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The Zipper-Mesh Method for Treating Delayed Generalized Peritonitis

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Abstract: Recently, many articles have been published related to the "open abdomen" concept which is performed particularly on patients with delayed generalized peritonitis. Since most arguments still support the effectiveness of this method and the results have been mostly favourable, it was decided to use the technique on 14 patients with peritonitis. Commercial zippers either with or without mesh were used on all. Four patients, however, died in the very early postoperative period and were excluded from the study. Others were examined as to the operative findings, period of delay, concomittant diseases, primary operations, indications of the technique, the number and type of the reinterventional procedures, status of remote organ failure, expected and realized mortality. Forty laparatomies were performed on 10 patients. In addition to obtaining a clean intraperitoneal cavity, some additional procedures such as anastomotic repair or gastroenterostomy could be done. The mean period of ventilator support was 27 h, the ambulation period was 3 days. The start of enteral nutrition early was able to be achieved more easily. In the patients whose expected mortality rate was as high as 70%–90%, a rate of 40% was established in those ten patients.

Key Words: zipper, zipper-mesh, generalized peritonitis, residual abscess, incisional hernia

Introduction

The classic therapeutic approach to delayed suppurative peritonitis (DSP) is comprised of the elimination of infective foci, as well as debridement and drainage for years.[1–3] Such methods, however, have not been satisfactory because of the high mortality rates reported in the literature. The main factors influencing mortality are the period of contamination, focus of infection, period of sepsis, and the presence of multiple organ failure (MOF) or concomittant diseases. The figures have been reported to be between 50% to 100%.[1–11] There is a consensus on the first two components of the classic treatment of DSP as rational approaches amongst the authors, however, as to drainage, many arguments still continue. Numerous reports have implied that the drainage of the whole peritoneal cavity is an impossibility, particularly in DSP, due to presence of compartments produced by adhesions.[3,8,12–16] As a consequence, inadequate drainage of the cavity leads to MOF and death because of recurrent peritonitis.[4,6,8,17–19] In light of these problems, "Open Abdomen" (OA) performance now seems to be a more rational approach for both realizing complete drainage and reducing intra-abdominal pressure, and the latter factor has been gaining support these days as the most significant factor affecting the overall prognosis.

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Materials and Methods

The zipper-mesh technique was performed on 14 patients with DSP between October 1988 and March 1990 in the Sixth Department of Surgery of Numune Hospital. Regarding the patients, ten were men and four were women with the mean age being 52. The following indications were taken into account for performing the technique:

- Large bowel perforations without consideration of the contamination period
- All patients who had DSP for over 72 h
- Patients who had extensive fibrinous plaque over the peritoneal surfaces established during the operation regarding either known or unknown reasons of peritonitis
- Necrotizing pancreatitis

Before starting the study, thick-toothed commercial synthetic Montgomery zippers, 30 cm in length, were

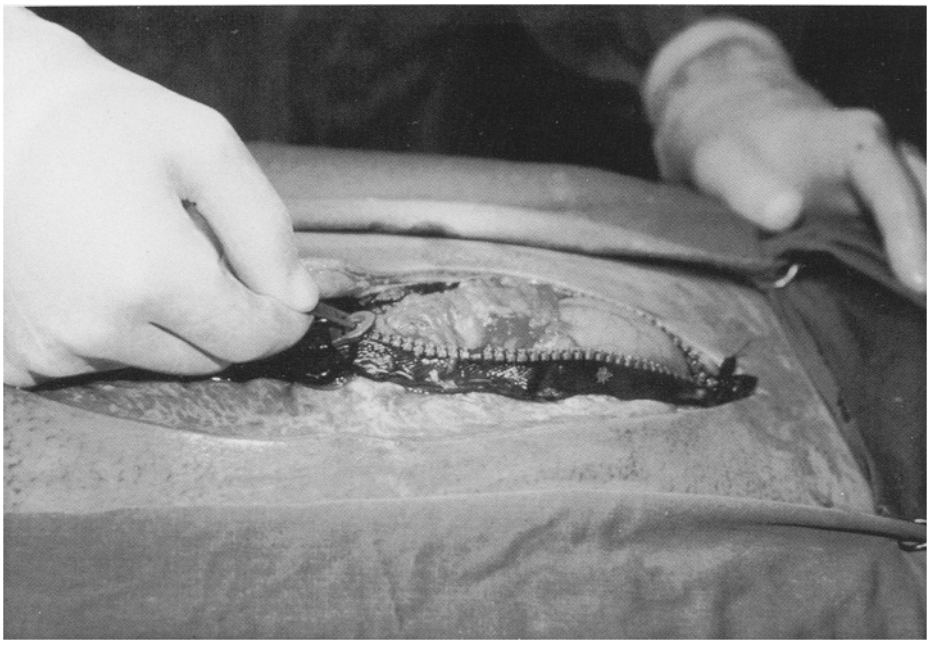

Fig. 1. Application of the zipper

sutured to the nylon mesh bilaterally and sterilized with ethylene oxide, thus they have now become available for all emergency cases. On the first three patients, however, zipper was performed without mesh for both reducing the fluid and protein loss and to facilitate the closure of incision after re-explorations. After those three cases, the performance of the zipper alone was abandoned due to reasons to be stated later and a zipper-mesh was thereafter routinely used. Third generation cephalosporins in combination with ornidazole were used on all cases starting with administration 30–60 min before the operation.

Four patients died in the very early postoperative period without undergoing re-exploration. For this reason, those cases were excluded from the study.

Techniques

A midline laparatomy incision was made on all patients. After the aspiration of intraperitoneal collections, the focus of contamination was eliminated either by resections or by a primary suture. In the patients in whom a resection was done, end-to-end anastomosis with proximal tube decompression ostomy was the method of choice. Moreover, "tube ostomies" were supplied in the patients who required nutritional support. Having completed the gastrointestinal continuation, fibrinous plaques over both the parietal and visceral peritonea were debrided cautiously. Cultures were taken for aerobes and anaerobes and then any foreign bodies such as blood clots, intestinal, or biliary contents were completely removed. Hemostasis was always provided. The peritoneal cavity was lavaged with 3 l povidone-iodine, 10% in concentration, and 3 l of saline consecutively. We attempted to remove all fluids in order to leave no deposits. Drains were avoided except under special conditions such as anastomotic leakage. Nylon mesh with a centrally placed zipper was sutured to the edges of abdominal fascia. After the greater omentum was placed between the intra-abdominal organs and the zipper-mesh, the zipper was closed. Subcutaneous tissue and skin were left open. The wound was wrapped up by the povidone-iodine absorbed gauze dressings (Fig. 1).

The patients were re-explored every 12–24 h taking into account the findings established at the first operation such as the presence of extensive fibrinous plaques and purulent collection or to the degree of the intestinal wall edema and postoperative clinical data. Re-explorations were performed either in the operating room or in the ICU under diazepam sedation without using a general anaesthesia. All intraperitoneal adhesions were divided and all peritoneal compartments were examined during each re-exploration. Jejunal and ileal loops were mobilized and so the interloop collections could be sucked out. Fibrinous plaques and necrotic tissues were debrided and the anastomosis was controlled if there had been done before. Furthermore, some supplementary procedures like gastroenterostomy or anastomotic repair were done during re-explorations. Aerobe and anaerobe cultures were taken in every re-exploration and then, the cavity was cleaned using 3 liters of povidone-iodine, 10% and 3 l of saline consecutively just as those in the primary

Table 1. Evaluation of organ functions

	Normal function	Minimum and moderate dysfunction	Severe dysfunction	No function
Pulmonary	$PaO_2 > 75$ mm Hg with spontanous respiration	PaO_2 between 60 and 75 mm Hg	$PaO_2 > 60$ mm Hg with mechanical respiration	$PaO_2 < 60$ mm Hg despite mechanical respiration
Cardiovascular	BP > 100 mm Hg	minimal vasopressor requirement	maximal vasopressor requirement	BP < 100 mm Hg despite maximum dose of vasopressor
Renal	Urinary output > 30 ml per hour, BUN normal, creatinine normal	Urinary output between 10 to 30 ml per h, BUN between 20 to 80 mg per 100 ml, creatinine normal	Urinary output between 10 to 30 ml per h, BUN > 80 mg per 100 ml, creatinine > 1.5 mg per 100 ml	No urinary output
Hepatic	SGOT, LDH, bilirubin normal	SGOT, LDH elevated; bilirubin normal	Bilirubin between 1.5 mg to 4 mg per 100 ml	Bilirubin > 4 mg per 100 ml
Gastrointestinal system	Normal intestinal activity	Intestinal hypoactivity	Paralitic ileus	Disintegrity of GIS due to paralitic ileus
Central nervous system	Normal consciousness	Somnolance	Agitation, disorientation	Coma

PaO_2, arterial partial oxygen tension ; *BP*, blood pressure; *BUN*, blood urea nitrogen; *SGOT*, serum glutamic oxaloacetic transaminase; *LDH*, lactate dehydrogenase; *GIS*, gastrointestinal system

operation. All lavage fluid was sucked out and the zipper was closed at the end of the re-exploration.

A decrease in the number of collections, change in the nature of the fluid accumulated to serous character, and increase of adhesion formation were all accepted as the criteria of peritoneal healing. Once the macroscopic healing was noticed, another 72 h were required for the completion of adhesion formation in order to prevent the patient from evisceration. Then, the zipper-mesh was removed under general anaesthesia and fascial closure was provided if the sepsis criteria were absent and the last microbiologic culture was negative. If the culture was positive, or sepsis was established clinically, the peritoneal cavity was explored again after removing the zipper-mesh. If a localized abscess formation or collection was found, sump drainage was done using Foley catheters and the fascia was closed with a continuous polydiaxanone suture. The skin and subcutaneous plane were left open and were then closed secondarily.

Patients whose PaO2 levels were below 60 mm Hg, were attached to a volume respirator in order to perform high positive end-expiratory pressure (PEEP). All patients were hemodynamically monitored via Swan-Ganz catheterization and volume replacement therapy was regulated, therefore, rationally.

Nutritional support of the cases was obtained by total parenteral nutrition (TPN) immediately after the first operation. If the patient was diabetic, TPN was introduced after regulation of the plasma glycemia level. Enteral nutrition (EN) was begun as soon as any intestinal activity was noticed, even while re-explorations were being planned on the patient.

All patients were evaluated for MOF postoperatively with regard to the criteria explained in Table 1.

The mortality rates were calculated in regard to septic severity score (SSS), acute physiologic score (APS), and acute physiologic and chronic health evaluation (APACHE-II) scoring systems in light of the data obtained by both clinical and biochemical analyses.[20]

More than 2 years have passed for the six surviving cases. They were investigated postoperatively every 3 months for incisional hernia formation and residual intraperitoneal abscess formation.

Results

Of the ten patients who have survived the early period, eight were men and two were women with a mean age of 53. Five (50%) had fecal peritonitis and the others had delayed generalized peritonitis. The findings of the patients are shown in Table 2.

The average period between the commencement of peritonitis and first operation was 74.4 h. This was 96 h in five patients, 72 h in two, 48 h in two, and 24 h in one. On the average, 10 h was the period established for all cases between hospitalization and operation.

In the examination of the patients with respect to MOF, pulmonary insufficiency was established in seven (70%), cardiovascular insufficiency in five (50%), hepatic failure in four (40%), gastrointestinal failure in ten (100%), and neurologic deficits in four patients (40%). Severe but easily managed high-output renal failure was noticed in six (60%). The number of organs in failure totalled 36 and severe dysfunction was

Table 2. General features of the cases

Case	Sex/Age	Concomittant diseases	Operative findings	Indication of zipper technique	Period 1 (h)[a]	Period 2 (h)[b]
1	M/31	Operated upon 4 days before due to cecum perforation	2 perforation sites 4 cm in diameter in cecum	Fecal peritonitis	96	12
2	M/55	Old sigmoid tumor, left hemicolectomy, MI 6 months before, CHD	Perforation of recurrent tumor	Fecal peritonitis	24	12
3	M/58	Left hemicolectomy 10 days before due to sigmoid tumor, colostomy, MI 5 months before, CHD, DM	Multiple jejunal perforations	Generalized peritonitis	96	6
4	M/55	Insulin-dependant DM	Appendiceal perforation 5 days before	Fecal peritonitis	96	12
5	F/70	Pylor stenosis, CHD, DM	Ulcer perforation 8 days before	Generalized peritonitis	96	12
6	M/45	DM, ketoacidosis	Thrombosis of mesenteric artery	Generalized peritonitis	48	6
7	M/62	CHD, ileus	Sigmoid tumor perforation	Fecal peritonitis	72	8
8	F/49	Anterior resection 6 days before, pneumonia	Anastomotic insufficiency	Fecal peritonitis	96	10
9	M/59	Ileus, CHD, ARDS	Ulcer perforation 4 days before	Generalized peritonitis	48	10
10	M/47	Trauma, ileus, multiple fractures, ARDS	Multiple ileal perforations	Generalized peritonitis	72	12

[a] Period between the onset of generalized peritonitis and surgery
[b] Period between the clinical admittance and surgery
CHD, Coronary heart disease; *MI*, Myocardial infarction; *DM*, Diabetes mellitus; *ARDS*, Adult espiratory distress syndrome

Table 3. Multiple organ failures established by clinical and laboratory findings

Case	Pulmonary	Cardiovascular	Renal	Hepatic	Gastrointestinal	Neurologic
1	++	−	+	++	+++	++
2	+	++	+	+	+++	+
3	+++	+++	++	+	+++	+++
4	++	−	++	−	+++	+
5	++	+++	++	+++	+++	++
6	+	+	++	++	+++	++
7	+	++	+	+	+++	+
8	+++	+	++	+	+++	+
9	++	++	+	+	+++	+
10	++	+	++	++	+++	+

−, Normal function; +, minimal or moderate dysfunction; ++, severe dysfunction, +++, no function

established roughly in at least two organs in each patient (Table 3).

The results of scoring calculated according to SSS, APS, and APACHE-II, which were all based on the clinical findings and biochemical analyses, have been shown in Table 4 together with the estimated mortality rates for each case.

Forty laparatomies were done for the ten cases (Table 5). Intraperitoneal collections were conducted at subhepatic, subdiaphragmatic, and interloop spaces during re-explorations (Fig. 2). While the character of the fluid was purulent at the previous operations, this eventually changed to serous fluid. In the cases in whom various drains were used, it was clearly established that the fibrinous plaques had wrapped up the drains and prevented effective drainage. It has also been understood that intestinal motility was not affected by the daily re-explorations. Some additional surgical procedures such as gastroenterostomy, anastomotic repair, or others were easily performed during relaparatomies, in spite of the lack of general anaesthesia (Table 5). Healing of anastomosis was easily controlled during relaparatomy in the patients with anastomosis. The anastomotic healing was con-

Table 4. Calculated scores and expected mortality in the cases using the acute physiologic score (APS), septic severity score (SSS), and acute physiologic and chronic health evaluation-II (APACHE-II) scoring systems

Case	APS		SSS		APACHE-II		Result
	Score	Expected mortality (%)	Score	Expected mortality (%)	Score	Expected mortality (%)	
1	30	60–70	34	40–60	25	40–60	Recovery
2	20	22–28	29	10–30	16	20–30	Death
3	49	80–100	66	80–100	43	80–100	Death
4	24	40–50	34	40–60	30	70–90	Recovery
5	37	80–100	48	80–100	40	80–100	Recovery
6	38	80–100	41	80–100	30	70–90	Death
7	24	40–50	34	40–60	26	40–60	Recovery
8	36	80–100	43	80–100	41	80–100	Death
9	30	60–70	33	40–60	30	70–90	Recovery
10	36	80–100	42	80–100	32	70–90	Recovery
Mean scores of survivors	30.1	60–70	37.5	50–80	30.5	70–90	
Mean scores of deaths	28.2	60–70	44.7	80–100	32.5	70–90	
General average	32.4	80–100	40.4	80–100	30.3	70–90	

Table 5. The type of operation carried out on the patients during the first operation and reinterventions and the number of laparatomies

Case	Primary operation	Reintervention	Total number of reinterventions
1	Right hemicolectomy, ileotransversostomy, tube ileostomy	Debridement and lavage	5
2	Colostomy	Debridement and lavage	3
3	Jejunal resection, termino-terminal anastomosis	Debridement and lavage	3
4	Debridement, primary suture of the cecum	Debridement and lavage	4
5	Primary suture of ulcer perforation, gastrostomy	Debridement and lavage, gastrojejunostomy	5
6	Jejunal resection, duodenojejunostomy	Debridement and lavage, anastomotic repair, drainage	4
7	Sigmoid resection with end-colostomy and Hartmann's pouch	Debridement and lavage	4
8	Anastomotic repair, transversostomy	Debridement and lavage	5
9	Primary suture of ulcer perforation	Debridement and lavage	3
10	Ileal resection, termino-terminal anastomosis, tube ileostomy	Debridement and lavage	4
Total number of laparatomies			40

sidered satisfying if the nutritional status of the patient was adequate even in the septic abdomen. Anastomotic leakage was only observed on the 4th postoperative day in the sixth patient in whom massive jejunal resection and duodenojejunostomy had been done because of thromboembolism in the mesenteric arteries.

The average period of ventilator support in the patients was 27 h and the mean mobilization period was 3 days postoperatively. To start EN required an average of 4.5 days. The figures for the survivals were 13.3 h, 2.6 days, and 4.6 days, respectively (Table 6).

During re-exploration, aggressive fluid and electrolyte therapy was carried out due to excessive fluid loss from the peritoneal surface. The required fluid amounts for maintaining the optimal hemodynamic parameters of the patients have been shown in Table 7. The mean amount was 4,900 ml a day for each case.

Of the patients, six survived and four died. The reasons of death have been listed in Table 8. The mean postoperative hospitalization period was 14.5 days and of this figure, 7.1 days were spent in the intensive care

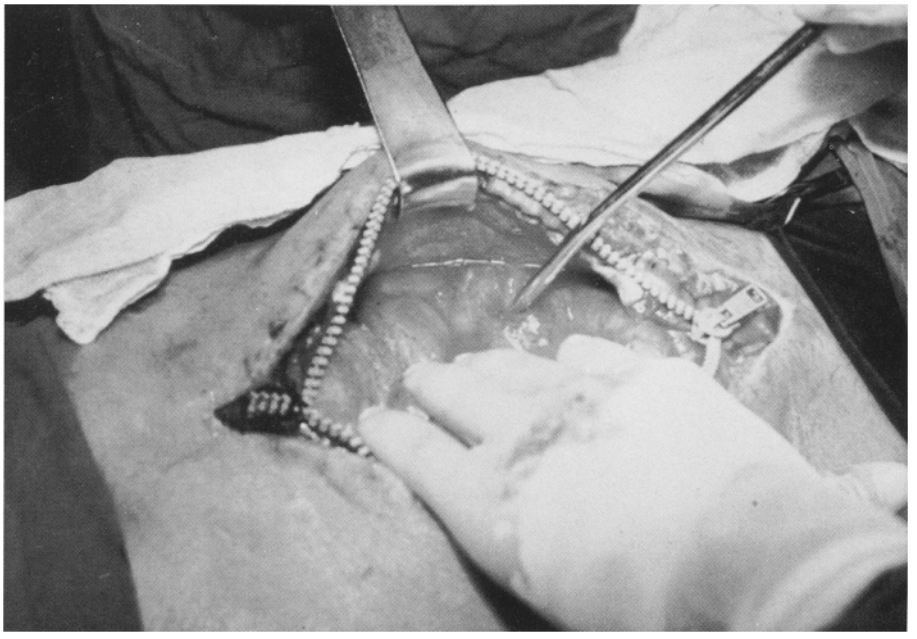

Fig. 2. Appearance of intraperitoneal collection during re-exploration

unit (ICU). These figures were established as 20.9 days and 8.6 days, respectively in the survivors (Table 9).

As seen in Table 10, the rate of incisional hernia among the survivors was 100%. Residual abscess formation, however, was not encountered.

Discussion

Numerous therapeutic methods have been attempted because of the high mortality rates in patients with suppurative peritonitis. There is still no consensus for any standard treatment mode and the investigations continue. However, three main principals have generally been accepted by surgeons. These are:

1. The elimination and drainage of septic foci.
2. Debridement of necrotic material, and
3. Avoidance of recurrent septic contaminations.

The role of recurrent septic contaminations has been proven previously.[7,11] According to this concept, the peritoneal cavity is contaminated continuously by the intraluminal bacteria. For this reason, proper drainage of the cavity is very important. However, today, some authors have claimed that the complete drainage of the peritoneal cavity is impossible.[3,8,13–16] Maetani and Tobe[8] pointed out that the peritoneal cavity is a space in which there are many compartments walled by flexible and soft intra-abdominal organs. Anderson et al.[12] stated that the drainage of the peritoneal cavity by available drains is impossible. According to Pitt,[3] 24 h later, drains start to drain their own tractus.

Table 6. The periods of ventilator-dependance, onset of ambulation, and the beginning of enteral nutrition in the cases

Case	Ventilator usage (hour)	First ambulation (postoperative day)	First enteral feeding (postoperative day)
1	4	3 with zipper	5
2	8	3 with zipper	3 with zipper
3	48	—	—
4	10	2 with zipper	4 with zipper
5	20	3 with zipper	6
6	72	4 with zipper	—
7	16	3 with zipper	4 with zipper
8	62	4 with zipper	5 with zipper
9	14	2 with zipper	4
10	16	3 with zipper	5
Average	27	3	4.5
Mean periods in survivors	13.3	2.6	

In view of the abovementioned concepts, we have thought that there is no standard therapy for generalized peritonitis, therefore, to leave the cavity open, just the same as is done in the abscess, seems to be more rational than the other techniques.

Many various techniques have been used so far to keep the peritoneum open. However, the most recent and accepted one is the zipper-mesh method in which the cavity can be easily explored anytime if necessary

Table 7. Daily average fluid requirements for the patients to maintain hemodynamic parameters optimally

Case	Amount of fluid infused for resuscitation (ml per day)
1	5,500
2	4,200
3	4,500
4	4,500
5	5,000
6	4,800
7	6,000
8	4,200
9	5,800
10	4,500
Average	4,900

Table 8. Causes of death in four cases

Case	Cause of death
2	Myocardial infarction
3	Multiple organ failure
6	Multiple organ failure
8	Multiple organ failure

Table 9. Postoperative hospitalization period of the cases

Case	Intensive care unit (day)	Surgical ward (day)	Total
1	8	7	15
2	6	—	6
3	2	—	2
4	10	12	22
5	10	20	30
6	5	—	5
7	7	11	18
8	6	—	6
9	9	13	22
10	8	11	19
Average	7.1	7.4	14.5
Average in survivors	8.6	12.3	21

Table 10. Results of long-term follow-up period of survivors

Case	Residual abscess			Incisional hernia		
	15th day	6th month	1st year	15th day	6th month	1st year
1	–	–	–	–	–	+
4	–	–	–	–	+	+
5	–	–	–	–	–	+
7	–	–	–	–	+	+
10	–	–	–	–	–	+

while the wound can be kept closed most of the time. Firstly, Teichman et al.[21] and, then, Hedderich et al.[1] reported the results of zipper-mesh technique in their series in 1986. Later, Garcia-Sabrido et al.,[6] Schein et al.,[16] Doody et al.,[22] and Walsh et al.[11] published the results of the same method and claimed that this technique covers all requirements for the principals of the therapy of generalized peritonitis. It was also reported by the same authors that the formation rates of residual abscess or fistula and mortality are all lower in this method than with the others and the ventilator-dependance period of the patient decreases.[1,6,11,16,22]

In our study, the indications of zipper-mesh technique have been established just as those of the others. Although non-delayed colonic perforations and necrotizing pancreatitis include the same indications, we did not have any such cases in our series since we did not encounter them in emergency. In the reported series, the method has already been proposed for all types of generalized peritonitis and necrotizing pancreatitis except for those due to appendiceal perforations.[6,22] Besides, it has been suggested that this technique can also be used in patients with MOF,[11] with high APACHE-II or APS scores and gastrointestinal perforation together,[7] or used in patients having unsafe anastomoses or mesenteric ischemia in order to monitor intestinal viability.[6]

To localize an abscess in an organism is possible only by utilizing the host defense mechanisms.[9,23] This means that a generalization of an infection in the peritoneal cavity indicates the inadequate ability of the host defense mechanisms. For that reason, we included all patients with generalized peritonitis in our study whether the source of infection was known or not. Therefore, even though the primary pathology was appendiceal perforation in case 4 of the series, we included it in the study because of the presence of extensive generalized peritonitis characterized by purulent collections and fibrinous plaques in all compartments.

The nature of the zippers used in the studies are not homogenous and some of them are commercial.[1,6,11,16] In only one report, the use of the commercial zippers has been criticized by a manufacturer.[24] He has expressed in a letter that they, as manufacturers, had taken no legal responsibility for the use of zippers in the medical area. No scientific rejection has been encountered in the papers. We also experienced no problems, in the use of such zippers in our patients.

There are some arguments as to suturing of mesh either to the edges of the fascia or skin. Garcia-Sabrido et al.[6] proposed suturing the mesh to the skin edges in order to save the fascia. In other studies, however, it has been shown that suturing to the fascial edges is more rational because the dense adhesions may miss

finding the correct plane where the mesh has been sutured to the skin.[1,11,16]

In a previous study, it has been recommended that the performance of anastomoses and ostomies be avoided.[16] Later, however, it has been understood that the intraperitoneal bacteria do not affect the healing of anastomoses.[25] Moreover, no complications have been encountered relevant to anastomoses in other studies.[1,11] Therefore, we performed either anastomoses or primary sutures during the first intervention because, thanks to the re-explorations, it was possible to notice such complications early. Among the cases in whom various anastomoses or primary sutures had been done, only in the third re-exploration of case 6, anastomotic leakage was established and repaired in the same session (10%) (Table 5). We also did not avoid ostomies in the first operation in order to provide sufficient nutrition and decompression. The use of drains, both in primary interventions and re-explorations, was avoided except for some special conditions. Nevertheless, Schein et al.[16] reported that there was no need in his series to use drains because of the early reoperations planned. Walsh et al.[11] showed that the drains used in his series had been mostly obstructed by debris and then, he stated that they had finally abandoned their use. We used a drain in only one patient during relaparatomy in whom anastomotic leakage had been noticed. In some cases, if abundant serous collections were seen during the removal of zipper-mesh, sump drainage was preferred. This method has already been suggested by some authors.[1,6,11,16]

It has been pointed out in the studies that the performance of re-explorations under diazepam sedation in the ICUs provides the avoidance of the patient transport and general anaesthesia requirements.[1,7,11,16] However, we preferred to perform relaparatomies in the operation room under diazepam or fentanyl sedation in order to create a completely sterilized medium. In our series, we found that the ventilator-dependance period was 27 h on the average. This figure was 13.3 h in the survivors. As can be seen in Table 3, in the cases whose pulmonary function was extremely disordered, to obtain quite short period of ventilator dependancy was completely due to the increase of pulmonary capacity subsequent to decrease of intra-abdominal pressure as a consequence of the zipper-mesh technique. In the studies in which low intra-abdominal pressure can be produced by an open abdomen, a semi-open abdomen or zipper-mesh methods, it has been proven that the requirement of ventilator support decreases substantially.[6,8,9,12,15,26]

The patients who had no need of ventilator support were mobilized as soon as possible. The average mobilization period was quite short in our study. Because this period has not yet been reported in other studies, it is still impossible to compare this parameter with that of the others, however, it can be stressed that the zipper-mesh technique does not prevent the patient from mobilization.

The period for starting EN in the patients was also reasonable in this series. We did not encounter any problems relevant to feeding despite consecutive re-explorations. In the studies, it has been reported that the EN can be well tolerated by the patients.[1,11] We had planned to use the zipper alone before we started the study in order to decrease loss of protein and fluid. However, we were not able to succeed in reducing the loss and furthermore, we noticed that the ansae of the small bowels were pressurized by the teeth of zipper and that the ventilation worsened. For these reasons, we added a mesh to the method after the third case. As can be seen in Table 4, the estimated mortality was around 70%–90% in the cases classified according to all three scoring systems. This figure is quite high if one compares them with that of the other reported series. For instance, the APACHE-II score was 16.7 in Walsh's series,[11] 25 in Garcia-Sabrido's[6] and 13.2 in Schein's.[16] The figure of 30.6 demonstrates the high risk situations of our patients.

The average period between the onset of peritonitis symptoms and operation was 74.4 h (Table 2). Such a long period was due to the delay in admittance of the patients to our clinic or hospital. This is unfortunately true, because almost all had been delayed due to improper treatment and diagnosis at other clinics. The period between the admittance of patients to our clinic and the operation was 10 h on the average. This period was generally obligatorily used for fluid resuscitation, catheterization or other monitorizations. As is known, the period between the onset of peritonitis and operation is extremely important and the longer it is, the higher the mortality is. Bohnen et al.[27] reported that while the mortality was 30% in the patients undergoing operation within the first 24 h, it rose to about 68% in those who were delayed. This also shows that our cases were too delayed as to risk assessment.

The main reason of death in the cases with generalized peritonitis is MOF.[1,5,10,11,17–19] The mortality has been reported between 20% to 70% among the patients undergoing zipper-mesh technique.[1,6,11,16] This rate was 28.5% in our series. If one were to consider that two or more organic malfunctions were established during the preoperative assessment of the patients (Table 3), this result could then be evaluated as successful.

One would think that the 40% of mortality is quite high. However, as is shown in Table 3, of the cases, 70% had pulmonary, 50% had cardiovascular, 100%

had gastrointestinal, 40% had hepatic and 60% had renal insufficiencies. The mortality rates reported in the literature are 74% for pulmonary insufficiency, 50% for hepatic failure, 82% for renal, and 65% for gastrointestinal failure.[5] Moreover, it has been reported that two-organ failure leads to a 58% to 67% mortality.[5,17] If it is not evaluated as the complete organ failure but severe dysfunction, we have noticed dysfunction averagely in 3.6 organs of the cases (Table 3). Knaus et al.[28] reported that in the case with severe dysfunction involving 3 organs and lasting more than 3 days, the mortality reaches 93%. Thus, the 40% mortality should be considered as quite successful. Besides, expected mortality calculated using APS, SSS, and APACHE-II scoring systems has ranged from 70% to 90% in our cases. It has also been reported that if the APACHE-II score is over 25, the mortality is 100% even in cases where zipper-mesh technique has been used.[6,11] There was only one case in our series where the APACHE-II score was below 25 and all six survivors had scores higher than 25 (Table 4). This supports the superiority of the zipper-mesh technique.

To evaluate the patients taking only the mortality rates into account may lead one to a misunderstanding. For this reason, the condition of a patient as to critical illness should be assessed according to some scoring systems.[5–7,10] Therefore, we evaluated our patients by comparing them with the critical conditions assessed on the rational scoring methods in the literature.

If the expected mortality rates calculated by scoring systems are considered as the basic criteria, we can claim that the zipper-mesh technique lowers the mortality significantly in the patients with DSP. This method may also be evaluated as a life-saving technique.

We encountered no complication of gastrointestinal system (GIS) fistula in our cases. As is known, this complication is not rare in the patients with peritonitis. With zipper-mesh technique, only Hedderich et al.[1] reported two cases with internal fistula. However, he carefully mentioned that this was not due to the zipper or the mesh itself. We only noticed that if the zipper is used alone without a mesh, the impressions of the teeth can be encountered on the external surface of the bowels, but this is not the case when the zipper and mesh have been performed together.

We easily performed some additional procedures such as gastrojejunostomy or anastomotic repair in our cases (Table 5). This can be considered as an advantage of the method. Anesthesia was not required in those patients. Such procedures have also been performed in the literature.[1,11]

The average hospitalization period of the survivors was 22.3 days (Table 9). Walsh et al.[11] reported this period to be 35 days. However, he declared that the first 16 days of this period were needed for coverage of the wound healing after removing the zipper-mesh. There is no consensus in the literature as to how to remove the zipper and mesh. Some prefer to remove the zipper first, and some remove them at the same time. Generally, it has been accepted that the macroscopic healing of the peritoneal cavity and recovery from sepsis are sufficient criteria for removal. In our study, we removed the zipper and mesh simultaneously and sutured the fascia continuously with polydiaxonone. Some authors prefer to leave both the fascia and subcutaneous tissue open.[1,6,11,16] We left the skin open and we did not encounter any problems concerning the respiratory or gastrointestinal systems. The obtaining of a short hospitalization period after performing this method may be attributed to the early closure of the fascia.

Survivors have been followed up an average of 20 months and evaluated for the development of late complications such as incisional hernia or residual abscess formation (Table 10). An incisional hernia developed in all patients. This should not be thought of as a significant complication. In many studies, this was accepted as a potential complication at the beginning while leaving the fascia open.[1,6,11,16] In our cases, even the early closure of the fascia did not reduce the incidence of incisional hernia. In the 20-month follow-up period, no residual abscess formation was seen in our patients by both ultrasonography and computed tomography (CT) examinations.

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