

## ORIGINAL PAPER

# Enhanced patient recovery with early extensive surgical debridement in Fournier's gangrene: Evaluation of perioperative outcomes in a multicentric experience

Giovanni Cochetti<sup>1</sup>, Alessio Paladini<sup>1</sup>, Luca Lepri<sup>1</sup>, Andrea Vitale<sup>1</sup>, Raffaele La Mura<sup>1</sup>, Miriam Russo<sup>1</sup>, Paolo Mangione<sup>1</sup>, Matteo Mearini<sup>1</sup>, Andrea Fabiani<sup>2</sup>, Emanuele Iacobone<sup>2</sup>, Lucilla Servi<sup>2</sup>, Ettore Mearini<sup>1,3</sup>, Michele Del Zingaro<sup>1</sup>

<sup>1</sup> Department of Medicine and Surgery, Urology Clinic, University of Perugia, Perugia, Italy;

<sup>2</sup> Surgery Department, Urology Unit, Macerata Civic Hospital, Area Vasta 3 Asur Marche;

<sup>3</sup> Department of Medicine and Surgery, Urological Andrological Surgery and Minimally Invasive Techniques Unit, S. Maria Hospital, University of Perugia, Terni, Italy;

**Summary** Objective: Fournier's gangrene (FG) is a rare, life-threatening necrotizing fasciitis primarily affecting the perineal, genital, and perianal regions. This rapidly progressing bacterial infection predominantly affects middle-aged and elderly men. This multicenter study aims to describe the management in a wide cohort of Fournier's gangrene cases that presented to three tertiary centers with early extensive surgical debridement.

**Materials and methods:** We retrospectively collect data from patients with FG who were referred to the Urology Clinic of the Department of Medicine and Surgery (Perugia), the Urological Andrological Surgery and Minimally Invasive Techniques Unit (Terni) of the University of Perugia, and the Urology Unit of the Surgery Department of the Macerata Civic Hospital between January 2019 and March 2024 for onset of classic signs and symptoms of FG. Extensive surgical debridement was immediately performed under general anesthesia to reach normochromic and vascularized tissue in wide and depth extension, assuring vital and healthy margins. For all patients, intravenous daptomycin plus piperacillin/tazobactam were administered.

**Results:** 28 male patients with FG underwent early surgical debridement. In two cases, orchidectomy and partial penectomy were required during surgical debridement due to extensive necrosis. Colon diversion and urinary diversion were not necessary for any of the patients. 32.1% complications were recorded in according to the Clavien Dindo classification; 6 patients died in the perioperative. Excluding death data, the average duration of antibiotic therapy was  $22.0 \pm 9.1$  days, and the average length of stay was  $17.6 \pm 11.8$  days.

**Conclusions:** Fournier's gangrene has high mortality rates. It requires timely surgical debridement and antibiotic therapy to achieve positive outcomes. This study shows that a primary extensive debridement can help reduce the need for further intervention and shorten the hospital stay.

**KEY WORDS:** Fournier's gangrene; Necrotizing; Fasciitis; Debridement.

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## INTRODUCTION

Necrotizing soft tissue infections are serious conditions caused by bacterial toxins that activate a severe systemic inflammatory response. Fournier's gangrene (FG) is a rare and severe form of necrotizing fasciitis that affects the perineum, external genitalia, and adjacent tissues.

It was first described in 1764 by Baurienne, but the French physician Jean Alfred Fournier is more widely credited with its identification. In 1883, Fournier presented a case series of 5 young men with this condition, highlighting its sudden onset and potentially fatal nature (1). FG progresses rapidly, affecting the subcutaneous and fascial planes (2). According to Sorensen *et al.*, FG affects less than 0.02% of hospital admissions, with an incidence rate of 1.6 cases per 100.000 people (3). It mainly affects men, with an average age of 60 years, and the male-to-female ratio is 10:1 (2, 4).

Several risk factors have been associated with the development of FG, including immunosuppression, diabetes, HIV, malignancies, inflammatory bowel disease, renal and hepatic failure, recent trauma, and medical procedures (2, 4). The use of antihyperglycemic drugs, such as sodium-glucose cotransporter 2 inhibitors (SGLT2i), has also been linked to FG in some cases (5).

Inflammation and edema result in obliterating endarteritis, leading to thrombosis of subcutaneous blood vessels. This causes ischemia and necrosis along the dartos fascia, Colles' fascia, Scarpa's fascia, and the abdominal wall (6). Diagnosis of FG usually involves a clinical examination, radiological tests, and laboratory analyses. The onset of necrotizing fasciitis can be slow, with up to 40% of cases showing no symptoms. When symptoms do appear, they may include pain in the genital and perineal areas, with little to no visible skin damage in the early stages. As the condition progresses, the skin may become red and dusky, and there may be a foul-smelling discharge from the genital and perineal areas, along with a crackling sensation under the skin (7).

Treatment usually involves a combination of broad-spectrum antibiotics, fluid resuscitation, and multiple surgical

debridements, with an average of 3.5 procedures per patient (8). In severe cases, intensive supportive care may be necessary for hours or days (9). Delayed diagnosis and treatment can lead to high mortality rates, which can reach up to 30% or more in some instances (3, 10, 11). To further explore this rare and deadly condition, we conducted a retrospective analysis of patients admitted and treated for FG with typically extensive surgical debridement in three tertiary referral centers in the last 5 years.

## MATERIALS AND METHODS

We included all patients who were referred to *Urology Clinic of the Department of Medicine and Surgery (Perugia)* and the *Urological Andrological Surgery and Minimally Invasive Techniques Unit (Terni)* of the *University of Perugia*, and the *Urology Unit of the Surgery Department of the Macerata Civic Hospital* between January 2019 and March 2024 for onset of classic signs and symptoms of FG.

All patients signed an informed consent form to anonymously treat their medical data for scientific purposes at the hospital admission.

For each patient, vital signs and parameters, the Charlson Comorbidity Index, medical history, blood exams, urinary samples, and blood cultures were recorded. A local ultrasound and a thoracic-abdomen CT scan were performed in all cases.

We included in the patient's evaluation the *Laboratory Risk Indicator for Necrotizing Fasciitis (LRINEC)* introduced in 2004 by Wong *et al.* to help distinguish necrotizing fasciitis from other soft tissue infections (12).

We also performed the *Fournier's Gangrene Severity Index (FGSI)* as a mortality predictor tool for FG patients, created by Laor *et al.* (13).

All patients underwent prompt fluid resuscitation and broad-spectrum intravenous antibiotics within one hour of emergency department admission. If there was suspicion of FG, extensive surgical debridement was immediately performed under general anesthesia in the operative theatre, considering reaching normochromic and vascularized tissue in wide and depth extension, assuring vital and healthy margins. Subsequent debridements were performed only when signs of local necrosis or de-vascularized tissue appeared in the next few days.

Patients were assumed to be cured once they achieved normalized vital signs, had negative blood cultures and wound microbiological examinations, and had normal levels of C-reactive protein and procalcitonin.

Additionally, their surgical wounds needed to heal completely without any discharge or pain. Follow-up care involved periodic visits with specialists and medication, if necessary.

Complications were recorded and reported according to the Clavien-Dindo classification.

A descriptive analysis was conducted, with continuous variables reported as mean with *standard deviation (SD)* and categorical variables reported as frequencies (%).

## RESULTS

The study involved 28 male patients, with an average age of  $59.6 \pm 14.3$  years and a mean Charlson Comorbidity Index

of  $4.7 \pm 2.4$ . All patients displayed local edema and necrotized skin (Figure 1) as the primary clinical presentation, with additional symptoms including erythema (78.5%), fever (57.1%), local pain (42.8%), subcutaneous crepitation (32.1%), and purulent exudate (10.7%) (Figure 2).

In all cases, the blood exams revealed a neutrophilic leukocytosis, a mean C-reactive protein of  $32.7 \pm 16.2$  mg/L, and procalcitonin of  $27.41 \pm 12.7$  ng/ml.

The ultrasound showed a significant thickening of the area involved with fluid intrafascial film and several hyperechoic spots with posterior echoes as for the aerial components. The CT scan confirmed the presence of a large amount of air and gas in the surrounding soft tissues and served to better explore the tissues involved.

The mean FGSI and LRINEC scores were  $3.6 \pm 1.4$  and  $6.3 \pm 2.1$ , respectively. The most common comorbidities were diabetes (64.3%), hypertension (57.1%), and cardiac disease (57.1%). Polymicrobial flora with aerobic and anaerobic bacteria was the dominant report (67.8%), followed by *Staphylococcus* (21.4%) and *Enterococcus faecium* (7.1%) wound culture.

For all patients, intravenous daptomycin plus piperacillin/tazobactam were administered: 3 (10.7%) and 2 (7.1%) patients required a switch from piperacillin/tazobactam to



**Figure 1.**  
Left hemiscrotal necrotizing fasciitis.



**Figure 2.**  
Fournier's gangrene with purulent discharge.

**Figure 3.**  
Surgical debridement of the necrotic tissue.



imipenem-cilastatin due to infection by *Enterococcus faecalis* and *Escherichia Coli extended-spectrum beta-lactamase* (ESBL) producer, respectively.

On average, patients underwent surgery  $14.2 \pm 5.7$  hours after accessing the emergency department (Figure 3). In two cases, orchidectomy and partial penectomy were required during surgical debridement due to extensive necrosis. Colon diversion and urinary diversion were not necessary for any of the patients.

Six patients (21.4%) required blood pressure support with intravenous noradrenaline after surgery and were admitted to the *intensive care unit* (ICU) for  $26 \pm 4.3$  hours. Five patients (17.8%) required subsequent debridement, with a mean of  $0.3 \pm 0.5$  further surgical debridements performed before discharge; all surgical debridements were performed bedside with local anesthesia.

Reconstructive surgery by a plastic surgeon was performed on 14.3% of in-patients to improve tissue and skin restoration in the treated site. One patient, affected by diabetes mellitus, chronic kidney disease, and immunosuppression due to the assumption of Everolimus for transplanted kidney required the use of *Vacuum-Assisted Closure* (VAC) therapy for the scrotal skin for approximately 20 days with gradual recovery and complete re-epithelialization.

Complications were recorded in nine patients (32.1%) according to the Claviend Dindo classification; 3 (10.7%) patients underwent blood transfusion (grade II), and six patients (21.4%) died (grade V), with an average time to death of  $3.5 \pm 2.1$  days. Of those, one patient had multiple comorbidities, a patient had Duchenne syndrome and succumbed to acute respiratory distress syndrome. One of these patients was admitted to the operating theatre 36 hours after symptom onset due to an unstable clinical condition. The other three patients died in the 48 hours after debridement due to the compromise of the cardiovascular system due to septic shock.

Excluding death data, the average duration of antibiotic therapy was  $22.0 \pm 9.1$  days, and the average length of stay was  $17.6 \pm 11.8$  days.

## DISCUSSION

Prompt fluid resuscitation, broad-spectrum intravenous antibiotics, and primary extensive surgical debridement are safe and effective procedures that help reduce mortality, re-interventions, and hospital length of stay.

FG constitutes a rare disease, accounting for only 0.02% of hospital admissions (3). Initially considered idiopathic, the cause of FG is now identifiable in most cases, often coming from aerobic and anaerobic bacterial infections in the ano-rectum (30-50%), uro-genitalia (20-40%), and genital surface (20%) (2, 11). It predominantly affects immunocompromised individuals and those with compromised microcirculation, with risk factors including diabetes, obesity, chronic alcoholism, smoking, drug abuse, renal and liver failure, pelvic malignancies, inflammatory bowel diseases, HIV infection, recent trauma, and recent urethral and perineal surgery. FG is more prevalent in individuals with malnutrition and lower socioeconomic status (2). Diabetes, in particular, has been associated with 32-66% of FG cases, with uncontrolled diabetes linked to a poorer prognosis and necessitating more aggressive treatment (11).

The use of SGLT2i drugs in diabetic patients has been initially correlated with increased FG cases, although subsequent studies have disputed this correlation, warranting further investigation.

Our case series is in line with previous studies, which highlight diabetes as a significant risk factor for the development of FG. Around 64% of the patients in our study had type II diabetes mellitus, and all of them were male. The average age at diagnosis was consistent with recent literature. It is well known that males are more susceptible to developing FG. However, females, despite being less affected, are at a higher risk of FG-related mortality due to anatomical differences that enable rapid infection spread in women (14).

Histological examination of patients with FG shows necrosis of the superficial and deep fascia, fibrinoid coagulation in the blood vessels, infiltration of tissues by various types of cells, and necrotic tissue debris. A key identifying feature is the presence of blood vessel thrombosis in the affected area. Interestingly, even when there are significant pathological changes in the deep tissues, the skin can remain intact for a prolonged period (4). Up to 40% of FG cases manifest with no symptoms initially, making early diagnosis challenging. Symptoms include genital and perianal pain, erythematous and dusky skin, subcutaneous crepitation, and malodorous and purulent exudates. Differential diagnosis involves distinguishing FG from conditions such as gangrenous balanitis in males with diabetes and ulcerative forms of inguinal lymphogranulomatosis, gangrenous diabetic vulvitis, acute genital ulcers, and soft cancer in women. The LRINEC score aids in diagnosis, with scores  $\geq 6$  indicating suspicion of necrotizing fasciitis and  $\geq 8$  strongly suggestive (15, 16).

In our study, we started the antibiotic therapy with intravenous daptomycin plus piperacillin/tazobactam, according to the empiric treatment of necrotizing fasciitis, and only after microbiological culture did we decide to switch the therapy according to the sensitivity. The primary goal of antibiotic therapy in FG is to control the systemic

infection and reduce the bacterial load in the affected area. Because the infection is polymicrobial, broad-spectrum antibiotic coverage is essential until specific bacterial cultures can guide more targeted therapy. Antibiotic treatment should begin immediately upon diagnosis, as any delay can result in the worsening of the infection and an increased risk of mortality. Initial antibiotic therapy typically involves broad-spectrum agents covering aerobic and anaerobic bacteria. This often includes a combination of agents such as a carbapenem (e.g., meropenem or imipenem) or piperacillin-tazobactam, which provide broad coverage against gram-positive, gram-negative, and anaerobic bacteria. In some cases, an aminoglycoside (e.g., gentamicin) or fluoroquinolone may be added to cover resistant gram-negative bacteria. Additionally, metronidazole or clindamycin is often included to target anaerobic bacteria, particularly *Clostridium* species, which can produce dangerous toxins (4). Once culture results and antibiotic sensitivity profiles are obtained, the treatment can be adjusted to target the specific bacteria responsible for the infection. This strategy helps minimize antibiotic resistance development while maintaining effective control over the infection.

The duration of antibiotic therapy varies depending on the severity of the infection and the patient's response to treatment. The management of FG with antibiotics presents several challenges. First, the condition often occurs in patients with underlying health issues, such as diabetes, immunosuppression, or chronic kidney disease, which complicate the selection and dosing of antibiotics. These patients may require adjusted dosages or alternative agents to avoid drug toxicity while ensuring effective antimicrobial coverage. Additionally, the rise of antibiotic-resistant organisms poses a growing threat to the treatment of necrotizing infections like FG. *Methicillin-resistant Staphylococcus aureus* (MRSA) and multidrug-resistant gram-negative bacteria, such as ESBL-producing *E. coli* and *Klebsiella*, are increasingly implicated in these infections. More specialized antibiotics may be required to combat resistant strains, such as vancomycin, linezolid, or daptomycin. Careful monitoring of antibiotic effectiveness and resistance patterns is essential to ensure successful treatment.

An urgent debridement is necessary to improve outcomes. According to Lin *et al.*, surgery should be performed within 15 hours of the onset of symptoms to avoid an increased risk of major complications (17). Moreover, multiple further surgical debridements are usually needed in the operative theatre to the rapid disease relapse. In our study, the average time to surgery was approximately 14 hours, which explains the survival rate in line with the literature. Surgery aims not only to remove damaged tissue but also to drain the infection completely. The full extent of the disease may not be apparent from the areas of skin involvement, which is typically less than the involvement of tissue beneath the skin. It's important to be careful not to unintentionally open up deeper facial layers that were not originally affected. Our case series differs from the findings in the literature, as only 17.8% of patients required additional debridement after 24 hours, and 14.3% underwent reconstructive surgery. This result could be reached with

a primarily extensive debridement in hemodynamically stable patients.

Our hospitals did not use *hyperbaric oxygen therapy* (HBOT) for wound healing due to logistical constraints. According to the literature, HBOT has been found to have lower mortality rates compared to conventional therapy. However, its impact on the length of stay and number of debridements is inconclusive. HBOT has emerged as a promising adjunct in the management of necrotizing fasciitis. By increasing the partial pressure of oxygen in tissues, HBOT can significantly enhance the body's natural defense mechanisms. The elevated oxygen levels create a hostile environment for anaerobic bacteria, often the primary culprits in necrotizing fasciitis, particularly in conditions like FG. Additionally, HBOT stimulates the production of reactive oxygen species, which can directly damage bacterial cells. Beyond its direct antimicrobial effects, HBOT promotes angiogenesis and tissue granulation, accelerating wound healing. This is achieved by improving local blood flow, enhancing the delivery of nutrients to damaged tissues, and stimulating the growth of new blood vessels. Furthermore, HBOT can modulate the immune response, reducing inflammation and enhancing the body's ability to fight infection. While the evidence supporting the use of HBOT in necrotizing fasciitis is growing, its application has limitations. The optimal timing, duration, and frequency of HBOT treatments remain subjects of ongoing research. Moreover, the cost of HBOT and the logistical challenges associated with its delivery can limit its accessibility in many healthcare settings (18). Our experience, on the other hand, suggests that a multimodal treatment strategy, which includes daily site cleansing, can achieve complete restoration without the need for HBOT or surgical grafting while maintaining optimal outcomes despite comparable mortality rates. One of the modern advancements in wound care is the use VAC therapy, also known as *Negative Pressure Wound Therapy* (NPWT). VAC therapy has become a valuable tool in managing the large, complex wounds that follow the debridement of necrotizing fasciitis, offering several benefits that promote healing and reduce complications (19).

VAC therapy offers several key advantages in the management of necrotizing fasciitis. First and foremost, it accelerates wound healing by creating an optimal environment for tissue regeneration. Large wounds, such as those caused by necrotizing fasciitis, are often slow to heal. Still, applying negative pressure can speed up the process by improving blood flow and promoting healthy tissue growth. This is particularly important in reducing the need for additional surgeries or skin grafts (20). Despite its many advantages, VAC therapy is not without challenges. The cost of the equipment and the need for specialized training to properly administer the therapy can limit its accessibility in some healthcare settings (21). In the case of FG, which poses a significant risk of mortality (20-30%), medical emergency measures should be taken. These measures include fluid resuscitation, broad-spectrum antibiotics, and urgent surgical debridement. The timely execution of these measures is crucial, and various validated scores, such as the FCSI and *Uludag FCSI* (UFGSI) (13, 22, 23) can predict mortality rates associated with FG (24-26). Our experience shows that the death rate (21.4%) is consistent with existing litera-

ture, with only one death attributed to the progression of Duchenne syndrome and not FG. In one case, delays in diagnosis and treatment were observed, highlighting the significance of timely intervention.

The length of hospital stay (LOS) has decreased significantly. The first study was conducted by Carroll *et al.* in 1986 (27) reported a LOS of 48 days, whereas the latest review by Bowen *et al.* (28) showed a reduced LOS of 18.5 days. Our study also reported a lower LOS, which we attribute to the small number of re-debridements.

## CONCLUSIONS

FG is a rare but serious health condition that still has high mortality rates. It requires prompt and comprehensive intervention that should include timely surgical debridement and antibiotic therapy to achieve positive outcomes. The study emphasizes the difficulties involved in managing this complex condition. However, it also shows that a primary extensive debridement can help reduce the need for further intervention and shorten the hospital stay.

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## DECLARATIONS

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### Correspondence

Giovanni Cochetti

giovanni.cochetti@unipg.it

Alessio Paladini

alessiopaladini89@gmail.com

Luca Lepri

lucalepri3@libero.it

Andrea Vitale (Corresponding Author)

andrea.vitale69@yahoo.it

Raffaele La Mura

lamura@specializzandi.unipg.it

Miriam Russo

miriam.russo@specializzandi.unipg.it

Paolo Mangione

paolo.mangione@specializzandi.unipg.it

Matteo Mearini

matteo.mearini@outlook.it

Michele Del Zingaro

michele.delzingaro@unipg.it

Department of Medicine and Surgery, Urology Clinic, University of Perugia, Perugia, Italy

Andrea Fabiani

andreadoc1@libero.it

Emanuele Iacobone

emanuele.iacobone@sanita.marche.it

Lucilla Servi

lucilla.servi@sanita.marche.it

Surgery Department, Urology Unit, Macerata Civic Hospital, Area Vasta 3 Asur Marche, Italy

Ettore Mearini

ettore.mearini@unipg.it

Department of Medicine and Surgery, Urological Andrological Surgery and Minimally Invasive Techniques Unit, S. Maria Hospital, University of Perugia, Terni, Italy