



Fournier Gangrene: From Infection to Reconstruction

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Fournier gangrene is a rapidly extensive necrotizing fasciitis of high morbidity and mortality despite the progress of therapeutic means, it is a medical and surgical emergency requiring multidisciplinary management.

The aim of our work was to study the epidemiological, clinical, paraclinical and therapeutic aspects of this pathology in order to identify prognostic factors of mortality, and exposing the contribution of plastic surgery.

Methods: We conducted a retrospective, descriptive and analytical study on 40 cases of Fournier gangrene handled at the Nabeul University Hospital at the department of general surgery and plastic surgery during the period from January 2009 to December 2019.

Results: Our series included 36 men and 4 women. The average age was 57 years old. Urogenital etiology was the most common. The average hospitalization time was 8 days and the mortality rate was 20%. Predictive factors mortality were: septic shock at admission, anemia below 9g/dl, hyperkalemia, renal failure, extent of necrosis beyond the pelvic region, and FMSI and U-FMSI scores. 7 patients received controlled wound healing, 9 had secondary sutures, 9 had skin grafts, and 7 had one or more flaps. Functional outcomes were good to very good for 80% of patients. Aesthetic results were good to very good for 70% of patients.

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Conclusion: A multidisciplinary and early treatment remains the best guarantee for obtaining the best results in the management of Fournier gangrene. Mortality rates are improved by advances in surgery and resuscitation. The identification of prognostic factors is essential in order to establish optimal treatment.

Keywords: Fournier gangrene; Necrotizing fasciitis; treatment; prognosis; mortality; plastic surgery.

1. INTRODUCTION

Fournier gangrene (FG) is a rapidly extensive necrotizing fasciitis of the perineal region, of considerable mortality, thus representing a medical and surgical emergency. The functional and aesthetic prognosis often compromised, calls for secondary surgical reconstruction. The aim of our work was to highlight the epidemiological, clinical, paraclinical and therapeutic aspects of Fournier gangrene, to identify the main prognostic factors influencing the morbidity and mortality rate of this serious pathological entity, as well as expose the contribution of plastic surgery in this field.

2. MATERIALS AND METHODS

Our study focused on a retrospective analysis of 40 cases of perineal gangrene in the Nabeul University Hospital at the General Surgery and Plastic Surgery departments, over a period of 10 years between January 2010 and December 2020.

To assess the severity of the infection, we used a specific score: the Fournier gangrene severity index (FGSI), initially described by Laor and al [1] (Table1). Results were evaluated in the short and long term.

In the short term, we took into account the vital prognosis and mortality rate.

Long term results considered the following aspects :

- Functional aspect judged by patients and doctors based on several criteria which are:
 - Hypoesthesia
 - Pain
 - Discomfort in walking, urination, or to issue the stool
 - Pursuit of sexual activity
- Aesthetic aspect judged on the volume, shape and color of the coverage.

3. RESULTS

The average age of our patients was 54 years with extremes ranging from 21 to 75 years. The age group was the most represented. Our population had a male predominance : 36 men versus 4 women, with a sex ratio of 9. Thirty-two (80%) of our patients had at least one co-morbidity or toxic habit. Diabetes mellitus was the most important one. Eight (20%) had no prior history. Urological history noted were: repeated urogenital infections, acute urine retention, urethral stenosis, prostate tumor. The proctological history noted was: anal margin abscess, anal fistula and rectal cancer.

The presumed etiology of Fournier gangrene was found in 85% of cases while in 15% of cases (6 patients) no cause was objectified. Etiologies found were dominated by urogenital causes, observed in 42.5% of patients. The average time to consult was 8 days with extremes ranging from 3 to 30 days. Systematic symptoms concerned particularly the state of consciousness, general state, temperature, heart and respiratory rates. These sins are detailed in Fig. 1.

Local Symptoms are Detailed in Table 1

Biologically disorders observed were:

- leukocytosis greater than 10,000 elements/mm³ in 23 patients
- Anemia in 11 patients, including 3 severe cases requiring blood transfusion
- Hyperglycemia in 25 patients
- 7 cases of kidney failure (acute or chronic)
- 8 cases of hyponatremia, 10 cases of hypernatremia
- hyperkalemia in 8 patients
- alkaline reserve disorders in 10 patients

Bacteriological sampling results were obtained in 31 patients (77.5%). A single germ was isolated in 9 patients (29%) versus several germs in 22 patients (71%), confirming the polymicrobial character of this infection. The most common bacterial agents involved were *Escherichia coli* (51%) and Group A hemolytic *Streptococcus beta* (32%).

Table 1. Fournier gangrene index severity

Physiologic variable		High abnormal values			Normal	Low abnormal values			
		+4	+3	+2	+1	0	+1	+2	+3
Temperature (°C)	> 41	39-40.9	--	38.5-38.9	36-38.4	34-35.9	32.-33.9	30-31.9	<29.9
Heart rate	>180	140-179	110-139	--	70-109	--	55-69	40-54	<39
Respiratory rate	>50	35-49	--	25-34	12-24	10-11	6-9	--	<5
Serum sodium (mmol/L)	>180	160-179	155-159	150-154	130-149	--	120-129	111-119	<110
Serum potassium (mmol/L)	>7	6-6.9	--	5.5-5.9	3.5-5.4	3-3.4	2.5-2.9	--	<2.5
Serum creatinine (mg/100ml)	>3.5	2-3.4	1.5-1.9	--	0.6-1.4	--	<0.6	---	---
hematocrit	>60	---	50-55.9	46-49.9	30-45.9	---	20-29.9	---	<20
WBC (total/ mm ³ *1000)	>40	---	20-39.9	15-19.9	3-14.9	---	1-2.9	---	<1
Serum bicarbonate (venous, mmol/L)	>52	41-51.9	---	32-40.9	22-31.9	---	18-21.9	15-17.9	<15

A score > 9 indicates a mortality rate of 75% ; and a score ≤9 indicates a survival rate of 78%

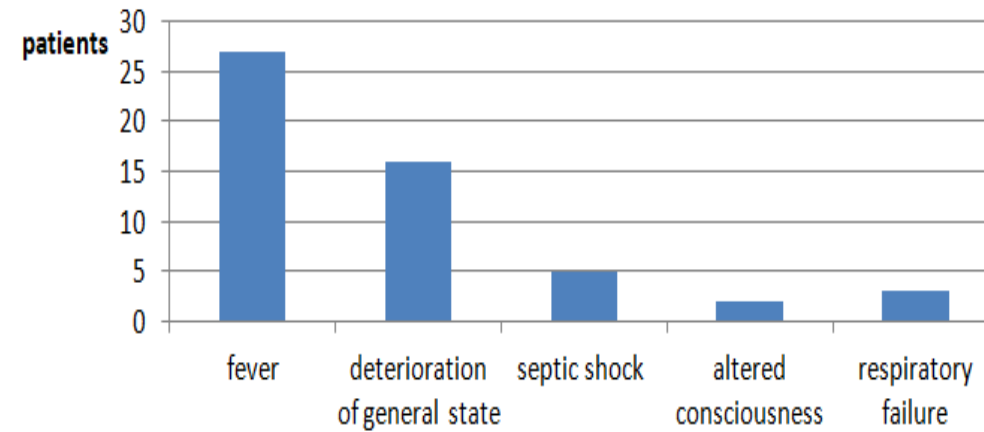


Fig. 1. patient repartition according to systemic signs objectified at the admission (deterioration of general state meaning asthenia, weight loss and anorexia)

Table 2. Patient repartition according to local signs present at admission

Symptom	Number of patients
Edema and perineal erythema	40
Perineal Cutaneous necrosis	Perineal : 12 Extended to abdominal skin : 5 Extended to abdomen and thorax : 1 Extended to external genitalia : 22
Anal sphincter hypotonus	3
Sub-cutaneous emphysema	14

All our patients were admitted via emergency where resuscitation was quickly introduced including hydro-electrolyte rehydration, hypercaloric and hyperproteidic parenteral nutrition and heparin therapy with a preventive dose. Correction of metabolic and ionic disorders for patients with acidosis or diabetes was immediately implemented. 5 patients were initially admitted to the ICU for septic shock or consciousness disturbances requiring active resuscitation. Paracetamol at 1 g/8 h was administered to all patients for its antipyretic and analgesic action. Probabilistic broad-spectrum antibiotic therapy was immediately instituted intravenously including a triple association of a third generation cephalosporin to cover Gram-positive aerobic germs and clostridium, Metronidazole to cover anaerobic germs and an aminoside (Gentamycin) if kidney function is not impaired to cover gram-negative germs. Aminosite was stopped within 5 days and the antibiotic therapy was secondarily adapted according to the results of the antibiogram. Its duration was 16 days on average with extremes ranging from 8 to 24 days.

Surgical management consisted of an aggressive surgical debridement in extreme emergency performed under general or spinal anesthesia, the limit of the excision being defined by the appearance of tissues and normal bleeding on contact. Surgical wounds were left wide open drained if necessary by Delbet blades or by betadine dressing inserted into the wound. Washing with isotonic saline serum, betadine and hydrogen peroxide was carried out systematically. The infected but not necrotic areas were treated less aggressively by large incisions and drained by Delbet blades. In 3 patients an orchidectomy was made in front of severe septic damage. A systematic urinary bypass was performed, with 28 patients using a Foley urethral catheter and a suprapubic catheter in 12 patients. A fecal derivation by a left iliac colostomy was performed in 7 patients with extensive rectal and sphincteric involvement, to

prevent bacterial contamination of the resulting defect.

Dressings were changed daily for all patients, in the operating room at first and secondarily in the department after improvement of the wounds.

Surgery was performed for one time in 17 patients while 9 patients needed revision surgeries were more than twice for extension of necrosis. Of these cases, 2 patients were revised 4 times for deep abscesses that resulted in a persistent infectious state.

Negative pressure wound therapy (NPWT) was used for 13 patients; and kept for 5 days. 7 patients received 2 sessions of NPWT and one patient needed 3 sessions.

Only one patient received hyperbaric oxygen therapy sessions, he had 15 sessions.

In our patients, coverage was achieved around the third week after improvements in the clinical and biological parameters of the infection. In our series only 6 patients required reconstruction for significant defects. 7 patients healed by controlled wound care, 9 had secondary sutures, 9 had skin grafts, and 7 patients had one or more flap coverage.

The average length of hospitalization for our patients was 27 days with extremes ranging from 5 to 35 days. The number of patients completely healed was 32 (or 80% as a cure rate).

8 deaths were recorded in our series (a mortality rate of 20%). 6 patients had died as a result of multi-visceral failure secondary to septic shock, and two patients from a massive pulmonary embolism. Deaths occurred within a time frame of 3 to 10 days. The FGSI was equal to 5 for survivors and 10 for the deceased patients.

The follow-up was carried out as part of outpatient service while assessing their local and

general evolution as well as functional and aesthetic results. The functional result was considered good to very good for 80% of patients, the aesthetic result was good to very good for 70% of patients.

4. DISCUSSION

4.1 Epidemiology

The true incidence of the disease is not known. A retrospective review of the literature between 1950 and 1990 reported 1726 cases. An average of 97 cases per year was reported from 1989 to 1998 [2,3]. Currently the incidence of FG is about 1.6/100000 inhabitants in Western countries, it represents only 0.02% of hospitalizations in the USA [4,5]. It is not confined to a region of the world, although the largest clinical series originate from the African continent [6]. Initially described as a healthy young adult pathology, FG actually affects a large population from the

neonatal period to older age [7,8]. In most reported cases, the age ranged from 30 to 70 years [2] with an average of 60 years [9].

According to the literature, this affection occurs ten times more in men than women [2,10,11]. This difference can be explained by the better drainage of the perineal region in women through vaginal secretions. However, according to Czymek and al., the occurrence of Fournier's gangrene in women is considered a mortality factor and is associated with a higher incidence of peritonitis and retroperitonitis. This can be explained by the diffusion of inflammatory processes directly from external genitalia to the abdominal cavity and retroperitoneal space through fallopian tubes [12]. In our series 4 patients were female, this is explained, among other things, by the fact that female pelvic-perineal lesions are often treated at gynecologic departments.



Fig. 2. Mr. A.A. 65 years old, with a history of smoking, hypertension and myocardial infarction in 2009, was also followed for prostate adenocarcinoma. He came to our emergency room with a FG extended to the penis, the perineoscrotal and abdominal region evolving for 5 days probably secondary to a epididymo-orchitis. U-ISGF was at 9. The patient was operated the same day after stabilization of hemodynamic state. He had an extensive debridement of necrotic, as well as a discharge incision in the abdomen (a,b). A bilateral orchidectomy was performed when testicular necrosis was found per-operatively. Due to the patient's age and history, a thin skin graft was used to cover the defect (c). The result is shown at 60 days after surgery (d)



Fig. 3. 66 years-old diabetic male patient, who presented in emergency for a FG of the pubic and perineo-scrotal region extended to penis. Debridement was made the same day (a,b) and the patient has been re-operated for skin graft of the residual defect. The result is shown at 3 months post operative(c,d)



Fig. 4. 40 years old male patient with a history of smoking, hypertension and diabetes has been on antibiotic therapy for 15 days for a recurrent urinary tract infection. The ER exam found a perineoscrotal FG with a U-ISGF score of 10. The patient underwent emergency debridement of necrotic tissue (a) and a left iliac colostomy was performed. A revision was necessary on 2 occasions for further debridement. In this case, due to the extent of the defect, a coverage with medial fasciocutaneous flaps of the thighs was chosen (b) and separated from thighs a month later (c)

The average time between the onset of symptoms and the admission of our patients is 8 days, with extremes from 3 to 30 days. The difference between the average admission time in cured and deceased patients is not statistically significant, which is consistent with the results of some studies [13], while others have proven the opposite [14].

4.2 Risk Factors

History analysis of patients most often finds associated factors promoting infection: Diabetes is associated with FG in 20-70% of cases [15] making it the most frequently associated risk factor. However it hasn't influenced clinical outcomes and mortality in our patients. This is

consistent with the results of most studies that do not recognize diabetes as a prognostic factor [12, 25,26]. Hypertension is not discussed as a risk factor, but since Fournier's gangrene is a result of an alteration of local blood vessels, it may be incriminated. In our series, hypertension was present in 25% of patients but did not significantly affect the prognosis [2,14].

Chronic renal failure is reported by some authors as predisposing factor to FG, it would be responsible for calcium deposition in loose tissue, arteries and skin resulting in atheromatous transformation of intima and total obstruction of vessels [16,17]. Hemodialysis, as well as kidney transplantation are also considered recognized risk factors for FG.

Chronic ethylism is the second major risk factor involved in the development of perineal gangrene, particularly in Western countries. It could promote gangrene by certain immune disorders and the alteration of liver function. Ethylism is associated with poor prognosis, especially in patients with combined diabetes [7,18]. It is cited as a contributing factor in several series. In ours 6 patients reported a history of alcoholism.

Smoking may be discussed as a contributing factor, but not as a risk factor.

Patients with neoplasia are also predisposed to developing perineal gangrene, either by the neoplastic disease itself or by the chemotherapy used in its treatment. In both situations, there is immunosuppression that promotes the development of serious infections [3,19]. In our series 2 patients were carriers of a neoplastic pathology with 1 case of rectal cancer and one case of cancer of the penis.

4.3 Clinical Diagnosis

In the majority of observations, an entry point of infection was found [1,20]. It can be: anorectal, frequently reported ischio-rectal and perianal abscesses, hemorrhoids, rectal cancer, anal fissures, diverticulosis, as well as colic perforations, dermatological pathology particularly acute and chronic skin infections, eruptive diseases and venereal ulcers may also constitute starting lesions. Urogenital sources of infection include urethral stenosis with urine extravasation and periurethral infection, urethral instrumentations, traumatic urethral false routes (including home catheter stand in paraplegics).

Cases of FG have been reported after circumcision, hernia treatment and implantation of penile prosthesis, urethral necrosis on incorrectly positioned probe balloon, epididymis or testicular abscesses and hydrocele treatment. Specific causes in women include septic abortions, abscesses of Bartholin glands and episiotomies.

Early diagnosis depends primarily on the clinician's alertness to symptoms and suggestive signs. The delay in diagnosis observed in most of the series including ours (on average about 6 days), is a factor of poor prognosis and explains that the lesions are often locally evolved [2,21]. However, in our study, although the time to diagnosis was longer in the deceased group, it did not statistically influence mortality. The classical symptomatology is preceded by various prodromes which usually last 1 or 2 days. But sometimes several days to a few weeks. These can include digestive problems, back pain, discomfort, febrile state, irritability or simple scrotal discomfort [6].

4.5 Paraclinical Examinations

It assess the overall impact and severity of the disease and guide antibiotic therapy. Biology: Abnormalities of blood cell count and elevation of CRP are frequent but not specific. Hydro-electrolyte balance may show hyponatremia, hypokalemia, hypocalcemia, or acute kidney failure [22]. Low levels of hematocrit, bicarbonates and albumin, or high levels of leukocytes, urea, creatinine, sodium, potassium were found to have a prognostic value [7,23]. Some of these parameters are essential to establish the GFSI score (hematocrit, leukocytes, natremia, kaliemia, creatinine, bicarbonates).

In our study, mortality was significantly higher in patients with low hemoglobin ($p=0.019$), as well as patients with high serum creatinine ($p=0.023$) and potassium ($p=0.004$). These biological disorders reflect kidney dysfunction related to septic shock and may be the initial stage of multivisceral failure. Low hemoglobin levels are explained either by severe sepsis or by chronic kidney failure, which are also significant prognostic mortality factors.

FG typically results from a synergetic infection by several bacteria. All isolated bacteria belong to the commensal flora of the digestive tract, urethra and perineum [23]. This flora becomes pathogenic in case of locoregional aggression.

Crackling, with or without fetid odor, suggests the presence of anaerobic bacteria. In the majority of cases, the samples show aerobic and anaerobic bacteria. However, their distribution varies greatly depending on the author. Since isolation of anaerobic germs is particularly difficult, it is difficult to demonstrate their real importance in the development of the disease. Rare cases of Candida infections have been reported. The realization of blood cultures is essential, note that in immunocompromised patients a bacteremia is more common. The negativity of bacteriological tests, in 3% to 13% of cases according to the literature [24], should not constitute a delay in therapeutic management. The main interest of these samples is to obtain an antibiogram and adapt the antibiotic treatment. Literature recommend to carry out samples, before any antibiotic therapy at the level of infected tissue. The bacteriological samples will be carried out at each debridement session because germs vary according to the phases of evolution of the pathology, with a secondary appearance of Pseudomonas Aeruginosa. According to many studies there is no correlation between isolated germs and mortality, so the bacteriological profile of patients cannot be considered as a prognostic factor [3,25].

4.6 Management

The treatment is based on a multidisciplinary approach implemented without delay : medical treatment fights against infection and its consequences but does not remove the infected tissue on which only surgical treatment is effective. Resuscitation is not specific. Its main purpose is to rule out vital risks and to stabilize the patient's condition in order to prepare him for the surgical procedure. Surgical treatment consists of an extensive debridement of all necrotic tissues. Local wound care with iterative dressing changes and adjuvant treatments such as NPWT and hyperbaric oxygen therapy. Healing can only be achieved in the presence of local and general conditions favourable to tissue regeneration. A good tissue infusion, the absence of necrosis and infection, a humid atmosphere are all local factors essential to healing explaining the use of gestures of digestive and urinary diversion.

Urinary bypass is systematic because it helps in monitoring the patient during resuscitation. It is realized in preference via a Foley catheter as it prevents urethral stenosis. If this method is impossible (anterior urethral stenosis or damage),

a suprapubic catheterisation is performed though it can expose to septic complications and extension of gangrene.

The timing of the reconstruction is valuable. It depends largely on general and local developments. Skin grafting and testicular burial are widely used. Certainly, skin grafting is a simple and useful but its disadvantages (maceration, difficulty of taking especially on fragile sites and wet zones) must limit its indications to cases where thigh flaps are unusable such as in case of defects extended to the crural regions. In our study, only one case of failure to take the grafts was recorded, it would be explained by a bad padding.

Regional fasciocutaneous flaps (in this case the medial fascio-cutaneous flap of the thigh), are the most widely used reconstruction method. In extended scrotal defects, two small bilateral flaps are preferable to a large one-sided flap as they allow the donor areas to be reduced and directly sutured, with a more aesthetic scrotal reconstruction thanks to a tension-free suture and a possible recreation of the scrotal raphe at the junction of the two flaps including a skin of colour and texture similar to that of the scrotum with a lesser thickness in comparison with other musculo-cutaneous flaps [26]. Fasciocutaneous flaps have the advantage to cover large defects without a tendency to retraction. The anterolateral flaps of the thigh [27] and the flap of Mc Gregor are interesting alternatives. When the perineal and scrotal defect is deep and irregular, muscle transfer is often necessary. However, its thickness is sometimes the cause of aesthetic dissatisfaction. The musculocutaneous flap of the gracilis muscle is the most used [28], the flap of the rectus abdominis muscle has also been described in this indication [29]. Other musculo-cutaneous flaps such as vastus medialis muscle remain less used because they bring excessively thick tissues. They also create a warm environment that may be incompatible with spermatogenesis.

The septic context as well as the often weakened body make the use of free flaps very random, they must be reserved for very particular cases with extensive and/or complex defects.

Thus, any repair cannot be conceived during the septic phase. In our patients, coverage was achieved on average around the third week after improvement of the clinical and biological parameters of the infection.

5. CONCLUSION

Fournier gangrene remains a serious affection. Prevention remains the best option by optimization of the basic treatment of chronic pathologies and a good clinical and para-clinical control of these pathologies (diabetes, hypertension, chronic obstructive bronchopneumopathy, cardiac and renal failure, obesity).

Urgent multidisciplinary management is essential to ensure optimal management of these patients. The psychological aspect, too, should not be neglected as this pathology affects the external genitalia.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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