REVIEW

Fournier's gangrene and its emergency management

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Fournier's gangrene (FG) is a rare but life threatening disease. Although originally thought to be an idiopathic process, FG has been shown to have a predilection for patients with diabetes as well as long term alcohol misuse; however, it can also affect patients with non-obvious immune compromise. The nidus is usually located in the genitourinary tract, lower gastrointestinal tract, or skin. FG is a mixed infection caused by both aerobic and anaerobic bacterial flora. The development and progression of the gangrene is often fulminating and can rapidly cause multiple organ failure and death. Because of potential complications, it is important to diagnose the disease process as early as possible Although antibiotics and aggressive debridement have been broadly accepted as the standard treatment, the death rate remains high.

Fournier's gangrene (FG) is a fulminant form of infective necrotising fascitis of the perineal, genital, or perianal regions, which commonly affects men, but can also occur in women and children.[1] Even though this clinical entity is eponymously credited to the Parisian venerologist Jean-Alfred Fournier, who described it as a fulminant gangrene of the penis and scrotum in young men,[2] Baurienne in 1764 and Avicenna in 1877 had described the same disease earlier.[3] Over the years, many terms have been used to describe this clinical condition including idiopathic gangrene of the scrotum, periurethral phelgmon, streptococcal scrotal gangrene, phagedena, and synergistic necrotising cellulitis.[4 5]

Early surgical debridement of necrotic tissues and antibiotics are fundamental in the treatment of FG. Despite advanced management mortality is still high and averages 20%–30%.[6]

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AETIOLOGY

Initially, FG was defined as an idiopathic entity, but diligent search will show the source of infection in the vast majority of cases, as either perineal and genital skin infections. Anorectal or urogenital and perineal trauma, including pelvic and perineal injury or pelvic interventions are other causes of FG.[7] The most common foci include the gastrointestinal tract (30%–50%), followed by the genitourinary tract (20%–40%), and cutaneous injuries (20%). Box 1 lists the commonest causes.

Comorbid systemic disorders are being identified more and more in patients with FG, the commonest being diabetes mellitus and alcohol misuse. Diabetes mellitus is reported to be present in 20%–70% of patients with FG[8] and chronic alcoholism in 25%–50% patients[9] (box 2). The emergence of HIV into epidemic proportions has opened up a huge population at risk for developing FG.[10]

PATHOGENESIS

In FG, suppurative bacterial infection results in microthrombosis of the small subcutaneous vessels leading to the development of gangrene of the overlying skin.[11] Cultures from the wounds commonly show poly microbial infections by aerobes and anaerobes, which include coliforms, klebsiella, streptococci, staphylococci, clostridia, bacteroids, and corynbacteria. On an average, at least three organisms are cultured from each diagnosed patient.[12] Most of these are normal commensals in the perineum and genitalia, which, because of the impaired host cellular immunity, become virulent and act synergistically to invade tissue and cause extensive damage.[13] Even though *E coli* has been reported to be the commonest organism isolated from the wound, it could be because of the commensal nature of these organisms in the perineal region. Anaerobes are less frequently isolated than expected, which could be because of technical faults.[12] Rare reports of other organisms being cultures include *Candida albicans*[11 14] and *Lactobacillus gasseri*.[15] The impaired defence mechanisms in the host help the infection to proceed unchecked, and at alarming speed, along the facial planes. The synergistic activity of aerobes and anaerobes lead to the production of various exotoxins and enzymes like collagenase, heparinase, hyaluronidase, streptokinase, and streptodornase, which aid in tissue destruction and spread of infection. The platelet aggregation and complement fixation induced by the aerobes and the heparinase and collagenase produced by the anaerobes lead to microvascular thrombosis and dermal necrosis. In addition the phagocytic activity is impaired in the necrotic tissue, aiding in further spread of the infection.[1]

CLINICAL PRESENTATION

FG shows vast heterogeneity in clinical presentation, from insidious onset and slow progression to rapid onset and fulminant course, the latter being the more common presentation. In contrast with Fournier's initial description, the disease tends to present more in elderly men,[16] and also has been reported in women and children.[18] The infection commonly starts as a cellulitis adjacent to the portal of entry, depending on the source of infection, commonly in the perineum or perianal region. The local signs and

Box 1 Aetiology of Fournier's gangrene

Urogenital
- Urethral stricture
- Indwelling catheter
- Traumatic catheterisation
- Urethral calculi
- Prostatic biopsy
- Vasectomy
- Insertion of penile prosthesis
- TVT procedure
- Hydrocele aspiration
- Delayed rupture of ileal neobladder
- Intracavernosal cocaine injection
- Genital piercing
- Perineal trauma (including iatrogenic, mentioned above)

Anorectal
- Perianal abscess
- Rectal biopsy
- Anal dilatation
- Haemorrhoidectomy
- Rectosigmoid malignancy
- Appendicitis
- Diverticulitis

Gynaecological
- Infected Bartholin's gland
- Septic abortion
- Episiotomy wound
- Coital injury
- Genital mutilation

Box 2 Comorbid risk factors for the development of Fournier's gangrene

- Diabetes
- Alcohol misuse
- Immunosuppression
- Chemotherapy
- Chronic cortiosteroid use
- HIV
- Leukaemia
- Liver disease
- Debilitating illness

symptoms are usually dramatic with significant pain and swelling. The patient also has pronounced systemic signs; usually out of proportion to the local extent of the disease. Crepitus of the inflamed tissues is a common feature because of the presence of gas forming organisms.[18] As the subcutaneous inflammation worsens, necrotic patches start appearing over the overlying skin and progress to extensive necrosis.[19] Unless aggressively treated, the patient can rapidly progress to sepsis with multiple organ failure, the common cause of death in these patients.[20] The spread of infection is along the facial planes and is usually limited by the attachment of the Colles' fascia in the perineum. Infection can spread to involve the scrotum, penis and can spread up the anterior abdominal wall, up to the clavicle.[21] The testes are usually spared as their blood supply originate intra-abdominally. Involvement of the testis suggests retroperitoneal origin or spread of infection.[23] Urogenital infections travel posteriorly along the Bucks and Dartos fascia to involve the Colles' fascia, but are limited from the anal margin by the attachment of the Colles' fascia to the perineal body. In contrast anorectal sources of infection usually start perianaly and this variation in initial clinical presentation can serve as a guide to localising the foci of infection.[1]

INVESTIGATIONS

Laor *et al* developed a scoring system (Fournier's gangrene severity index), to quantify the severity of infection, using common vital sign and laboratory data[16] (box 3). This score helps to prognosticate the illness and helps to predict the mortality. With a score of over 9, they found a 75% probability of death while a score of less than 9 was associated with 78% probability of survival. Chawla *et al* used this scoring system in their series of 19 patients and found that Fournier's gangrene severity index was useful in predicting survival but not length of hospital stay.[23]

Even though the diagnosis of FG is primarily clinical, imaging modalities may be useful in those cases where the presentation is atypical or when there is concern regarding the true extent of the disease. Plain radiography may show air within the tissues. Ultrasonography is useful to differentiate intrascrotal abnormality and can also show thickened and swollen scrotal wall, with gas within.[24] Computed tomography and magnetic resonance imaging are useful in select cases to diagnose or rule out retroperitoneal or intraabdominal disease process.[25] Box 4 summarises the differential diagnosis for FG.

TREATMENT

FG warrants an aggressive multimodal approach, which includes haemodynamic stabilisation, broad spectrum antibiotics, and surgical debridement. It must be highlighted however, that early surgical debridement is the primary component of treatment and if delayed will have a negative impact on the prognosis.[26] All non-viable and necrotic tissue must be excised, until well perfused viable tissue is reached (figs 1 and 2). The full extent of the disease may not be apparent from the areas of cutaneous involvement, which is usually less than the subcutaneous disease. Care must be

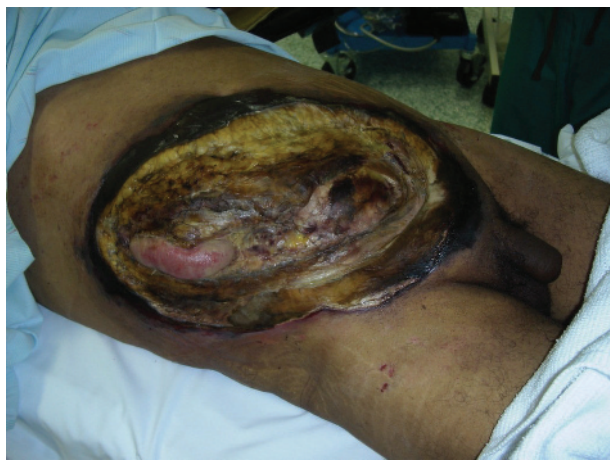

Figure 1 A case of Fournier's gangrene in a 45 year old man after live unrelated kidney transplant (transplanted kidney can be seen through the necrotic tissue).

Box 3 Variables in Fournier's gangrene severity index

- Temperature
- Heart rate
- Respiration rate
- Serum sodium
- Serum potassium
- Serum creatinine
- Packed cell volum (%)
- Whole blood cell count
- Serum bicarbonate

Box 4 Differential diagnosis of Fournier's gangrene

- Cellulitis
- Strangulated hernia
- Scrotal abscess
- Streptococcal necrotising fascitis
- Vascular occlusion syndromes
- Herpes simplex
- Gonococcal balanitis and oedema
- Pyoderma gangrenousm
- Allergic vasculitis
- Polyarteritis nodosa
- Necrolytic migratory erythema
- Warfarin necrosis
- Ecthyma gangrenosum

taken not to accidentally open up deeper facial planes, which were not initially involved. Urinary or faecal diversion may be necessary depending upon the foci of origin of the disease.[18] Multiple surgical debridement is the rule rather than the exception, with an average of 3.5 procedures required per patient.[23] Even though testes are classically spared in the process of FG, orchidectomy, for non-viable testis, is eventually required in up to 21% patients.[27]

Various workers have used different techniques to provide skin cover including transplantation of testes, free skin grafts, axial groin flaps, and myocutaneous flaps. Split thickness skin graft seems to be the treatment of choice in treating perineal and scrotal skin defects. Parkash *et al* reported their series of treatment of 43 cases in the past 11 years. In three cases the gangrene had spread beyond the scrotum and penis and cover had to be supplemented with split-skin grafts. In all the other cases, cover was provided with scrotal skin remnants at the edge of the lesion and on the penis with the inner layer of the prepuce, which had remained intact.[28] On the other hand Black PC *et al* reported their series of Meshed unexpanded split-thickness skin grafting (STSGs) for skin defects. They treated nine patients with penile skin loss between March 2001 and January 2003, with meshed STSGs to the penis. The underlying condition was FG in four cases, chronic lymphodema in two, skin deficiency from previous surgeries in two, and Crohn's disease in one. Graft thickness was 0.012 or 0.016 inches and meshing was performed in a 1:1 ratio. Meshed slits were oriented transversely without expansion and the graft juncture was located on the ventral surface in zigzag fashion. Graft take, appearance, and sexual and voiding function were assessed postoperatively. All nine patients had 100% graft take. At a mean follow up of six months a satisfactory cosmetic outcome was reported photographically in all except one case involving chronic penile manipulation. Erectile function and ejaculation were preserved in potent patients.[29]

With the recent advent of the vacuum assisted closure (VAC) system dressing, there seems to be a dramatic improvement with minimising skin defects and speeding tissue healing. It simply works by exposing a wound to subatmospheric pressure for an extended period to promote debridement and healing. In early studies no attempts were made to investigate the physiological basis for the observed clinical effects, or to determine the optimum levels of pressure required. In a seminal paper Morykwas *et al* tackled both of these issues with a series of animal studies. Deep circular defects, 2.5 cm in diameter, produced on the backs of pigs were dressed with open cell polyurethane ether foam with a pore size ranging from 400–600 μm. In the first series of experiments, a laser Doppler technique was used to measure blood flow in the subcutaneous tissue and muscle surrounding the wounds as these were exposed to increasing

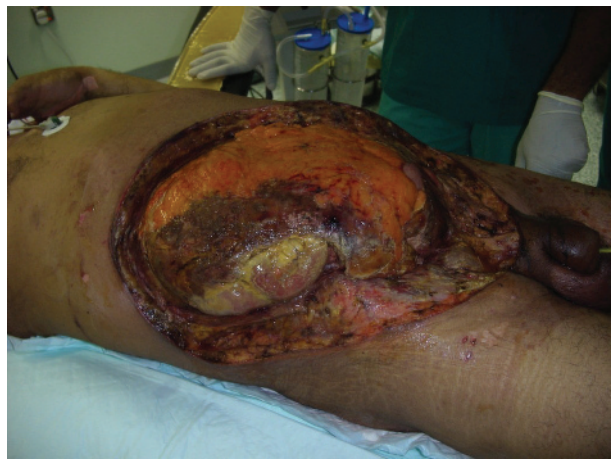

Figure 2 The same case as in figure 1, after the first debridement: extensive tissue debridement is the rule.

levels of negative pressure, applied both continuously and intermittently. Their results showed that while an increase in blood flow equivalent to four times the baseline value occurred with negative pressure values of 125 mm Hg, blood flow was inhibited by the application of negative pressures of 400 mm Hg and above. A negative pressure value of 125 mm Hg was therefore selected for use in subsequent studies.

The rate of granulation tissue production under negative pressure was determined using the same model by measuring the reduction in wound volume over time. Compared with control wounds dressed with saline soaked gauze, significantly increased rates of granulation tissue formation occurred with both continuous (63.3 (SD26.1%)) and intermittent (103% (SD35.3%)) application of negative pressure. Microbiological studies were also undertaken that entailed inoculation of punch biopsy wounds with large numbers of micro-organisms. These showed that, compared with control values, tissue bacterial counts of vacuum treated wounds decreased significantly after four days.[30]

Weinfeld *et al* treated four consecutive cases using negative pressure dressings (VAC) to bolster skin grafts in male genital reconstruction. In this series reconstruction followed one case of tumour ablation and three cases of debridement of abscesses or FG. The VAC was applied circumferentially to

the penis to secure skin grafts either directly to the penile shaft or to facilitate skin grafting to the scrotum. Graft areas ranged from 75 cm to 250 cm. All cases resulted in successful genital wound coverage; minor complications are described.[31]

Antibiotic therapy should be broad spectrum to empirically cover all possible organisms. The usual combination includes penicillin for the streptococcal species, third generation cephalosporin, with or without an aminoglycaside, for the Gram negative organisms, plus metronidazole for the anaerobes.[27] Some topical agents like Dakins solution (sodium hypochlorite), hydrogen peroxide, or unprocessed honey has been tried to aid in the separation of the slough and accelerate granulation tissue.[32] If the initial tissue stain using potassium hydroxide shows the presence of a fungus or if grown in the culture, then addition of amphotercin B is necessary.

Hyperbaric oxygen is widely believed to be an effective adjunctive therapy in the treatment of FG, even though there is no conclusive evidence regarding its effectiveness. Putative benefits of hyperbaric oxygen therapy include neutralisation of anaerobic organisms, improvement in neutrophil function, increased fibroblast proliferation, and angiogenesis.[33]

Recent advances in wound healing such as the application of growth hormones, trophic agents, and the use of vacuum dressing (fig 2) to hasten the wound closure has been used successfully.

OUTCOME

Early series reported high mortality rates around 80%,[34] but more recent studies show an improvement with lower rates of generally less than 40%.[8] Despite better understanding of the aetiopathogenesis of the disease, the availability of more broader spectrum antimicrobials, and the trend towards early and timely surgical intervention, the continuing high mortality rate reflects the potentially devaststing nature of this disease. Factors that have been identified to negatively affect survival include age, primary anorectal source of infection, delay in treatment, and immunocompromised state.[35] There is as yet inconclusive evidence to suggest that diabetes[36] or number of surgical debridements adversely affects the prognosis.

Long term complications, for those who survive this life threatening condition are not uncommon. Long term pain is not uncommon after FG. Only 50% of the patients are expected to be free of pain. The sexual function may be impaired by penile deviation or penile torsion as well as by a loss of sensitivity of the penile skin or pain during erection. Some patients may suffer from temporary stool incontinence. However, despite major complaints because of extensive scarring, most patients considered their cosmetic result as well as their quality of life to be satisfactory.[37]

CONCLUSION

FG is still a life threatening condition with unacceptably high death rates despite insights gained regarding the disease process. Diagnosis should be prompt with early surgical intervention, along with antibiotics and good supportive care. Radiography can be helpful when the clinical picture is not straightforward. Continued medical care in the form of a multidisciplinary approach is necessary as these patients may require reconstructive procedures in the future. Proactive management of the diabetic and immunosuppressed patients with perineal infections is of extreme importance to prevent the development of the condition in the first instance as this condition in the presence of such comorbidities is associated with high mortality.

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