

Closed Peritoneal Lavage in the Treatment of Foecal Peritonitis: An Experimental Study

AHMED M. ELLABBAN, M.D.; EL-SAYED A. F. EL-ZAYAT, M.D.;
MOUSTAFA A. ABOU ALI, M.D. and KHALIFA I. KHALIFA, M.D.

*The Departments of Surgery and Biochemistry,
Faculty of Medicine, Suez Canal University.*

Abstract

This study was carried out on 72 Guinea pigs to evaluate the use of every 12 hour intermittent lavage for 72 hours with or without antibiotics in management of foecal peritonitis. Animals were divided randomly into 6 groups; each received either low or high doses of standard foecal inocula intraperitoneally. Results of the groups of high inocula (100% mortality) showed that the least mortality (16.6%) was seen with the use of lavage containing gentamycin and clindamycin ($p < 0.05$). Intramuscular antibiotics did not improve survival of this group. Other methods (lavage alone or parenteral antibiotics alone) had either little or no effect on mortality. By contrast, in the groups of low foecal inocula (33.3% mortality), lavage not containing antibiotics increased mortality to 100% ($p < 0.05$). The specific antibiotics used are not critical provided that they are effective against enteric organisms. These results demonstrate that postoperative peritoneal irrigation containing antibiotics is beneficial in treatment of foecal peritonitis, but the lavage alone may be harmful. To find out the validity of these results in man, further studies are needed.

Introduction

BACTERIAL peritonitis remains a formidable problem in abdominal surgery. Conventional treatment includes fluid resuscitation, administration of intravenous antibiotics, surgical removal of the source

of contamination and cleansing of the peritoneal cavity. However, in cases of gross contamination, this treatment may be insufficient. Several reports have described the use of continuous post operative lavage with or without intraperitoneal antibiotics.

Such treatment is not new and in fact was used at the beginning of this century [1]. The lavage is supposed to rinse the abdominal cavity of contaminating material and bacteria and thereby reduce the concentration of toxins in the peritoneum [2, 3]. However, some surgeons fear that continuous peritoneal lavage may spread the infection, impede the function of leukocytes, and overwhelm the host defense system [1]. Thus, continuous intraperitoneal lavage may be helpful or it may be harmful. In this study using an experimental model of foecal peritonitis, the effectiveness of peritoneal lavage using antibiotics in the treatment of foecal peritonitis was evaluated. Dose-response experiments were performed, and two different intraperitoneal foecal inocula were given. The low dose inoculum (33.3% mortality) was used to ascertain if peritoneal lavage increased mortality, and the high dose inoculum (100% mortality) was used to determine if the use of antibiotic lavage enhanced survival.

Material and Methods

Seventy two Guinea pigs weighing 400-500 gm were maintained at the Laboratory Animal Services, Faculty of Medicine, Suez Canal University on a standard food prior to the study. They were anaesthetised by ketamine 44 mg/kg and diazepam 0.1 mg/kg. A right iliac incision 2 cm in length was made to expose the peritoneal cavity and a Nelton catheter (gauge 12) with multiple holes at its distal 4 cm

was placed inside the right lower quadrant of the peritoneal cavity. The abdominal incision was closed using continuous 2-0 catgut sutures for the muscles and 2-0 silk for the skin and fixation of the catheter. Another plastic cannula (size 1.4x45 mm) was introduced into the left upper quadrant of the peritoneal cavity by direct puncture and fixed to skin by 2-0 silk suture. The concentration of foecal suspension was prepared from fresh human stool mixed with two parts prereduced peptone-yeast extract-glucose broth (weight per volume) in an anaerobic chamber. The mixtures were coarsely filtered through gauze, and 10 ml aliquot were placed in tubes and frozen at -70°C. Cultures of one thawed suspension from both high and low inocula yielded the organisms listed in Table (1). Intraperitoneal inoculation of 1ml/kg of the high dose foecal suspension (1:1.5 dilution) and 1ml/kg low dose foecal suspension (1:2 dilution) was done through the left sided upper cannula. Intermittent irrigation with lactated Ringer's solution 20 ml/12 hours was performed also through the cannula for 72 hours. The outflow of the intraperitoneal fluid was collected by gravity from the lower abdominal catheter.

Animals were divided into 6 groups. Each day, twelve animals were prepared and 2 of them were assigned to one group to avoid bias. These groups were:

1. No lavage, no antibiotics (control).
2. Lactated Ringer's lavage, no antibiotics.

3. No lavage, antibiotics intramuscularly.
4. Lactated Ringer's lavage, antibiotics intramuscularly.
5. Lactated Ringer's lavage containing antibiotics, no antibiotics intramuscularly.
6. Lactated Ringer's lavage containing antibiotics, antibiotics intramuscularly. Follow up examination of all animals was done every 12 hours for survival data. After 72 hours, the living animals were sacrificed, necropsied and examined for the presence of intraperitoneal pus or abscesses. Cultures of the obtained pus were performed. The intra-

muscular antibiotics used were gentamycin (2 mg/kgm) which provided a serum level in guinea pigs of 6 µg/ml and clindamycin (76 mg/kg) which provided a serum level of 16 µg/ml. Concentrations in the lavage solution were 1 mg/100 ml and 2 mg/100 ml respectively. Doses were chosen in order to provide serum levels in the therapeutic ranges utilised in humans [1].

Blood samples were taken after 24 hours of inoculation from the ear veins of animals of high dose inoculum (one from each group) for blood cultures on aerobic and anaerobic media.

Table (1): Bacteriology of High and Low Dose Inocula.

	High Dose (CFU/ml)	Low Dose (CFU/ml)
<i>Escherichia coli</i>	1X10 ⁽⁶⁾	3X10 ⁽⁶⁾
<i>Staphylococcus aureus</i>	3X10 ⁽⁵⁾
<i>Enterococcus</i>	6X10 ⁽⁵⁾	3X10 ⁽⁵⁾
<i>Alpha streptococcus</i>	1.5X10 ⁽⁶⁾
<i>Escherichia cloacae</i>	1X10 ⁽⁵⁾
<i>Klebsiella pneumoniae</i>	7X10 ⁽⁴⁾
<i>Clostridium perfringes</i>	3X10 ⁽⁴⁾
<i>C.clostridiiforme</i>	1X10 ⁽⁸⁾
<i>Bacteroides fragilis</i>	2X10 ⁽⁷⁾	1X10 ⁽⁷⁾
<i>Bifidbacterium</i>	4X10 ⁽⁷⁾
<i>B.distasonis</i>	4X10 ⁽⁷⁾	1X10 ⁽⁷⁾
<i>B. vulgatus</i>	5X10 ⁽⁷⁾
<i>B. thetaiotamicron</i>	1X10 ⁽⁷⁾
Anaerobic gram-negative rod	4X10 ⁽⁶⁾

CFU = colony - forming unit

Results

Positive blood cultures were seen in all 6 animals drawn after 24 hours of foecal inoculation. The commonest organisms were *E.coli* (100%), proteus (50%) and klebsiella (16.5%).

The results of the groups of high foecal inocula (36 animals) are summarized in table (2) and fig (1). In the control group, 6 animals (100%) died within 72 hours. The use of peritoneal Ringer's lavage alone or the intramuscular antibiotics alone showed minor or no effect on the mortality. Similarly, was the results of using both lines together. However, lavage using Ringer's solution containing antibiotics (gentamycin and clindamycin) re-

duced mortality down to 33.3%. The addition of intramuscular antibiotics added little improvement. These last two methods of treatment significantly decreased mortality as compared with all other groups ($p < 0.05$), but they were not significantly different from one another.

In the groups of low foecal inoculum, the mortality among the untreated control animals was 33.3%. The use of intermittent Ringer's solution lavage alone for 72 hours resulted in a marked increase of mortality to 100%. The addition of intramuscular antibiotics had almost similar effect (83% mortality), The increased mortality in these 2 groups was significantly greater than the control group ($p < 0.05$).

Table (2): Overall 72 Hour Mortality of all Groups.

Group	Therapy	High foecal inocula	Low foecal inocula
1	No IM antibiotics, no lavage	6 / 6 (100%)	2 / 6 (33.3%)
2	No IM antibiotics, Ringer's lavage	6 / 6 (100%)	6 / 6 (100%)*
3	IM antibiotics, no lavage	5 / 6 (83%)	2 / 6 (33.3%)
4	IM antibiotics, Ringer's lavage	5 / 6 (83%)	5 / 6 (83%)*
5	No IM antibiotics, Ringer's lavage containing antibiotics	2 / 6 (33.3%)*	1 / 6 (16.6%)
6	IM antibiotics, Ringer's lavage containing antibiotics	1 / 6 (16.6%)*	1 / 6 (16.6%)

IM = Intramuscular.

* $p < 0.05$ for difference.

These harmful effects of Ringer's solution lavage were not observed in other groups where antibiotics (gentamycin and clindamycin) were added to the lavage and their results were of insignificant difference when compared with control group (Table 2).

Necropsy of the 30 surviving animals revealed free intraperitoneal pus in all animals and localised abscesses in 66% of cases of high foecal inoculum and 50% of cases of low inoculum figs. (2-5). Cultures of these abscesses grew *E. coli* (83% of cases), *proteus* (50% of cases) and *klebsiella* (16.6% of cases).

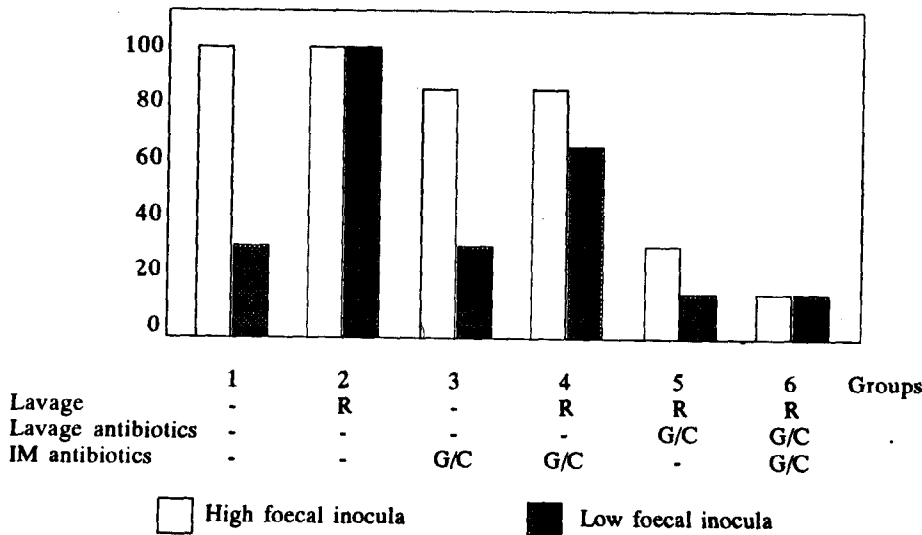


Fig. (1): Overall 72 hours mortality rate in all groups, R, Ringer's solution G, gentamycin, C, clindamycin.

Discussion

Despite modern advances in diagnosis, antibiotic therapy and intensive care, generalised peritonitis remains a highly lethal peritonitis.

Currently, however, more surgeons are accepting the philosophy that the bacteria should be "drowned" in litres of irrigation fluids and "killed" directly in intraperito-

neal cavity by antibiotics [4]. Noon et al. [5] found that wound infections occurred half as frequently in the 400 patients of foecal peritonitis who had received the irrigation with antibiotics containing solution. Stephen and Lowenthal [6] treated 27 high-risk patients with peritonitis with continuous peritoneal lavage containing gentamycin, lincomycin and cephalothin for 72 hours. Seventy eight percent of this



Fig. (2): A Guinea pig with the two peritoneal catheters.



Fig. (3): Diffuse peritonitis in a case of high foecal inoculum.



Fig. (4): Localised intraperitoneal abscess in a cases of high foecal inoculum.



Fig. (5): Localised intraperitoneal abscess in a case of low foecal inoculum.

group survived in comparison to only 51% survival in patients treated without lavage. Previous experiments on animal resulted in equivocal data to support the use of continuous lavage for peritonitis. Per-kash et al [7] and Carodis et al [8] studied peritonitis in rats treated with lavage with and without antibiotics. They found that peritoneal lavage containing antibiotics reduced mortality especially if systemic antibiotics were added. Stewart and Matheson [9] found that intra operative peritoneal lavage containing antibiotics was significantly better than systemic antibiotics in preventing death from peritonitis in rats. However, Lally et al [10] reported that intraperitoneal aminoglycosides were found to be no better than saline solution in survival or abscess formation postoperatively.

Peritoneal lavage alone was criticised as it may disseminate contaminants beyond the area of localisation [1]. However, Autio [11] demonstrated that, even without lavage, intraperitoneal matter is spread by gravity and by respiratory motion of the diaphragm. In this experimental study, mortality was markedly increased (from 33.3% to 100%) with the use of 72 hours peritoneal lavage without antibiotics in the low dose foecal inoculum groups. These results are inconsistent with those obtained by Honovanian and Saddawi [12] but almost agree with the work of Dobrin et al. [1]. These results were attributed to the possible role of lav-

age, if used alone, in dissemination of infection, in dilution or inactivation of host defense systems and even in washing out of antibiotics given systemically [1]. Hence, we must admit that the addition of antibiotics to lavage solution is mandatory.

Regarding the type of antibiotic used, we selected the known combination of gentamycin and clindamycin in the lavage solution [6] to cover aerobic and anaerobic organisms and they were effective. Other investigators used variety of other antibiotics such as kanamycin, cephalothin, polymyxin and bacitracin. These groups were also effective [2, 5, 13]. This suggests that the specific antibiotics may not be critical, provided they are effective against enteric organisms.

Though antibiotics given systemically can achieve bactericidal levels in the peritoneum, yet these systemic antibiotics may be ineffective if bacteria are sequestered in a layer of fibrin, blood or bile [14]. These products are not uncommon in cases of peritonitis and may be responsible for the unexpected minor effect of systemic antibiotics in our animals.

In conclusion, this study proved that the use of postoperative intraperitoneal lavage with a solution containing suitable antibiotics is beneficial for foecal peritonitis in experimental animals. By contrast, peritoneal lavage without antibiotics may be harmful. Further investigations are

needed to find out whether these beneficial effects are applicable in man or not.

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