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Which Method Is Better to Provide Wound Healing in Fournier Gangrene: Dakin Solution or Conventional Antiseptic Dressings? A Retrospective Study

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Fournier gangrene is described as necrotizing fasciitis involving the genital, perineal, and perianal area. Early surgical debridement of necrotic tissues, topical therapy, and antibiotics are fundamental in the treatment of Fournier gangrene. We aimed to compare the effects of Dakin solution and povidone iodine solution on patient outcomes by using the Fournier gangrene severity index (FGSI). The demographic data, comorbid diseases, local therapeutic interventions, FGSI, necessity of diverting colostomy or orchiectomy, hospitalization time, number of debridements, complications, and outcomes of 57 patients with Fournier gangrene were retrospectively analyzed. A total of 47 of 57 patients (82.5%) were male, and 10 patients (17.5%) were female, with a mean age of 62.3 ± 13.8 years (range, 27–85 years). The survivors were significantly younger than the nonsurvivors. The mean FGSI score was 4 (range, 1–9) in survivors, and mean FGSI score was 9 (range, 6–10) in nonsurvivors. FGSI score was significantly higher in the mortality group. The median hospital stay was 13 days (range, 3–34 days) in the Dakin solution group and 20 days (range, 1–41 days) in the povidone iodine group. Overall mortality rate was 17.5%. Advanced age had a statistically significant effect on mortality. The

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hospitalization time was significantly shorter in the Dakin solution group, and use of Dakin solution decreased the number of debridements. Dakin solution has favorable effects on hospital stay and the necessity of multiple debridements. Dakin solution seems to be a good and cost-effective choice for treatment in local wound healing.

Key words: Fournier gangrene – Dakin solution – Wound healing

Fournier gangrene (FG) is a fulminant form of infective necrotizing fasciitis of the perineal, genital, or perianal regions, which commonly affects men but can also occur in women and children.[1] It is secondary to polymicrobial infection by aerobic and anaerobic bacteria with a synergistic action.[2,3] The source of infection is identifiable in 95% of cases, mainly arising from anorectal, genitourinary, and cutaneous sources.[4] Malignant disease, obesity, diabetes mellitus (DM), peripheral vascular disease, local trauma, urethral stricture, and perianal disease have been cited as the main predisposing factors.[5] The most common presentation is perianal/scrotal pain, followed by tachycardia, purulent discharge from the perineum, crepitus, and fever.[6] Crepitus of the inflamed tissue is a common feature of the disease due to the presence of gas-forming organisms.[7]

Early surgical debridement of necrotic tissues and antibiotics are fundamental in the treatment of FG. Urgent resuscitation with fluids as well as blood transfusions may be needed, and use of albumin and vasopressors may also be needed in patients who present with shock, in order to improve hemodynamics.[7] It has been reported that honey, sodium hypochlorite, fibrin glue, lyophilized collagenase, and hydrogen peroxide were used in the topical therapy.[8–11] Dakin solution (sodium hypochlorite) was originally developed to treat battlefield wounds. It was used during the 20th century for cleaning and disinfecting wounds.[12,13] Dakin solution is effective against a broad spectrum of aerobic and anaerobic organisms and fungi, including those highly resistant to today's systemic antibiotics.[12,14]

Despite the advances in the management of FG, mortality is still high and averages 20% to 30%.[7,15] Laor *et al*[22] formulated an FG severity index (FGSI) to predict patient survival and prognosis. The parameters measured in FGSI are temperature, heart rate, respiratory rate, serum sodium, potassium, creatinine, hematocrit, white blood cell count, and venous bicarbonate. In the present study, we aimed to compare the effects of Dakin solution and povidone iodine solution on patient outcomes with FGSI guidance.

Patients and Methods

Patients

Patients receiving a diagnosis of FG from August 2007 to December 2013 were retrospectively searched by International Classification of Diseases code (ICD-10) from computer databases, and 63 patients were identified. A total of 6 cases were excluded because of incomplete data. Empirical broad-spectrum antibiotics (a third-generation cephalosporin with the combination of metronidazole) were administered to all patients, and antibiotherapy was adjusted according to the culture results. All patients underwent surgical debridements under emergency conditions, and additional debridements were performed if needed. The wounds were covered with antiseptic dressings (povidone iodine solution) or Dakin solution (0.025% sodium hypochlorite solution) according to the surgeon's choice.

The demographic data, comorbid diseases, local therapeutic interventions, FGSI, necessity of diverting colostomy and orchidectomy, hospitalization time, number of debridements, complications, and outcomes were analyzed. The medical recordings of all of the patients were reviewed in detail and compared with the data in the literature.

Statistical analysis

Data analysis was performed by using SPSS for Windows, version 11.5 (SPSS Inc, Chicago, Illinois). Whether the distributions of continuous variables were normal or not was determined by Kolmogorov-Smirnov test. Continuous variables were shown as mean ± SD or median (minimum–maximum), where applicable. Although the mean differences between groups were compared by Student *t*-test, Mann-Whitney *U* test was applied for comparisons of the median values. Nominal data were analyzed by Pearson χ^2 or Fisher exact test, where applicable. Determining the best predictor(s) that affect the outcomes was evaluated by multiple logistic regres-

Table 1 Demographic and clinical characteristics of patients

Variables	Value (N = 57)
Age, y, mean ± SD (minimum–maximum)	62.3 ± 13.8 (27–88)
Sex, n (%)	
Male	47 (82.5)
Female	10 (17.5)
Comorbidities, n (%)	49 (86.0)
DM	34 (59.6)
HT	16 (28.1)
CAD	8 (14.0)
Obesity	8 (14.0)
Neurologic disorders	6 (10.5)
Malignancy	5 (8.8)
CHF	4 (7.0)
ARF	4 (7.0)
COPD	3 (5.3)
Ue of Dakin solution, n (%)	28 (49.1)
FGSI, median (minimum–maximum)	5 (1–10)
No. of debridements, median (minimum–maximum)	1 (1–3)
Hospital stay, d, median (minimum–maximum)	15 (1–41)
Orchidectomy, n (%)	5 (8.8)
Colostomy, n (%)	14 (24.6)
Mortality, n (%)	10 (17.5)

ARF, acute renal failure; CAD, coronary artery disease; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; HT, hypertension.

sion analysis by the Enter method after adjustment for all possible confounding factors. Forward logistic regression elimination method was applied for discrimination between alive and deceased patients. Any variable whose univariable test had a P value <0.25 was accepted as a candidate for the multivariable model, along with all variables of known clinical importance. Odds ratios and 95% confidence intervals for each independent variable were also calculated. A P value less than 0.05 was considered statistically significant.

Table 2 Demographic and clinical characteristics of survivors and nonsurvivors

Variables	Alive (n = 47)	Deceased (n = 10)	P value
Age, y	60.6 ± 13.9	70.2 ± 10.4	0.045
Sex, n (%)			0.357
Male	40 (85.1)	7 (70.0)	
Female	7 (14.9)	3 (30.0)	
Comorbidity, n (%)	39 (83.0)	10 (100.0)	0.327
DM	27 (57.4)	7 (70.0)	0.724
HT	15 (31.9)	1 (10.0)	0.253
CAD	7 (14.9)	1 (10.0)	1.000
Obesity	6 (12.8)	2 (20.0)	0.619
Neurologic disorders	4 (8.5)	2 (20.0)	0.281
Malignancy	4 (8.5)	1 (10.0)	1.000
Use of Dakin solution, n (%)	24 (51.1)	4 (40.0)	0.730
Orchidectomy, n (%)	4 (8.5)	1 (10.0)	1.000
Colostomy, n (%)	12 (25.5)	2 (20.0)	1.000
FGSI score	4 (1–9)	9 (6–10)	<0.001

CAD, coronary artery disease; HT, hypertension.

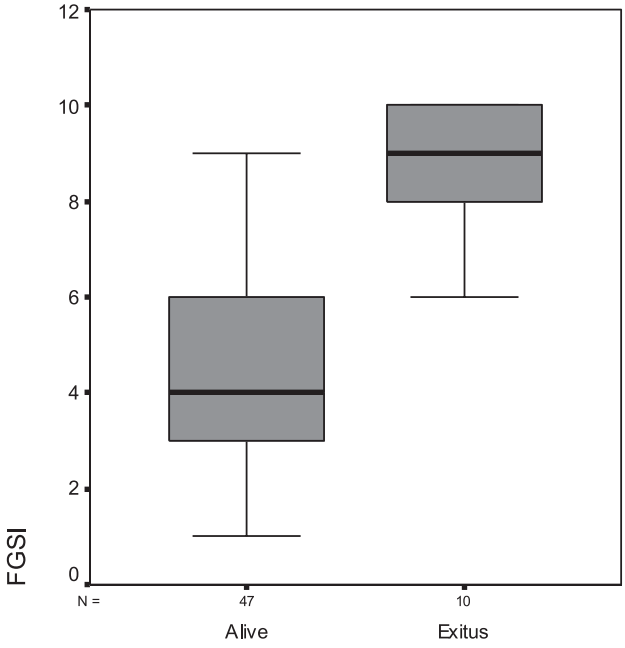

Fig. 1 FGSI scores of the survivors and nonsurvivors.

Results

There were 47 men (82.5%) and 10 women (17.5%), with a mean age of 62.3 ± 13.8 years (range, 27–85 years; Table 1). A total of 49 patients (86%) had comorbid diseases, and some of these patients had more than one comorbid disease. The most common comorbidities were DM, hypertension, coronary artery disease, and obesity (Table 1). The median number of debridements was 1 (1–3) and median FGSI score was 5 (1–10). The FGSI scores were similar in the Dakin solution and povidone iodine groups, and there was no statistically significant difference ($P = 0.395$). Orchiectomy was performed in 5 patients (8.8%), and diverting colostomy was performed in 14 patients (24.6%). The median hospital stay was 15 days (1–41 days). A total of 10 patients died, and overall mortality rate was 17.5%.

The survivors were significantly younger than nonsurvivors ($P = 0.045$; Table 2). The mean FGSI score was 4 (1–9) in survivors, and mean FGSI score was 9 (6–10) in nonsurvivors. FGSI score was significantly higher in the mortality group in univariate analysis ($P < 0.001$; Fig. 1). However,

Table 3 Demographic and clinical characteristics of patients due to hospital stay

Variables	Hospital stay	*P* value
Sex		0.011
Male	13 (1–41)	
Female	20 (15–34)	
Comorbidity		0.083
No	11 (6–17)	
Yes	18 (1–41)	
DM		0.225
No	14 (4–38)	
Yes	18.5 (1–41)	
HT		0.055
No	15 (1–38)	
Yes	19.5 (5–41)	
CAD		0.628
No	15 (1–41)	
Yes	18 (2–35)	
Obesity		0.866
No	15 (1–41)	
Yes	15.5 (4–32)	
Neurologic disorder		0.713
No	15 (1–41)	
Yes	12.5 (3–38)	
Malignancy		0.073
No	15 (1–41)	
Yes	21 (13–34)	
Orchitectomy		0.113
No	16.5 (1–41)	
Yes	7 (4–26)	
Colostomy		0.012
No	14 (2–41)	
Yes	25.5 (1–38)	
Use of Dakin solution		0.008
No	20 (1–41)	
Yes	13 (3–34)	

CAD, coronary artery disease; DM, diabetes mellitus; HT, hypertension.

multivariate logistic regression identified age and FGSI score as independent predictors of mortality, and the statistical significance of age disappeared [odds ratio (OR), 1.047; 95% confidence interval (95% CI), 0.953–1.151; $P = 0.338$].

Comorbid diseases, sex, necessity of diverting colostomy or orchidectomy, and use of Dakin solution or povidone iodine solution for covering the wounds had no statistically significant effect on mortality.

Median hospital stay was significantly longer for female patients ($P = 0.011$; Table 3). Comorbidities, necessity of orchidectomy, and age had no effect on hospital stay. The patients who underwent diverting colostomy had significantly longer hospital stay (1–38 days; $P = 0.012$). The median hospital stay was 13 days (3–34 days) in the Dakin solution group and 20 days (1–41 days) in the povidone iodine group. Use of Dakin solution had a statistically significant effect on hospitalization time ($P = 0.008$). But although multivariate logistic regression identified sex, hypertension, malignancy, colostomy, and use of Dakin solution as independent predictors of hospital stay, none of these factors had a statistically significant effect on hospital stay ($P > 0.05$). Only use of Dakin solution and hypertension had statistically significant effects on the number of debridements in univariate analysis (Table 4). However, multivariate logistic regression identified age, sex, comorbid diseases, and use of Dakin solution as independent predictors of number of debridements, and the statistical significance of hypertension disappeared (OR, 3.603; 95% CI, 0.949–13.679; $P = 0.060$).

Table 4 Demographic and clinical characteristics of patients by number of debridements

Variables	Single (n = 38)	Multiple (n = 19)	*P* value
Age, y	62.7 ± 15.2	61.4 ± 10.9	0.743
Sex, n (%)			1.000
Male	31 (81.6)	16 (84.2)	
Female	7 (18.4)	3 (15.8)	
Comorbidity, n (%)	31 (81.6)	18 (94.7)	0.247
DM	21 (55.3)	13 (68.4)	0.504
HT	7 (18.4)	9 (47.4)	0.048
CAD	3 (7.9)	5 (26.3)	0.102
Obesity	5 (13.2)	3 (15.8)	1.000
Neurologic disorder	4 (10.5)	2 (10.5)	1.000
Malignancy	2 (5.3)	3 (15.8)	0.321
Use of Dakin solution, n (%)	23 (60.5)	5 (26.3)	0.031

CAD, coronary artery disease; HT, hypertension.

Discussion

FG is a rare and rapidly progressive infection, with necrotizing fasciitis involving the genital, perineal, and perianal area, which commonly affects male patients, as in the present study.[1] These patients usually have comorbidities, such as DM, cardiac disorders, chronic obstructive pulmonary disease, alcoholism, malignancies, chemotherapy, human immunodeficiency virus (HIV) infection, renal failure, or steroid therapy related to impaired microcirculation and immunosuppression.[12,16] The presence of DM has been reported to range from 39% to 64% (17%–19%). In the present study, the ratio of DM was 59.6%, similar to the literature. Age was stated as one of the most important predictors of mortality in FG.[20,21] Advanced age had a statistically significant effect on mortality in our study.

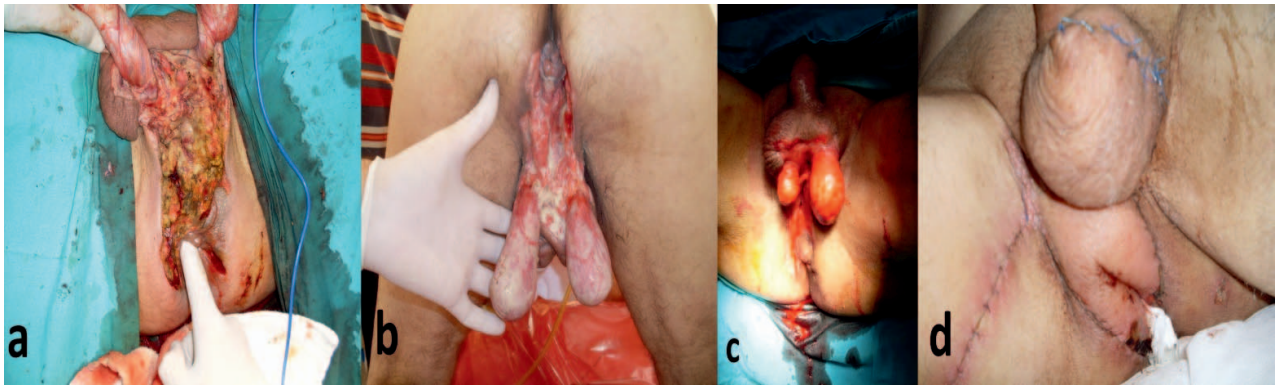

Fig. 2 (a) Patient with FG after extensive surgical debridement. (b) The same patient dressed with Dakin solution, on day 6 from onset of debridement. (c) Last phase of treatment with Dakin solution. (d) After wound closure; scrotum was closed with primary sutures, and upper inner thigh was closed with free flap.

The main principles for the management of FG are urgent and aggressive surgical debridement, administration of antibiotic therapy against aerobic and anaerobic microorganisms, and hemodynamic stabilization. All patients received antibiotic therapy against aerobic and anaerobic microorganisms empirically, and then the regimens were changed according to the findings of antimicrobial susceptibility testings. Despite advanced management, mortality is still high and averages 20% to 30%.[7,15] The mortality rate in the present study was 17.5% and is similar to the results reported in the literature. Many studies suggested that mortality is directly associated with high FGSI, as in the present study.[22–24] So, the outcomes of the patients were discussed with the guidance of FGSI scores.

The surgical debridement is the headstone of the treatment. After surgical debridement, daily wound care needs to be carried out to control local infection.[12] In most cases, wounds are managed with classic dressings that contain a wide variety of active agents, such as honey, sodium hypochlorite, fibrin glue, lyophilized collagenase, hydrogen peroxide, and saline.[8–12] Henry Dakin, cooperating with Alexis Carrel, intended to heal wounded French soldiers by using a buffered sodium hypochlorite 0.05% solution (Dakin solution).[25] Dakin solution has a wide antimicrobial efficacy against aerobic and anaerobic organisms as well as viruses and fungi, and is also nontoxic to host tissues.[11,26,27]

In the present study, the FGSI scores of the Dakin solution group and the povidone iodine group were similar. In the comparison of mortality between these groups, we did not find any statistically significant difference. The hospitalization time was significantly shorter in the Dakin solution group, as stated by Altunoluk *et al*.[12] Additionally, use of Dakin solution decreased the number of debridements (Fig. 2).

Another question in the management of FG is the necessity of diverting colostomy. There is still a controversy on the necessity and timing of diverting colostomy. Chen *et al*[28] stated that fecal diversion is not a prognostic factor, and early colostomy may reduce mortality. But in a study by Korkut *et al*,[3] the mortality was significantly higher in the patients with diverting colostomy. We did not find a statistically significant relationship between mortality and diverting colostomy. In the present study, the hospital stay was significantly longer for patients with diverting colostomy. The patients with diverting colostomy had extensive disease or anal sphincter involvement. We indicated that the main reason for longer hospital stay was extension of FG.

To conclude, FG is still a very catastrophic disease with high mortality and morbidity rates. Early diagnosis, and invasive and aggressive treatments are essential to decrease the morbidity and mortality. Dakin solution has favorable effects on hospital stay and the necessity of multiple debridements, and it seems to be a good choice for treatment for local wound healing in FG.

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