

Wound Management Practices in Scrotal-Confined Fournier's Gangrene

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ABSTRACT

Objective: To compare real-world outcomes of different wound care strategies following surgical debridement in scrotal-confined Fournier Gangrene (FG), without inferring causality.

Study Design: Observational study.

Place and Duration of the Study: Department of Urology, Aydin Adnan Menderes University, and Ege University, Izmir, Turkiye, from August 2013 to October 2023.

Methodology: Eighty-six patients with scrotal-confined FG were included. They were divided into three postoperative wound care groups: Group 1 used gauze impregnated with rifampicin and nitrofurantoin, Group 2 used rivanol-impregnated gauze, and Group 3 used vacuum-assisted closure (VAC). Data on demographics, microbial profiles, antibiotic use, and clinical outcomes (including hospital stay) were recorded. Group comparisons were performed using one-way ANOVA, Kruskal-Wallis, or Chi-square tests as appropriate.

Results: The patients' age ranged from 26 to 96 years (mean 63.9 years). The most common single morbidity was diabetes (29.1%). Predominant pathogens were polymicrobial (24.4%) and *E. coli* (23.3%) in isolation. Overall mortality was 5.8%. Median hospital stays were 9 days (range: 5–28) in Group 1, compared to 14 days (6–40) and 15 days (6–31) in Groups 2 and 3, respectively ($p < 0.001$), with Group 1 being significantly shorter. Secondary debridement rates were similar across groups: 12.5% in Group 1, 37.5% in Group 2, 50% in Group 3 ($p = 0.32$). Antibiotic choices differed significantly among the groups ($p < 0.001$). Notably, the triple combination regimen of daptomycin, tigecycline, and meropenem was not used in Group 1.

Conclusion: Topical antibiotic dressing using mesh dressings impregnated with rifampicin and nitrofurantoin was associated with a shorter hospitalisation compared to rivanol and VAC therapy in scrotal-confined FG. These findings suggest that rifampicin and nitrofurantoin-based topical therapy may be viable alternatives in resource-limited settings, or where VAC is unavailable.

Key Words: Fournier gangrene, Wound care, Vacuum-assisted closure, Conventional dressing, Length of hospitalisation.

How to cite this article: Bahceci T, Aydogan O, Koyuncu E, Ergun KE, Kalemci MS. Wound Management Practices in Scrotal-Confined Fournier's Gangrene. *J Coll Physicians Surg Pak* 2025; **35**(08):981-986.

INTRODUCTION

Fournier's gangrene (FG) is a rare but life-threatening necrotising fasciitis affecting the perineal, genital, or perianal regions. It usually originates from anorectal or genitourinary sources, or from cutaneous injuries in the groin.¹ The most common primary foci are colorectal (30–50% of cases), genitourinary (20–40%), and cutaneous (~20%) infections.¹ FG typically affects patients with comorbidities, most often diabetes mellitus (in up to 70% of cases), followed by chronic alcoholism and other immunosuppressive conditions.² Despite prompt and aggressive treatment, FG mortality remains high at 3–67% in reported series.³ Immediate surgical debridement of all necrotic tissue and the initiation of broad-spectrum antibiotics are essential, and the wound is typically left open.⁴

Subsequent wound care and repeat debridements are performed as needed until complete healing is achieved. However, a universally accepted protocol for FG wound care has yet to be established.

Conventional wound management typically involves regular dressing changes, often using wet-to-dry gauze with solutions such as normal saline, povidone-iodine, rifampicin, ethacridine lactate, or enzymatic and polyhexanide preparations.^{5–7} These approaches aim to continually debride the wound bed and reduce bacterial burden; however, but they are not standardised. Advanced wound care technologies have also been applied to FG, most notably vacuum-assisted closure (VAC) therapy. VAC therapy promotes wound contraction and angiogenesis by applying controlled suction.^{8–10}

Most FG studies include heterogeneous case extents—ranging from isolated scrotal involvement to extensive perineal or abdominal spread—which complicates the evaluation of wound care strategies. This observational study addresses that limitation by focusing on FG cases confined to scrotum, thereby reducing variability and enabling a clearer assessment of wound care approaches.

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Received: May 14, 2025; Revised: July 17, 2025;

Accepted: July 23, 2025

DOI: <https://doi.org/10.29271/jcpsp.2025.08.981>

The primary aim of this study was to compare the clinical outcomes of three different postoperative wound care strategies—topical antibiotic dressings (rifampicin and nitrofurantoin), antiseptic dressings (Rivanol), and VAC therapy—in patients with scrotal-confined FG. Although it is not designed to establish causality, this descriptive comparison aims to provide evidence-based guidance for optimising wound care in this specific clinical context.

METHODOLOGY

This retrospective multicentre study reviewed the medical records of FG cases treated at the Department of Urology, Adnan Menderes, Aydin, and Ege University, Izmir, Turkiye, from August 2013 to October 2023. Initially, 143 patients who underwent emergency surgical debridement for FG were identified. Those patients were eligible for inclusion who underwent emergency surgical debridement for FG during the study period; whose infection was confined exclusively to the scrotum, without extension to the perineum, perianal region, or abdominal wall; who received one of the three predefined postoperative wound care strategies—topical antibiotic dressings (rifampicin and nitrofurantoin), antiseptic Rivanol dressings, or VAC therapy, and who had complete medical records available, including documentation of demographics, wound care, microbial culture results, and clinical outcomes. Patients were excluded if they had incomplete documentation regarding the extent of necrosis; if the gangrene extended beyond the scrotum, if they did not receive any of the predefined wound care strategies; or if their clinical data were insufficient for analysis. After applying these criteria, 86 patients with scrotal-confined FG were included in the final analysis.

Of the 86 patients, 36 received topical antibiotic dressings (Group 1), 21 received Rivanol dressings (Group 2), and 29 received VAC therapy (Group 3). Demographic characteristics, microbial profiles, antibiotic use, dressing type, and clinical outcomes were documented to assess the impact of wound care strategy on recovery. The three dressing strategies included topical antibiotic dressings (rifampicin and nitrofurantoin), antiseptic Rivanol dressings (1:1000 ethacridine lactate), and VAC therapy. Each centre adhered to its own wound care protocol, as no standardised procedure was defined for the study. Dressings were changed once daily, and the wound was assessed during each dressing change or VAC sponge replacement.

Upon emergency department admission, all patients underwent comprehensive preoperative evaluation, including physical examination and laboratory tests (blood counts and chemistry). Intravenous fluids and empirical broad-spectrum antibiotics were initiated immediately. Once they were hemodynamically stable, patients proceeded to emergency surgical debridement, during which all necrotic scrotal skin and subcutaneous tissue were excised. Wound cultures were obtained, and debridement continued until viable, bleeding tissue was encountered. Orchiectomy was performed if the infection extended beyond the tunica vaginalis to involve a testis.

Postoperative wound care was carried out using the available dressing methods. VAC therapy was applied when it was available. If VAC was not accessible or deemed unsuitable, conventional open dressings were utilised. At the first centre, gauze dressings impregnated with rifampicin and nitrofurantoin were used, while at the second centre, gauze soaked in Rivanol solution was applied. Wound care was performed once daily, and the wound was reassessed at each dressing change or VAC reapplication. Additional debridement was performed when it was needed.

During the healing process, tissue cultures were obtained when wound closure was being considered. If cultures were sterile and the wound bed was assessed as suitable, primary closure of the scrotal defect was performed by the urology team. In cases involving large tissue defects, plastic surgery consultation was sought for reconstructive management.

Statistical analysis was performed using the SPSS version 25.0 (IBM Corp.). The normality of the continuous variables was evaluated using both visual methods (histograms and Q-Q plots) and statistical tests (Kolmogorov-Smirnov and Shapiro-Wilk). For normally distributed data, results are presented as mean $\pm$ standard deviation; for non-normally distributed data, as median (range). Categorical variables are reported as frequencies and percentages. Group comparisons were conducted using the one-way ANOVA for parametric data, the Kruskal-Wallis test for nonparametric data, and the Chi-square test for categorical data. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Eighty-six patients with scrotal-confined FG (age range 26-96 years, mean 63.9 years) were analysed. The most common comorbid conditions were multimorbidity (40.7%), diabetes mellitus (29.1%), and alcoholism (17.4%). Wound cultures were polymicrobial in 24.4% of cases. *Escherichia coli* (E. Coli) was isolated in 23.3% of patients, while *Pseudomonas* spp. and *Streptococcus* spp. were each identified in 8.1%, of cases. No microbial growth was observed in 7% of the cultures.

The most common antibiotic regimens were the combination of daptomycin + tigecycline + meropenem (30.2% of patients), ampicillin/sulbactam (25.6%), and ceftriaxone + metronidazole (17.4%). Antibiotic choices differed significantly among the groups ($p < 0.001$); the triple regimen was not used in Group 1 but was common in Groups 2 and 3, whereas ampicillin/sulbactam and ceftriaxone + metronidazole were more frequently used in Group 1.

Overall mortality rate was 5.8% (5 out of 86). The median hospital stay was significantly shorter in Group 1 (9 days, range 5-28) than in Group 2 (14 days, range 6-40) or Group 3 (15 days, range 6-31; $p < 0.001$). Groups did not significantly differ in age, comorbidities, wound culture results, orchiectomy rates, need for re-debridement, or wound reconstruction. Patient characteristics, clinical variables, and treatment outcomes are presented in Table I.

Table I: The comparative analysis of patient characteristics, clinical variables, and treatment outcomes across groups.

Variables	Group 1	Group 2	Group 3	p-values
Age (year, mean $\pm$ SD)	66.4 $\pm$ 16.7	62.6 $\pm$ 15.9	61.8 $\pm$ 12.9	0.44
Comorbidity (n, %)				
Diabetes mellitus	13 (52)	8 (32)	4 (25)	0.41
Alcoholism	6 (40)	3 (20)	6 (40)	
Hypertension	3 (75)	0 (0)	1 (25)	
Chronic arterial disease	1 (50)	0 (0)	1 (50)	
Chronic obstructive pulmonary disease	1 (100)	0 (0)	0 (0)	
Chronic renal failure	1 (100)	0 (0)	0 (0)	
Malignancy	2 (66.7)	0 (0)	1 (33.3)	
Multimorbidity	9 (25.7)	10 (28.6)	16 (45.7)	
Wound cultures (n, %)				0.22
Polymicrobial	8 (38.1)	6 (28.6)	7 (33.3)	
<i>Escherichia coli</i>	5 (25)	5 (25)	10 (50)	
<i>Pseudomonas</i> species	5 (71.4)	2 (28.6)	0 (0)	
<i>Streptococcus</i> species	3 (42.9)	1 (14.3)	3 (42.9)	
<i>Klebsiella</i> species	1 (33.3)	2 (66.7)	0 (0)	
<i>Acinetobacter</i> species	1 (25)	2 (50)	1 (25)	
<i>Staphylococcus</i> species	2 (66.7)	0 (0)	1 (33.3)	
<i>Enterococcus</i> species	0 (0)	2 (50)	2 (50)	
<i>Proteus</i> species	2 (66.7)	0 (0)	1 (33.3)	
<i>Clostridium</i> species	0 (0)	1 (50)	1 (50)	
Carbapenem-resistant <i>Enterobacteriaceae</i>	0 (0)	0 (0)	1 (100)	
Candida species	4 (80)	0 (0)	1 (20)	
Non-microbial	5 (83.3)	0 (0)	1 (16.7)	
Antibiotics (n, %)				<0.001*
Ampicillin / sulbactam	16 (72.7)	0 (0)	6 (27.3)	
Dual antibiotic combinations	12 (80)	2 (13.3)	1 (6.7)	
Ertapenem	2 (50)	1 (25)	1 (25)	
Meropenem	4 (66.7)	1 (16.7)	1 (16.7)	
Daptomycin	1 (16.7)	3 (50)	2 (33.3)	
Tigecycline	0 (0)	0 (0)	1 (100)	
Triple-antibiotic combinations	0 (0)	9 (34.6)	17 (65.4)	
Piperacillin / tazobactam	1 (20)	4 (80)	0 (0)	
Linezolid	0 (0)	1 (100)	0 (0)	
Orchiectomy (n, %)	4 (36.4)	4 (36.4)	3 (27.3)	0.61
Length of hospitalisation (median, IQR)	9 (5-28)	14 (6-40)	15 (6-31)	
Secondary debridement (n, %)	1 (12.5)	3 (37.5)	4 (50)	0.32
Wound reconstruction (n, %)				
Primary wound closure	21 (48.8)	11 (25.6)	11 (25.6)	0.64
Grafting	11 (40.7)	4 (14.8)	12 (44.4)	
Secondary healing	1 (9.1)	6 (54.5)	4 (36.4)	

*Statistically significant ($p < 0.05$). Continuous variables are presented as mean $\pm$ standard deviation or median (interquartile range), and categorical variables as number and percentage (n, %). One-way ANOVA, Kruskal-Wallis, and Chi-square tests were used for group comparisons, as appropriate.

DISCUSSION

FG remains a life-threatening infection, with mortality rate reported as high as 67%.^{3,11,12} In the series confined to the scrotum, the mortality rate was 5.8%, reflecting the aggressive nature of FG, often compounded by sepsis and comorbidities. Diabetes mellitus is a well-known predisposing factor reported in 20-77% of cases, and 29% of the studied patients were diabetic.^{3,13} Other observed risk factors (alcoholism, immunosuppression, malignancy) were consistent with known associations.

FG wounds are typically polymicrobial. Large case series have reported mixed infections in the most of cases — for example, one study found that 71% of FG cases to be polymicrobial, with *E. coli* and *Pseudomonas aeruginosa* frequently isolated.^{13,14} These microbiological findings corroborated this pattern: *E. coli* and *Pseudomonas* were among the most common isolated pathogens, confirming the polymicrobial nature of FG. In current clinical practice, all patients received empirical broad coverage, which was based on culture once

available. Group 1 often did not require advanced triple-antibiotic regimens (daptomycin + tigecycline + meropenem), whereas these intensive combinations were frequently needed in Groups 2 and 3. This suggests that Group 1 patients had a lower infection burden or severity, while Groups 2 and 3 had more severe infections or septic presentations, necessitating aggressive multi-drug therapy.

Prompt, aggressive surgical debridement is critical in FG to remove necrotic tissue and halt disease progression.⁴ Multiple debridements are often required (~3-4 operations per patient),¹⁵ although their impact on outcomes is debated. One study linked more frequent debridements with higher mortality,¹⁶ whereas others found no significant difference. Additionally, one report noted that fewer re-debridements were needed when VAC dressings are used.^{17,18} In the present series of strictly limited to scrotal FG, only 9.3% of patients required more than one debridement—a much lower rate than generally reported, likely because these were localised cases requiring less extensive resection. The need for repeat debridement did not significantly differ between dressing

groups, indicating that the wound care modality (antibiotic, antiseptic, or VAC) did not impact the frequency of surgical re-intervention in this subset.

FG rarely involves the testes due to their separate blood supply and fascial protection; orchiectomy is required in only ~2–35% of cases.^{14,19} Orchiectomy was performed in 12.5% of patients, aligning with the expected range, with no variation observed across dressing types.

Once infection is controlled, and viable tissue is clearly demarcated, wound reconstruction is planned according to the size and the location of the defect. Options include healing by secondary intention, primary closure, split-thickness skin grafts, or local flap coverage. Primary closure often provides optimal, functional, and cosmetic results for smaller scrotal defects.¹³ Moreover, in this cohort 50% of patients underwent primary closure. Larger or deeper defects may require grafts or flaps; roughly 20–30% of FG patients in the literature needed skin grafts or flaps, while the rest were healed by secondary intention.^{13,14} In this series, 31% of patients ultimately required skin grafting and approximately 13% of patients were healed by secondary intention, paralleling these prior reports. No significant differences were observed among Groups 1, 2, and 3 in reconstruction method or success, suggesting that dressing choice did not influence the eventual wound closure strategy in localised FG.

Wound care after surgical debridement plays a pivotal role in FG management, yet there is no consensus on the optimal approach. Conventional dressing methods vary widely and often depend on clinician preference and resource availability. Commonly described approaches include wet-to-dry gauze dressings with agents such as normal saline, povidone-iodine, rifampicin, ethacridine lactate, and enzymatic or polyhexanide preparations.^{5–7} In this study, three post-debridement wound management strategies were compared. Group 1 (rifampicin/nitrofurantoin dressings) had a significantly shorter median hospital stay (9 days) than Group 2 (Rivanol, 14 days) or Group 3 (VAC, 15 days).

The present finding that rifampicin-nitrofurantoin dressings were associated with the shortest hospitalisations contrasts with some other reports in the literature. Ghabisha *et al.* applied topical rifampicin in FG and reported an average hospital stay of ~57 days.¹⁸ Similarly, Kutsal *et al.* observed a median 46.2-day stay in patients treated with rifampicin + nitrofurantoin dressings, significantly longer than the 19.1-day median in their VAC-treated group ($p = 0.0001$).⁵ At face value, these studies suggest that the rifampicin dressings may be less efficient than VAC or other methods. However, case selection likely explains this discrepancy. The present study included only patients with disease confined to the scrotum, whereas the patients in the Ghabisha and Kutsal series had more extensive perineal or abdominal involvement

(larger, deeper wounds).^{5,18} A localised infection can heal faster because the wound is smaller and easier to manage. Additionally, rifampicin has excellent tissue penetration and antibacterial activity.²⁰ The authors hypothesise that the use of local rifampicin combined with systemic antibiotics produced a synergistic effect that rapidly reduced the wound's bacterial load. The limited wound area and lower baseline severity in Group 1 likely contributed to accelerated healing. Thus, in well-selected cases of localised FG, topical rifampicin dressings—when used with appropriate systemic therapy—may be a cost-effective treatment option, yielding faster recovery compared to more complex interventions. This insight is especially relevant in resource-limited settings where VAC therapy is unavailable.

Ethacridine lactate (Rivanol) is an antiseptic that has been used historically for wound irrigation; however, evidence for its efficacy in FG is sparse. Kizilay *et al.* compared Rivanol dressings to VAC in FG patients and found the VAC group had a significantly shorter mean hospital stay (16.8 days) than the Rivanol group (25.3 days).⁶ This suggests that VAC therapy was superior to conventional antiseptic dressings in a general FG patient population. In this study, Group 2 had a median hospital stay of 14 days, substantially shorter than the ~25 days reported by Kizilay *et al.* This discrepancy likely reflects differences in disease extent: patients treated with Rivanol in this study had infection limited to the scrotum, whereas those in Kizilay's study had more extensive disease. Thus, the study suggests that Rivanol dressings can achieve faster healing in cases of localised FG wound; however their benefit diminishes in more extensive diseases when compared to VAC therapy. Besides from Kizilay's report, data on the use of Rivanol in FG remain scarce. In this comparison, outcomes for Group 2 were intermediate between Groups 1 and 3, indicating no clear advantage.

VAC therapy has been advocated for FG wound management, with reports of its successful use to halt spreading infection.⁸ However, the impact of VAC therapy on hospital stay in FG varies across studies. Some researches have noted longer hospitalisations for patients treated with VAC, as compared to traditional dressings or primary closure, whereas others found no significant difference in the length of stay.^{8,9,11,21–23} VAC is often reserved for more severe cases of FG, which confounds comparisons. One series noted that VAC use in extensive FG cases was associated with longer hospitalisation, likely reflecting disease severity rather than the effect of the therapy itself.²¹ Similarly, Iacovelli *et al.* found that in localised FG, patients treated with VAC had a median hospital stay of 28 days (IQR 16–51), compared to 18 days (IQR 12–26) with conventional dressings ($p = 0.006$).²⁴

In this study, Group 3 — which had the highest use of VAC — also had a longer median hospital stay than Group 1. The authors attributed this to patient factors and treatment selection bias: Group 3 patients had the highest rate of

multimorbidity and often required intensive multi-agent antibiotic regimens, indicating they were the most critically ill subset. Clinicians likely applied VAC preferentially to these high-risk patients with severe infections. Therefore, the prolonged recovery of Group 3 was probably due to disease severity rather than the effect of the VAC therapy itself.

This study has several limitations. First, the Fournier's Gangrene Severity Index (FGSI) could not be calculated because some key clinical and laboratory parameters were not consistently recorded in the patient files. Second, wound size and depth were not documented; however, by including only patients with isolated scrotal involvement, the variability in disease extent was reduced, resulting in a more homogeneous comparison. Third, because each dressing type was used at a specific centre, there may have been centre-related differences in surgical technique, wound care protocols, and overall patient management (a potential centre effect) that could have influenced outcomes. Fourth, treatment allocation was not randomised. Clinicians may have preferentially used VAC therapy for patients perceived to be at higher risk due to comorbidities or wound characteristics. This selection bias could have skewed the results, associating worse outcomes with VAC not because of the therapy itself, but because those patients had more severe illness.

Despite these limitations, this study provides valuable comparative data on three different wound management strategies in a distinct FG subgroup (scrotal-confined involvement), offering insights to inform clinical practice and guiding future research.

CONCLUSION

In isolated scrotal FG, patients treated with topical antibiotic dressings had shorter hospital stays, possibly due to a lower infection burden and the local antimicrobial effects of rifampicin and nitrofurantoin. However, the patient profile differences and the lack of randomisation limit any causal interpretation. Nonetheless, these findings may inform wound care management, especially in resource-limited settings where VAC therapy is unavailable. Further prospective studies with standardised protocols and randomisations are needed to validate these results.

ETHICAL APPROVAL:

The study was approved by the Ethics Committee of the Aydin Adnan Menderes University for Non-Interventional Clinical Research (Project No: 2024/18).

PATIENTS' CONSENT:

Informed consent was waived due to the retrospective nature of the study.

COMPETING INTEREST:

The authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:

TB: Conceived and designed the study, prepared the manuscript, analysed the data, and revised the manuscript.

OA: Conducted the literature review, collected and managed the clinical data, and analysed the data.

EK: Collected data, performed data analysis, and drafted the manuscript.

KEE: Designed the data tables, verified the analytical methods, and revised the manuscript.

MSK: Supervised the study, ensured data integrity and accuracy, and provided significant revision.

All authors approved the final version of the manuscript to be published.

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