

Progress in Multidisciplinary Treatment of Fournier's Gangrene

Ke-Fan Zhang^{1,*}, Chuan-Xin Shi^{1,*}, Si-Yu Chen^{2,*}, Wei Wei¹

¹Department of General Surgery, The Second Affiliated Hospital of Nanjing Medical University, Nanjing, People's Republic of China; ²Department of Cardiology, Nanjing First Hospital, Nanjing Medical University, Nanjing, People's Republic of China

*These authors contributed equally to this work

Correspondence: Wei Wei, Department of General Surgery, The Second Affiliated Hospital of Nanjing Medical University, Nanjing, People's Republic of China, Email kevinwei@njmu.edu.cn

Abstract: Fournier's gangrene (FG) is a life-threatening and special form of necrotizing fasciitis, characterized by occult onset, rapid progress and high mortality, occurring mainly in men over 50 years of age. Risk factors of FG include diabetes, HIV infection, chronic alcoholism and other immunosuppressive state. FG was previously considered as an idiopathic disease, but in fact, three quarters of the infections originated from the skin, urethra and gastrointestinal tract. Initial symptoms of FG are often inconsistent with severity and can progress promptly to fatal infection. Although the treatment measures of FG have been improved in recent years, the mortality does not seem to have decreased significantly and remains at 20% – 30%. The time to identify FG and the waiting period before surgical debridement are directly related to the prognosis. Therefore, in addition to the combination of intensive fluid resuscitation and broad-spectrum antibiotics, treatment of FG should particularly emphasize the importance of early surgical debridement assisted with fecal diversion and skin reconstruction when necessary. This paper is to briefly summarize the progress in the definition, epidemiology, clinical manifestations, diagnosis, treatment and prognosis of Fournier's gangrene in recent years, more importantly, illustrates the importance of multidisciplinary cooperation in the management of FG.

Keywords: Fournier's gangrene, necrotizing fasciitis, lethal infection, surgical debridement, multidisciplinary cooperation

Introduction

Fournier's gangrene (FG) is a rare and dangerous necrotizing soft tissue infection (NSTI), characterized by obliterative endarteritis and arteriolar thrombosis of subcutaneous tissue caused by bacterial infection. FG mainly occurs in the external genitalia and perineal areas, and can spread rapidly along the fascia plane, eventually leading to sepsis and multiple organ failure.¹ Genital gangrene was first mentioned in the middle-ages medical works of famous Arab physician Avicenna. Baurienne published the first case of FG in early modern medical literature in 1784. A boy developed scrotal swelling and tissue damage on the fourth day after being bitten by a cow. This disease was eventually named after French eminent venereologist Dr. Alfred Fournier after he reported a case series in 1883, containing five cases of previously healthy young men with rapidly progressive necrotizing infection.² Willison introduced the term "necrotizing fasciitis" to describe the characteristic symptoms of FG.³ Many terms have been used to describe the clinical condition including "idiopathic gangrene of the scrotum", "periurethral phlegmon", "streptococcal scrotal gangrene", "phagedena" and "synergistic necrotizing cellulitis."⁴

Epidemiology

Incidence and Demographics

FG is a relatively rare surgical emergency, which was initially considered as an idiopathic disease of male. The latest epidemiological investigation found that this disease can occur at any age and gender. The overall incidence is about 1.6/100,000 males, and male incidence increased with age reaching the peak of 3.3/100,000 between the age of 50 and 79.^{5,6}

Epidemiological study based on State Inpatient Database of United States identified 1641 male FG patients (97.7%) and 39 female FG patients (2.3%), accounting for only 0.02% of hospitalizations.^{5,6} Male cases are far more than female cases (male:female is 10:1), and the proportion of patients younger than 40 years old is very small.^{7,8} Contemporary study based on National Inpatient Sample from 2004 to 2012 found that the proportion of FG patients aged 40 to 59 years was the highest, reaching 50.7%.⁸ The large-scale case analysis showed that the female incidence of FG is far lower than that of male, but the severity of female patients seems to be greater than male.⁶ Recent studies showed that the female incidence rate is increasing, the proportion of female patients was as high as 23% and 55% in the two recent case studies.^{9,10} However, with the increase of the average age of the population and the number of patients receiving immunosuppressive therapy or infected with human immunodeficiency virus (HIV), the incidence of FG incidence rate has increased in some areas.¹¹

Mortality and Prognosis Predication

A study systematic reviewed 6152 cases published from 1993 to 2018, and found that the case mortality was between 0–42% respectively, and the total mortality was 19.8%, which did not seem to have improved significantly over the twenty-five years.¹² However, a recent study found that the mean mortality of FG patients from 2000 to 2021 was 7.5%, which has decreased compared with previous years.¹³

There are many factors significantly related to the prognosis of FG patients, including early diagnosis, waiting period to surgery and comorbidity. Surgery is the cornerstone of the treatment of FG, any factors delaying surgical intervention predicts a poorer prognosis. A retrospective study found that the mortality will rise when the time for making a definitive diagnosis exceeds 136 minutes in the emergency department.¹⁴ Goh et al found that as the waiting period before debridement after admission increased from 24 hours to 48 hours, the survival rate decreased from 93.2% to 75.2%.¹⁵ Comorbidity is not only an important risk factor of FG, but also affects the prognosis. Relevant study found that the mortality of FG patients with diabetes, heart disease, renal failure and kidney disease was significantly higher, but there was no significant correlation between liver and malignant diseases and mortality.¹⁶

Fournier's gangrene severity index(FGSI), including body temperature, respiratory rate, heart rate and serum sodium, was used to predict the prognosis of FG patients. When the FGSI score is >9, the mortality is 75%. When the FGSI score is ≤ 9, the survival rate is 78%.¹⁷ Although several studies support different thresholds, most studies have demonstrated that higher FGSI scores are helpful to identify high-risk patients and indicate poor prognosis.^{18,19} Considering the significant relationship between comorbidity and prognosis, adding comorbidity to FGSI may more accurately predict prognosis.¹⁶ There are many scoring systems that can predict the prognosis of FG patients, but little attention was paid to the length of stay, which is associated with hospitalization expenses and treatment methods.

Based on the correlation between each univariate and the length of stay, Ghodoussipour et al finally chose age and eight laboratory indicators to constitute a multivariable model, namely Combined Urology and Plastics Index (CUPI), for predicting the length of stay (LOS) (Table 1). The average LOS in patients with CUPI score ≤ 5 was 25 days (SD 15.6), while average LOS in patients with CUPI score >5 was 71 days (SD 49.8).²⁰ CUPI is a supplement to the existing prognosis prediction model, high CUPI score being useful to detect high-risk FG patients and urge multidisciplinary participation, which can shorten LOS and improve the prognosis. However, there is a lack of prospective and multicenter studies to validate this scoring system.

Pathogenic Microorganism and Mechanism

FG was once considered idiopathic because of the lack of clear etiology. Modern systematic review found that only about a quarter of patients can be classified as idiopathic. The majority of infections of FG patients originated from genitourinary tract, anorectal and external genital soft tissues.^{21,22} According to the pathogenic microorganisms, necrotizing fasciitis can be roughly divided into four types: Type I (polymicrobial), Type II (monomicrobial), Type III (Clostridium) and Type IV (fungal) (Table 2).^{23–28} Type I was most common, accounting for about 80%, which always endangers the elderly with comorbidity (such as diabetes, chronic kidney disease and alcoholism).^{25,28} Most FG was a mixed infection of multiple microorganisms, including Gram-positive and Gram-negative bacteria, anaerobic bacteria and/or spindle spore rods. Tang et al reviewed 2265 patients in the database in recent 30 years and found that 54% of patients had multiple microbial infections.²⁹ Clara m et al retrospectively studied

Table 1 CUPI Scoring System.²⁰

Criteria	0	+1	+2
Age (years)	<35	35–50	>50
Hematocrit (%)	30–50	<30	>50
Serum Calcium (mg/dL)	8–10	<8	>10
Serum Alkaline Phosphatase (IU/L)	40–150	<40 or >150	
Serum Albumin (g/dL)	>4		<4
INR	1–1.5	1.5–2	>2
Serum Bicarbonate (mEq/L)	20–30	<20 or >30	
Total Bilirubin (mg/dL)	0.3–1.9		>1.9
BUN (mg/dL)	10–20	>20	

Note: Total score = 0–15.

Table 2 Classification of Necrotizing Fasciitis Based on Pathogenic bacteria^{23–28}

Types	Pathogen	Location	Risk Factors	Character
Type I (55–80%) polymicrobial	mixed Gram-positive/negative bacteria, and anaerobe	Trunk, Perineum	Comorbidity: DM, CKD and Obesity. Low immunity	Most common
Type II (10–15%) monomicrobial	β -hemolytic Streptococcus Staphylococcus aureus	Limbs	Trauma, surgery, intravenous drug use	MRSA second most common
Type III Rare monomicrobial	Clostridium spp Vibrio vulnificus	Most of the body	Contaminated water or raw oyster, penetrating wounds	Early and severe systemic shock and cardiovascular failure High mortality (30–40%)
Type IV Rare	Aeromonas hydrophila Candida spp zygomycetes	Most of the body	Penetrating wounds, low immunity	High mortality

131 FG patients underwent bacterial culture in a tertiary medical center in the United States from 2011 to 2018. The results showed that the median number of microorganisms was 3, and the most common pathogens were Staphylococcus (66; 46%), Streptococcus (53; 37%), Bacteroides (34; 24%), Candida (31; 22%), and Escherichia coli (28; 20%).³⁰

The exotoxins and enzymes produced by aerobic and anaerobic bacteria can destroy tissues at the speed of 1 inch per hour and prolong the infection time. The lethal infection spreads rapidly from the genital area to the anterior abdominal wall and other important organs.^{31,32} Platelet aggregation and complement fixation induced by aerobic bacteria together with heparanase and collagenase produced by anaerobic bacteria promotes the thrombosis of local microvessels and severe ischemia in this area, which eventually progresses to Fournier's gangrene.⁴

Risk Factors

FG related risk factors impair the function of the patient's immune system, creating a favorable environment for the occurrence and progress of infection (Table 3).³³ When the host is in a state of low immunity, common symbiotic bacteria in human perineum play a synergistic role in the occurrence and progression of FG.

Comorbidity is an important risk factor of FG. Comorbidity such as diabetes causes persistent immune disorder and enhances the susceptibility of patients to sepsis by weakening innate immunity, adaptive immunity and immune regulation.^{34–36} The data show that about 52–88% of patients have at least one comorbidity.^{37,38} Patients with

Table 3 Related Risk Factors for the Development of Fournier's Gangrene

Comorbidity	<ul style="list-style-type: none"> • Diabetes¹⁶ • Alcohol abuse⁴² • HIV⁴³ • Leukemia⁴⁴ • Chemotherapy^{45,46} • Liver disease¹⁶ • Atherosclerosis³⁸ 	
Local factors	Urinary system diseases	<ul style="list-style-type: none"> • Renal abscess⁵¹ • Urinary calculi⁵³ • Urethral stricture^{52,54}
	Anorectal diseases	<ul style="list-style-type: none"> • Perianal abscess^{55,56} • Thrombotic external hemorrhoids • Strangulated inguinal hernia^{57,58}
	Local skin diseases	<ul style="list-style-type: none"> • Necrotic ulcer^{59,60}
Invasive operation	<ul style="list-style-type: none"> • Renal abscess⁵¹ • Urinary calculi⁵³ • Urethral stricture^{52,54} 	

comorbidities such as diabetes and alcoholism, atherosclerosis, peripheral arterial disease, malnutrition, prostate cancer, human immunodeficiency virus (HIV) infection, leukemia and liver disease are likely to develop into FG.^{16,39–46} If the patient has more than one comorbidity at the same time, the incidence and severity of FG will rise.⁴⁷

Diabetes has been considered as the most important causative factors of FG. Based on 1641 FG patients in 35 states in the United States, evidence showed that 37% of patients were complicated with diabetes, and the increase in diabetes prevalence is related to the increase in Fournier's gangrene incidence.⁵ The FG incidence rate will increase by 0.2 / 100,000 for every 1% increase in the prevalence of diabetes.⁵ It is also pointed out that the use of sodium glucose cotransporter-2 (SGLT2) inhibitors in diabetes patients may be related to FG.^{48,49} However, there is no statistical evidence to support the correlation between SGLT2 inhibitors and FG, so this correlation needs to be strictly verified.⁵⁰

Some local diseases around the perineum, especially in immunosuppressed people, are also important risk factors of the FG including urinary system diseases (renal abscess, urinary calculi, and urethral stricture),^{51–54} anorectal diseases (perianal abscess, thrombotic external hemorrhoids, and strangulated inguinal hernia)^{55–58} and local skin diseases (necrotic ulcer).^{59,60} In addition, pathogens that commonly cannot penetrate the skin can quickly reach deeper tissues through invasive operations, such as medical operations (catheterization,^{61,62} prostate biopsy⁶³) and intravenous injection (drug abuse^{64,65}).

Diagnosis

Clinical Manifestation

The early diagnosis of FG mainly depends on clinical manifestations and past history, but the early symptoms are subtle and unspecific. Study have showed that the interval from the initial symptoms to skin gangrene is 5.1 ± 3.1 d, and about three quarters of cases were misdiagnosed.^{42,66} A population-based longitudinal study found the prodromal period of FG before diagnosis was about 21-day and nearly 50% of the 8098 patients got a symptomatically similar diagnosis (such as scrotal swelling, cellulitis and genital pain), which resulted in diagnostic delay.⁶⁷ Early diagnosis of FG patients without risk factors and inducing conditions is very difficult, which require clinician to sufficiently understand the early manifestations.^{37,68}

The earliest clinical manifestation of skin in FG patients includes perineum and perianal pain, pruritus, edema and unclear boundary patchy erythema. As the infection continues to spread along the fascia plane at the speed of 1 inch/h,

the erythema color become deepen and bullae appear.^{16,31,66,69,70} Because of the local nerve injury, the pain in the lesion is reduced. When combined with anaerobic infection, subcutaneous twisting and malodorous purulent drainage may occur, and the final skin manifestation is gangrene.⁴² In addition to typical local skin manifestations, systemic symptoms include fever, chills and tachycardia. Goh et al systematically reviewed 1463 patients from 1980 to 2013 and determined several manifestations with diagnostic significance, including pain inconsistent with physical examination, deteriorate despite broad-spectrum antibiotics, bullae in the skin, and gas in the soft tissue on plain X-ray.¹⁵

The genital organ of most patients was affected by FG. In female patients, vulva or labia (95–100%) were almost all encroached by pathogen. In men, scrotum (71–76%) was easily involved, while testicles were less involved (47–53%), benefiting from independent blood supply.¹⁰ Isolated penis FG is more rarely, and its early manifestations are genital pain and fever, which can quickly develop into penis swelling, necrosis, ulcer and stench.⁷¹

Imaging Examination

The specific imaging features of FG, especially gas in the fascia, can help clinicians make a clear diagnosis and determine the extent of FG.

Computed tomography (CT) is the first choice of imaging examination to evaluate the FG, which has the advantages of high sensitivity (88.5%), high specificity (93.3%), and rapid acquisition.⁷² Contrast enhanced CT can further estimate the degree of fascia involvement before operation and determine whether the lesion is from the rectum.^{73,74} Some CT scoring system is also helpful. McGillicuddy developed a computed tomography-based scoring system (5 points for fascia air, 4 points for muscle/fascia edema, 3 points for fluid formation between soft tissues, 2 points for local lymphadenopathy and 1 point for subcutaneous edema), which can help clinicians to make the diagnosis of necrotizing fasciitis when the total score is greater than or equal to 6.^{10,75}

The imaging feature of FG on MRI are extensive perineal inflammation, fascia thickening and soft tissue gas, with or without effusion or fistula.⁷⁴ Because long acquisition time may delay surgery, some studies advocated MRI as a postoperative evaluation.⁷⁶ The imaging feature of FG on Ultrasound are subcutaneous emphysema, inflammation and exudation, which is very useful in differentiating incarcerated indirect inguinal hernia, testicular torsion or orchitis.⁷⁷ Fine-needle aspiration biopsy under Ultrasound guidance can be used to assist diagnosis.⁷⁸ However, small field of vision and pain caused by direct compression limit the use of US in FG.⁷⁹ X-ray seems not to be a good imaging examination choice for suspected FG patients, because of the overlapping gas in the pelvic cavity organs may lead to misdiagnosis.⁷⁴ A research containing 5982 patients found that the sensitivity of CT to necrotizing fasciitis (93%) is far better than that of X-ray (49%).⁷²

Laboratory Examination-Dependent Diagnostic and Predictive Scoring System

There is no specific laboratory index or biomarker, so the difficulty of diagnosis lies mainly in how to early distinguish FG from other soft tissue infections.^{80,81} Based on the blood routine and biochemical test of 89 necrotizing fasciitis patients, researchers developed the laboratory risk indicator for necrotizing fasciitis (LRINEC) (Table 4), which can detect early necrotizing fasciitis. Suspected patients with LRINEC score ≥ 6 should be attentively evaluated for the risk of necrotizing fasciitis.⁸² The LRINEC scoring system has been subsequently verified and show great reliability (the sensitivity: 43.2–80%, positive predictive value: 57–64% and negative predictive value: 42–86%) to effectively assist in detecting early clinical necrotizing fasciitis.⁸³ The high false negative rate (35.71%) of LRINEC in the retrospective study reminded clinicians not to rely solely on the scoring system to exclude suspected cases.⁸⁴ Many clinicians try to continuously improve LRINEC. For example, after adding comorbidity (chronic hepatitis) to LRINEC, the false negative rate can be reduced by 30%, the sensitivity can be increased by 11%, and the specificity can be reduced by only 1%.⁸⁵

Combined Treatment

The management of FG often requires multidisciplinary participation. The cornerstone of treatment is rapid resuscitation of critical patients, broad-spectrum antibiotic and complete surgical debridement, of which early surgical debridement is the most important. Some adjunctive treatments (such as HBOT, VAC and UPH) have been proved to have positive effects in practice, which should not be ignored in the management of FG.

Table 4 The Laboratory Risk Indicator for Necrotizing Fasciitis (LRINEC Score)⁸²

Variable, Units	Criteria	Points
C-Reactive Protein (mg/L)	<150	0
	≥150	4
Leukocyte count (10 ⁹ /L)	<15	0
	15–25	1
	>25	2
Hemoglobin (g/dL)	>13.5	0
	11–13.5	1
	<11	2
Sodium (mmol/L)	≥135	0
	<135	2
Creatinine (μmol/L)	≤141	0
	>141	2
Glucose (mmol/L)	≤10	0
	>10	1

Note: Total score =13.

Fluid Resuscitation

FG patients may soon progress to severe systemic infection even death due to the rapid progress, the data shows the final direct cause of death was sepsis (76%) and multiple organ failure (66%).¹⁶ Inadequate fluid intake, coupled with body fluid loss at the wound site and capillary leakage to the stroma caused by endothelial injury, reduced venous reflux and microcirculation perfusion.⁸⁶ Fluid resuscitation is an effective way to improve venous return, cardiac output (CO), and oxygen transport and create opportunities for surgical intervention.⁸⁷ SSC guidelines for adults recommend starting resuscitation immediately after identification and using at least 30 mL/kg of liquid within 3 hours. Crystalloid fluid is the first choice for fluid resuscitation.^{88,89} Under the premise of full fluid resuscitation, the prognosis can be significantly improved by properly handling the comorbidity of patients. A retrospective study found that some comorbidities significantly affect the prognosis and increased the mortality of FG patients, including diabetes, heart disease, renal failure and kidney disease.¹⁶

Source Control (Operation)

Source control is very important for managing FG, including abscess drainage, removal of potentially infectious devices, and thorough debridement of necrotic tissue, which can prevent the sepsis and septic shock.⁹⁰ Characteristic findings during operation, including the gray soft tissue, pus and turbid “dishwashing water” like liquid, odor, no bleeding, and the tissue lacks resistance, can further clarify the diagnosis.^{42,85} The mortality can be significantly reduced when the operation was performed within 6 hours after admission.⁹¹ Kabay et al also found that the delay of surgical debridement was significantly related to the increased mortality.⁹² After identifying the degree of the infection in soft tissue, including zone 1 (necrotic), zone2 (inflamed epidermis/dermis without necrosis), and zone 3 (normal skin), appropriate skin and soft tissue sparing surgery can prepare for subsequent primary closure.⁹³ Some clinicians attach great importance to the ‘60-minute rule’ in debridement, which includes 20 mins for debridement and 40 mins for complete hemostasis until the entire necrosis tissue is excised.⁹⁴ After the operation, the exposed wounds need to be properly covered with gauze (such

as saline gauze and biologic dressings), which need to be replaced frequently every day.⁹⁵ FG patients often need repeated debridement, Sam N's retrospective study containing 19 FG patients found that the average number of operations for complete debridement was 3.5, including 2.3 for survivors and 5.2 for dead patients.⁹⁶

Combined Broad-Spectrum Antibiotics

Due to the diversity of pathogenic microorganisms, clinicians must empirically select sufficient broad-spectrum antibiotics, and their antibacterial spectrum should cover for gram-positive, gram-negative, aerobic and anaerobic bacteria.⁹⁷ Classic selection of broad-spectrum antibiotics includes carbapenems or β -Lactamase inhibitor plus Clindamycin, when methicillin-resistant *Staphylococcus aureus* (MRSA) infection is suspected vancomycin or linezolid should be added; Patients with allergy to β -Lactamase inhibitor antibiotics should choose aminoglycosides or fluoroquinolones plus metronidazole. For patients with obvious risk of fungal infection (type I, IV), amphotericin B or fluconazole should be added.^{30,42}

The selection of antibiotics should be adjusted in time according to the results of bacterial culture and drug sensitivity. Deep samples taken by surgeons at the interface between healthy and necrotic tissues in first operation can help to identify the pathogens in about 90% of cases.⁹⁸ The de-escalation of antibiotics is usually safe and important, which can save costs, reduce the risk of antibiotic resistance and reduce toxicity and side effects, because of that the use of antibiotics is related to antibiotic resistance.⁹⁹ So, it is necessary to adjust the use of antibiotics in time once the result of bacterial culture is clear, including stopping unnecessary antibiotics and narrowing the antibacterial spectrum.

Hyperbaric Oxygen Therapy (HBOT)

Hypoxia is the main factor leading to delayed wound healing in patients with FG. HBOT can increase the oxygen partial pressure of tissues and organs, and promote wound recovery through various mechanism.¹⁰⁰ HBOT is especially suitable for FG patients who are unresponsive to conventional treatment, complicated with *Clostridium* or anaerobes and deep tissue involvement.¹⁰¹

Although few studies reported an increase in mortality, most studies showed that HBOT has a beneficial effect in the prognosis of FG. Several current systematic and meta-analysis on the assessment of HBOT in FG patients showed that HBOT can reduce the mortality of FG patients without significantly increasing the length of hospital stay.^{102,103} HBOT and early debridement are independent predictor of the lower mortality of FG patients.¹⁰⁴

Vacuum Assisted Closure (VAC)

VAC can promote debridement and increase wound perfusion through continuous negative pressure suction, which is help to wound vascularization, fibroblast migration, and cell proliferation.^{105,106} VAC has been demonstrated to reduce the wound area, frequency of dressing change, and the dose of analgesics, thereby ultimately increasing the quality of life of FG patients.^{107,108} However, the use of VAC may prevent clinicians from observing wounds clearly and prolong the stay of hospital, so the equipment should be changed every 72 to 96 hours.^{95,109,110} VAC was often used in patients with large skin defects, which can act as temporary closure method to prepare for underlying secondary reconstruction. Moreover, latest retrospective multi-institutional cohort study found that the number of pathogens in FG patients is positively related to the use of VAC, which further supported the use of VAC in FG patients.¹¹¹

Fecal Diversion

FG patients need strict wound management including fecal diversion after the aggressive debridement because of fecal pollution can affect wound healing even cause serious sepsis.¹¹² Appropriate fecal diversion includes colostomy and rectal catheter. The traditional method is to perform colostomy after debridement and drainage. Although the actual application frequency of diversion colostomy in the literature varies greatly due to the absence of a consensus, and most of the time rely on the personal experience of the surgeon, but it can bring great benefit to patients who are complicated with anal sphincter dysfunction and fecal incontinence.¹¹³ Enterostomy has been proved in practice that can decrease the length of stay and the fatality rate of patients with FG, but what cannot be ignored is that colostomy has some postoperative complications such as anastomotic leak, bowel obstruction, and surgical site infection, worse still some temporary stoma may not be reversed due to some prohibitive comorbidity.^{114,115} The flexible seal fecal management system (FMS) is a non-surgical fecal diversion method, which transfers feces to the fecal bag through the soft catheter in

the rectum to avoid fecal pollution.^{116,117} This method not only avoids the complications related to colostomy, but also reduces the psychological and economic burden of patients, but the contraindications such as rectal perforation and ulcer should be excluded before use.¹¹⁷ In several years, occasional complications such as tenesmus and rectal bleeding may bring some risks to the implementation of FMS.¹¹⁸

Unprocessed Honey Therapy (UPH)

Fungi (such as *Candida*) can lead to systemic infection when the mucosal or skin barrier is damaged or the host is in a state of hyp immunity.¹¹⁹ Unprocessed honey has been proved has antibacterial effect on many bacteria and fungi in vitro due to its low pH value, high permeability and enzyme activity. UPH is cheap and easy to access, but it is only recommended to be used in patients with small skin lesions and no complications.¹²⁰ Although many studies have proved the benefits of UPH, several studies found that the therapeutic effect of UPH is still controversial. Sufya n et al applied unprocessed honey locally in 25 FG patients, the results showed that UPH could not promote the healing of wound and even delayed wound healing in some cases.¹²¹

Postoperative Skin Reconstruction

The invasive pathological process of Fournier's gangrene can lead to skin defects of scrotum, perineum and penis. Although the component separation primary wound closure after debridement was demonstrated to be safe, large defects or severe infections often need to be reconstructed.¹²² Based on the location, size and depth of defects and the availability of local tissues, surgical reconstruction methods can be divided into skin grafts, local advancement flaps, scrotal flaps, multiple fasciocutaneous and myocutaneous flaps, and testicular transposition.¹²³ Meanwhile, for the reconstruction of defect larger than half of the scrotum area, systematic review recommended split-thickness skin grafting (STSG) or flaps.¹²⁴ Both flaps and skin grafts have been proved to have satisfactory aesthetic effects for genital reconstruction of FG patients.¹²⁵ Thanks to the good elasticity of scrotal skin, even if the remaining healthy scrotum skin is less than half, it can still be closed and sutured to cover the entire scrotum to complete reconstruction or secondary intention.⁹⁵ Unlike the scrotum, if the skin defect of penile is larger than 25%, grafts were usually needed.⁹⁵ The first objective of skin reconstruction is to cover the exposed soft tissues with skin. At the same time, this ideal reconstruction should sufficiently preserve the function, restore the appearance and reduce postoperative complications.

Conclusion

FG is a rare and life-threatening necrotic infection, often associated with mixed infection of aerobic and anaerobic bacteria, mainly involving external genitalia and perianal area. The susceptible population is middle-aged and elderly patients with comorbidity and predisposing factors. Definite diagnosis needs the combination between identification of susceptible population and familiarity with early clinical manifestations beside the assistance of laboratory and imaging examinations, because early clinical manifestations of skin are obscure. In addition, predictive scoring systems such as LRINEC can provide reference for clinicians. Early and decisive surgical debridement and empirical application of broad-spectrum antibiotics can greatly improve the prognosis of patients.

Due to multi-disciplinary cooperation, the improvement of medical level and postoperative nursing level, the survival rate of FG has been continuously improved. But multiple debridement often leads to large-area skin defects, therefore clinical workers still need to continue to explore better diagnosis, treatment and nursing modes of FG. Multidisciplinary collaborative diagnosis and treatment is very important in the management of FG. At present, there is a diagnosis and treatment mode dominated by department of burn plastic surgery, which can fully evaluate the damaged skin area before operation to determine the operation mode, and determine the reconstruction mode after debridement, which can improve the prognosis and quality of life of patients.

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Disclosure

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