

# Role of Damage Control Surgery in the Treatment of Hinchey III and IV Sigmoid Diverticulitis

## *A Tailored Strategy*

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**Abstract:** Many of the treatment strategies for sigmoid diverticulitis are actually focusing on nonoperative and minimally invasive approaches. The aim of this systematic review was to evaluate the actual role of damage control surgery (DCS) in the treatment of generalized peritonitis caused by perforated sigmoid diverticulitis.

A literature search was performed in PubMed and Google Scholar for articles published from 1960 to July 2013. Comparative and non-comparative studies that included patients who underwent DCS for complicated diverticulitis were considered.

Acute Physiology and Chronic Health Evaluation score, duration of open abdomen, intensive care unit length of stay, reoperation, bowel resection performed at first operation, fecal diversion, method, and timing of closure of abdominal wall were the main outcomes of interest.

According to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses algorithm for the literature search and review, 10 studies were included in this systematic review. DCS was exclusively performed in diverticulitis patients with septic shock or requiring vasopressors intraoperatively. Two surgical different approaches were highlighted: limited resection of the diseased colonic segment with or without stoma or reconstruction in situ, and laparoscopic washing and drainage without colonic resection.

Despite the heterogeneity of patient groups, clinical settings, and interventions included in this review, DCS appears to be a promising

strategy for the treatment of Hinchey III and IV diverticulitis, complicated by septic shock. A tailored approach to each patient seems to be appropriate.

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**Abbreviations:** AD = acute diverticulitis, APACHE = Acute Physiology and Chronic Health Evaluation, DCS = damage control surgery, HP = Hartmann procedure, ICU = intensive care unit, PA = primary anastomosis, POSSUM = Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity.

## INTRODUCTION

Generalized peritonitis as a consequence of complicated acute diverticulitis (AD) is rare and corresponds to stages III and IV of the Hinchey classification.<sup>1</sup> Mortality is still high, up to 40% of cases, despite the progress in antibiotics regimens and fluid administration.<sup>2</sup> Hartmann procedure (HP) has long been considered to be a safe treatment for this severe clinical condition, accounting for about a half of all patients undergoing surgery for complicated AD in Europe, mostly as an open procedure;<sup>3</sup> however, more than 1/3 of the patients who undergo a HP do not have their stoma reversed within 1 year,<sup>4</sup> if ever<sup>5</sup> and when they have, they are exposed to the risk of a difficult surgical procedure due to the unrare sequela of the generalized peritonitis. Combined with improvements in medical support, this has led surgeons to consider whether resection with primary anastomosis (PA) or any other less-invasive surgical procedure could provide equivalent safety. Two multicenter trials,<sup>6,7</sup> the latter aborted because of difficult accrual,<sup>8</sup> found substantial equivalence between HP and PA groups in terms of morbidity, although patients with both purulent and fecal peritonitis were included. A recent systematic review and meta-analysis including 1041 patients, despite a vast heterogeneity of patients' characteristics, suggested an advantage in terms of mortality and hospital stay in favor of PA.<sup>9</sup>

Patients with Hinchey III and IV with severe sepsis might benefit from damage control surgery (DCS).<sup>10</sup> Initially described for the treatment of major abdominal injuries,<sup>11,12</sup> indications for DCS have been extended to patients with necrotizing pancreatitis, severe peritonitis, or intraperitoneal hemorrhage.<sup>13</sup>

The aim of this systematic review was to evaluate the actual role of DCS in the treatment of generalized peritonitis caused by perforated sigmoid diverticulitis and determine

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whether there were any specific indications for one approach or another

## METHODS

A systematic literature search was performed on PubMed and Google Scholar from January 1960 to July 2014. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses was followed. The following search strategies were used in PubMed:

- 1 damage[All Fields] AND (“prevention and control”[Sub-heading] OR (“prevention”[All Fields] AND “control”[All Fields]) OR “prevention and control”[All Fields] OR “control”[All Fields] OR “control groups”[MeSH Terms] OR (“control”[All Fields] AND “groups”[All Fields]) OR “control groups”[All Fields]) AND (“surgery”[Sub-heading] OR “surgery”[All Fields] OR “surgical procedures, operative”[MeSH Terms] OR (“surgical”[All Fields] AND “procedures”[All Fields] AND “operative”[All Fields]) OR “operative surgical procedures”[All Fields] OR “surgery”[All Fields] OR “general surgery”[MeSH Terms] OR (“general”[All Fields] AND “surgery”[All Fields]) OR “general surgery”[All Fields]) AND (“diverticulitis”[MeSH Terms] OR “diverticulitis”[All Fields])
- 2 damage[All Fields] AND (“prevention and control”[Sub-heading] OR (“prevention”[All Fields] AND “control”[All Fields]) OR “prevention and control”[All Fields] OR “control”[All Fields] OR “control groups”[MeSH Terms] OR (“control”[All Fields] AND “groups”[All Fields]) OR “control groups”[All Fields]) AND (“laparotomy”[MeSH Terms] OR “laparotomy”[All Fields] AND (“diverticulitis”[MeSH Terms] OR “diverticulitis”[All Fields])
- 3 (“colon, sigmoid”[MeSH Terms] OR (“colon”[All Fields] AND “sigmoid”[All Fields]) OR “sigmoid colon”[All Fields] OR “sigmoid”[All Fields]) AND (“diverticulitis”[MeSH Terms] OR “diverticulitis”[All Fields]) AND damage[All Fields] AND (“prevention and control”[Sub-heading] OR (“prevention”[All Fields] AND “control”[All Fields]) OR “prevention and control”[All Fields] OR “control”[All Fields] OR “control groups”[MeSH Terms] OR (“control”[All Fields] AND “groups”[All Fields]) OR “control groups”[All Fields]) AND (“surgery”[Sub-heading] OR “surgery”[All Fields] OR “surgical procedures, operative”[MeSH Terms] OR (“surgical”[All Fields] AND “procedures”[All Fields] AND “operative”[All Fields]) OR “operative surgical procedures”[All Fields] OR “surgery”[All Fields] OR “general surgery”[MeSH Terms] OR (“general”[All Fields] AND “surgery”[All Fields]) OR “general surgery”[All Fields])
- 4 feculent [All Fields] AND (“peritonitis”[MeSH Terms] OR “peritonitis”[All Fields])

All titles and abstracts were assessed to select those focusing on DCS. Subsequently, the full text of the selected trials was independently screened by 2 authors (RC and GC) for eligibility.

When there was overlapping between multiple articles published by the same authors and no difference in the examined time, only the most recent trial was enclosed to avoid redundant counting. The PubMed function “related articles” were used to search further articles. The references of the included studies were evaluated for other potential trials missed by the screening process. Ethical approval for this study was not necessary because of its design consisting a systematic review of the literature.

## Inclusion Criteria

We considered both comparative and noncomparative studies, which included patients who underwent DCS for complicated diverticulitis irrespectively of their size, publication status, or language. Comparative studies were included if they focused on selected outcomes of interest (Acute Physiology and Chronic Health Evaluation [APACHE] II score, duration of open abdomen, intensive care unit [ICU] day, reoperation, bowel resection performed at first operation, fecal diversion, method, and timing of closure of abdominal wall), irrespectively of the type of surgical approach used for comparative group (laparoscopic or open).

## Data Extraction

Included studies were reviewed and data were extracted by 2 blinded reviewers (RC and GC) using a standardized data extraction form.

## Assessment of Risk of Bias in Included Studies

We assessed the methodological quality of the trials independently, without masking the trial names. The review authors performed the risk of bias assessment according to “The Cochrane Collaboration tool for assessing risk of bias.”<sup>14</sup>

## RESULTS

Our comprehensive literature search identified 4550 records, of which 50 full texts were identified for further examination, while the others were excluded based on the titles and/or abstract. According to the inclusion criteria, 10 studies were selected for the current review and analysis. All studies were published in English (Figure 1).

## Description of Studies

A detailed description of the characteristics of patients included in the 10 selected studies is presented in Table 1.<sup>15–24</sup>

Only patients with septic shock caused by severe purulent (Hinchey III) or fecal (Hinchey IV) peritonitis<sup>15</sup> and who required catecholamine administration because of perioperative general conditions<sup>15,16,20,21</sup> underwent conventional DCS.

## Definition of DCS

Two different DCS approaches have been described in the literature to treat acute peritonitis caused by diverticulitis.

The first, that is, conventional,<sup>15,16,18,20,21,24</sup> is characterized by the shortest possible initial emergency operation focused on source control (limited resection of the diseased colonic segment) leaving the stapled remaining colon with or without a stoma or reconstruction in situ. In selected cases, instead of colonic resection, closure of the perforation site with interrupted sutures, adequate lavage, and temporary closure was performed. In all cases after 24–48 hours of reequilibration in the ICU, definitive surgical treatment was applied. The authors who followed this approach proposed different abdominal closure techniques: most recommended temporary abdominal closure while a few preferred vacuum-assisted closure (VAC).<sup>15,21</sup>

The second consists laparoscopic abdominal washing and drainage only, without resection.<sup>19,24</sup> The proponents of washing and drainage<sup>19,24</sup> considered these procedures as definitive surgery and reintervention was performed only in case of postoperative complications.<sup>19</sup> Moore et al<sup>20</sup> did not consider this technique as DCS and reserved it only for patients with Hinchey III without septic shock.

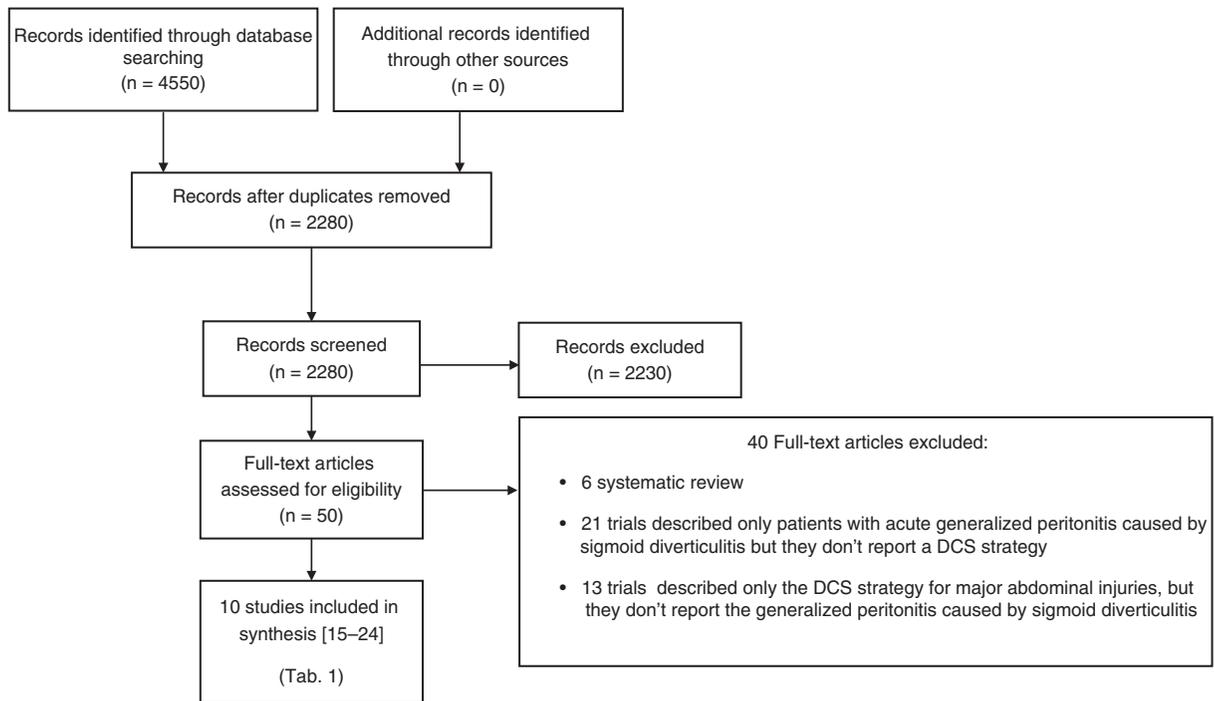


FIGURE 1. PRISMA flowchart of literature search. PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

### Patients Who Underwent DCS

Conventional DCS<sup>15,16,18,20,21,24</sup> was performed in patients with septic shock defined as hemodynamically unstable patients who required immediate inotropic or vasopressor support<sup>15,16,20,21</sup> and generalized purulent or fecal peritonitis; on the contrary, patients who underwent laparoscopic DCS had only generalized purulent or fecal peritonitis and were not hemodynamically unstable.<sup>19,22</sup> Kwon et al<sup>16</sup> recommended the HP in unstable but controllable patients, while DCS should be limited to extremely unstable patients.

DCS involved a 3-staged approach—stage I: an abbreviated initial operative procedure with temporary abdominal closure; stage II: continued resuscitation and management of physiologic and acid–base derangements; and stage III: definitive treatment and closure.<sup>25</sup>

Subgroup analysis for type of abbreviated initial operative procedure with temporary abdominal closure (stage I of DCS) revealed that the majority of surgeons insisted on limited resection of diseased colon. Both Kafka-Ritsch et al<sup>18</sup> and Perathoner et al<sup>21</sup> left the colon stapled-off in situ without reconstruction in 45 of 51 cases. In the remaining, selected cases (6/51), the perforation site was closed with interrupted sutures without colonic resection.<sup>15,18</sup> Other authors performed colonic resection with colostomy in all cases (HP).<sup>24</sup> According to Ferrada and Ivatury,<sup>15</sup> Kwon et al,<sup>16</sup> and Moore et al,<sup>20</sup> treatment should be tailored: “a limited colon resection of the inflamed colon is performed using staplers, with no colostomy.” Ferrada and Ivatury,<sup>15</sup> Kwon et al,<sup>16</sup> Kafka-Ritsch et al,<sup>18</sup> and Perathoner et al<sup>21</sup> preferred temporary abdominal VAC.

Subgroup analysis for recovery in ICU (stage II of DCS) revealed that after surgery, all patients were admitted to ICU for resuscitation. The duration of ICU ranged from 24 to 48 hours in all reports.<sup>15–24</sup>

Subgroup analysis for type of secondary procedures (stage III of DCS) showed that bowel continuity restoration or colostomy was performed by planned relaparotomy<sup>21</sup> or on-demand relaparotomy<sup>20</sup> and the choice was based on surgeon’s preference.

Moreover, our review failed to determine whether any distinct physiologic parameters (eg, APACHE and Physiologic and Operative Severity Score for the Enumeration of Mortality and Morbidity [POSSUM]) were useful to triage patients into receiving DCS versus other treatment.

### DISCUSSION

The goal of DCS is the same as in trauma surgery: the initial emergency operation is to be kept as short as possible and focused on limiting the physiological insult.

The concept of DCS is based on a sequence of key phases<sup>25</sup>: short initial surgery, ICU for resuscitation, and return to the operating room as soon as normal or near-normal physiology is reached for the definitive operation. In trauma patients, this multistage approach is first of all performed to avoid or correct the lethal triad of hypothermia, acidosis, and coagulopathy,<sup>26</sup> particularly well suited in patients with critical hemodynamic conditions, excessive peritoneal edema, difficulty to obtain a definitive control of the source of sepsis, incomplete debridement of necrotic tissue, uncertainty about bowel viability, uncontrolled bleeding, and massive abdominal wall loss.<sup>27</sup> The goal of DCS in nontrauma patients is to obtain the same reduction of mortality. Some authors<sup>28</sup> prefer the terms “advanced open operative treatment of peritonitis” or “aggressive method” terms<sup>29</sup> instead of DCS. This approach is in accordance with the American Society of Colon and Rectal Surgeons practice parameters for sigmoid diverticulitis: minimum resection and diversion in urgent and emergent cases are generally required.<sup>30</sup> Perathoner et al<sup>21</sup> and Kafka-Ritsch et al<sup>18</sup>

TABLE 1. Characteristics of the Included Studies

Author	Year of Publication	Type of Article	Characteristics of Patients	Procedure Performed During DCS	ICU Stay	Reoperation Timing
Ferrada and Ivatury <sup>15</sup>	2013	Review	Patients with compromised hemodynamic parameters caused by severe purulent or fecal peritonitis resulting in consequent acidosis and septic shock	Rapid perforectomy and leaving the colon in discontinuity, abdominal washout to evacuate pus and feces, and temporary abdominal closure with application of any variation of the VAC	Resuscitation in ICU	Usually within 24–48 h patients returned to definitive HP, colonic anastomosis is performed very rarely
Kwon et al <sup>16</sup>	2013	Review	Extremely unstable patients	Emergent laparotomy, colonic resection (no anastomosis/stomy at first intervention), peritoneal washing, temporary abdominal closure	Resuscitation in ICU	24–48 h
Moore et al <sup>17</sup>	2013	Review	Stages III and IV diverticulitis with signs of sepsis	First intervention lasting roughly 30–45 min, TAC, limited resection of perforated colon segment using staplers, no colostomy. TAC is applied using a “vac pack” technique. Delayed anastomosis seems to be unsafe because of persistent septic shock, bowel wall edema, and hyperperfusion	Resuscitation in ICU	After limited resection in course of DCL definitive resection in case of feasibility is performed to prevent formation of fistulas and recurrence
Kafka-Ritsch et al <sup>18</sup>	2012	Case series	Patient recovery from septic shock with severe purulent or fecal peritonitis from perforated diverticulitis	Initial emergency operation includes preliminary source control without reconstruction and stoma fashioning, adequate lavage, and placement of abdominal vacuum therapy. The initial emergency operation is as short as possible and focused on source control with limited resection of diseased colonic segment, leaving the stapled colon without reconstruction in situ. In selected cases, closure of the perforation site with interrupted sutures was performed instead of colonic resection	Resuscitation in ICU	Second-look operation is performed after 24–48 h in an elective setting
Liang et al <sup>19</sup>	2012	CCT	Complicated diverticulitis (Hinchey I–IV)	Laparoscopic damage control surgery: lavage and drainage without resection	If necessary	Three patients (6.4%) are reoperated because of worsening of septic symptoms during post-LLD period
Moore et al <sup>20</sup>	2012	Review	Septic shock patients, by definition, require vasopressors in Hinchey IV	Limited resection of involved colon using staplers, without colostomy, and a temporary abdominal closure are performed	Returned to ICU for resuscitation	Once physiologic abnormalities are corrected, patients are returned to the operation room for peritoneal lavage and colostomy fashioning

TABLE 1. Characteristics of the Included Studies

Author	Year of Publication	Type of Article	Characteristics of Patients	Procedure Performed During DCS	ICU Stay	Reoperation Timing
Perathoner et al <sup>21</sup>	2010	Case series	Patients with poor preoperative and intraoperative conditions (septic shock and organ failure) and a significant need for catecholamines due to perioperative deterioration requiring rapid source control of perforated sigmoid diverticulitis complicated by purulent or fecal peritonitis (Hinchey III and IV)	Lavage, limited bowel resection (sigmoid resection with blind colonic ends), or a simple closure of the perforation site VAC	Postoperatively all patients were treated in surgical ICU	After 24–36 h all patients with VAC underwent a planned second look supervised by a colorectal surgeon to decide about further surgical management: restoration of continuity (IIa) or fashioning of colostomy (IIb)
Vermeulen and Lange <sup>22</sup>	2010	Review	Purulent peritonitis (Hinchey III)	Laparoscopic damage control surgery: lavage and drainage without resection	NR	NR
Nystrom <sup>23</sup>	2009	Book chapter	Hinchey III and IV	Sigmoidectomy and colostomy	NR	NR
Deenichin et al <sup>24</sup>	2008	Case series	Patients with generalized feculent peritonitis with signs of MOF and IAH > 25 cm and development of abdominal compartment syndrome	Resection with colostomy (HP) and temporary abdominal closure (half-opened or modified laparostomy) applying nonabsorbable mesh	NR	NR

CCT = clinical controlled trial; DCL = damage control laparotomy; DCS = damage control surgery, HP = Hartmann procedure, IAH = intra-abdominal hypertension, ICU = intensive care unit, LLD = laparoscopic lavage and drainage; MOF = multiorgan failure, NR = not reported; TAC = temporary abdominal closure, VAC = vacuum-assisted closure.

underlined the fact that this kind of treatment should be applied only to patients with colic perforation. Others support that laparoscopy can be offered to all patients with complicated diverticulitis ranging from Hinchey stages I–IV.<sup>19</sup>

This review showed that DCS for treatment of peritonitis caused by complicated colon diverticulitis is not always applied according to the same criteria and methods. The results are quite inconsistent, likely because of the innate heterogeneity of patient groups, presentations, and operations. The extreme heterogeneity of indications and procedures make it difficult to analyze this procedure systematically. Nevertheless, it is possible to identify the pros and cons of the different approaches. Although much has been written over the last 50 years, only 2 randomized controlled trial have been performed.<sup>31,32</sup> In both the studies, one of the arms was a precursor to DCS. Analysis of the published articles demonstrated 2 different surgical approaches, nonetheless not yet compared between themselves. This review showed that DCS is not a new strategy for the management of sepsis caused by diverticulitis, although distinctly different management DCS approaches are presented. Laparoscopy might have a role as DCS only in hemodynamically stable septic peritonitis unresponsive to medical or percutaneous treatment, with lavage/drainage operation but which needs to be validated for both purulent and fecal peritonitis. The question is if inclusion of the concepts, today widely approved, of trauma DCS in the guidelines for diverticulitis, should contribute to standardization of the therapeutic protocols. In the future, there is need to design longitudinal prospective studies apt to prove the results (already obtained for trauma surgery) in the septic complications of AD. The results of 3 ongoing trials are largely awaited (Ladies, Scandiv, and LapLAND trials).<sup>33–35</sup>

## CONCLUSIONS

Our literature review showed that there was an extreme heterogeneity in the performance of DCS for treatment of acute generalized peritonitis caused by sigmoid diverticulitis. Also, the review failed to determine specific physiologic parameters (eg, APACHE, POSSUM, ...) that could be used to triage patients to receive DCS versus other treatment. DCS is not a new strategy for the management of sepsis caused by diverticulitis, although distinctly different management DCS approaches are presented. The only new procedure is laparoscopic lavage for perforated diverticulitis (grade III). Clearly, an individual tailored approach to each patient might be appropriate depending on the patient's status.

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