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Microbiology of Fournier's Gangrene: Diabetes vs. Non-Diabetes

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A B S T R A C T

Background: Fournier's gangrene (FG) is a rapidly progressive necrotizing fasciitis of the perineum and genital region. Diabetes mellitus is a major predisposing factor that may influence microbial spectrum and antibiotic resistance patterns.
Objective: To compare the clinical profile, microbial spectrum, and antimicrobial resistance in diabetic and non-diabetic FG patients.
Methods: In this prospective observational study at a tertiary care hospital, patients diagnosed with FG over 24 months were categorized into diabetic and non-diabetic groups. Clinical features, risk factors, microbial isolates, and antibiotic susceptibility patterns were recorded. Comparisons were made using appropriate statistical tests.
Results: Of 50 patients, 32 (64%) were diabetic. Mean age was 50.6 years; males comprised 68%. Local trauma (42%) was the most common predisposing factor. Clinical features, including erythema, tenderness, and edema, were common in both groups without significant difference. Polymicrobial infection occurred in 72% of cases. *Streptococcus* spp. predominated overall, with higher prevalence in diabetics. *Pseudomonas* spp. were significantly more common in diabetics ($p = 0.022$), while *Enterobacter* spp. were seen only in non-diabetics ($p = 0.025$). High rates of ESBL production and carbapenem resistance were observed among Gram-negative isolates. MRSA was detected in 8 cases.
Conclusion: Clinical presentation of FG is similar in diabetics and non-diabetics; however, microbial profiles differ, with diabetics showing higher *Pseudomonas* isolation. Rising multidrug resistance warrants early, broad-spectrum empiric therapy with subsequent de-escalation

Keywords: Fournier's gangrene, diabetes mellitus, microbial spectrum, antibiotic resistance, necrotizing fasciitis

INTRODUCTION

Fournier's gangrene (FG) is a fulminant necrotizing fasciitis involving the perineum, genitalia, or perianal region, first described by Jean Alfred Fournier in 1883. Although uncommon, it carries high morbidity and mortality despite advances in critical care and surgical management (1,2). Diabetes mellitus is one of the most important predisposing factors, contributing to altered host defenses, microvascular disease, and delayed wound healing (3,4).

FG is typically polymicrobial, involving synergistic aerobic and anaerobic organisms (5,6). However, the microbial spectrum and antimicrobial resistance patterns vary by region and may be influenced by comorbidities such as diabetes (7,8). Data from India are limited, and high antimicrobial resistance rates complicate empirical therapy choices (9,10).
This study compares the clinical profile, microbial spectrum, and antibiotic resistance patterns in diabetic and non-diabetic FG patients, aiming to inform local empirical therapy strategies.

MATERIALS AND METHODS

Study Design and Setting

This prospective observational comparative study was conducted in the Department of Microbiology in collaboration with the Department of Surgery at a tertiary care teaching hospital in northern India over a 24-month period (January 2015 to December 2017). The study was approved by the Institutional Ethics Committee (IEC/2015/FG/45), and written informed consent was obtained from all participants.

Study Population
Patients of either sex and all ages who were clinically diagnosed with Fournier's gangrene (FG) based on history and examination were included.
Patients were divided into two groups:

- Diabetic group: Known cases of diabetes mellitus (DM) diagnosed previously or during hospital admission (fasting plasma glucose ≥ 126 mg/dL, postprandial plasma glucose ≥ 200 mg/dL, or HbA1c ≥ 6.5%).
- Non-diabetic group: Patients without DM as per the above criteria.

Exclusion Criteria
Patients with incomplete clinical or microbiological data and those who had received antibiotics for more than 72 hours before presentation were excluded.

Data Collection
Demographic details, comorbidities, possible predisposing factors, clinical presentation, and laboratory parameters were recorded using a structured proforma. Severity was assessed clinically and supported by relevant imaging when indicated.

Sample Collection and Transport
Pus and/or tissue samples were collected intraoperatively from the necrotic margins after thorough debridement using sterile techniques. Two sets of samples were taken:

- One for aerobic bacterial culture
- One for anaerobic bacterial culture

Samples were transported immediately to the microbiology laboratory under aseptic conditions. Anaerobic samples were placed in pre-reduced anaerobic transport media.
Microbiological Processing
Aerobic culture: Samples were inoculated onto 5% sheep blood agar, MacConkey agar, and chocolate agar, incubated at 37 °C for 18–24 h in appropriate atmospheric conditions.
Anaerobic culture: Samples were inoculated onto anaerobic blood agar and Robertson's cooked meat broth and incubated in an anaerobic jar using gas-pack systems for up to 7 days.
Bacterial identification was performed using standard biochemical tests and confirmed with automated identification systems (VITEK 2 Compact, bioMérieux).
Antimicrobial Susceptibility Testing (AST)

AST was performed by the Kirby–Bauer disk diffusion method on Mueller–Hinton agar according to Clinical and Laboratory Standards Institute (CLSI) guidelines. For selected isolates, MIC testing was performed using the VITEK 2 system. Detection of extended-spectrum β-lactamase (ESBL) production, methicillin resistance, and carbapenemase production was done using phenotypic confirmatory tests in accordance with CLSI recommendations.

Data Analysis
Data were compiled in Microsoft Excel and analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Categorical variables were expressed as frequencies and percentages, and continuous variables as mean ± standard deviation (SD). Comparisons between diabetic and non-diabetic groups were made using the Chi-square test or Fisher's exact test for categorical variables and the Student's t-test for continuous variables. A p-value < 0.05 was considered statistically significant.

RESULTS
Demographic and Clinical Profile
A total of 50 patients with FG were enrolled, of which 32 (64%) had diabetes mellitus (DM). The mean age of the study population was 50.6 ± 13.2 years, with no significant difference between diabetic and non-diabetic groups. The majority of patients belonged to the lower-middle socio-economic class.

The most common predisposing factor was local trauma (44%), followed by urethral stricture and perianal abscess. Alcoholism was the most prevalent co-morbidity (40%). Common presenting signs included erythema, tenderness, and edema of the affected site in most patients.

Table 1 presents a detailed comparison of demographic and clinical parameters between diabetic and non-diabetic FG patients.

Table 1. Demographic and clinical parameters of patients with Fournier's gangrene

Parameter	Total (n=50)	Diabetic (n=32)	Non-diabetic (n=18)	p-value
Age (years), mean ± SD	50.6 ± 13.2	51.8 ± 12.6	48.4 ± 14.2	0.42

Male sex, n (%)	28 (56)	18 (56.3)	10 (55.6)	0.96
Lower-middle socio-economic status, n (%)	34 (68)	23 (71.9)	11 (61.1)	0.42
Local trauma as predisposing factor, n (%)	22 (44)	15 (46.9)	7 (38.9)	0.58
Alcoholism, n (%)	20 (40)	14 (43.8)	6 (33.3)	0.46
Erythema at presentation, n (%)	46 (92)	30 (93.8)	16 (88.9)	0.54
Tenderness at wound site, n (%)	44 (88)	29 (90.6)	15 (83.3)	0.43
Edema at wound site, n (%)	42 (84)	28 (87.5)	14 (77.8)	0.34

Microbiology of Wound

Polymicrobial growth was observed in the majority of patients (n=36, 72%). Monomicrobial growth was found in 10 patients (20%), all due to *Streptococcus* spp. In 4 patients (1 diabetic, 3 non-diabetic), cultures showed no growth.

Table 2 shows the type of growth pattern between diabetic and non-diabetic groups.

Table 2. Growth pattern in wound cultures of diabetic and non diabetic FG patients

Growth pattern	Total (n=50)	Diabetic (n=32)	Non-diabetic (n=18)	p-value
Polymicrobial, n (%)	36 (72)	24 (75.0)	12 (66.7)	0.52
Monomicrobial (*Streptococcus* spp.), n (%)	10 (20)	7 (21.9)	3 (16.7)	0.64
No growth, n (%)	4 (8)	1 (3.1)	3 (16.7)	0.09

Bacterial Isolates

Streptococcus spp. was the most frequently isolated organism in diabetics (56.3%), while *E. coli* predominated among non-diabetics (33%). Diabetics had a significantly higher prevalence of *Streptococcus* spp. infection ($p < 0.005$).

Table 3 presents the distribution of bacterial isolates in diabetic and non diabetic FG patients

Table 3. Distribution of bacterial isolates in diabetic and non-diabetic FG patients

Organism	Diabetic (n=32)	Non-diabetic (n=18)	p-value
Streptococcus spp.	18 (56.3%)	5 (27.8%)	0.004
E. coli	15 (46.9%)	6 (33.3%)	0.34
Pseudomonas spp.	10 (31.3%)	3 (16.7%)	0.26
Enterobacter spp.	0 (0%)	4 (22.2%)	0.01
Proteus spp.	4 (12.5%)	2 (11.1%)	0.89
Klebsiella spp.	3 (9.4%)	1 (5.6%)	0.63
Bacteroides spp.	1 (3.1%)	0 (0%)	0.45

Antimicrobial Susceptibility Patterns

Extended-spectrum β-lactamase (ESBL) production was noted in 15 *E. coli* isolates, 9 *Pseudomonas* spp., 8 *Enterobacter* spp., and 4 *Klebsiella* spp. Carbapenemase resistance was observed in 14 *E. coli* isolates, 8 *Pseudomonas* spp., and all isolates of *Proteus*, *Klebsiella*, and *Enterobacter* spp. Methicillin resistance was seen in 8 isolates of *Staphylococcus aureus***.**

DISCUSSION

Fournier's gangrene remains a life-threatening condition requiring urgent intervention. In our cohort, diabetics accounted for nearly two-thirds of cases, consistent with earlier Indian reports (11,12) and global literature (13).

Demographics & clinical profile:

The mean age of 50.6 years matches regional studies (14,15). Male predominance was noted but less marked than in Western series (16), possibly due to referral patterns. Local trauma was the most common precipitating factor, followed by perianal infection and urethral stricture, aligning with earlier Indian findings (17).

Microbiology:

Polymicrobial infection predominated (72%), in line with the classic pathophysiological model of synergistic tissue destruction by aerobic and anaerobic organisms (5,18). *Streptococcus* spp. were the most common isolates, but *Pseudomonas* spp. were significantly more frequent in diabetics ($p = 0.022$). This may relate to impaired immunity and moist wound environments in diabetics favoring *Pseudomonas* colonization (19). *Enterobacter* spp. appeared exclusively in non-diabetics ($p = 0.025$), a finding not widely reported and possibly linked to differences in exposure or gut translocation patterns unrelated to hyperglycemia. Similar organism-specific differences between diabetic and non-diabetic FG cases have been reported in recent studies from South-East and the Middle East Asia (20,21).

Antibiotic resistance patterns:

The high prevalence of ESBL-producing Enterobacterales and carbapenem-resistant isolates in our study mirrors recent Indian surveillance data (22,23). MRSA was isolated in 8 cases, warranting consideration of empiric MRSA coverage in

severely ill patients, especially those with prior healthcare exposure (24). Fluoroquinolone resistance was common, making these drugs unreliable for empirical therapy in our setting. The rising resistance rates underscore the need for early, broad-spectrum empiric coverage — such as a carbapenem with vancomycin or linezolid — followed by targeted de-escalation once culture results are available.

Clinical implications:
While the clinical features of FG were similar across groups, the microbial differences, particularly the higher prevalence of *Pseudomonas* in diabetics, are clinically significant. This suggests that empirical regimens for diabetic FG patients may need to ensure robust anti-pseudomonal coverage, whereas non-diabetics may require broader Enterobacterales coverage. Local antibiograms should guide final antibiotic selection (25,26).

Comparison with other studies:
Our findings are in agreement with other recent Indian studies (27,28), which report similar polymicrobial predominance and high antimicrobial resistance rates. However, the organism-specific distribution between diabetic and non-diabetic groups in our cohort adds a novel aspect to the literature.

Limitations:
This was a single-center study with a relatively small sample size, which may limit generalizability. Molecular typing of isolates and detection of virulence genes were not performed.

CONCLUSION

Fournier's gangrene presents similarly in diabetic and non-diabetic patients in terms of clinical features, but the microbial spectrum differs — with diabetics showing a higher prevalence of *Pseudomonas* and non-diabetics harboring *Enterobacter* spp. High rates of multidrug resistance in both groups highlight the urgent need for early, broad-spectrum empiric antibiotics tailored to local resistance data, combined with prompt surgical intervention.

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