Trial of Electrolyzed Strong Acid Aqueous Solution Lavage in the Treatment of Peritonitis and Intraperitoneal Abscess

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Abstract: Electrolyzed strong acid aqueous solution is acidic water that contains active oxygen and active chlorine and possesses a redox potential. We performed peritoneal and abscess lavages with an electrolyzed strong acid aqueous solution to treat 7 patients with peritonitis and intraperitoneal abscesses, who were seen in our department between December 1994 and April 1995. The underlying disease was duodenal ulcer perforation in 4 of these 7 patients and gastric ulcer perforation, acute enteritis, and intraperitoneal perforation of pyometrium in 1 patient each. Irrigation was performed twice a day. Microbiological studies of the paracentesis fluid were negative in 3 cases, and the irrigation period was 2–4 days. Anaerobic bacteria were isolated in 3 of the 4 positive cases (Bacteroides in 2, Prevotella in 1), and a fungus (Candida) was isolated in the remaining patient. The period of irrigation in these patients ranged from 9 to 12 days, but conversion to a microorganism negative state was observed in 3–7 days. Key Words: Electrolyzed strong acid aqueous solution—Peritoneal lavage—Lavage of intraperitoneal abscess—Redox potential.

Electrolyzed strong acid aqueous solution is produced on the anode side by electrolyzing salt-containing water through a diaphragm; it contains active oxygen and active chlorine and a redox potential (1). This electrolyzed strong acid aqueous solution is said to create an environment beyond the boundaries of the region in which microorganisms can survive and to have a germicidal effect on all bacteria and fungi as a result of the action of the active oxygen and active chlorine that it contains. It has recently come to be used in a variety of medical settings. It is also being used in our department, for hand washing in the outpatient clinic and on the ward and for disinfecting floors, disinfecting contaminated wounds, and so forth. However in this study, we tried to use it for lavage of foci of contamination within the peritoneal cavity.

SUBJECTS AND METHODS

The subjects were 7 patients with peritonitis or intraperitoneal abscesses secondary to peritonitis whom we treated between December 1994 and April 1995. The cases are outlined in Table 1. There were 4 men and 3 women ranging in age from 19 to 91 years. The primary disease was duodenal ulcer perforation in 4 cases and gastric ulcer perforation, acute enteritis, and pyometrium in 1 case each.

The site of paracentesis was the right hypochondrium in all patients with additional drainage being performed on the lower abdomen and the left hypochondrium of the patient treated 48 h after duodenal ulcer perforation and from the lower abdomen in the patient with the ruptured pyometrium. To determine the response to the irrigation, the paracentesis fluid was collected and cultured for aerobic and anaerobic bacteria, and for fungi (2, 3).

Key Words: Electrolyzed strong acid aqueous solution—Peritoneal lavage—Lavage of intraperitoneal abscess—Redox potential.

Table 1. Cases in which electrolyzed strong acid aqueous solution was used to treat peritonitis and intraperitoneal abscesses

<table>
<thead>
<tr>
<th>No. of patients</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>4 men, 3 women</td>
</tr>
<tr>
<td>Age</td>
<td>19-91 years old; mean, 67.6 years</td>
</tr>
<tr>
<td>Diseases</td>
<td>4 cases of peritonitis, 2 cases of intraperitoneal abscess, and 1 case of intraperitoneal rupture of pyometrium</td>
</tr>
<tr>
<td>Primary disease</td>
<td>4 cases of duodenal ulcer perforation and 1 case each of gastric ulcer perforation, acute enteritis, and intraperitoneal rupture of pyometrium</td>
</tr>
<tr>
<td>Site of puncture</td>
<td>Right hypochondrium (an additional puncture was performed in the lower abdomen in the patient with pyometrium and in the lower abdomen and the left hypochondrium in the patient treated 48 h after perforated duodenal ulcer)</td>
</tr>
</tbody>
</table>

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TABLE 2. Properties of electrolyzed strong acid aqueous solution

- Acidic, pH 2.7 or lower
- Effective chlorine concentration, 50 ppb-50 ppm
- Dissolved oxygen concentration, 50 ppb-20 ppm
- Redox potential; +1000 mV or greater

TABLE 3. The method we used to perform lavage with electrolyzed strong acid aqueous solution

- Volume each time: 200-300 ml into the peritoneal cavity
- 50-200 ml into the abscess cavity
- Number of repetitions: 3-5
- Number of lavages per day: 2

pyometrium. The equipment we used to produce the electrolyzed strong acid aqueous solution was a SUPER OXSEED JES-010 (manufactured by Amano Co., Ltd., sold by Shionogi & Co., Ltd.). As shown in Table 2, the electrolyzed strong acid aqueous solution generated is acidic (with a pH of 2.7 or less), and has an effective chlorine concentration of 50 ppb-50 ppm and a dissolved oxygen concentration of 50 ppb-20 ppm, with a redox potential of at least +1,000. As shown in Table 3, the method of electrolyzed strong acid aqueous solution lavage we used consisted of infusing 200-300-ml volumes of electrolyzed strong acid aqueous solution each time when lavaging the peritoneal cavity for peritonitis and 50-200-ml volumes each time when treating peritoneal abscesses. These volumes were infused 3-5 times, and repeated drainage was performed. The lavage procedure was performed twice daily.

RESULTS

Table 4 describes the patients with peritonitis secondary to ulcer perforation. Three of the patients had a duodenal ulcer and 1 had a gastric ulcer. Patient 1 was a 66-year-old man who was treated 48 h after the onset of duodenal ulcer perforation, and Candida was isolated from his ascitic fluid. Because the inflammation had spread throughout the abdomen, the lavage tube was inserted into the right hypochondrium, and additional punctures were made in the lower abdomen and the left hypochondrium. Lavage was continued for 10 days, but the patient had already become negative for microorganisms by Day 5. Patient 2 was a 91-year-old woman who was treated 12 h after the onset of perforation, and Candida was isolated from his ascitic fluid. Because pus was aspirated when the abdomen was punctured, open drainage was performed. After the aspiration of 500 ml pus and lavage with electrolyzed strong acid aqueous solution, the patient was admitted and given additional treatment. The cause was unknown, but when a contrast study was performed 3 days later because pus had begun to drain from the uterus, rupture had occurred into the abdominal cavity, and a diagnosis of abdominal rupture of pyometrium was made. Bacteroides was isolated from the pus, but bacteriological studies were negative 7 days later. Peritoneal lavage was completed on Day 12, but uterine lavage was continued because the site of uterine perforation had failed to close. Although the patient’s general condition improved, when
the site of perforation had still failed to close 1 month later, a hysterectomy was performed. The patient’s post-operative course was favorable, and 10 days later she was transferred to another institution.

**DISCUSSION**

Electrolyzed strong acid aqueous solution is acidic water that contains active oxygen and active chlorine and possesses a redox potential. It is said to have a germicidal effect because it creates an environment beyond the habitat in which microorganisms can live and because the active oxygen and active chlorine act in combination. Figure 2 shows the range in which microorganisms can live in terms of redox potentials and pH values. The cross-hatched area in the center represents that region, and it is separated from the rectangular region defined by the diagonal line created by the electrolyzed strong acid aqueous solution. In this way, the solution creates an environment in which microorganisms are unable to live and is believed to exert a more powerful germicidal effect as a result of the addition of active oxygen and active chlorine (2) although the mechanism has not been elucidated in detail.

In the beginning we used electrolyzed strong acid aqueous solution in our department for hand washing and disinfecting floors and external surfaces of contaminated wounds; however, because its convenience dovetailed with the desire for a germicidal solution suitable for use in treating contaminated intraperitoneal wounds, we tried using it for that purpose in this study. As shown in Table 6, the advantages of the electrolyzed strong acid aqueous solution are that it has powerful germicidal activity, it is inexpensive and available in large quantities, and there is no fear of air pollution or environmental pollution even when large amounts are used (3). Its disadvantages are that it cannot be stored for long periods, its efficacy immediately decreases when it comes in contact with microorganisms to be killed, it corrodes metals, and it is a mucosal irritant. The disadvantage that poses the greatest problem for peritoneal lavage is mucosal irritation, but given that the potency of the electrolyzed strong acid aqueous solution infused into the peritoneal cavity immediately diminishes when it comes into contact with body fluids, presumably the mucosal irritation is not very great. In fact, when the patients in whom the solution was actually used were examined, they did not complain of severe pain nor was the inflammation prolonged. Moreover, although intestinal adhesions were observed in the patient with the rupture of the pyometrium into the abdominal cavity when we performed surgery after peritoneal lavage, they were mild and did not interfere with the operation. Furthermore, when we considered the fact that the potency of electrolyzed strong acid aqueous solution is immediately reduced by contact with body fluids, we concluded that it would be necessary to infuse it and withdraw it several times.

Although the evaluation of the results of this study is certainly tentative because the number of cases was small and we did not conduct a controlled study, ele-

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**TABLE 5. The cases of intraperitoneal abscess**

<table>
<thead>
<tr>
<th>Patient</th>
<th>Sex</th>
<th>Age (years)</th>
<th>Primary disease</th>
<th>Microorganism</th>
<th>Site of lavage</th>
<th>Duration of lavage (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SH</td>
<td>Female</td>
<td>80</td>
<td>Abdominal rupture of pyometrium</td>
<td>Bacteroides</td>
<td>Right hypochondrium</td>
<td>12</td>
</tr>
<tr>
<td>FH</td>
<td>Male</td>
<td>39</td>
<td>Perforation of DU&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Prevotella</td>
<td>Right hypochondrium</td>
<td>9</td>
</tr>
<tr>
<td>YM</td>
<td>Female</td>
<td>19</td>
<td>Acute enteritis</td>
<td>Bacteroides</td>
<td>Right hypochondrium</td>
<td>10</td>
</tr>
</tbody>
</table>

<sup>a</sup> DU, duodenal ulcer.
ELECTROLYZED STRONG ACID AQUEOUS SOLUTION LAVAGE

The electrolyzed strong acid aqueous solution creates a redox potential of approximately 800-400 mV. This region in which microorganisms can live is shown in the graph.

FIG. 2. The region in which microorganisms can live according to pH and redox potential is shown.

The electrolyzed strong acid aqueous solution does seem to be useful, and we would like to perform a future study on a larger case series, comparing electrolyzed strong acid aqueous solution with another germicidal agent as a control.

CONCLUSION

We performed lavage with an electrolyzed strong acid aqueous solution to treat 7 patients with peritonitis or intraperitoneal abscesses between December 1994 and April 1995. The primary disease was ulcer perforation in 5 cases, and acute enteritis and abdominal rupture of pyometrium in 1 case each. Microorganisms were detected in 4 cases, anaerobic bacteria in 3, and a fungus in 1. The patient from whom microorganisms had been isolated converted to a negative state within 3–7 days after the start of peritoneal lavage with electrolyzed strong acid aqueous solution twice daily. The outcome was favorable in all of the patients, except the 91-year-old woman with duodenal ulcer perforation, who developed ARDS as a complication and died.

REFERENCES