial of antibiotics in acute uncomplicated diverticulitis*. Br J Surg, 2012; 99(4):532-39.

34. Shabanzadeh DM, Wille-Jørgensen P: *Antibiotics for uncomplicated diverticulitis.* Cochrane Database Syst Rev, 2012; 11:CD009092.

35. Unlu C, de Korte N, Daniels L, et al.: *A multicenter randomized clinical trial investigating the cost-effectiveness of treatment strategies with or without antibiotics for uncomplicated acute diverticulitis (DIABOLO trial)*. BMC Surg, 10:23.

36. Vennix S, Morton DG, Hahnloser D, et al.: *Systematic review of evidence and consensus on diverticulitis: An analysis of national and international guidelines*. Colorectal Dis, 2014; 16(11):866-78.

37. Siewert B, Tye G, Kruskal J, et al.: *Impact of CT-guided drainage in the treatment of diverticular abscesses: size matters*. AJR Am J Roentgenol, 2006; 186(3):680-86.

38. Bahadursingh AM, Virgo KS, Kaminski DL, et al.: *Spectrum of disease and outcome of complicated diverticular disease.* Am J Surg, 2003; 186(6):696-701.

39. Durmishi Y, Gervaz P, Brandt D, e al.: *Results from percutaneous drainage of Hinchey stage II diverticulitis guided by computed tomography scan*. Surg Endosc, 2006; 20(7):1129-133.

40. Gallinaro LS, Forte A, D'Urso A, Bezzi C, Lorenzotti A, Palumbo P, Lo Storto G, Bezzi M: *Indications and surgical treatment of acute complicated diverticulitis*. Ann Ital Chir. 2001; 72(4):431-35; discussion 435-36. Italian.

41. Oberkofler CE, Rickenbacher A, Raptis DA, et al.: *A multicenter randomized clinical trial of primary anastomosis or Hartmann's procedure for perforated left colonic diverticulitis with purulent or fecal peritonitis.* Ann Surg, 2012; 256(5):819-26; discussion 826-27.

42. Abbas S: *Resection and primary anastomosis in acute complicated diverticulitis, a systematic review of the literature*. Int J Colorectal Dis, 22:351-57.

43. Binda GA, Karas JR, Serventi A, et al.: *Study Group on Diverticulitis (2012) Primary anastomosis vs nonrestorative resection for perforated diverticulitis with peritonitis: a prematurely terminated randomized controlled trial*. Colorectal Dis, 14:1403-410.

44. Constantinides VA, Tekkis PP, Athanasiou T, et al.: *Primary resection with anastomosis vs. Hartmann's procedure in nonelective surgery for acute colonic diverticulitis: a systematic review*. Dis Colon Rectum, 2006; 49:966-81.

45. Salem L, Flum DR: *Primary anastomosis or Hartmann's procedure for patients with diverticular peritonitis? A systematic review*. Dis Colon Rectum 2004; 47:1953-64.

46. Maggard MA, Zingmond D, O'Connell JB, et al.: *What proportion of patients with an ostomy (for diverticulitis) get reversed?* Am Surg, 2004; 70(10):928-31.

47. Vermeulen J, Coene PP, Van Hout NM,et al.: *Restoration of bowel continuity after surgery for acute perforated diverticulitis: Should Hartmann's procedure be considered a one-stage procedure?* Colorectal Dis, 2009; 11: 619-24.

48. Nugent KP, Daniels P, Stewart B, et al.: *Quality of life in stoma patients*. Dis Colon Rectum. 1999; 42:1569574.

49. Hassan I, Larson DW, Cima RR, et al.: *Long-term functional and quality of life outcomes after coloanal anastomosis for distal rectal cancer*. Dis Colon Rectum, 2006; 49:1266-274.

50. Camilleri-Brennan J, Steele RJ: *Prospective analysis of quality of life after reversal of a defunctioning loop ileostomy*. Colorectal Dis, 2002; 4(3):167-71.

51. Tonelli F, Di Carlo V, Liscia G, Serventi A: Div*erticular disease of the colon: Diagnosis and treatment*. Consensus Conference, 5th National Congress of the Italian Society of Academic Surgeons. Ann Ital Chir. 2009; 80(1):3-8. Italian. Erratum in: Ann Ital Chir. 2009;80(2):3 p preceding table of contents. Liscia, Gabriel [corrected to Liscia, Gadiel].

52. Köckerling F: *Emergency surgery for acute complicated diverticulitis*. Viszeralmedizin, 2015; 31(2):107-10.

53. Fornaro R, Canaletti M, Terrizzi A, et al.: *Surgery for complicated colonic diverticulitis. Our experience*. G Chir. 2005; 26(4):143-52

54. Angenete E, Thornell A, Burcharth J, et al.: *Laparoscopic Lavage is feasible and safe for the treatment of perforated diverticulitis with purulent peritonitis: The first results from the randomized controlled trial DILALA*. Ann Surg, 2016; 263(1):117-22.

55. Occhionorelli S, Zese M, Tartarini D, Lacavalla D, Maccatrozzo S, Groppo G, Sibilla MG, Stano R, Cappellari L, Vasquez G: *An approach to complicated diverticular disease. A retrospective study in an Acute Care Surgery service recently established*. Ann Ital Chir, 2016; 87:553-63.

56. Rogers AC, Collins D, O'Sullivan GC, et al.: *Laparoscopic lavage for perforated diverticulitis: A population analysis.* Dis Colon Rectum 2012; 55: 932-38.

57. Vennix S, van Dieren S, Opmeer BC, et al.: *Cost analysis of laparoscopic lavage compared with sigmoid resection for perforated diverticulitis in the Ladies trial*. Br J Surg, 2017; 104(1):62-68.

58. Ceresoli M, Coccolini F, Montori G, et al.: *Laparoscopic lavage versus resection in perforated diverticulitis with purulent peritonitis: a meta-analysis of randomized controlled trials.* World J Emerg Surg, 2016; 11(1):42.

59. Catry J, Brouquet A, Peschaud F. et al.: *Sigmoid resection with primary anastomosis and ileostomy versus laparoscopic lavage in purulent peritonitis from perforated diverticulitis: Outcome analysis in a prospective cohort of 40 consecutive patients.* Int J Colorectal Dis, 2016; 31(10):1693-699.

60. Schultz JK, Yaqub S, Wallon C, et al.: *Laparoscopic lavage vs primary resection for acute perforated diverticulitis: The SCANDIV Randomized Clinical Trial*. JAMA, 2015 6;314(13):1364-375.

61. Vennix S, Musters GD, Mulder IM, et al.: *Laparoscopic peritoneal lavage or sigmoidectomy for perforated diverticulitis with purulent peritonitis: A multicentre, parallel-group, randomised, open-label trial*. Lancet, 2015; 386(10000):1269-277.

62. Cirocchi R, Trastulli S, Vettoretto N , et al.: *Laparoscopic peritoneal lavage: a definitive treatment for diverticular peritonitis or a "bridge" to elective laparoscopic sigmoidectomy?: A systematic review*. Medicine (Baltimore), 2015; 94(1):e334.

63. Netri G, Verbo A, Coco C, Cogliandolo S, Mattana C, Salvadori L, D'Andrilli A, Picciocchi A: *The role of surgical treatment in colon diverticulitis: Indications and results.* Ann Ital Chir, 2000; 71(2):209-14; discussion 214-15.

64. Fornaro R, Stabilini C, Picori E, et al.: *Abdominal emergency surgery in the geriatric patients. Our experience.* G Chir, 2006; 27(4):137-44.

65. Toorenvliet BR, Swank H, Schoones JW, et al.: *Laparoscopic peritoneal lavage for perforated colonic diverticulitis: a systematic review.* Colorectal Dis, 2010; 12: 862-67.

66. Sorrentino M, Brizzolari M, Scarpa E, et al: *Laparoscopic peritoneal lavage for perforated colonic diverticulitis: A definitive treatment? Retrospective analysis of 63 cases*. Tech Coloproctol, 2015; 19(2):105-10.

67. Sauerland S, Agresta F, Bergamaschi R, et al.: *Laparoscopy for abdominal emergencies: Evidence-based guidelines of the European Association for Endoscopic Surgery*. Surg Endosc, 2006; 20(1):14-29.

68. Cuomo R, Barbara G, Pace F, et al.: *Italian consensus conference for colonic diverticulosis and diverticular disease*. United European Gastroenterol J, 2014; 2(5):413-42.

69. Vermeulen J, Lange JF: *Treatment of perforated diverticulitis with generalized peritonitis: past, present, and future*. World J Surg, 2010; 34: 587-593.

70. Stabilini C, Bracale U, Pignata G, Frascio M, Casaccia M, Pelosi P, Signori A, Testa T, Rosa GM, Morelli N, Fornaro R, Palombo D, Perotti S, Bruno MS, Imperatore M, Righetti C, Pezzato S, Lazzara F, Gianetta E: *Laparoscopic bridging vs. anatomic open reconstruction for midline abdominal hernia mesh repair [LABOR]: single-blinded, multicenter, randomized, controlled trial on long-term functional results.* Trials, 2013; 14: 357. doi: 10.1186/1745-6215-14-357.

71. Muysoms FE, Dietz UA: *Prophylactic meshes in the abdominal wall.* Chirurg, 2017; 88(Suppl 1):34-41. doi: 10.1007/s00104-016-0229-7.