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How has Changed The Surgical Approach for The Management of Acute Inflammatory Complications of Diverticular Disease of The Colon: Analysis Of Two Periods

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***Abstract*— Background: The aim of this study was to analyze the most appropriate surgical strategy in the management of patients with major inflammatory complications of colonic diverticular disease.**

Materials and Methods: Out of 539 patients affected by complicated diverticular disease of the colon, 125 consecutive patients (23.2%) who underwent urgent or emergency surgical intervention for diverticular perforation during a 13 year period (2000-2013), were retrospectively analyzed. According to the changes in the surgical approach over the time, the series was divided into two groups: 2000-2005 Group A (n=59), 2006-2013 Group B (n=66). The clinical diagnosis was confirmed by operative and pathologic findings.

Results: **Out of 109 patients, 28 underwent derivative procedure and 81 resection. There were no significant differences among the two groups of patients according to sex ratio and mean age. The overall percentage of patients in group B who underwent resective procedure (91%) was significantly greater in comparison with that in group A (53%). Colostomy and drainage was employed only during the first period (30%), (Group A vs Group B, $p<0.05$) and the proportion of patients who underwent primary resection and anastomosis was significantly higher during the second period (41%), (Group B vs Group A, $p<0.05$).**

Conclusions: It must be stressed that resection of the diseased segment at initial operation appears mandatory; one-stage procedure is indicated when infection is confined to the mesentery, while resection and anastomosis with covering colostomy (two-stage procedure) is preferable whenever peritoneal contamination has occurred. According to the literature Hartmann's operation may be the procedure of choice in the patients presenting known impaired immunity or fecal contamination.

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***Index Terms*— Diverticular disease, Complicated diverticulitis, Intra-abdominal infections, Conservative Treatment, Colostomy.**

I. INTRODUCTION

Only a small proportion of patients with diverticular disease of the colon develop life-threatening complications such as diverticulitis, free perforation, stricture formation, bleeding, abscess and fistula [1]. It has been estimated that about 10-20% admitted with acute diverticulitis, both complicated and uncomplicated, will require surgical intervention during their initial admission [2,3,4], generalized purulent or fecal peritonitis is found in 20% to 60% of this cases, with an overall mortality rates varying from 5% to 45% [1].
Those with complicated diverticulitis are even more likely to require an operation during their initial hospitalization, upwards of 50% of the time [5]. Given the substantial morbidity associated with urgent colectomy for complicated diverticulitis, however, there is a trend to favor non-operative management initially. The proportion of patients undergoing urgent colectomies has decreased in recent years, from 71 to 55% [5].

With this retrospective study we tried to analyze the results of surgical treatment in a series of 125 consecutive patients presenting with perforated sigmoid diverticulitis.

II. METHODS

Five-hundred-thirty-nine patients admitted for acute diverticulitis in a 13 years period, from January 2000 to December 2013, were recorded in our database. Of these, 125 (23.2%) consecutive patients who underwent surgical intervention for complicated diverticulitis was analyzed in the present study.
Their mean age was 62.7 years (range from 32 to 87); 48 females and 77 males.

The series were divided into two groups according to the surgical approach which changed over the time: 59 patients who underwent surgery between January 2000 and December 2005 constituted Group A, and Group B included 66 patients surgically treated between January 2006 and December 2013.
All patients required surgery or either an acute condition or failure to respond to medical treatment. The

clinical diagnosis was confirmed by operative or pathologic findings. We used the modified Hinchey classification, introducing stage 0 and differentiating stage I in Ia and Ib (Table 1) [6]. The increasing use of CT, as to become the gold standard in the diagnosis of acute diverticulitis (AD), led to several radiologic classifications. The most used imaging classification was proposed by Kaiser et al [7]: CT findings were correlated with the modified Hinchey scores to come to uniform reporting of CT findings (Table 1) [8].

Table 1. Modified Hinchey classification and CT findings

0	Clinically mild diverticulitis	Diverticula with or without colonic wall thickening
Ia	Confined pericolic inflammation or phlegmon	Colonic wall thickening with inflammatory reaction in pericolic soft tissue
Ib	Pericolic or mesocolic abscess formation (<5 cm) in proximity of the primary inflammatory process	Stage Ia changes + pericolic or mesocolic abscess formation
II	Intra-abdominal, pelvic or retroperitoneal abscess, abscess distant from the primary inflammatory process	Stage Ia changes + distant abscess (generally deep in the pelvis or interloop regions)
III	Generalized purulent peritonitis	Free gas associated with localized or generalized free fluid and possible peritoneal wall thickening
IV	Generalized fecal peritonitis	Same findings as stage III

Data regarding age, sex, associated diseases, surgical procedure, pathologic findings, major complications (fistula, anastomotic leakage, intra-abdominal abscess and wound infection) and hospital mortality were collected for all patients.

The significance of differences between groups was assessed by test with Yates's correction and Student's t two-tailed test. Probabilities of less than 0.05 were accepted as significant.

III. RESULTS

There were no significant differences between the two groups of patients according to the sex ratio and mean age. In both groups, about 20% of the patients had associated diseases requiring concurrent medical treatment: cardiovascular disease, chronic obstructive airways disease, or diabetes mellitus were the most frequently observed.

Sixteen patients, 6 in the Group A and 10 in Group B, submitted only to laparoscopic peritoneal lavage and drainage without colonic resection and/or colostomy were excluded from the study because we decided to analyzed the patients with the same surgical approach . All of these patients were males. Table 2 shows the characteristics of the 109 remaining patients and the various types of treatment they have undergone in the two periods of time under consideration.

Table 2. Characterstics of the two groups of patients treated for complicated diverticular disease of the Colon

	Group A	Group B
Time interval	2000-2005	2006-2013
of patients	53	56
Mean age (year)	63.9	61.1
Sex (m/f)	30/23	31/25
Associated diseases	11 (20.7%)	9 (16%)
Surgical procedure:		
Colostomy and Drainage	16 (30%)*	3 (5.4%)
Bloch-Mikulicz exteriorization	9 (17%)	2 (3.6%)
Hartmann's procedure	5 (9.4%)	15 (26.8%)
Resection and Anastomosis	5 (9.4%)*	23 (41%)
Resection, Anastomosis, Colostomy	18 (34%)	13 (23%)
Major complications	10 (18.8%)	5 (8.9%)
Mortality	8 (15.1%)	3 (5.3%)

*vs group B $p<0.05$

The overall percentage of patients in group B who underwent resective procedure (100%) without colostomy was significantly greater than that observed in group A (41% group B vs 9.4% group A; $p< 0.0001$). Colostomy and drainage, which was employed only in the first time period (30% group A vs 5.4% group B; $p< 0.002$), was the first step of a three-stage procedure in 16 patients. In the second period (group B) the proportion of patients who underwent resection and anastomosis with and without colostomy was percentage higher than in Group A (64% vs 43%). The frequency of the other procedures (Bloch-Mikulicz exteriorization and Hartmann operation) was not discernibly different between groups.

Although the incidence of major complications progressively declined from 18.8% in the earliest group to 8.9% in the most recent, the difference is not statistically significant.

The overall mortality associated with perforated diverticular disease throughout the period of study was 15.1% in group A and 5.3% in group B; in spite of this evident difference, the small size of the sample has precluded any statistical significance.

The distribution of the type and extent of peritoneal contamination in the two groups, according to the modified Hinchey classification, is shown in Table 3. The distribution of the different stages in the group A was quite similar to that found in group B, although Hinchey's stage IV occurred

more frequently in the earlier period: 14 patients (26.4%) in Group A, and 6 patients (10.7%) in Group B

Table 3. Degree of peritoneal contamination in 109 patients with complicated diverticulitis, according to the modified Hinchey's classification.

		Group A	Group B
Stage	I a-b	7	14
Stage	II	16	25
Stage	III	16	11
Stage	IV	14	6

Table 4 summarizes the correlations between surgical procedure, stage of disease, and associated mortality, stratified by the two time periods.

In the 53 patients of group A, the derivative procedures (colostomy and drainage, and Block-Mikulicz exteriorization) were employed in 69% of patients with generalized purulent peritonitis (stage III) and in all the patients with generalized fecal peritonitis (stage IV). Hartmann's operation was carried out in the other five patients at stage III (31%). All cases with a walled-off pelvic abscess (stage II) were managed by resection and anastomosis with colostomy. Primary resection and anastomosis without colostomy was the surgical treatment of choice in 5 of the 7 patients (71%) with pericolic abscess or acute phlegmonous diverticulitis (stage I), while in the remaining case a colostomy was associated with the resective procedure.

The mortality rate observed in 25 patients of group A treated with derivative procedure was 24%.

In group B, the percentage of patients who underwent Hartmann's operation was 100 % at stage IV, 50% at stage III, and 12% at stage II. Primary resection and anastomosis with colostomy was die procedure performed in 27% of patients at stage III, and in 44% at stage II. Primary resection and anastomosis without colostomy represented the surgical option in 11 of the 25 patients (44%) at stage II, and in all 14 patients at stage I.

The overall mortality rate observed in the two groups after Hartmann's procedure was 9% and 6.7% after primary resection and anastomosis, where the frequency of clinically significant anastomotic leaks occurring in the 30 patients without a protective stoma accounted for 7%.

Table 4. Correlation between surgical procedure and stage of the perforative diverticular disease of the colon.

Procedure	Group	Stage			
		I	II	III	IV
Colostomy and drainage	**A**	-	-	**5***	**12**[4]**
	B	-	-	-	-
Bloch-Mikulicz exteriorization	**A**	-	-	**6 [2]**	**2**
	B	-	-	-	-
Hartmann's procedure	**A**	-	-	**5**	-
	B	-	3	8	6|2]
Resection and anastomosis	**A**	**5 [1]**	-	-	-
	B	14	11 [1]	-	-
Resection, anastomosis, and colostomy	**A**	**2**	**16 [1]**	-	-
	B	-	11	3	-

[ ] = number of death * = three-stage approach in 3/ patients ** = three-stage approach in 7 [2] patients

IV. DISCUSSION

Left colon diverticulitis is an increasingly common and costly disease, endemic in industrialized nations. Between 1998 and 2005 the costs for hospital admissions for AD increased by 26% and elective operations by 29% in US [9]. Furthermore, hospitalizations for acute diverticulitis are increasing, leading to escalating costs in the US, now estimated to exceed 2.4 billion dollars annually [9]. Surgical approach to perforative diverticular disease of the colon, continues to give rise to controversy in a substantial portion of the literature [10]. It has been estimated that about 15-20% of all patients admitted with acute diverticulitis, both complicated and uncomplicated, will require surgical intervention during their initial admission [11,4]. However, treatment of complicated diverticulitis in the acute setting depends on the patient's overall clinical condition and degree of peritoneal contamination and infection [2]. Main surgical options have been available in the treatment of acute perforated sigmoid diverticulitis: drainage alone; diverting colostomy with drainage of the perforation; exteriorization of the perforated colonic segment; resection of the perforated segment with end colostomy or primary anastomosis with or without covering colostomy. Changing patterns in the surgical treatment of perforated diverticular disease may be abridged from diverting proximal colostomy with drainage, characterized by a high mortality rate (20% - 40%) especially in patients with advanced generalized peritonitis [12] toward resection of the perforated colonic segment and primary anastomosis, with a covering stoma whenever indicated [13,14].

In our experience, the conservative procedure alone (transverse loop colostomy and drainage) was established in poor risk patients who could not stand any other type of treatment, while in the others it represented the first stage procedure. It should be pointed out that this approach was chosen exclusively in the earlier period because of the less sophisticated antibiotic, anesthesia and postoperative care required.

Since 1960s, numerous reports on perforated diverticulitis have shown a decrease in morbidity and mortality after primary resection of the diseased segment as compared to staged procedures where colostomy and drainage represented the first stage [15,16,17]. However, it should be stressed that the main characteristic of a safe procedure is to allow the removal of the source of infection both from the peritoneal cavity and the blood stream, and to avoid the problem of anastomosis in unprepared and inflamed large bowel, particularly in patients with generalized peritonitis [18,19], in whom anastomotic leak may occur with a frequency ranging from 20% to 30% [20]. This is not the case for the Bloch-Mikulicz exteriorization, frequently a very troublesome procedure because of inflammatory changes; however, this surgical option does not avoid endotoxemia resulting from reabsorption of toxic: and bacterial substances from the perforated sigmoid laying outside the peritoneal cavity and it has been abandoned in our practice because of the related mortality approaching 50% [21].

Hartmann's procedure has gained a wide acceptance in the treatment of acute diseases of the left colon and rectum. Along with main others [22,23] who emphasized usefulness and safeness of this procedure, Fisenstat et al. [24] reported a series of 44 patients who underwent Hartmann's procedure

with a mortality rate of 4.5% and Hollender et al. [25] managed 75 patients with the same operation and achieved a mortality rate of 17.5%. In contrast. Berry et al [26] criticized this procedure, reporting a mortality rate near to 30%. Further criticism comes from some reports suggesting technical difficulty in restoring the intestinal continuity because of adhesions in the pelvic region and withdrawal of rectal stump, even if this drawback appears to be overcome by widespread use of mechanical staplers [21,27,28]

Undoubtedly, Hartmann's procedure is very useful to treat the acute phase of most severe conditions and the employment of this operation in our patients with generalized peritonitis gave valuable results, with an overall mortality rate (12.5%) in the range of that generally reported 2 (3%) to 3 (3.8%) and significantly lower as compared to diverting proximal colostomy combined with drainage and Bloch-Mikulicz exteriorization.

Althought historically, Hartmann procedure (HP) has been the intervention of choice in the urgent setting, retrospective studies comparing HP to primary anastomosis (PA) with or without ileostomy have shown similar short-term outcomes (including mortality and postoperative infections) [29,30.].

A systematic review concluded that the overall morbidity and mortality were higher for HP than for PA, suggesting that PA with or without proximal ileostomy is safe in patients with diverticular peritonitis [31]

Reports in the literature [32,33,34] showed great enthusiasm for primary resection of the perforated colonic segment and immediate anastomosis in many instances of pelvic: abscess or peritonitis, this approach is not advisable and it should be established only in strictly selected patients. The fact that primary resection and anastomosis presents the lowest mortality is probably due to the selection of cases and inappropriate inclusion of patients with localized peritonitis and abscesses in studies devoted to diffuse peritonitis [34]. However, most reports resolutely affirm that primary resection and anastomosis is not advisable in wide abdominal and pelvic abscess or in case of generalized purulent or fecal peritonitis. In these patients and in those with an unprepared bowel, Hartmann's procedure has been widely advocated [31]. Killingback et al. [36] reported an anastomotic leakage rate of 29.7% in patients treated by resection and immediate anastomosis, Krukowski and Malheson [37] indicated clinical leak rates of 17% to 30% and mortality rates of 28% to 50% after primary anastomosis in the unprepared colon. Otherwise, Alanis et al. [38], comparing the results of the primary resection and anastomosis with those of Hartmann's procedure, reported a mortality rate of 3.4% and 15.7% respectively.

In our retrospective study, primary resection and anastomosis resulted with an acceptable overall mortality rate (6.7%) and abscess formation did not preclude the employment of this procedure. Our tendency, however, was to protect the anastomosis with a proximal colostomy whenever peritoneal contamination was encountered. As our data suggest, the results obtained after primary resection and anastomosis combined with protective stoma seem to be better than, not only those after one-stage procedure, but also after the other two-stage procedure (Hartmann's operation). Nevertheless, the type and extent, of inflammatory changes, determined by Hinchey's classification and CT findings [39], and the condition of the patient at the time of operation are more important factors in the operative management plan of patients with perforative diverticular disease than the choice of operative approach and whether or not a primary anastomosis may be performed. Therefore patient selection remains an important component. In most studies, the patients selected for PA were younger, with lower Hinchey scores [40]. In a trial by Oberkofler et al [41], which randomized 62 patients to PA with ileostomy versus HP found similar mortality and complication rates, only 58% of the patients who underwent HP, however, had future reversal of their stoma [41]. Furthermore, colostomy use has been associated with higher comorbidities [9]. Concordant with recommendations from the literature, recent data has shown that the use of primary anastomosis in the acute setting is increasing [14].

Laparoscopic lavage has been proposed as an alternative management strategy in patients with peritonitis in order to control contamination and bridge these patients to elective resection with primary anastomosis at a later date. Small observational studies have shown fewer complications in patients with diverticulitis undergoing laparoscopic lavage versus primary resection but the patients selected for laparoscopic lavage were healthier with lower Hinchey grades [1,42,43]. Our experience with laparoscopic surgery in emergency is initial, the few cases handled do not allow us to express an opinion on the validity of the method, so of course we did not included these experience in the present study.

In conclusion, in planning the surgical management of complicated diverticulitis is at first mandatory to recognize and differentiate diverticulitis associated with abscess or phlegmon and diverticulitis with free perforation. Actually we believe that the treatment of complicated diverticulitis must follow a proper framework within the classification Hichey modified: Hinchey Ib-II, conservative treatment with antibiotics and fluid therapy; the literature reports a success rate of 73% [44,45]. In case of failure of conservative treatment, US or CT guided percutaneous drainage should be performed, with a success up to 81% [8].
Hincey III-IV, many surgical procedures may be performed: peritoneal toilette and drainage, colonic resection with primary anastomosis (with or without a protective ileostomy or colostomy).

CONCLUSIONS

In conclusion, the decision on the type of surgical procedure is left to the judgment of the surgeon, taking into account the clinical status of the patient including comorbidities, health of the remaining intestine, and extent of peritoneal contamination.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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MG: manuscript preparation, interpretation of data and critical review.
GL: acquisition data and drafting the manuscript.
FDS: acquisition data and literature review.
CN: acquisition and processing data
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MC: acquisition and processing data.

SG: acquisition and processing data.
MV: literature review and manuscript preparation.
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