Review Article

DOI: 10.7860/JCDR/2026/80885.23241

Modern Perspectives on Fournier's Gangrene: A Narrative Review of Surgical Advances, and Adjunctive Therapies

Surgery Section

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ABSTRACT

Fournier's Gangrene (FG) is a rare but rapidly progressive necrotising fasciitis of the perineal, genital, and perianal areas, more commonly occurring in older males with comorbidities such as diabetes mellitus and immunosuppression. This narrative review aims to define variations in the clinical presentation of FG, given its broader impact, and to highlight unresolved diagnostic challenges due to its non-specific initial presentation and specific atypical presentations in females. Aetiopathogenesis involves polymicrobial aerobic and anaerobic organisms synergistically infiltrating along fascial planes. Emerging literature notes a rare association between FG and Sodium-Glucose Co-Transporter 2 (SGLT2) inhibitors. A definitive treatment remains urgent surgical intervention for debridement, broad-spectrum intravenous antibiotics, and intensive supportive care. There are advanced therapies that may improve patient outcomes, such as Vacuum-Assisted Closure (VAC), Hyperbaric Oxygen Therapy (HBOT), negative-pressure wound therapy, and novel options in reconstructive surgery. These include reconstruction using gracilis muscle flaps or super-thin Anterolateral Thigh (ALT) flaps to improve functional and aesthetic results. This narrative review shows the importance of heightened clinical suspicion, particularly in the more aggressive form of necrotising fasciitis, the need for multidisciplinary care, and the incorporation of techniques in surgical practice and adjunctive therapy that may improve surgical outcomes for patients with FG.

Keywords: Adjunctive therapy, Debridement, Hyperbaric oxygen, Necrotising fasciitis, Reconstruction

INTRODUCTION

Fournier's Gangrene (FG) is an uncommon, rapidly progressive necrotising fasciitis of the perineum, genitalia, or perianal area [1]. It was first described by Jean-Alfred Fournier in 1883 as an idiopathic process primarily affecting young men [2]. FG is now most recognised for affecting men mostly 50 to 60 years of age, and typically with comorbid diseases, such as diabetes mellitus, significant immunosuppression, or steroid use [3,4]. Current epidemiological evidence suggests that the incidence of FG is estimated at 1.6 cases per 100,000 men [5]. In India, FG has a mortality of 11.8% to 26.5% depending on age, diabetes and delayed presentation among other co-morbidities [6,7]. Other groups at risk include patients with delayed presentation, multiple comorbidities, and advanced age, who constitute the population most commonly affected by the disease [8,9].

REVIEW

Early and Atypical Clinical Presentations of FG

The early clinical symptoms of FG are subtle and non-specific, which include localised pain, swelling, erythema, and tenderness in the affected area [10]. When the infection progresses to a stage requiring systemic treatment, patients may develop signs of sepsis, such as fever, tachycardia, hypotension, and leucocytosis [11]. The patient's examination might show crepitus if there are subcutaneous gas collections, skin colour changes, necrosis, and discharge with a pungent odour [12,13]. The infection will tend to track and spread rapidly along fascial planes primarily due to the Dartos, Colles and Scarpa's fascia. It can also spread rapidly to adjacent areas and the abdominal wall [14].

FG may present unusually, such as with a small, seemingly benign lump or induration on the genitalia that does not look or feel serious, progressing to advanced necrotising fasciitis if left untreated [15,16]. Another rare feature is the formation of ulcerative lesions in the scrotum or perineum, which may develop before overt signs of infection [17,18]. Clinical features and presentations of FG are described in [Table/Fig-1] [10-18].

Clinical feature	Description	Implication
Early symptoms [10]	Localised pain, swelling, erythema, tenderness	Non-specific and may mimic benign conditions like cellulitis
Misleading early signs [10,15,16]	Resemble cellulitis	Delays in diagnosis
Systemic signs of sepsis [11]	Fever, tachycardia, hypotension, leukocytosis	Indicate progression requiring systemic treatment
Local examination findings [12,13]	Crepitus (gas under skin), skin discolouration, necrosis, foul-smelling discharge	Suggestive of advanced infection
Spread of infection [14]	Tracks along Dartos, Colles' and Scarpa's fascia; may involve adjacent and abdominal regions	Rapid disease progression
Systemic complications [11]	Systemic toxicity, septic shock, multi-organ failure	Poor prognosis if not treated promptly
Atypical presentations [15,16]	Small, benign-looking lump or induration on genitalia	May mislead clinicians; allows unchecked progression
Sex-based diagnostic oversight [15,16]	Uncommon in women; may be misdiagnosed	Diagnostic delays in female patients
Ulcerative lesions [17,18]	Rare ulceration of scrotum/perineum prior to overt infection	Can mimic other skin conditions

[Table/Fig-1]: Clinical features and presentations of Fournier's Gangrene (FG) [10-18].

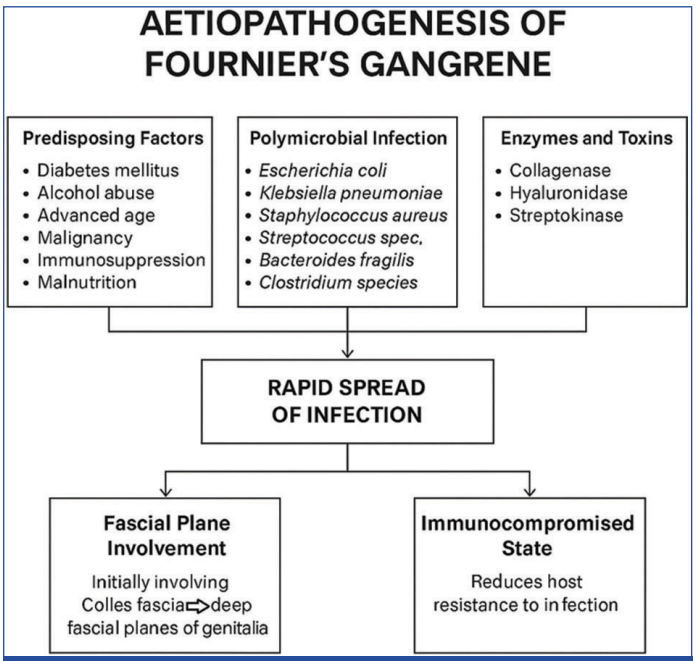
Aetiopathogenesis of Fournier's Gangrene (FG) and Microbial and Host Risk Factors

Many organisms, including aerobes and anaerobes, are involved in typical FG cases. In FG, common bacteria are Escherichia coli, Klebsiella pneumoniae, Staphylococcus aureus, Streptococcus species, Bacteroides fragilis and Clostridium species [19,20]. These pathogens produce tissue-degrading enzymes such as collagenase and hyaluronidase, as well as fibrinolytic agents

such as streptokinase, which collectively facilitate rapid spread of infection and significant damage to surrounding tissues [21]. Cases of FG are often reported to originate from anorectal, urogenital, or cutaneous sources [22]. Overall, sources of the FG include 30-50% colorectal sources, 20-40% urogenital sources, and 20% cutaneous infections [23].

Aerobic bacteria induce platelet aggregation and complement fixation, amplifying coagulation [24]. Anaerobic bacteria promote microvascular thrombosis through the action of collagenase and heparinase [24]. Other bacteria, such as Bacteroides, will coat aerobic bacteria and inhibit phagocytosis. This promotes further spread of infection along fascial planes, with potential rupture of fascial barriers. Concurrent thrombosis reduces vascular supply, facilitating disease progression [25,26].

The infection in FG initially involves the superficial (Colles' fascia) and deep fascial planes of the genitalia [27]. It can then extend to the overlying skin, sparing the muscles [27]. Infection of the Colles' fascia may spread to the penis and scrotum via Buck's and Dartos fascia, or to the anterior abdominal wall via Scarpa's fascia. Fascial planes connect these areas, and reduced vascular flow resulting from thrombosis allows the disease to spread [28,29]. FG is more likely to occur when host immunity is weakened by diabetes mellitus, which is found in about 20% to 70% of patients with FG [3,10]. Other risk factors include alcohol overindulgence, extremes in age, malignancy, chronic steroid use, cytotoxic drugs, lymphoproliferative disease, malnutrition, and Human Immunodeficiency Virus (HIV) infection [30,31]. These factors contribute to making the host less likely to resist infections and help microorganisms get into the perineal area [30]. The aetiopathogenesis and associated predisposing factors for FG are depicted through [Table/Fig-2].



[Table/Fig-2]: Aetiopathogenesis and associated predisposing factors for Fournier's Gangrene (FG).

SGLT2 Inhibitors and the Rare Risk of Fournier's Gangrene (FG)

The risk of FG has been linked in some cases to SGLT2 inhibitors, which are prescribed for the management of type 2 diabetes mellitus [32]. When SGLT2 inhibitors are used, glucose excretion in the urine increases, helping reduce blood glucose levels [32]. Increased urine glucose concentration in the overall urinary tract supports microbial growth in the urinary/genital tract [33].

Association between SGLT2 inhibitors and the risk of FG are described in [Table/Fig-3] [32-34].

Aspect	Details
Medication class	Sodium-Glucose Co-Transporter 2 (SGLT2) inhibitors [32].
Indication	Type 2 Diabetes Mellitus (T2DM) [32]
Mechanism of action	Increases urinary glucose excretion → lowers blood glucose levels [32]
Potential risk	Rare risk of Fournier's Gangrene (FG) [32]
Contributing factors	- Elevated glucose concentration in urine - Favours microbial growth in the urinary/genital tract [33]
Additional risk factors	- Obesity - Poor glycaemic control - Immunosuppression [33]
Pathophysiology	Not fully understood, but increased urinary glucose may create an environment conducive to infection [33]
Incidence	Very low; FG is a rare adverse event among SGLT2 inhibitor users [34]
Clinical red flags	- Genital/perineal pain - Swelling - Redness [33,34]
Recommended action	Discontinue SGLT2 inhibitors immediately if FG is suspected [33,34]
Management of FG	- Prompt surgical debridement - Broad-spectrum antibiotics - Supportive care [32]
Clinical consideration	Despite this rare risk, benefits of SGLT2 inhibitors in managing diabetes, cardiovascular, and renal conditions are well-established [32,34]

[Table/Fig-3]: Association between SGLT2 inhibitors and the risk of Fournier's Gangrene (FG) [32-34].

Medication-Associated Mechanisms Leading to Fournier's Gangrene (FG)

Commonly used SGLT2 inhibitors include canagliflozin, dapagliflozin, and empagliflozin, which reduce blood glucose levels by blocking their reabsorption in the proximal convoluted tubule, stimulating urine glucose excretion [35]. It shows oral bioavailability of about 65%, with peak plasma concentrations reached in 30-120 minutes, and is hepatically metabolised, with excretion in the urine and faeces [35]. In addition to the antihyperglycaemic effect, canagliflozin alters fluid and electrolyte homeostasis, leading to increased natriuresis and glucose excretion, which may cause dehydration and peripheral tissue hypoxia [35]. When combined with a high glucose environment in the urine, these physiological alterations put patients at risk of infection, including urinary tract infections and genital mycotic infections. They may lead to serious diseases, such as FG [35].

Bevacizumab is a humanised monoclonal antibody used in metastatic colorectal cancer that inhibits tumour angiogenesis by blocking vascular endothelial growth factor [36]. Its side effects are gastrointestinal perforation, complications in wound-healing, haemorrhage and arterial thromboembolism [36]. Gamboa EO et al., reported a case of a 67-year-old man who developed FG four months after completing bevacizumab therapy, despite having no other predisposing conditions or concurrent medications, indicating that FG may arise as a rare but serious complication of bevacizumab therapy [36].

Strategies in the Management of Fournier's Gangrene (FG)

Initial stabilisation: Treatment of FG begins with rapid patient identification and stabilisation [37]. Intravenous fluids are required to support haemodynamics and maintain blood pressure and organ perfusion [37]. Timely identification and resuscitation are critical, as delayed intervention is associated with significantly reduced survival [37].

Medical treatment: Broad-spectrum intravenous antibiotics are also started once the patient's condition has been stabilised, to address aerobic and anaerobic pathogens commonly involved in FG [38]. Specific therapy must be adjusted based on culture results

and local patterns of antibiotic resistance [38]. Early administration of appropriate antibiotics reduces the duration of infection and the risk of systemic complications [38].

Surgical Management: Surgery remains the most critical aspect of FG management [39]. Early and aggressive debridement of the necrotic area is essential to control the infection [39]. Repeat debridements are required in cases of extensive tissue involvement to excise the area of devitalised tissue [39]. Advancements such as ultrasound-assisted debridement can be used to selectively remove necrotic tissue while preserving critical structures, including blood vessels and nerves, thereby minimising collateral damage [40]. Ultrasound debridement is particularly beneficial in the perineum, where more surgical debridement techniques pose a greater risk of collateral damage to nearby organs [40].

Adjunctive Therapies: Adjunctive therapies such as Negative Pressure Wound Therapy (NPWT), including VAC systems, and HBOT have been shown to promote wound healing and decrease hospital length of stay [39,41]. Faecal diversion techniques, such as Flexi-Seal devices, have been used to prevent wound contamination, thereby making a colostomy unnecessary [42].

Reconstructive Strategies: If the infection is under control, surgeons might use skin grafts or local flaps to improve the patient's appearance and restore function as part of the reconstructive surgical approach [43]. Alternatively, new technologies and procedures, such as the creation of an inguinal pouch to preserve the testicle, are now utilised to provide a feasible alternative to exposing the gonads, which also offers a valid psychological option related to FG [44,45].

Novel Reconstructive Strategies for Sphincter and Scrotal Restoration in Fournier's Gangrene (FG): Another significant surgical development is the use of a double-opposing gracilis muscle flap with a "camera shutter" effect for the reconstruction of the dynamic anal sphincter [46]. When FG affects the anal sphincter, this technique uses two gracilis muscles on each side of the sphincter, arranged to reflect the natural sphincter, so that the patient may voluntarily control dynamics without electrostimulation or extensive microsurgery [46]. Patients who undergo this reconstruction can regain continence after biofeedback training and are not left with permanent colostomies, thus significantly improving their quality of life [46].

The use of super-thin pedicled ALT flaps treatment has become a possible new technique for total scrotal reconstruction [47,48]. The technique involves harvesting a thin, pliable flap with exceptionally reliable vascularity, which can be carefully thinned and shaped to mimic the scrotum's natural anatomy [48]. The super-thin ALT flap improves both function and aesthetic outcome, with satisfactory coverage and aesthetics [47]. Surgical and adjunctive management strategies in FG are described in [Table/Fig-4].

Emerging Adjunctive Therapies in Management of Fournier's Gangrene (FG): Innovative adjunctive therapies have afforded opportunities in the management of FG [49]. HBOT has been studied extensively and may improve oxygenation, encourage neovascularisation (angiogenesis), and have bactericidal effects, especially against anaerobic organisms [50]. Patients treated with HBOT, in addition to regular care, had significantly lower rates of mortality compared to patients who received standard care without HBOT [50]. HBOT also had a significant association with improved healing and less extensive debridement [49].

NPWT has been another adjunctive therapy that shows value in FG treatment [51]. NPWT promotes wound healing by removing excess exudate, stimulating granulation tissue formation, and inhibiting bacterial proliferation [51]. When combined with HBOT, the two adjunctive therapies can work synergistically, leading to improved healing outcomes and possibly shorter hospital time [52]. These treatment options can significantly improve the management approach for these patients, their everyday lives, and their treatment outcomes [52].

Approach	Description	Clinical benefits
Initial management	Early surgical debridement, i.v. broad-spectrum antibiotics, and fluid resuscitation	Reduces mortality; prevents progression
Multidisciplinary team approach	Collaboration among urologists, general surgeons, infectious disease and critical care specialists	Enhances decision-making and outcomes
Repeated debridement	Performed when extensive tissue involvement is present	Ensures complete removal of necrotic tissue
Vacuum-Assisted Closure (VAC) therapy	Application of Negative Pressure Wound Therapy (NPWT)	Promotes wound healing, reduces oedema, decreases hospital stay
Faecal diversion devices (e.g., Flexi-Seal)	Prevents faecal contamination of perineal wounds	May eliminate need for colostomy
Skin grafts and local flaps	Used post-infection control for reconstructive purposes	Improves function and appearance
Ultrasound debridement	Precise removal of necrotic tissue while preserving vital structures (e.g., vessels, nerves)	Reduces collateral damage, especially in sensitive areas like the perineum
Inguinal pouch for testicle preservation	Surgical relocation of testes into inguinal pouch	Avoids external exposure, improves psychological outcomes
Double-opposing gracilis flap ("camera shutter")	Reconstruction of dynamic anal sphincter using gracilis muscles	Restores voluntary continence; avoids permanent colostomy
Super-thin ALT flap	Anterolateral Thigh (ALT) flap harvested and shaped for scrotal reconstruction	High vascularity, good anatomical mimicry, satisfactory aesthetic and functional outcomes

[Table/Fig-4]: Surgical and adjunctive management strategies in Fournier's Gangrene (FG).

Optimal management of FG requires a multidisciplinary team comprising urologists, general surgeons, infectious disease specialists, and critical care physicians [53]. Urologists deal with involvement of the genitourinary system, such as reconstruction of the scrotum and penis, and urinary diversion in case of necessity [53]. General surgeons offer extensive necrotic tissue debridement and deal with perineal or abdominal involvement [53]. Specialists in infectious diseases direct the appropriate use of broad-spectrum and culture-directed antibiotic therapy, whereas critical care physicians manage haemodynamic stabilisation, organ support, and sepsis treatment [53].

CONCLUSION(S)

FG remains an acute life-threatening surgical emergency with a fulminant course, high morbidity, and high mortality. Early diagnosis, early surgical intervention, and early administration of broad-spectrum antibiotics are the pillars of management. Although more recent advances in reconstructive surgery and adjunct therapies (such as HBOT and negative-pressure wound therapy) have improved outcomes and reduced hospital stays, a multidisciplinary team approach involving surgeons, intensivists, and infectious disease experts remains necessary for optimal treatment.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: May 26, 2025
- Manual Googling: Nov 17, 2025
- iThenticate Software: Nov 21, 2025 (1%)

ETYMOLOGY: Author Origin

EMENDATIONS: 6

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **May 25, 2025**
Date of Peer Review: **Sep 20, 2025**
Date of Acceptance: **Nov 25, 2025**
Date of Publishing: **May 01, 2026**