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OPEN MANAGEMENT OF THE SEPTIC ABDOMEN

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ABSTRACT

Severe intraabdominal infection associated with abdominal wall, intraperitoneal and remote organ complications, still carries an unacceptably high morality rate. In addition to the fundamental principle of eradication of the source of infection, various treatment modalities have been suggested to improve the commonly grave outcome. Amongst these, open management (OM) of the septic abdomen, even though based at least theoretically on sound physiologic principles, has not been generally accepted as an uncontroversial method of treatment due to the many and varied complications associated with it.

Frustrating efforts in the treatment of severe intraabdominal infection (IAI) led us to investigate a method of open management while avoiding the complications which others have encountered. What you will read in this report are new, innovative techniques in the open management of IAI which will obviate the complictions of leaving the peritoneal cavity open, such as disruption of anastomoses, evisceration, the need for assisted respiration after paralyzing the patient to prevent evisceration, recurrent abscess formation and need for reexploration to drain such abscesses, complications associated with late closure of the abdominal wall due to severe adhesions, and the negative nitrogen balance existing in such patients.

40 patients have been treated with this method after conventional treatment failure and continued deteriorating condition. Almost all patients had one organ failure (kidney, liver, brain, etc.), and some had multiple organ failure associated with hepatorenal syndrome requiring hemodialysis. Nearly all patients were referred to us in grave condition and were put on this study. The case selection, assessment of patients, preoperative evaluation and preparation, detailed operative technique and post-operative care, along with the final results are discussed. We are recommending this technique as a sound and safe method of management of severe intraabdominal sepsis, and a modality of treatment with an acceptable mortality rate.

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INTRODUCTION

Severe intraabdominal sepsis associated with multiple intraabdominal abscess with or without abdominal wall infection and multiple organ failure has been associated with a high mortality rate.[1-3] Eradicating the source of infection in itself, even though a fundamental principle in surgery, is not always sufficient if performed with the conventional way of closing the peritoneal cavity. Various treatment modalities have been suggested to improve the commonly grave outcome. Repeated reexploration of the abdominal cavity for recurrent or residual intraabdominal sepsis has been indicated. Disappointing results have been reported with reoperation on demand,[4-6] when sepsis becomes clinically manifest or signs of multiple organ failure develop. The policy of elective, staged laparotomies every two-to-four days until the peritoneal cavity is macroscopically clean seems more attractive.[7] While the value of radical peritoneal debridement alone has been disputed,[8] controversy still exists concerning the merits of continuous postoperative peritoneal lavage[9,10].

Frustrating efforts in the treatment of severe intraabdominal infection led Donald Steinberg in 1979 to leave the abdomen open in two cases of purulent peritonitis associated with severe systemic weakness as the result of disruption of anastomoses and severe IAI.[11] He left the abdomen open only for 48-72 hours and noticed dramatic improvement in the clinical course with markedly reduced mortality and intraperitoneal postoperative complications. He states, "Perhaps this is not a new concept, but I believe it has not achieved its place in the surgical armamentarium".

John H. Duff and colleagues in 1981[12] reported 18 cases of seriously ill patients with abdominal sepsis treated by leaving the abdomen completely open. All except two of his patients had severe intraabdominal sepsis. Eight patients had full-thickness wound infections and IAI refractory to the usual surgical drainage technique. Two had necrotizing wound infections only. In 12 patients, an upper abdominal incision was managed open and in six, the open incision was lower. In spite of the fact that *respiratory failure* made *mechanical ventilation* necessary in 13 patients for an average of *44 days*, three patients required *paralysis* and *mechanical ventilation* until adhesions became firm, six had continuous infection leading to death, and one had fatal hemorrhage (mortality, 39%), he still concluded that leaving the abdomen completly open facilitates the widest possible drainage, uncompromising debridement of the abdominal wall, and is compatible with good recovery.

Shunzo Maetani and Takayoshi Tobe in 1981[13] reported 13 cases of far advanced peritonitis (postoperative suture line breakdown in eight and spontaneous intestinal perforation in five patients) treated by widely opening the peritoneal cavity and exposing the contaminated viscera. Even though five patients had *residual collection* requiring additional drainage procedures and *one death* occurred, with *another mortality* during the course of closure of the abdominal wall, he concluded that the open peritoneal drainage procedure should be considered for advanced peritonitis causing grave systemic complications.

To prevent evisceration and the need to paralyze

Figure 1. The incision from the xyphoid to the pubis, exposed bowel, Penrose drains and nelathon catheter in place.

the patient, Eric D. Anderson, et al [14] in 1982 advocated leaving the abdomen open and packing the peritoneal cavity in generalized microbial peritonitis. He stated that he treats the peritoneal cavity like an abscess cavity and thus provides adequate drainage. He compared 20 cases treated as such with 18 cases treated with the conventional method of closing the abdomen. He reassessed his patients every 48 hours for closing the abdomen, and if purulent material persisted, packed the cavity again for another 48 hours. He concluded that in spite of previous reports, open management has no advantages over the conventional abdominal closure.

In 1985, Giles Hedderich [15] advocated use of marlex mesh along with a zipper in OM of the septic abdomen to prevent evisceration and the need for ventilatory support and paralyzing the patient, while providing easy access to the peritoneal cavity for daily peritoneal lavage and exploration through the zipper in the ICU. He reports 10 cases with eight survivors. Only three of his patients needed respiratory support. He suggested more controlled studies for final assessment of the benefits of this technique.

In December of 1986, Moshe Schein, et al,[16] in a collective review, try to resolve the confusion and uncertainty among surgeons concerning the merits and pitfalls of OM of the septic abdomen by summarizing the advantages, different techniques, complications, etc. They conclude that "the open method of management has not made the treatment of the septic abdomen much easier. It requires intensive care support and repeated assessment of the peritoneal cavity. *Closure of the abdomen is a problem* which must be addressed when the sepsis has subsided. The value of this technique is still difficult to assess in the absence of controlled randomized trials."

What come in this report are modifications and new inventions in the technique of open management of septic abdomen which will retain the advantages of proper and adequate drainage while obviating the complications associated with this method as aforementioned; [17-34] i.e. disruption of new or recent anastomoses, evisceration, need for respiratory assistance, mechanical ventilation and paralyzing the patient, fistulization of the exposed bowel, hemorrhage, accumulation of purulent material in dependent areas of the peritoneal cavity requiring additional drainage procedures, and finally, difficulties associated with secondary closure of the abdominal wall.

MATERIAL AND METHODS

From 1985 to 1987, 42 patients were treated for severe intraabdominal sepsis and multiple intraabdominal abscesses associated with or without abdominal wall sepsis and necrotizing fasciitis. 37 patients were male and five were female and the patients' age ranged from 17 to 65 years, with an average age of 28.5 years. All were in grave condition, some with multiple organ failure associated with hepatorenal syndrome (elevation of bilirubin, BUN, creatinine and K) requiring hemodialysis. All of the patients were referred to the Shohada Medical Center, Shahid Beheshti University of Medical Sciences or the Shahid Mostafa Khomeini Hospital affiliated to the Martyrs' Foundation.

Figure 2. Granulation tissue has formed over the bowel, and is ready to receive a skin graft.

Case selection

All of the patients had severe intraabdominal sepsis with multiple intraabdominal abscess with or without necrotizing fasciitis or sepsis of all abdominal layers. The cause of peritonitis was leakage of anastomoses of small or large intestine or stomach and occasionally missed perforation of large or small intestine as a result of projectile missile particles during original exploration. In some cases, multiple intraabdominal abscesses followed perforated appendicitis and after conventional treatment of closing the abdomen, the patients' conditions failed to improve. Generalized peritonitis following perforated appendicitis or perforated viscus where there were no multiple intraabdominal abscesses and which were in the early stage were treated by peritoneal lavage and primary closure and were not included in this series.

Assessment, preoperative evaluation, preparation for operation

The patients were usually in grave condition, most being in septic shock and multiple organ failure, and prior to operation, they should be resuscitated with fluids and blood. Measuring central venous pressure and resusucitaion with fluids and blood to achieve a pressure of 10-12 cm H_2O and dopamine drip to maintain satisfactory systolic pressure may be required. When the patient has an elevated serum potassium level due to renal insufficiency, [illegible] should be performed prior to operation. Wide-spectrum antibiotics or combination therapy against Gram-positive, Gram-negative and anaerobic organisms should be initiated immediately to achieve adequate blood levels for the time of operation. Sufficient quantities of cross-matched blood should be available since there may be considerable blood loss due to coagulopathies or DIC which usually exists in these patients. Assessment of coagulation factors before or during operation may be necessary if unusual oozing of blood exists. Respiratory evaluation and measurement of blood gases may also be required, especially if ARDS is suspected.

Operative technique

The principals of surgical technique are:

I) A long midline incision from the xyphoid process to the pubic symphysis. Taking advantage of all possible length is an important factor in the prevention of dehiscence. Increase in intraabdominal pressure with smaller incisions leads to extrusion of viscera. A long incision allows the edges of the wound to separate with contracture of the muscles rather than causing an increase in intraabdominal pressure and evisceration. No other incision should be used.

II) Radical surgical debridement of intraabdominal viscera, removing fibrous adhesions and opening all interloop abscesses. Culture and smear are obtained in all patients, all pus and free peritoneal fluids are initially suctioned away and copious warm saline solution is used to wash blood and debris and achieve adequate hemostasis. Control of oozing is performed by temporary packing of cleaned areas with warm moist packs while proceeding with debridement of other intraabdominal areas.

Since most of the patients have paralytic ileus and

Figure 3. The defect has been grafted with a split-thickness skin graft.

substantial small bowel distension, decompression of the small bowel is an important part of surgical management. This is done usually by use of a sump-type suction tube introduced through the disrupted anastomtic site or if a long tube has been placed in the small bowel preoperatively, this is advanced to the cecum for immediate decompression. All other patients will have nasogastric suction implemented prior to surgery. In some cases we had to perform a jejunostomy for passing a long tube or sump-type suction tube to decompress the entire small bowel loops. Care should be taken to place this incision where it can be properly covered by other loops of bowel and away from the drain sites.

III) Removing the source of contamination. During the initial examination of the peritoneal cavity, and during surgical debridement, the source of contamination is usually identified without difficulty. The source of contamination must be eliminated if treatment is to be successful.

Diverting colostomies when there is anastomotic leakage from the large bowel anastomosis and the site of leakage cannot be brought out of the abdominal cavity should be performed. Closure of disrupted anastomoses if possible without undue tension or resection of edges is carried out with monofilament 4-0 nylon, prolene or wire using Gambie's method in one layer. Care should be taken to just approximate the edges and prevent ischemia under the sutures by overtightening of knots. Conventional two-layer closure is impossible due to edema of the bowel and should be avoided. Small bowel leakage or disrupted anastomosis is managed in the above manner also and no proximal diverting enterostomy is necessary.

IV) Adequate washing of the peritoneal cavity with saline solution and preferably, a small amount of hydrogen peroxide should be added (not more than one to two volume percent). Careful reexamination of all loops of small bowel should be performed in order to be sure that all pus collections between loops of small bowel, especially in the subhepatic, subdiaphragmatic areas and the pouch of Douglas have been opened and suctioned away. Peritoneal detritus, pseudomembranes and other exudates are removed by suction, forceps debridement and gentle dissection. Substantial bleeding is not a problem if proper planes

Table I. Cause and type of injuries in the surviving group.

Patient	cause	Description	other
1	war injury	perforation of small & large bowel, stomach & spleen	chest
2	war injury	colon	lumbar region
3	war injury	colon and bladder	—
4	war injury	colon	left flank and shin
5	civilian	perforated appendicitis	—
6	civilian	small bowel gangrene following reduction of hernia	—
7	war injury	perforation of small & large bowel & ureter	—
8	civilian	liver laceration	—
9	war injury	perforation of large & small bowel & bladder	fracture of pelvis
10	war injury	perforation of colon & laceration of spleen	left chest .
11	war injury	perforation of colon	—
12	war injury	colon, stomach, laceration of spleen	left chest, fx left leg
13	war injury	small bowel, necrotizing fasciitis of abd.wall	left chest, fx femur, arm
14	war injury	stomach, laceration of liver, & gall bladder	STI of right forearm
15	war injury	small bowel, colon, pancreas	STI rt thigh
16	war injury	cecum, colon, small bowel	fx rt forearm & pelvis
17	war injury	stomach, meso, transverse colon	—
18	civilian	perforated appendicitis	—
19	war injury	perforation of small bowel	STI rt leg
20	war injury	small bowel, colon	—
21	war injury	stomach, liver, spleen	left chest, STI Lt leg
22	civilian	small bowel	—
23	civilian	small bowel	—
24	civilian	small and large bowel	—
25	civilian	colon	—
26	war injury	kidney, retroperitoneal area	—

STI = soft tissue injury
FX = fracture

are entered. The serosal surface of the bowel should not be entered. If pseudomembranes and exudate are not easily removed from the peritoneal surface with a dry gauze or forceps, they should be left alone rather than deserosing the bowel. After the entire peritoneal cavity is grossly debrided of all evident material, it is again thoroughly irrigated with physiologic salt solution containing a small amount of hydrogen peroxide. The irrigation is continued until the effluent is clear. Depending on the size of the patient, this may require from five to 20 liters of irrigation fluid. bridement, irrigation and cleansing are continued until the peritoneum has a grossly normal appearance. Rectal and esophageal temperatures are monitored and the body temperature is returned to normal by controlling the temperature of the irrigation fluid.

V) Drying the abdominal cavity after proper cleansing and assurance of removing irrigation fluids from dependent areas.

VI) Proper drainage of all dependent areas with Penrose drains and providing the means for intermittent irrigation by placing a small nelathon catheter (size 12-14) alongside the Penrose drains. One set of drains and a catheter are placed in the pelvis, exiting from the lower angle of the incision. Another set is placed in the left lower gutter, coming out from the left lower and lateral side and a third set is placed in the left upper and/or subdiaphragmatic area, exiting from the left lateral and upper portion of the incision. Still a fourth set is placed in the right gutter, exiting from the right lower and lateral side of the incision. Finally a drainage set is placed in the right subdiaphragmatic or subhepatic area, coming out from the right upper and lateral part of the incision. If there has been a collection in the lesser sac, it is drained through the lesser omentum, coming out from the upper corner of the incision.

VII) Covering the intestinal anastomosis with adjacent loops of bowel, or situating it against the abdominal wall away from the drain sets.

VIII) If the patient has sufficient greater omentum (as in older patients) it is spread over the small bowel as much as possible.

XI) Covering the omentum and exposed loops of small bowel and large bowel by a fine mesh soaked with vaseline (petroleum jelly). The mesh should be tightly woven and the holes small enough to prevent granulation tissue from growing through. The mesh is spread such that it protrudes somewhat under the edges of the peritoneum. The space between the edges of the abdominal wound is filled with gauze and held in place with Montgomery tape to facilitate repeated change.

X) After completion of operation, the patient should not be extubated and should continue to receive assisted ventilation until he has an adequate tidal volume. Due to severe systemic infection, weakness and occasional cachexia as a result of negative nitrogen balance and hepatorenal syndrome, these patients metabolize anesthetic agents with great difficulty and may take several hours before achieving an adequate tidal volume.

Postoperative care

During the first few days when drainage is copious, the dressing should be changed several times a day.

Table II. Cause and type of injuries in non-surviving group.

Patient	Cause	Description	Other
1	war injury	perforation of small & large bowel	It chest, STI buttocks
2		small bowel and necrotizing fasciitis of abdom. wall	STI rt leg and arm
3		liver laceration	gangrene It leg
4		perforation of small bowel & duodenum	—
5		perforation of small bowel	gangrene rt leg
6	civilian	perforated appendicitis & necrotizing fasciitis of abdominal wall	—
7	war injury	small, large intestine, laceration of spleen	STI It leg
8		perforation of cecum	gangrene It arm
9		perforation of small bowel	rt chest
10		duodenum, stomach, small & large bowel	—
11		stomach, colon, necrotizing fasciitis of retroperitoneal area	—
12		small, large bowel, stomach	It chest, STI It leg
13		small bowel	gangrene it leg
14	civilian	perforated appendicitis	—
15	war injury	small, large bowel, rectum, sigmoid colon	STI It thigh
16		cecum, colon	STI arm, forearm, buttock

Physiologic salt solution containing dilute hydrogen peroxide (one to two volume percent) is injected into the nelathon catheters to foam out via the Penrose drainage sites. This will prevent secondary collection of pus in dependent areas and obviate secondary surgical drainage.

The vaseline gauze should be left in place during dressing changes and be changed only once a day. Otherwise, the vaseline gauze will adhere to the bowel and cause deserosation, leading to eventual fistulization.

Adequate fluid and blood replacement with monitoring of hourly urine output, hemoglobin and hematocrit, and CVP measurement should be caried out carefully. Urine output should be kept at about 50 cc/hr or greater and hemoglobin above 14 g/dl.

Coverage with broad spectrum or triple antibiotics should be continued until the results of aerobic and anaerobic cultures are ready, at which time specific antibiotics may be utilized. Multiple organisms are usually recovered from cultures.

Administration of nasal oxygen or oxygen by mask is necessary in case of mild ARDS. We did not have to give ventilatory support to these patients after recovery from anesthesia, since the pulmonary function soon improved after operation.

The drains should be left in place as long as signs of sepsis exist and oral feeding has not been started. After purulent secretions have abated, the drains are advanced daily until they are removed completely and only then are the Nelathon catheters advanced and removed. Injection of dilute hydrogen peroxide via the catheters should be continued until they are removed.

Oral feeding is started as soon as bowel function returns and the patient develops bowel movement or his colostomy fuctions.

By the time the drains are removed, the bowel surfaces are usually covered by a cherry-red granulation tissue, at which time a split-thickness skin graft will be placed over them.

Secondary closure of the abdominal wound should never be attempted at this time since it requires a deep general anesthesia and the possibility of injuring the small bowel is great. Moreover, the patient is still in a negative nitrogen balance state and an added operation risk is unjustifiable.

The patient is discharged from the hospital at this time, to be readmitted after two months when he has regained his normal weight, for closure of the colostomy. He is again discharged to be readmitted after one month for the repair of his incisional hernia. If the patient has a double-barrel colostomy and a laparotomy is needed to close the colostomy, the skin can be incised and again sutured with a no. O prolene. These sutures are left in place for a month, after which the patient will be readmitted for repair of his incisional hernia.

For repair of the incisional hernia, an incision is made over the normal skin just lateral to the skin graft, and the skin is separated from the rectus fascia for a distance of one centimeter. Another incision is placed over the skin graft. Interestingly, the undersurface of the graft is covered by peritoneum and there are very few fine adhesions between the bowel loops and the peritoneum covering the undersurface of the skin graft. The graft is removed completely and the fascia will be closed using Tom Jones method with monofilament suture material such as prolene or ethilon.

RESULTS

From 1985 to 1987, 42 patients were treated with the above method. The cause of intraabdominal injury was war injuries (missile particle or bullet) in 35 patients, and inflammation of intraabdominal organs or car accident in seven cases. Table I demonstrates the intraabdominal (including retroperitoneal), organ and limb lesions in the patients who tolerated the operation and survived, and Table II, those who did not tolerate the stress of operation and died either on the operating table or immediately afterwards during hemodialysis.

Associated injuries other than intraabdominal wounds which existed in patients who survived are shown in Table III, while extraabdominal injuries of those who expired are shown in Table IV.

The time interval between injury (leakage) and open management of intraabdominal sepsis was between two and 38 days, with an average of 12.25 days. The average for patients who lived was nine days while that of those who expired was 14.4 days. 17 patients were in end stage and did not tolerate the stress of operation and died on the operating table or immediately afterwards during postoperative hemodialysis, and we can not attribute these mortalities to the procedure.

The preoperative condition of the patients who expired during operation or immediately afterwards is shown in Table V and that of patients who survived is

Table III. Associated injuries in surviving group.

chest injury	2 patients
limb injury	7 patients
chest & limb injury	3 patients

Table IV. Associated injuries in non-surviving group.

chest injury	1 patient
limb injury	8 patients
chest & limb injury	2 patients

Table V. Preoperative condition of patients who expired during operation or immediately afterwards.

multiple organ failure (liver, kindey, lung)	4 patients
liver failure	7 patients
renal failure	5 patients
respiratory insufficiency	1 patients

Table VI. Preoperative condition of surviving patients.

multiple organ failure	1 patient
upper GI bleeding	1 patient
renal failure	3 patients
severe cachexia	6 patients

Table VII. Complications in patients who expired.

upper GI bleeding	4 patients
DIC	1 patient

shown in Table VI.

Complications as the result of stress and multiple organ failure such as upper GI bleeding, coagulopathy and DIC in patients who expired are shown in Table VII.

In six patients, we had disruption of the anastomotic site. In four patients, the anastomoses were placed in such an area that proximal enterostomy was impossible (duodenum) and it was impossible to cover the anastomotic site with small bowel (due to stiffness of the bowel as the result of edema) and continuous soiling of the peritoneal cavity was unavoidable, resulting in death. In the other two patients, revision of the anastomosis with proper coverage was performed and the patients' conditions improved.

All fistulae were at the site of revision of previous anastomotic leakage and we did not experience fistulization of the bowel as a result of exposure of bowel with open management.

In other patients, peristalsis soon returned and oral feeding was initiated between three and nine days, with an average of four days. Systemic infection subsided and return of renal function was observed.

DISCUSSION

Considering the above results noted in 25 patients who tolerated the operative stress and did not die during operation or immediately afterwards, we experienced only four deaths as the result of anastomotic leakage (16% mortality). This itself could have been avoided if the operation had been undertaken earlier, before the patients had deteriorated to grave conditions with negative nitrogen balance, multiple organ failure with its complications of upper GI bleeding and DIC. Open management of the septic abdomen with technical points as detailed above is a safe and life-saving procedure, and can enter the armamentarium of the surgeon.

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