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The role of hyperbaric oxygen therapy in treating extensive Fournier's gangrene

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ABSTRACT

Background: Fournier's gangrene (FG) is a rapidly progressive necrotizing infection of the perineal and genital fascia. The disease is always associated with high morbidity and mortality if diagnosed late and treated improperly.

Purpose: This paper analyzed the epidemiology of FG, and clarified the treatment strategy of FG of different origins and prognosis.

Methods: From January 2007 to December 2015, 60 patients with FG were treated at the Chi Mei Medical Center (Tainan, Taiwan). Their medical records were reviewed and analyzed.

Results: Sixty patients were identified: 50 (83.33%) men and 10 (16.66%) women who were aged 29–90 years (mean 59.6 ± 14.5 years). The most frequent systemic illness was diabetes mellitus (73.33%). The location of FG was in the anorectal region in 21 (35.00%) patients, urogenital region in 25 (41.66%) patients, and dermatological region in 14 (23.33%) patients. The patients underwent from zero to nine surgical debridements with an average of 3.1 surgical debridements. Septic shock was observed in 25 patients. All 14 patients who expired died of sepsis. The survival rates were better for patients who underwent an early colostomy than for patients who underwent a delayed colostomy [20/21 (95.2%) patients vs. 2/7 (22.2%) patients, respectively; $p < 0.001$]. Patients with septic shock who received hyperbaric oxygen therapy (HBO) had better survival rates than patients who did not have HBO [7/7 (100%) vs. 4/18 (22.22%), respectively; $p = 0.0007$].

Conclusion: Bacteremia and sepsis are major indicators of the mortality rate for FG. The cornerstones of treatment are early diagnosis, aggressive resuscitation, broad-spectrum antibiotic therapy, early colostomy, and prompt and repeated surgical intervention. Adjuvant HBO therapy led to higher survival rates.

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1. Introduction

Fournier's gangrene (FG) is a rare necrotizing fasciitis with rapid progression. It involves the genitals and perineum and is associated with high morbidity and mortality.¹ It often originates in the genitals and quickly spreads from Buck's fascia to subcutaneous tissues such as the scrotum, penis, perineum, and anterior abdominal

fascia.^{1,2} The most common bacteria are Enterobacteriaceae and anaerobic bacteria such as *Bacillus fragilis*. Early clinical symptoms include redness, swelling, heat, and pain, followed by progressive pain, fever, and other symptoms of systemic toxicity (e.g., septic shock).^{1,3}

In 1992, the American College of Chest Physicians/Society of Critical Care Medicine Consensus Conference defined septic shock as severe sepsis plus persistently low blood pressure after the administration of intravenous fluids.⁴ Septic shock can cause organ dysfunction and death.⁵ The literature indicates that the mortality rate of FG is high—up to 14–45%—with higher mortality for the diffuse type than for the local type.⁶ Early colostomy for FG of the

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anorectal region decreases wound infection and reduces the mortality rate.^{7,8} Delayed colostomy is defined as a colostomy that is created 2 days after the first debridement.⁹

Fournier's gangrene usually causes local tissue hypoxia. The infectious agents include aerobic and anaerobic gram-negative bacilli. Hyperbaric oxygen (HBO) therapy has a bactericidal effect on anaerobic infection caused by aerobic or anaerobic bacteria. Hyperbaric oxygen therapy is widely and successfully used to treat mixed infections by improving tissue perfusion, promoting angiogenesis, increasing the oxygen level in tissues, and inhibiting the production of toxins. These factors inhibit the growth of anaerobic bacteria. It has an adjuvant role in the management of severe Fournier's gangrene.¹⁰

2. Materials and methods

2.1. Study objective

The aim of the study was to investigate the epidemiology of FG, effectiveness of treatment, and prognosis. The study provides information on the effectiveness of early diagnosis, aggressive surgical debridement, and adjuvant HBO therapy on FG.

2.2. Methods

This study is a retrospective analysis of 60 patients diagnosed with FG (ICD-9 codes 603.83 for men and 728.86 for women) in Chi Mei Medical Center (Tainan, Taiwan) from January 2007 to December 2012. We analyzed sex, age, comorbidities, clinical symptoms, lab testing results, wound culture data, timing of debridement, antibiotics use, treatment outcome, and prognosis. The study was approved by the Institutional Review Board (IRB) of Chi Mei Medical Center (IRB number, 10203-010). In 1995, Laor and colleagues¹¹ created the Fournier's gangrene severity index (FGSI). It is composed of nine parameters: temperature, heart rate, respiratory rate, serum sodium level, potassium level, creatinine level, bicarbonate level, hematocrit, and leukocyte count. On admission, the nine parameters were scored with values of 0–4, as described in Table 1.

2.3. Statistical analysis

The data were stratified by the outcome of whether the patient died or survived. Continuous data were presented as the mean with standard deviation, and were compared between groups by using the two-sample *t* test. Categorical data were presented by the count and percentage, and were compared by using the Chi-square test or Fisher's exact test, as appropriate. To identify the predictors of

survival, multivariable binary logistic regression analyses were conducted. A difference was statistically significant at $p < 0.05$. Data analyses were performed by using SPSS version 17.0 software (SPSS Inc., Chicago, IL, USA).

3. Results

3.1. Sex and age

Fournier's gangrene affects all ages and primarily men with a male:female ratio of 10:1. The current study had 60 patients, which included 50 men and 10 women. Their age ranged from 29 years to 90 years (mean age, 59.6 ± 14.5 years).

3.2. Clinical symptoms, complications, and laboratory results

Early clinical symptoms include redness, swelling, heat, pain (100%), symptoms similar to cellulitis, and systemic reactions such as high fever (i.e., body temperature $> 38^\circ\text{C}$). Fifty-seven (95%) patients had a comorbidity. The most common comorbid diseases were diabetes mellitus [44 (73.33%) patients], hypertension [25 (41.66%) patients], liver cirrhosis [4 (6.66%) patients], and end-stage renal disease [ESRD; 7 (11.66%) patients].

3.3. The location and extent of injury

The primary origins of injury are summarized in Table 2, as follows: dermatological [14 (23.33%) patients], anorectal [21 (35%) patients], and urogenital [25 (41.66%) patients]. Fournier's gangrene progressed to the groin, lower abdomen, and thigh in 12 patients. Necrotizing fasciitis can occur in any part of the body; however, the limbs, abdominal wall and perineum are the most common sites. Fournier's gangrene is an infection involving the perineal region (Figures 1 and 2).

3.4. Bacteriology

Necrotic tissue or pus obtained from the wound during surgery or at the bedside was sent for microbial culture and antibiotic testing. For each of the 60 patients, the wounds were cultured, and the species were cultured. The most commonly isolated organisms were *Escherichia coli* in 21 patients, *Enterococcus* species in 16 patients, *Viridans streptococcus* in 15 patients, *Klebsiella pneumoniae* in 14 patients, and *Staphylococcus* species in eight patients; *Proteus* species in seven patients; oxacillin-resistant *Staphylococcus aureus* (ORSA) in six patients; and anaerobic bacteria such as *Bacteroides* species in four patients, *Clostridium perfringens* in four patients, *Peptoniphilus* species in four patients, and *Fusobacterium* species in

Table 1
Fournier's gangrene severity index.

Physiological variables	High abnormal values			Normal values			Low abnormal values		
	4+	3+	2+	1+	0	1+	2+	3+	4+
Point assignment									
Body temperature ($^\circ\text{C}$)	>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	—	56–69	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/100 mL)	>3.5	2–3.4	1.5–1.9	—	0.6–1.4	—	<0.6	—	—
Hematocrit (%)	>60	—	50–59.9	46–49.9	30–45.9	—	20–29.9	—	<20
Leukocytes (total/mm ³ × 1000)	>40	—	20–39.9	15–19.9	3–14.9	—	1–2.9	—	<1
Serum bicarbonate	>52	41–51.9	—	32–40.9	22–31.9	—	18–21.9	15–17.9	<15

FGSI = Fournier's gangrene severity index.

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