

RESEARCH ARTICLE

Impact of a Major Earthquake on the Clinical Severity and Outcomes of Fournier's Gangrene: A Retrospective Comparative Study

Büyük Bir Depremın Fournier Gangreninin Klinik Şiddeti ve Sonuçları Üzerindeki Etkisi: Retrospektif Karşılaştırmalı Bir Çalışma

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ABSTRACT

Objective: Fournier's gangrene (FG) is a rare but life-threatening necrotizing soft tissue infection requiring early diagnosis and aggressive intervention. Natural disasters, such as earthquakes, can disrupt healthcare services, potentially delaying diagnosis and affecting outcomes. This study aimed to evaluate the clinical presentation, laboratory parameters, and treatment outcomes of FG patients before and after the Kahramanmaraş-centered earthquake that occurred on February 6, 2023.

Material and Method: This study included 45 patients diagnosed and treated for FG between January 1, 2015, and December 31, 2023. Patients were divided into pre-earthquake (n=26) and post-earthquake (n=19) groups. Demographic characteristics, clinical findings, laboratory results, microbiological cultures, and mortality rates were compared between the groups.

Results: The demographic characteristics and comorbidities of the patients were similar between the two groups. Post-earthquake patients presented with significantly higher white blood cell counts (p=0.002) and creatinine levels (p<0.001), as well as more frequent local fever (p=0.043). Although FGSİ scores did not significantly differ, the need for additional surgical intervention (p=0.021) and in-hospital mortality rate (p=0.029) were significantly higher in the post-earthquake group. The odds ratio for mortality after the earthquake was calculated as 8.929 (95% CI: 0.946–84.248). Culture positivity was also significantly higher post-earthquake (p=0.002), with *Escherichia coli* being the most commonly isolated microorganism.

Conclusion: The findings suggest that natural disasters may contribute to delayed diagnosis and more severe presentations of FG, leading to increased surgical complexity and higher mortality. In disaster-prone regions, early access to care and infection control measures are essential for reducing FG-related morbidity and mortality.

Keywords: Fournier's Gangrene, Earthquake, Mortality, Sepsis, Surgical Debridement.

ÖZET

Amaç: Fournier gangreni (FG), erken tanı ve agresif müdahale gerektiren nadir ancak yaşamı tehdit eden nekrotizan yumuşak doku enfeksiyonudur. Deprem gibi doğal afetler sağlık hizmetlerini aksatabilir, tanıyı geciktirebilir ve hasta sonuçlarını etkileyebilir. Bu çalışma, 6 Şubat 2023'te meydana gelen Kahramanmaraş merkezli depremden önce ve sonra FG hastalarının klinik sunumunu, laboratuvar parametrelerini ve tedavi sonuçlarını değerlendirmeyi amaçlamıştır.

Gereç ve Yöntem: Bu çalışmaya 1 Ocak 2015 ile 31 Aralık 2023 arasında FG tanısı konulan ve tedavi edilen 45 hasta dahil edildi. Hastalar deprem öncesi (n =26) ve deprem sonrası (n =19) gruplara ayrıldı. Gruplar arasında demografik özellikler, klinik bulgular, laboratuvar sonuçları, mikrobiyolojik kültürler ve ölüm oranları karşılaştırıldı.

Bulgular: Hastaların demografik özellikleri ve eşlik eden hastalıkları iki grup arasında benzerdi. Deprem sonrası hastalarda belirgin olarak daha yüksek beyaz kan hücresi sayısı (p =0,002) ve kreatinin düzeyleri (p <0,001) ve daha sık lokal ateş (p =0,043) görüldü. FGSI skorları belirgin olarak farklı olmasa da ek cerrahi müdahale ihtiyacı (p =0,021) ve hastane içi ölüm oranı (p =0,029) deprem sonrası grupta belirgin olarak daha yüksekti. Deprem sonrası ölüm oranı için olasılık oranı 8,929 olarak hesaplandı (%95 CI: 0,946–84,248). Kültür pozitifliği de deprem sonrası belirgin olarak daha yüksekti (p =0,002), *Escherichia coli* en sık izole edilen mikroorganizmaydı.

Sonuç: Bulgular doğal afetlerin FG'nin gecikmiş tanısına ve daha şiddetli sunumlarına katkıda bulunabileceğini, bunun da cerrahi karmaşıklığın artmasına ve daha yüksek ölüm oranına yol açabileceğini düşündürmektedir. Afetlere eğilimli bölgelerde, FG ile ilişkili morbidite ve mortaliteyi azaltmak için bakıma erken erişim ve hızlı enfeksiyon kontrol önlemleri esastır.

Anahtar Sözcükler: Fournier Gangreni, Deprem, Mortalite, Sepsis, Cerrahi Debridman.

Fournier's gangrene (FG) is a rapidly progressive and potentially fatal necrotizing soft tissue infection that primarily involves the perineal, genital, and perianal regions. Although it can affect both sexes, it occurs more frequently in men, with an estimated incidence of 1.6 to 3 cases per 100,000 population annually (1). First described by Jean-Alfred Fournier in 1883, FG is strongly associated with underlying comorbidities such as diabetes mellitus, obesity, hypertension, and immunosuppression (2, 3). Timely diagnosis, broad-spectrum antibiotic therapy, and prompt surgical debridement represent the cornerstone of FG management (4). Despite these interventions, mortality remains high, typically ranging between 20% and 40% (5). Several clinical and biochemical factors contribute to poor outcomes, including the extent of tissue involvement, presence of comorbid conditions, deranged laboratory values, and the severity of systemic inflammatory response (6, 7).

In recent years, major natural disasters-especially earthquakes-have been recognized for their potential to exacerbate the burden of infectious diseases (8). These events can disrupt hygiene, delay access to healthcare services, and interfere with the management of chronic illnesses, ultimately leading to more severe infections (9). However, data on the clinical characteristics of FG in the aftermath of natural disasters remain scarce.

This study aims to evaluate the clinical and laboratory features, treatment approaches, and mortality outcomes of patients diagnosed with FG following the devastating Kahramanmaraş-centered earthquake on February 6, 2023. The findings are discussed in the context of existing literature to better understand the implications of disaster-related healthcare disruption on FG outcomes.

MATERIAL AND METHOD

Ethical Considerations

This study was conducted at the Urology Department of İnönü University Turgut Ozal Medical Center and received approval from the İnönü University Non-Interventional Clinical Research Ethics Committee (Approval No: 2023/5161). Due to the retrospective and observational design of the study, individual written informed consent was not required. Patient data were processed in accordance with confidentiality principles and in full compliance with the Declaration of Helsinki.

Study Design

In this retrospective cohort study, medical records of patients diagnosed with Fournier's gangrene between January 1, 2015, and December 31, 2023, were reviewed. A total of 45 patients with confirmed diagnoses based on clinical, radiological, or histopathological findings were included. Patients with incomplete data, those treated at other medical centers, and those with Fournier's gangrene secondary to direct trauma sustained during the earthquake were excluded.

The diagnosis of Fournier's gangrene was confirmed through retrospective analysis of patient charts and computed tomography (CT) imaging. FG was defined as a polymicrobial necrotizing fasciitis affecting the genital, perineal, or perianal regions (Figur 1).

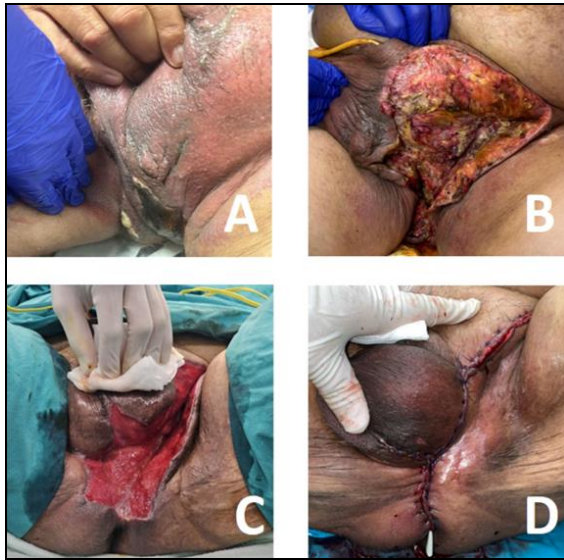


Figure 1. Progression of Fournier's gangrene and surgical management in a patient.

Diagnostic confirmation was based on the presence of severe pain, erythema, edema, and crepitus in the affected regions, as well as CT findings such as subcutaneous emphysema, fascial thickening, and fluid collections.

Additional surgical intervention was defined as the need for one or more unplanned surgical procedures following the initial debridement, including repeated debridement sessions and/or reconstructive procedures. Multidisciplinary consultations alone were not considered additional surgical interventions unless they resulted in a surgical procedure.

The Fournier's Gangrene Severity Index (FGSI) was calculated using clinical and laboratory parameters, and a score of ≥ 9 was classified as high-risk. This threshold has been widely accepted in the literature as a predictor of poor prognosis. In our study, this classification was used to stratify patients according to disease severity and potential clinical outcomes.

Data Collection

Patient data were retrospectively retrieved from the hospital information management system. The collected data were categorized into the following groups:

- **Patient characteristics:** age, sex, smoking status, presence of diabetes mellitus, hypertension, malignancy, and asthma/COPD.
- **Clinical findings:** presence of swelling, pain, erythema, purulent discharge, and localized fever at admission.
- **Laboratory parameters:** white blood cell count (WBC), C-reactive protein (CRP), hematocrit, pH, lactate, aspartate aminotransferase (AST), alanine aminotransferase (ALT), gamma-glutamyl transaminase (GGT), creatinine, and albumin levels.
- **Clinical scores:** FGSI score, infection severity indicator

- **Treatment and outcomes:** duration of hospitalization, intensive care unit (ICU) stay, need for additional surgical intervention, and in-hospital mortality.

- **Microbiological data:** culture results, isolated pathogens, and presence of multidrug-resistant (MDR) bacterial infections.

Statistical Analysis

Continuous variables were presented as mean $\pm$ standard deviation (SD), and categorical variables were expressed as frequency and percentage (%). The distribution of continuous variables was evaluated using the Kolmogorov-Smirnov test and visual inspection of histograms. The Student's t-test was used for normally distributed variables, while the Mann-Whitney U test was applied for non-normally distributed data. Categorical variables were compared using the Chi-square test or Fisher's exact test, as appropriate. Due to the relatively small sample size, categorical variables were analyzed using Fisher's exact test.

To identify risk factors associated with in-hospital mortality, univariate and multivariate logistic regression analyses were performed. Multivariate models were adjusted for age, body mass index (BMI), Charlson Comorbidity Index (CCI), and FGSI score. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to estimate risk levels. A p-value of <0.05 was considered statistically significant. All statistical analyses were conducted using IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, NY, USA).

RESULTS

Demographic and Clinical Characteristics

A total of 45 patients diagnosed with Fournier's Gangrene were included, with 26 patients treated before and 19 after the earthquake (Figure 2).

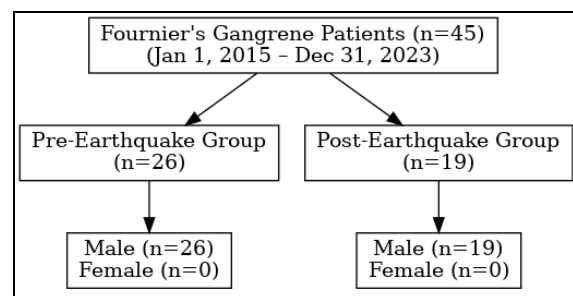


Figure 2. Patient distribution by earthquake period and gender.

The mean age was 64.38 ± 16.11 years in the pre-earthquake group and 61.84 ± 13.64 years in the post-earthquake group, with no significant difference ($p = 0.580$).

Comorbidities such as diabetes mellitus, hypertension, malignancy, and asthma/COPD were similarly

distributed between groups ($p > 0.05$ for all). Smoking status also did not differ significantly between

groups ($p = 0.821$) (Table 1).

Table 1. Summarizes the demographic and comorbidity data.

Variable	Before Earthquake (n =26)	After Earthquake (n =19)	p-value
Age (years)	64.38 ± 16.11	61.84 ± 13.64	0.580
Smoking	11 (42.3%)	7 (36.8%)	0.821
Diabetes Mellitus	14 (53.8%)	8 (42.1%)	0.436
Hypertension	20 (76.9%)	14 (73.7%)	0.496
Malignancy	1 (3.8%)	1 (5.3%)	0.820
Asthma/COPD	0 (0%)	2 (10.5%)	0.091

All patients presented with swelling and pain. No statistically significant differences were found between groups regarding the presence of erythema or purulent discharge ($p = 0.387$ and $p = 0.107$, res-

pectively). However, local fever was significantly more common in the post-earthquake group ($p = 0.043$) (Table 2).

Table 2. Shows the clinical presentation findings.

Clinical Symptom	Before Earthquake (n =26)	After Earthquake (n =19)	p-value
Swelling	26 (100%)	19 (100%)	—
Pain	26 (100%)	19 (100%)	—
Erythema	1 (3.8%)	0 (0%)	0.387
Purulent Discharge	8 (30.8%)	2 (10.5%)	0.107
Local Fever	0 (0%)	5 (26.3%)	0.043

White blood cell (WBC) counts were significantly higher in the post-earthquake group (11.01 ± 6.65 vs. 4.86 ± 5.66 ; $p = 0.002$). Similarly, creatinine levels were markedly elevated in the post-earthquake group (11.68 ± 7.56 $\mu\text{mol/L}$ vs. 118.38 ± 64.15 $\mu\text{mol/L}$; $p < 0.001$).

There were no statistically significant differences between groups regarding CRP, hematocrit, pH, lactate, AST, ALT, GGT, and albumin levels ($p > 0.05$ for all) (Table 3).

Table 3. Presents the laboratory findings.

Laboratory Parameter	Before Earthquake (n =26)	After Earthquake (n =19)	p-value
WBC ($\times 10^3/\mu\text{L}$)	4.86 ± 5.66	11.01 ± 6.65	0.002
CRP (mg/L)	25.01 ± 21.28	22.66 ± 15.51	0.680
Hematocrit (%)	31.00 ± 13.55	30.43 ± 13.65	0.889
Ph	7.49 ± 1.23	6.67 ± 2.16	0.297
Lactate (mmol/L)	1.98 ± 1.81	1.60 ± 1.76	0.650
AST (U/L)	35.52 ± 22.25	27.74 ± 12.61	0.180
ALT (U/L)	36.74 ± 30.65	29.00 ± 15.87	0.326
GGT (U/L)	95.95 ± 101.52	63.43 ± 62.04	0.295
Creatinine ($\mu\text{mol/L}$)	11.68 ± 7.56	118.38 ± 64.15	<0.001
Albumin (g/L)	2.12 ± 0.84	2.39 ± 1.02	0.334

Fournier's Gangrene Severity Index (FGSI)

The mean FGSI score did not differ significantly between the pre- and post-earthquake groups (5.2 ± 1.1 vs. 5.7 ± 1.9 , $p = 0.276$). Based on FGSI stratification, all patients in the pre-earthquake

group were classified as low-risk (FGSI < 9). In contrast, one patient (5.3%) in the post-earthquake group met the criteria for high-risk classification (FGSI ≥ 9) (Table 4).

Table 4. Fournier's Gangrene Severity Index (FGSI).

FGSI Metric	Before Earthquake (n =26)	After Earthquake (n =19)	p-value
Mean FGSI Score	5.2 ± 1.1	5.7 ± 1.9	0.276
Low Risk (FGSI < 9)	26 (100%)	18 (94.7%)	—
High Risk (FGSI ≥ 9)	0 (0%)	1 (5.3%)	—

FGSI: Fournier's Gangrene Severity Index. High-risk classification is defined as FGSI ≥ 9 .

This case suggests that more clinically severe presentations may have occurred in the aftermath of the

disaster, even though overall risk scores remained similar.

Treatment Outcomes

The mean hospital stay was 19.27 ± 8.82 days in the pre-earthquake group and 26.11 ± 29.06 days in the post-earthquake group; this difference was not statistically significant ($p = 0.264$).

The requirement for additional surgical intervention was significantly higher in the post-earthquake group, representing one of the most important findings of the present study ($p = 0.021$). While only two patients required additional surgical interventions in the pre-earthquake period, all of which involved colostomy formation, the number increased

to seven patients in the post-earthquake period. Notably, orchiectomy was required in one patient following the earthquake, whereas the remaining additional interventions consisted of colostomy formation.

Mortality was significantly elevated in the post-earthquake group compared to the pre-earthquake group (26.3% vs. 3.8%, respectively; $p = 0.029$). The odds ratio for mortality in the post-earthquake group was calculated as 8.929 (95% CI: 0.946-4.248) (Table 5).

Table 5. Outlines the clinical outcomes.

Clinical Outcome	Before Earthquake (n =26)	After Earthquake (n =19)	p-value
Hospital Stay (days)	19.27 ± 8.82	26.11 ± 29.06	0.264
Additional Surgery Required	2 (7.7%)	7 (36.8%)	
Colostomy formation	2	6	0.021
Orchiectomy	0	1	
Mortality	1 (3.8%)	5 (26.3%)	0.029

Urine culture positivity was more frequent in the post-earthquake group compared to the pre-earthquake group. Although statistical significance was observed in the initial analysis, this finding

should be interpreted with caution due to the limited sample size. The most commonly isolated microorganism was *Escherichia coli* (Table 6).

Table 6. Summarizes the microbiological culture results.

Culture Results	Before Earthquake (n =26)	After Earthquake (n =19)	p-value
Positive Culture	7 (26.9%)	8 (42.1%)	0.002
Most Common Organism	<i>E. coli</i>	<i>E. coli</i>	—

DISCUSSION

Fournier's gangrene is a septic condition marked by fulminant necrotizing fasciitis of the perineal or genital region. It may develop through three primary mechanisms: infections of the lower urinary tract, infections in and around the rectum, and skin infections caused by bacterial entry following trauma. FG can progress rapidly, potentially leading to sepsis, multiple organ failure, and death (10). In earthquake-affected regions, the spectrum of pathogens responsible for wound infections may differ from typical settings due to soil contamination (11-14). Given the challenging conditions in disaster-stricken areas, some patients may experience delays in accessing medical care, which in turn can postpone timely intervention. In cases of Fournier's gangrene, delayed diagnosis and treatment are known to contribute significantly to increased morbidity and mortality.

FG is often associated with poor health conditions in low socioeconomic populations, and commonly coexists with diabetes mellitus and alcoholic liver disease, with diabetes being considered the most critical medical comorbidity (15). Additional risk factors include immunosuppression, alcoholism, acquired immunodeficiency, trauma, and genitouri-

nary infections (16). In our study, demographic variables such as age, smoking status, and major comorbidities (diabetes mellitus, hypertension, malignancy, and chronic obstructive pulmonary disease) did not show significant differences between patient groups before and after the earthquake. However, smoking, diabetes mellitus, and hypertension were found to be highly prevalent in both groups, consistent with existing literature, with diabetes mellitus emerging as the most influential factor (17, 18). This association may be linked to diabetic neuropathy and vascular complications, yet maintaining stable blood glucose levels and achieving adequate glycemic control appear to be the most critical factors in influencing disease outcomes.

The diagnosis of Fournier's gangrene is primarily clinical and is often supported by imaging studies. The most common presenting symptoms include pain, swelling, and black discoloration of the affected area (2). In our series, all patients presented with classic FG symptoms such as swelling and pain. Notably, the incidence of localized fever was significantly higher in post-earthquake cases, suggesting a more pronounced systemic inflammatory response and potentially delayed presentation. This observation aligns with previous reports indicating that disruptions following disasters often lead to delayed

access to medical care and worsening severity of infections (19).

Laboratory findings revealed significantly elevated white blood cell (WBC) counts and serum creatinine levels in the post-earthquake group, indicating a more severe systemic infection. Elevated WBC counts have been strongly associated with increased mortality in necrotizing infections (20, 21). Likewise, elevated creatinine levels-reflecting acute kidney injury-are recognized as important prognostic markers (22, 23). In a retrospective series by Liu et al. (23), increased creatinine levels were independently associated with higher mortality in patients with FG. Such laboratory abnormalities, including elevated creatinine, underscore the systemic impact of FG and highlight the potential value of incorporating additional biomarkers to refine risk stratification and improve patient outcomes (24).

The Fournier's Gangrene Severity Index (FGSI), developed by Laor et al. (25) in 1995, has proven useful in predicting prognosis in patients with FG. The index includes parameters such as body temperature, heart rate, respiratory rate, serum potassium and sodium levels, creatinine, bicarbonate, hematocrit, and white blood cell count. A score greater than 9 has been associated with a mortality rate exceeding 75%, whereas patients scoring below 9 have a survival rate of approximately 78% (25). In our study, mean FGSI scores were statistically similar between the pre- and post-earthquake groups; however, one patient in the post-earthquake group was classified as high risk (FGSI ≥ 9), whereas no such cases were observed in the pre-earthquake group. Although this represents an isolated finding, it may reflect an increased clinical burden and potential delays in healthcare access following the earthquake.

Importantly, despite comparable FGSI scores at presentation, patients in the post-earthquake group required significantly more additional surgical interventions. This discrepancy suggests that FGSI alone may not fully capture disease complexity or clinical severity under extraordinary conditions such as natural disasters. Environmental and infrastructural disruptions following large-scale emergencies may contribute to delayed presentation, impaired wound care, and a more complicated disease course that is not adequately reflected by admission-based severity indices. Previous studies have similarly emphasized that such disruptions can result in more advanced or systemic presentations of Fournier's gangrene.

These findings underscore the importance of timely intervention and highlight the need for disaster-resilient healthcare systems, particularly in the management of rapidly progressing infections such as FG. The treatment approach in our cohort included urgent surgical debridement and the administration of broad-spectrum antibiotics tailored to pathogens identified in intraoperative tissue cultures (18, 26).

Despite advances in management strategies, reported mortality rates for FG have generally remained between 15% and 40% (23). In our cohort, mortality was 3.8% in the pre-earthquake group and 26.3% in the post-earthquake group. Although this difference falls within the range reported in the literature, we believe that the observed disparity may be related to earthquake-associated delays and increased treatment complexity. Additionally, while the length of hospital stay was longer in the post-earthquake group, this difference did not reach statistical significance. However, the significantly higher need for additional surgical interventions further supports the notion that delays in diagnosis and treatment during disaster periods can markedly increase morbidity and mortality.

Limitations

This study has several limitations, including its retrospective design and the potential for inaccurate data collection from the earthquake-affected region. Additionally, it was conducted at a single center with a relatively small sample size, which may not fully represent the broader population of earthquake victims. Furthermore, reconstructive procedures were not addressed in this analysis. Future studies with larger sample sizes and longer follow-up periods are needed to validate these findings and to better assess the long-term outcomes of patients affected by the earthquake.

Conclusion

Fournier's gangrene remains a life-threatening surgical emergency that requires prompt recognition and aggressive management. Our study highlights the potential impact of natural disasters on the clinical course and outcomes of FG, with post-earthquake patients demonstrating higher mortality rates and increased need for surgical interventions. Although overall demographic and comorbidity profiles were similar between groups, delays in access to care and more severe systemic involvement may explain the worse outcomes observed in the post-disaster cohort. These findings emphasize the critical importance of maintaining disaster-resilient healthcare systems capable of ensuring timely diagnosis and intervention, particularly for rapidly progressive infections. Further multicenter studies with larger sample sizes and long-term follow-up are warranted to confirm these observations and to guide future preparedness and management strategies for vulnerable populations during crises.

Ethics, Consent to Participate, and Consent to Publish Declarations: This study was approved by the Ethics Committee of Inonu University (Approval No: 5161, Date: 2023). As the study was conducted retrospectively using anonymized patient data, the requirement for informed consent to participate and consent to publish was waived by the ethics committee.

Acknowledgements Publication: The results of the study were not published in full or in part in form of abstracts.

Financial Disclosure: The authors declared that this study received no financial support.

Conflict of Interest: The authors declare no conflicts of interest with any institution and/or persons in this study.

Contribution: There is not any contributors who may not be listed as authors.

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