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Etappenlavage: Advanced Diffuse Peritonitis Managed by Planned Multiple Laparotomies Utilizing Zippers, Slide Fastener, and Velcro® Analogue for Temporary Abdominal Closure

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Etappenlavage is defined as a series of planned multiple operative procedures performed at a 24-hour interval. It includes a commitment to reexplore the patient's abdomen at the initial corrective operation. This is a report of a prospective study of 117 patients treated by etappenlavage for severe advanced suppurative peritonitis in 2 institutions. Etappenlavage was performed in 15% of all patients with operations for peritonitis. In these patients, the abdominal infection had progressed to an advanced stage of severe functional impairment. A total of 669 laparotomies were performed and the abdomen closed temporarily utilizing retention sutures (n = 45), a simple zipper (n = 26), a slide fastener (n = 29), and Velcro® analogue (n = 17). An average of 6.1 procedures were necessary to control the infection. In 57% of the patients, additional complications were recognized and repaired after the initial operation. Patients were artificially ventilated for an average of 17 days. The median duration of therapy was 33 (range, 3–183) days. Twenty-eight patients died between days 3 and 71 (median, 9) after initiation of therapy. In 88%, uncomplicated wound healing was observed after wounds were closed definitely. In the last 17 patients, no complications were attributable to the use of 2 adhesive sheets of polyamide plus nylon or perlon for temporary abdominal closure (Velcro®-like artificial burr). APACHE II scoring predicted a median mortality of 47%. The actual mortality was 25%. Overall, the mortality of advanced diffuse peritonitis was reduced from a predicted 34–93% (APACHE II/SIS scoring) to 24%. Velcro® analogue (artificial burr) was the most practical device for temporary abdominal closure.

Intraabdominal infections are treated according to principles established during the first 2 decades of this century. This included one operative procedure, antibacterial treatment with drugs, and support of functional impairment [1]. The operation is considered to be the most important step. Its purpose is to evacuate purulent necrotic material from the abdominal cavity and to eliminate the infectious source. This therapeutic strategy has become the gold standard of operative management of intraabdominal infections. Overall mortality was reduced from 90% at the turn of the century to about 40% in 1926 [1]. Further improvements were expected to follow the introduction of more potent antimicrobials and better intensive care facilities. The mortality rates, however, remained unchanged [2]. Consequently, during the past decade, surgeons explored new operative approaches to improve the ultimate outcome. Three basically different methods emerged: (a) postoperative lavage procedures, (b) open management of the abdomen, (c) planned multiple reoperations. While the different postoperative lavage procedures were designed to treat all forms and stages of intraabdominal infections, the open management and the stepwise repair procedures were developed to treat patients at high risk with diffuse advanced purulent peritonitis only. Patients qualifying for the latter 2 procedures usually have a predicted mortality exceeding 50%.

Etappenlavage, as presented in this article, embodies the advantages of methods 2 (open abdomen) and 3 (planned reoperations) and excludes most of the risks of these procedures. It comprises a commitment made to reexplore the patient's abdomen at regular intervals after the original corrective operation. This ensures gentle elimination of the infected source and promotes maximal reduction of toxic necrotic material by daily abdominal cleansing. Intraabdominal complications are promptly recognized to effect immediate repair. Like the technique of "leaving the abdomen open," it takes into account the increased intraabdominal pressure. The abdominal cavity is not closed by suturing the fascia. Instead, different devices for temporary abdominal closure (TAC) are utilized to cover the abdominal aperture, allowing for sufficient space within the abdominal cavity to contain the inflamed and edematous intraabdominal organs.

Our experience with 117 cases of intraabdominal infections treated with etappenlavage and prospectively studied are presented in this article. Four different methods for temporary abdominal closure were utilized.

Operative Technique

The cornerstone of etappenlavage is the decision made at the initial corrective operation to reoperate on a daily basis. The original corrective operation is performed through a wide longitudinal or transverse abdominal incision.

Feculent/purulent material is then washed out, utilizing generous amounts of Ringer's lactate solution. The source of the

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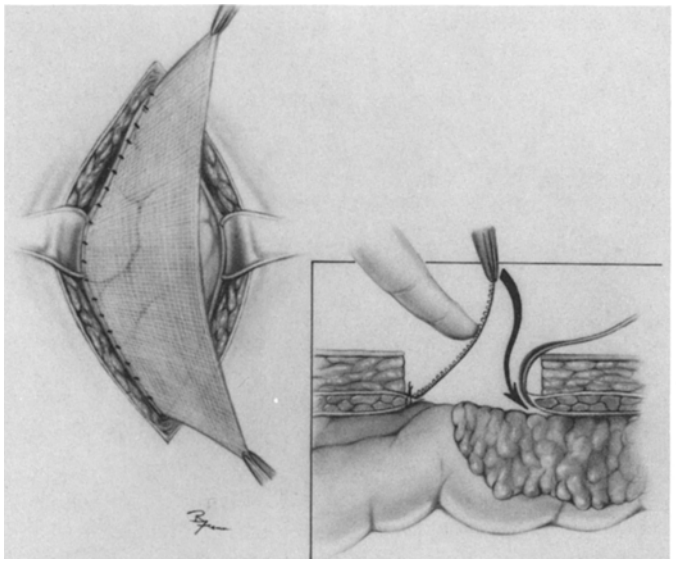

Fig. 1. Technique: Fastening the loop side of the Velcro® equivalent to the right fascia with running sutures and by inserting the free end between the opposite parietal peritoneum and intestines.

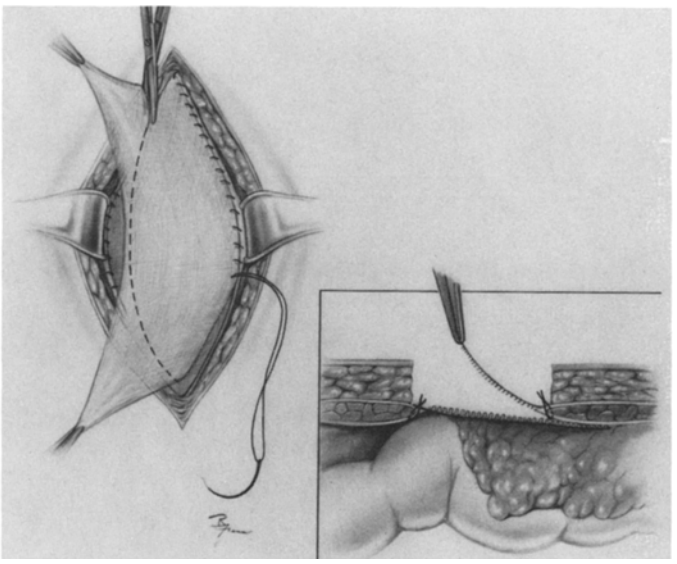

Fig. 2. Technique: Fastening the hook side of the Velcro® equivalent to the opposite fascia with running sutures and adhering it onto the loop side. Only minimal tension is exerted on the fascial edges.

infection is subsequently eliminated either by suture or staple closure, excision, or exteriorization. If the patient's general condition prohibits prolonged operative trauma, an anastomosis, a colostomy, or other more definitive repairs may be postponed to subsequent etappenlavages. A stapled blind loop may stay in situ as long as sufficient perfusion is seen to allow for anastomosis during subsequent etappenlavages. Bleeding may be controlled by packing. Packs are easily removed during subsequent etappenlavages. If the patient's condition permits, more extensive debridement of necrotic tissue may be started at the first operation, followed by an intense irrigation of the abdominal cavity with an average of 8 liters of Ringer's lactate solution. Special care is taken to handle the intraabdominal organs gently to prevent traumatic debridement and to minimize intraperitoneal bleeding. Drains are not used. At the end of the procedure, the abdominal opening is covered with alloplastic material for temporary abdominal closure rather than being closed by suturing the fascia. The sheets of this material are fastened to the fascial edges with running nylon sutures (Figs. 1–3). The 2 sheets are adapted either by the slide fastener mechanism (G-TAC), by a zipper sutured to a Marlex® mesh (Z-TAC), or by adhesive sheets (Velcro® or glider) (V-TAC). The abdominal aperture is left wide enough to avoid any tension or increased intraabdominal pressure. Reoperations are best facilitated by the use of V-TAC since it can be easily trimmed to the decreasing abdominal aperture as the inflammatory intraabdominal edema lessens (Fig. 4).

After 24 hours, the abdomen is reoperated. This is done in the operating room only to allow for optimal conditions. The entire abdominal cavity is inspected and additional necroses are debrided. Packs may be removed and anastomosis of blind loops is possible providing adequate perfusion is seen. Since their healing may be observed during subsequent etappenlavages, anastomoses can be sutured more safely. All abdominal organs are lavaged again with 5–10 liters of Ringer's lactate solution. Should new sources of contamination be discovered,

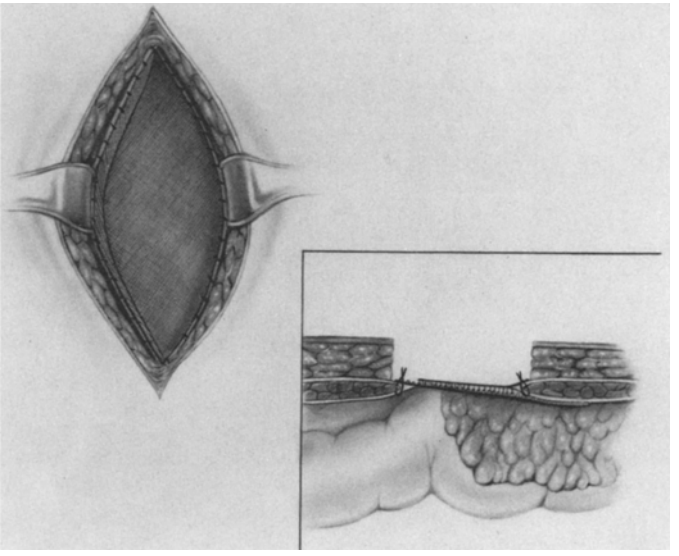

Fig. 3. Technique: Velcro®-like equivalent in place: The hook side covers the loop side. Intraabdominal tension is relaxed and the abdomen is closed at the same time.

the appropriate surgical procedure is possible at an early stage. Repeated laparotomies are performed until the infectious sources are contained, the exudate is clear, the abdominal cavity is clean, evidence of anastomotic healing is seen, and the edges of the abdominal fascias are approximated with ease. The abdomen is then definitely closed without drains, utilizing common techniques for suturing fascia and skin. The skin is not sutured, allowing for secondary healing if less than 6 etappenlavages were necessary. After 6 and more etappenlavages, there is usually enough local host defense to safely close the skin, and wound abscesses do not develop.

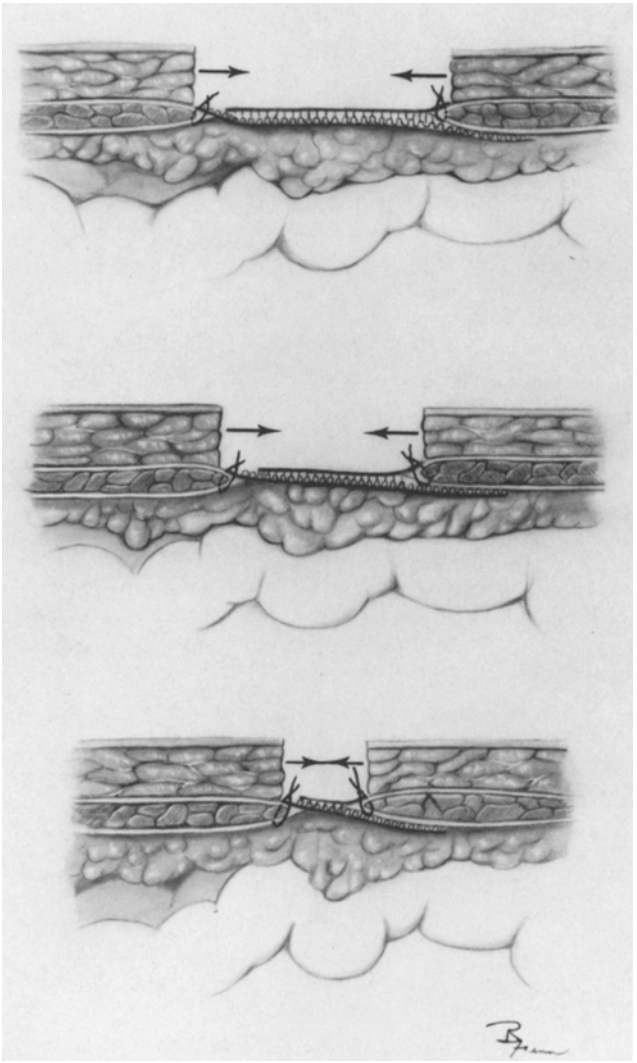

Fig. 4. Technique: Velcro® equivalent in place (step 3) and approximation of fascial edges (step 4, 5, . . .). As peritoneal edema decreases, the abdominal opening can be reduced by tailoring the Velcro® equivalent size to the distance between the fascial edges. Finally, the Velcro® equivalent is removed and the abdomen is closed by suturing the fascias.

Bacteriologic specimens are taken at the beginning of every procedure. An additional dose of the antibiotic in use should be given at induction of anesthesia for each operation to ensure sufficient antimicrobially-active concentrations in tissues during operative manipulations.

The antimicrobial regimen should be directed against known pathogens and should include an antimicrobial with 100% activity against *Escherichia coli* and pathogenic bacteroides spp., and clostridia even if those bacteria are not identified in the initial cultures [2].

The patient usually remains intubated and receives mechanical ventilatory support and epidural analgesia until after the last etappenlavage. Early use of continuous arteriovenous hemofiltration (CAVH) reduces fluid overload.

Material and Methods

Only patients with advanced diffuse peritonitis were eligible to enter the study. Additionally, 2 of the following study entrance criteria had to be met:

Study Entry Criteria and Indications for Etappenlavage

1. Diffuse peritonitis and inability to clean the abdominal cavity and/or to safely exclude the source of infection with one single operation.
2. Diffuse peritonitis and presence of primary process of more than 48 hours.
3. Impending or established multisystem organ failure or poor prognosis according to one of the scoring systems for peritonitis.

The patients were then treated by etappenlavage according to the protocol and their disease-specific information collected and entered into a database. The abdomen was temporarily closed utilizing retention sutures (R-TAC), an ordinary zipper (Z-TAC), or a plastic slide fastener (G-TAC) (group A). Group M consists of 17 patients who fulfilled the same study entrance criteria, but were treated at another institution. In these patients, adhesive alloplastic sheets (Velcro® equivalent) were utilized for temporary abdominal closure (V-TAC). Detailed results of this new technique concerning tensile strength, adhesiveness, microbial colonization, and practicability are presented elsewhere [3].

To classify these critically ill patients more objectively as to severity of illness, their admission data were scored according to the SIS (Surgical Infection Society) modified APACHE II score [4] and the PIA II score [5]. Study end point was mortality. Complications recognized during surgery and seen after etappenlavage were recorded.

Microbiological specimens for anaerobic and aerobic cultures were taken initially and at each subsequent lavage for identification of pathogens and determination of minimal inhibitory concentrations [6]. In selected cases, peritoneal biopsy specimens were taken for microscopic examination to evaluate peritoneal healing. Antibiotic concentrations (protein-bound and protein-unbound portions) were measured in peritoneal fluid representative of the site of infection [7].

The initial antibiotic regimen of group A consisted of cefotaxime sodium (2 g/12 hr) with metronidazole hydrochloride (500 mg/12 hr), moxalactam disodium (2 g/12 hr), or imipenem (1 g/8 hr), all administered intravenously [6, 8]. Aminoglycosides were not primarily used due to their potential nephrotoxic effect [9]. In cases where clinical signs of infection persisted, antibiotics were changed according to the bacteriologic results and concentrations achieved in peritoneal fluid. In group M, similar antimicrobial regimens were given.

Results

Fifteen percent of all patients treated for local or diffuse peritonitis had advanced suppurative diffuse peritonitis and fulfilled the study entrance criteria. These were divided into 2 groups identifying different institutions. Various devices for temporary abdominal closure were utilized: retention sutures

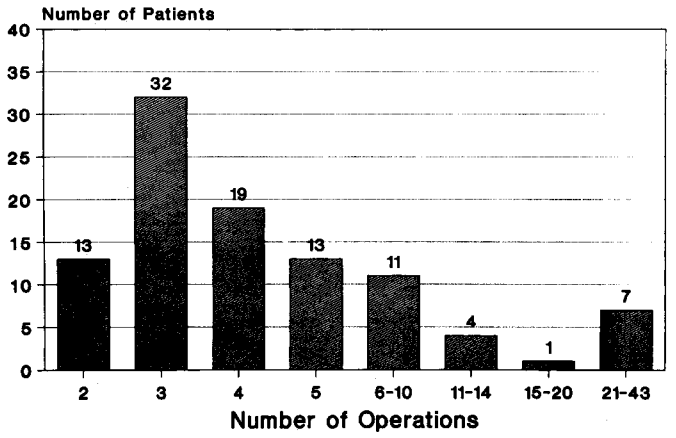

Fig. 5. Etappenlavage for diffuse peritonitis: Group A—Number of procedures performed per patient.

(R-TAC) in 51 patients, a simple zipper (Z-TAC) in 32 patients, a Glider (G-TAC) in 18 patients, and the newly developed Velcro® adhesive closure (V-TAC) in 17 patients.

Group M

Group M consisted of 17 patients (median age, 56 yr; range, 23–81) who underwent a total of 68 procedures. Seven etappenlavages were necessary in 2 patients, 6 in 6, 5 in 1, 4 in 4, 3 in 3, 2 in 1, and 1 in 1 patient, respectively. Six patients were referred from other hospitals. Nine patients had postoperative peritonitis: 6 after colon resection, 1 after partial gastrectomy, 1 after a Whipple procedure, and 1 after an incarcerated hernia repair. The disease process was present for a median of 5 days (range, 56–216 hours), and the median predicted mortality according to APACHE II was 47% (range, 23–91%). The V-TAC was well tolerated, needed no replacement as intraperitoneal edema decreased, and was bacteriologically inert. Skin closure was done in 11 of 14 patients, resulting in uncomplicated healing in 7 patients. Wound infection was seen in 4 patients; in 2 of these it was combined with a fascial dehiscence. Wound infection was precipitated by premature skin closure. The median hospital stay was 14 days (range, 12–94) and the median time in the intensive care unit was 13 days (range, 1–15). Four patients died. In all 4 cases, the source of infection could not be eliminated: 2 patients with upper gastrointestinal tract leaks, 2 patients with total bowel gangrene.

Group A

In group A, 100 patients (52 women) with diffuse peritonitis underwent a total of 601 etappenlavages (Fig. 5). There was a significant difference ($p < 0.05$) between the 13% mortality of the younger patients (10–69 years), and the 42% mortality of older patients (70 years and more). Fifty-seven infections were due to perforation of an intestinal viscus secondary to inflammation, obstruction, or other causes. Forty-three infections occurred postoperatively after abdominal surgery. Eleven (26%) of these died. The median duration from onset of signs of infection to initial etappenlavage was 123 hours (range, 63–300). Mechanical ventilatory support was necessary for a median of 17 days (range, 3–90). Etiology of infection and associated mortality is shown in Table 1.

Table 1. Etiology of infection and associated mortality of all patients treated by etappenlavage—Group A.

Etiology	All (n)	Died (n, %)
Spontaneous peritonitis[a]	**66**	**13, 20**
Perforation	48	10, 21
Bowel wall necrosis	12	2, 17
Intraabdominal abscesses	6	1, 17
Postoperative peritonitis[a]	**45**	**14, 31**
Anastomotic leak	27	9, 33
Missed iatrogenic perforation	4	1, 25
Leak of duodenal stump	6	3, 50
Ruptured abscesses	3	1, 33
Bowel necrosis	5	0, 0
Trauma[a]	**6**	**1, 17**
Missed bowel perforation	3	0, 0
Necrotic bowel (mesenteric injury)	1	1, 100
Anastomotic leak	2	0, 0
Total[a]	117	28, 24

[a]Bold entries are E_{max} and are not included in totals.

Table 2. Associated diseases and underlying system function impairment in 100 patients with advanced suppurative peritonitis.

Risk factors	All (n)	Died (n, %)
Cardiovascular system	59	15, 25
Chronic renal insufficiency	21	8, 38
Liver cirrhosis	8	3, 38
Respiratory system	18	6, 33
Associated malignancy	23	6, 26
Diabetes mellitus	16	4, 25

Sixteen infections originated from the stomach or duodenum. Seven of these patients died. None of the patients died with origin of infection from the biliary system. Peritonitis originating from the small bowel had a mortality of 6 (27%) of 22, appendix, 1 of 10, large bowel, 7 (19%) of 37, and genitourinary system, 2 of 8.

Table 2 shows the conditions that have the potential of complicating the outcome such as associated diseases and preexisting system function impairment. Common definitions were used [9]. Evidence of multiple systems organ failure was present in most patients and severity scoring predicted a median mortality of 76% (range, 27–97) for PIA II and 34% (range, 11–74) for APACHE II.

The operations performed are summarized in Table 3. Thirty primary anastomoses were tolerated with a mortality of 33%. During the lavage period, 55 additional complications were seen which required repair (Table 4). The beginning of small bowel motility was observed during the lavage period in most cases. A Dennis tube was used in 17 cases. All patients had epidural anesthesia for a median of 9 days (range, 3–44). The blood of 14 patients was hemofiltrated (CAVHF) for 23 days (range, 5–65). Ninety-three patients received a mean of 15 blood transfusions, with a median of 8 (range, 1–99). Nineteen patients required more than 20, 23 patients, 11–20, 18 patients, 6–10, 4 patients, 11, and 9 patients, 5 transfusions.

Table 3. Procedures performed in 100 patients—Group A.

Operations performed	All (n)	Died (n, %)
Laparotomy/debridement/lavage only	470	
Stomach/bowel anastomoses	30	10, 33
Colostomies	25	4, 16
Simple suture	24	8, 33
Resection of an organ	18	3, 17
Insertion of drains	11	2, 18
Extirpation of various structures	6	2, 33
Appendectomy	6	2, 33
T-drains	4	0, 0
Necrosectomy of pancreas	3	1, 33
Cholecystectomy	2	0, 0
Splenectomy	2	1, 50
Total	601	33

Table 4. Additional intraabdominal complications recognized after the original corrective etappenlavage—Group A.

Complications recognized during etappenlavage	All (n)	Died (n)
Leak of a suture	4	2
Leak of an anastomosis	8	2
Leak of a bowel stump	8	2
Iatrogenic bowel leak	2	0
Intraabdominal hemorrhage	12	3
Intraabdominal abscesses	7	4
Retroperitoneal necroses	2	1
Stomach/small bowel necroses	3	0
Necroses of omentum	2	0
Necrotic colostomy loop	4	1
Necrotic ovary	1	0
Gallbladder necrosis	1	0
Mesenteric tear	1	0
Total	55	

Duration of treatment averaged 39.9 days with a median of 33 days (range, 3–183). Twenty-four patients died between days 5 and 71 after the beginning of therapy, and 1–48 days (median, 9) after the last etappenlavage. Seven patients died of uncontrolled sepsis 7–33 days (median, 12) after the first etappenlavage. Eight patients died of cardiac arrhythmia and other cardiovascular dysfunctions between days 5 and 36 (median, 12). Two patients developed lethal gastrointestinal hemorrhage on days 54 and 71. One patient had fulminant pulmonary embolism 13 days after the first etappenlavage and resuscitation was unsuccessful. One patient with preexisting chronic obstructive pulmonary disease developed postextubation pulmonary failure and died on postoperative day 35. Nutritional problems due to malignancies and short bowel syndrome accounted for the remaining mortality between days 28 and 37.

After the last etappenlavage, uncomplicated wound healing was seen in 62 of 80 patients. Wound dehiscence occurred in 6 survivors and a wound infection was seen in 9 patients.

Bacteriology

Escherichia coli was isolated in 78 patients, initially often in combination with *Bacteroides fragilis*. It was present in all patients who died during the first 2 weeks due to septicemia. The third-generation cephalosporins yielded sufficient high concentrations at the infectious site as previously published [2, 6, 7] and elimination of pathogenic bacteria was seen when adequate operative treatment was performed. Aminoglycosides were not primarily used due to their nephrotoxic potential [10]. The addition of aminoglycosides, however, or other drug combinations were necessary in selected cases with *Pseudomonas aeruginosa*, *Enterobacter cloacae*, and aerogenes responsible for the persistence of clinical symptoms. The emergence of *Enterococcus faecalis* was often noted, especially in cases requiring more than 6 procedures, but in most cases was eliminated without specific treatment when the abdomen was definitely closed. Superinfection with fungi was a serious problem in cases with more than 6 procedures and septic metastasis was seen to the eye and heart valves. These complications, however, were controlled by adequate antifungal therapy and heart valve replacement. Intravenous catheters were changed frequently to limit problems due to *Staphylococcus epidermidis*.

Table 5. APACHE II scoring of 117 patients treated by etappenlavage with predicted mortality (weight category sepsis) compared to observed mortality. While the score predicted 46 deaths of 117 (groups A and M), only 28 died.

APACHE II score	n	Predicted mortality		Observed mortality	
		n	%	n	%
≤10	20	3	15.0	1	5.0
11–15	36	10	27.8	5	13.9
16–20	33	14	42.4	7	21.2
21–25	20	12	60.0	8	40.0
>25	8	6	75.0	7	87.5
Total	117	45	38.5	28	23.9

Discussion

In 1975, Pujol [11] laid the basis for the open abdomen management of intraabdominal infections, i.e., to leave the abdominal wound open once the initial surgical closure of the infectious source and evacuation of damaged and necrotic tissue and toxic fluids from the abdominal cavity had been accomplished. The abdominal wound is then treated like an open wound in an attempt to apply Celsus' classical principle of treatment of surgical infection "ubi pus, ibi evacua."

Fistula formation [12] and difficulties in managing subsequent huge abdominal hernias [13, 14] have motivated alterations of this method. Some authors utilized different materials such as polyurethane foam "mousse" [15] or Marlex® [16–18], or latex tubes with retention sutures [19] to cover intraperitoneal organs. Others closed the mobilized skin only and left the fascia distracted [14]. Excellent reviews of this literature are offered by Schein and associates [20] and Maddaus and Simmons [21].

The surgical repair of advanced diffuse peritonitis through planned multiple relaparotomies was first used by Hay and colleagues [22] in 1979, then by Sakai and coworkers [23] in 1981 for peritonitis due to diverticulitis. During the same year, etappenlavage was first presented in the United States of America by our group [24]. Our experience with more patients has been published in 1985 and 1986 [25, 26]. In 1982, a Dutch group [27, 28] presented their experience with planned reoperations.

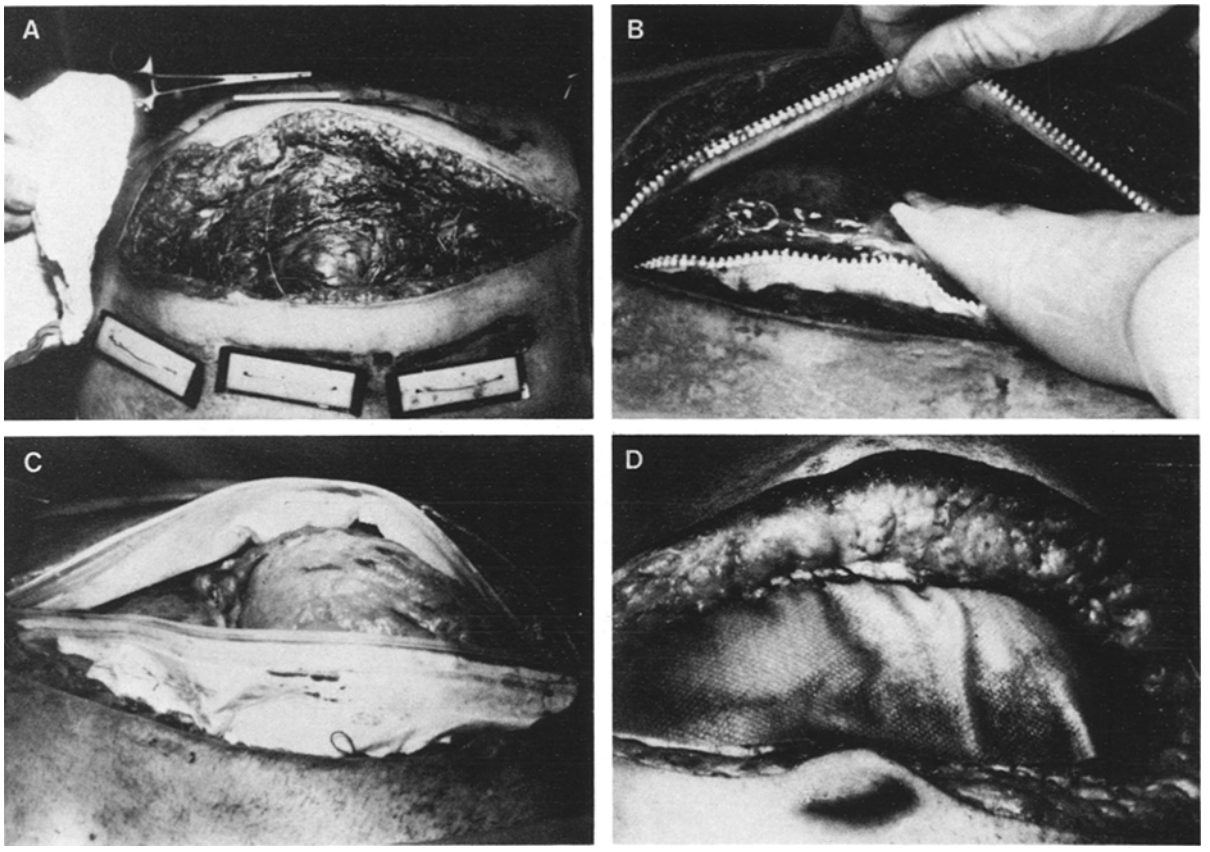

Fig. 6. Different methods for temporary abdominal closure. **A.** Etappenlavage utilizing retention suture for temporary abdominal closure: The intraabdominal edema and the abdominal wall necrosis underneath the retention suture plates are clearly visible. **B.** Etappenlavage utilizing a commercially available zipper for temporary abdominal closure: The abdomen is open; the parietal peritoneum is inflamed. A plastic (polyethylene) drape is used to cover the bowel and omentum. **C.** Etappenlavage utilizing a Glider (ETHZIP ®) for temporary abdominal closure: The large sheath allowing for abdominal expansion is clearly visible. The Glider is open. **D.** Etappenlavage utilizing 2 adhesive sheets (Velcro® equivalent) for temporary abdominal closure: The abdomen is closed. The hook sheet is on top of the loop sheet to which it adheres. Note the wide opening of the abdominal aperture.

These procedures are based on the concept of second-look operations to surgically control, at an early stage, failures and complications of the initial operation. It is now recognized that, in most cases of advanced diffuse peritonitis, the abdominal infectious injury cannot be resolved by a single procedure, and multiple operations are required to fully appreciate the extent of destruction and to complete the subsequent management and repair.

To ease temporary closure and reopening of the abdomen, different ingenious techniques have been promoted. Retention wires were used first. Then a zipper, first employed surgically in 1936 by Strauss [29], was successfully sutured to the fascial edges for temporary abdominal closure [30, 31]. Later, when the negative influence of increased abdominal pressure on pulmonary, cardiac, and renal function [32–34] became apparent, retention sutures or a simple zipper for temporary abdominal closure were replaced by devices allowing for abdominal expansion without exerting increased intraabdominal pressure. With these devices, forceful approximation of the abdominal fascias was avoided, thus combining the concept of the open abdomen with that of the planned relaparotomies. A Spanish group and a Canadian group published a paper where the zipper closure was combined with the Marlex® mesh, representing the fusion of these 2 concepts [35, 36].

Our group in Hamburg, Germany, named this procedure etappenlavage, erroneously overemphasizing the washing of the abdomen rather than emphasizing the increased possibilities for safer repair and closure of the infectious source. Recently, however, Lazarou and associates [37] found that wound fluid contains factors which markedly impair host response to sepsis, but do not appear related to known immune inhibitory cytokines. This supports the clinical impression that peritoneal lavage at 24-hour intervals counteracts postsurgical immunosuppression in addition to removing toxins.

The relatively low mortality (24%) in this high-risk group compares favorably with conventional surgical therapy and attests to its usefulness (Table 5). The ultimate proof that etappenlavage is superior to other methods, however, requires a controlled study. It was not possible to randomly assign the patients to an etappenlavage and a nonetappenlavage group while the method of etappenlavage was developed and slowly gained its distinct contours. Nevertheless, we tried to estimate the severity of disease more accurately. This was done by comparing the pathological and pathophysiological pattern of

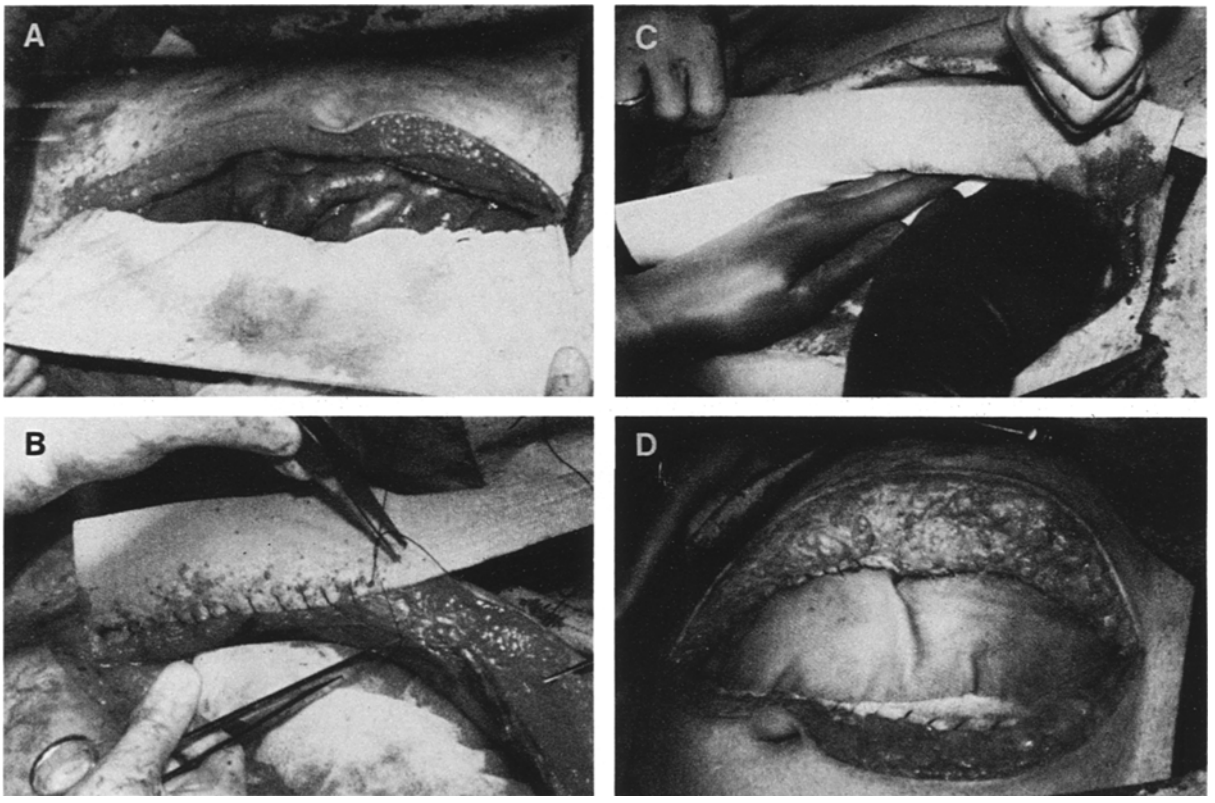

Fig. 7. Attachment of Velcro® to the abdominal fascias. **A.** Suturing of the fuzzy side (loop sheet) to the right side abdominal fascia. **B.** Suturing of the hook side to the left abdominal fascia. **C.** Tucking the fuzzy side underneath the hook side. The fuzzy side covers the bowel and omentum. **D.** The hook side has been brought down to the fuzzy side, closing the abdominal aperture temporarily.

our patients to large control groups of patients who were treated conventionally and used for validation of 2 scoring systems—APACHE II/SIS [4] and PIA II [5]. The limitations of this procedure are delineated by the difference yielded between the 2 groups. According to APACHE, the control group, which compares to the etappenlavage patients, had a median mortality of 34–47%; according to the PIA II system, which is specific for peritonitis, the mortality is 73% for controls. Although control groups of both scoring systems had a higher mortality than that actually observed in etappenlavage patients, differences only allow for preliminary conclusions. Some study circumstances prevented correct APACHE II scoring—the first 64 patients were assessed retrospectively since the score was not available; forty-seven patients had postoperative peritonitis and laboratory values had been corrected, resulting in too low scores. This was also true for 17 additional patients who were referred from outside hospitals after various treatment regimens had failed to control intraabdominal infections. A specific score, such as PIA II, which was developed to assess prognosis for intraabdominal infections only, is probably more reliable to define the prognosis of etappenlavage patients. The PIA II classifies prognosis based on clinical and anatomical findings at the time of the initial operation. By means of discriminant analysis, it was possible to predict correctly (89%) the outcome of 90% of patients with intraabdominal infections [38]. According to this score, the probability of survival of group A patients of this series was 36%. In fact, 76% survived, suggesting a true therapeutic improvement.

The high-risk nature of the disease process in etappenlavage patients is not surprising given the additional risk factors of elderly patients, the relative long duration of symptoms before treatment, and the high incidence of multiple systems organ failure in the patients of this series. Patients over the age of 70 years had a mortality of 40%, indicating exhaustion of vital reserves in a special patient group. Postoperative intraabdominal infections accounted for 43% of patients in this series. Since postoperative peritonitis can carry a mortality exceeding 72% [39], and given a mortality of 24% in etappenlavage patients, there seems to be a particularly useful indication for etappenlavage in postoperative peritonitis.

During the lavage period, we discovered additional problems not seen at the first laparotomy (Table 4); these problems might have been missed by closed operative techniques. Fistula formation as seen with the open abdomen methods [12] was not a problem in this series. Etappenlavage also allowed inspection of newly-created anastomoses.

Of the 4 different methods for temporary abdominal closure, R-TAC (Fig. 6A) was associated with the majority of complications. R-TAC causes severe necroses of the abdominal wall. R-TAC and Z-TAC (simple zipper, Fig. 6B) did not allow for decompression of the intraabdominal pressure. The slide fastener or glider (G-TAC, Fig. 6C) is large enough to permit

intraabdominal decompression, but may open itself when the patient moves in bed. This requires immediate additional reoperation. Another problem encountered with the zipper is the fact that it needs to be replaced by one with a smaller seam once the inflammatory edema reduces. These problems are avoided with the V-TAC method (Figs. 1–4, 6D, 7). It enables gradual approximation of the fascias along with the decrease of the inflammatory edema (Fig. 4) and removal and resuturing the device to the fascia is no longer necessary.

The relatively low complication rate seen after definitive wound closure compares favorably to the open abdomen technique. The majority of wound infections developed in patients who had less than 5 operations, indicating that local defense, as a function of time, may be more effective in older wounds.

Not all patients with intraabdominal infections are suitable candidates for etappenlavage, and it is difficult to define who would benefit from this procedure. Common features seen in our patients included diffuse peritonitis at first operation, duration of symptoms for more than 48 hours, multiple systems organ failure [26], and inability to remove the infectious foci. Due to limited experience, perhaps more patients than necessary were managed by etappenlavage. It is also questionable whether all critically ill patients are candidates for this labor-intensive and costly treatment. Based on this experience, we estimate that 10% of patients with secondary peritonitis might benefit from etappenlavage.

The etappenlavage concept for diffuse peritonitis ensures improved elimination of the infectious source, better reduction of the bacterial inoculum in the peritoneal cavity, and better elimination of toxic necrotic material. With etappenlavage, early diagnosis and therapy of postoperative complications is possible. Etappenlavage is a flexible therapeutic modality that avoids the complications seen with intraperitoneal drains. The results reported here confirm the theoretical advantages discussed by Maddaus and Simmons [21]: "fluid, microbes and infection-potentiating agents are removed intermittently, persistent sepsis and intestinal leak or necrosis are detected early, fluid and protein losses are diminished, and it offers the possibility of evaluating the persistence or eradication of the infectious process." Final confirmation, however, might be obtained only from a controlled study. The most useful device for temporary abdominal closure proved to be V-TAC.

Résumé

L'etappenlavage est défini comme une série d'interventions répétées à intervalles de 24 heures. Cette technique implique une nouvelle exploration de l'abdomen lors de l'intervention initiale. Dans ce travail, nous rapportons les résultats chez 117 patients étudiés prospectivement traités par l'etappenlavage pour péritonite sévère dans 2 institutions. L'etappenlavage a été effectuée chez 15% des patients ayant une péritonite. Chez ces patients, l'infection abdominale avait évolué et comportait une défaillance fonctionnelle avancée. On a pratiqué 669 laparotomies et la fermeture pariétale provisoire a nécessité des sutures sur bourdonnets (n = 45), une fermeture éclair (n = 26), un fermoir à glissière (n = 29), et des Velcro® équivalent (n = 17). En moyenne, on a réopéré ces patients 6.1 fois pour contrôler l'infection. Chez 57% des patients on a mis en évidence des complications supplémentaires qui ont requis une réparation secondaire. La ventilation artificielle était nécessaire environ 17 jours. La durée moyenne du traitement à ventre ouvert a été de 33 (3–183) jours. Vingt-huit patients sont morts entre jour 3 et 71 (médiane, 9 jours) après la première laparotomie. La plaie abdominale a cicatrisé sans problème chez 88% des patients après fermeture définitive. Chez les 17 autres patients, on a utilisé 2 feuillets adhésifs de polyamide mélangé soit à du fil de nylon soit à du perlon, rapprochés avec un Velcro®. La mortalité médiane prévisible avec le score APACHE II était de 47%. La mortalité réelle était de 25%. La mortalité de la péritonite diffuse avancée a été réduite depuis un score combiné (APACHE II/SIS) de 34–93% à 24%. La fermeture temporaire par Velcro® équivalent s'est avérée la plus pratique.

Resumen

Se define el etappenlavage como una serie de procedimientos operatorios múltiples que se realizan cada 24 horas para el tratamiento de la sepsis intraabdominal avanzada. La definición implica el compromiso de reexplorar el abdomen diariamente después de la operación inicial. El presente artículo informa los resultados de un estudio prospectivo sobre 117 pacientes tratados mediante etappenlavage por peritonitis supurativa en 2 instituciones. Se realizó etappenlavage en 15% de todos los pacientes operados por peritonitis, aquellos en quienes la infección abdominal había progresado hasta un estado de severa alteración funcional. En total se realizaron 669 laparotomías y el abdomen fue cerrado temporalmente utilizando suturas de retención (n = 45), un zipper simple (n = 26), un cierre de lámina plástica (n = 29), o una lámina de plástico adhesivo (Velcro® equivalente, n = 17). Fue necesario realizar un promedio de 6.1 procedimientos para lograr el control de la infección. En 57% de los casos se reconocieron y corrigieron complicaciones adicionales después de la operación inicial. Los pacientes fueron sometidos a ventilación mecánica por un promedio de 17 días. El promedio de duración del regimen terapéutico fue de 33 (rango, 3–183) días; 28 pacientes murieron entre los 3 y los 71 días (promedio, 9) después del inicio del regimen terapéutico. Cicatrización libre de complicaciones ocurrió en 88% de los casos una vez que las heridas fueron cerradas en forma definitiva. En los últimos 17 pacientes el cierre temporal del abdomen fue efectuado mediante el uso de 2 láminas adhesivas de nylon o perlon (Velcro®); no se hallaron complicaciones que pudieran ser atribuíbles a este método. La aplicación del método APACHE II para establecer el grado de severidad de la enfermedad predijo una tasa de mortalidad promedio de 47%; la tasa real de mortalidad fue de 25%. La tasa global de mortalidad de la peritonitis difusa avanzada fue reducida de una tasa predecible de 34–93% (APACHE II/SIS) a 24%. El Velcro® equivalente probó ser el aditamento mas útil para el cierre temporal de la laparotomía.

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