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Fournier's Gangrene – Medical and Surgical Considerations

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1. Introduction

There is a consensus to consider Fournier's Gangrene a form of necrotizing fasciitis that typically starts in the perineal region, but can involve genital, perianal or surrounding structures. Although it is typically described in men, it can also affect women and, very rarely, children.

A synergistic infective process is always present triggering thrombosis of the subcutaneous blood vessels, developing a gangrene of the skin and later of deeper nearby tissues. Local edema and especially hypoxia affects local blood supply. This situation offers an ideal medium for growth to aerobic and anaerobic bacteria, and sometimes causing typical crepitation.

The local process is associated with severe systemic manifestations usually related to endotoxin liberation. Rapid dispersion of the infection may cause the death of the patient up to 45% of cases.

2. Historical considerations

In 1883, Jean Alfred Fournier described a scrotal necrotizing fasciitis in five young males previously sane. In the initial Fournier's description, the illness was considered idiopathic. However, in 1764 Bauriène reported a case of scrotal gangrene, which is considered to be the first case published in medical literature, although the origin of the case was not idiopathic but due to injury by ox horn. (Medina Polo et al., 2009)

In the past, some authors advocated that the eponym Fournier should be reserved for the idiopathic cases of perineal gangrene, and use the term secondary necrotizing fasciitis to the cases with a proven etiology. In fact this classification is not used in the present (Eke, 2000)

The American surgeon Frank L. Meleney described in 1924 for the first time the importance of extensive debridement of the necrotic tissues to achieve better results. The term Meleney's gangrene is associated with a synergistic gangrene that affects the skin and subcutaneous tissues, but not the deep fascia except in advanced cases, and always starts as a necrotic ulcer (Meleney, 1924). Other historical terms applied to Fournier's Gangrene include periurethral phlegmon, phagedema or synergistic necrotizing cellulitis.

3. Aethiology

3.1 Anatomical origin

Far from being idiopathic, the origin of the process can be located in one of these three sites: Lost of cutaneous barrier of perineal skin, urinary tract or intestinal tract. Recent studies conclude that only in a small percentage of the cases is not possible to determine the origin of the sepsis. The importance of the sources are variable according to the authors. Possibly the urogenital origin is the most important of all, followed by the anorectal and the cutaneous in the last position.

3.1.1 Urogenital origin

Any surgery or non-surgical procedure on the urogenital territory like vasectomy, urethral catheterization, penile prosthetic implants, prostate biopsies and others could be the gateway of the germs.

Accidental local traumatism are described to be origin of the sepsis.

Also any local infection as epididymitis, chronic urinary tract infection or predisposing factors as neurogenic bladder could be the etiology of the disease.

Urethral stricture is one of the main predisposing factor, with incidence ranging up to 31%. In theory, urethral stricture may lead to urethral diverticula and its eventual rupture could induce urine extravasation. In these situation, the leak of contaminated urine is the origin of Fournier's gangrene. (Hakan Yanar et al, 2006)

In women, additional causes of Fournier gangrene have included septic abortion, episiotomy, and hysterectomy, but in case of genital gangrene the physician always has to look for a vulvar Bartholin's abscess as responsible of the process up to 24% of cases. (Eke, 2000)

3.1.2 Anorectal origin

Hidden perianal abscess is certainly the main cause of gangrene in this region. Other reasons like colorectal surgical procedures, have also been described. The most referrals are haemorrhoidal interventions, carcinoma of the colon and rectum and diverticulitis

Traumatic local wounds or anal intercourse appear to be possible aethiologic factors (Smith et al., 1998)

3.1.3 Cutaneous origin

From the original description of the ox horn penetrating wound of Bauriene in the XVIII century, any possible traumatism in the perineal region are described as origin of the septic process. Animal or human bites, burns, piercings, injections are only an example of possible causes.

3.1.4 Idiopathic origin

As I has been stated above, currently idiopathic origin is a lower percentage of cases. More extensive cultures with better conditions of collection and grown, make possible to identify in most cases the germ responsible and indirectly the anatomical origin.

In some series neither the identification of the causative organism nor localizing the source to genitourinary or colorectal origin was associated with high mortality. (Corcoran et al., 2008)

3.2 Involved organism

These organisms are usual commensals of perineal skin and genital organs, and include Clostridia, Klebsiella, Streptococci, Coliforms, Staphylococci, Bacteriodes and Corynebacteria. Characteristically in Fournier's Gangrene exists synergism between theoretically low aggressive bacteria alone.

In this situation of synergism, one bacterium produces a nutrient for another, which produces leucocidal toxin. This toxin then protects both organisms from phagocytosis. Similarly, the aerobic bacteria consume the oxygen present in tissues that benefits the growth of an anaerobic. (Eke, 2000)

3.2.1 Most frequent isolation in cultures

The most commonly isolated aerobic microorganisms are Escherichia coli, Klebsiella pneumoniae and Staphylococcus aureus. The most commonly isolated anaerobic microorganism is Bacteriodes fragilis. (Patty et al., 1992) Actually both aerobes and anaerobes are present in the tissues but anaerobes are less frequently isolated because these samples are more difficult to preserve. In some series, a mean of four different organisms is cultured from each patient. (Addison et al. 1984)

Gram Positive	Gram negative
Staphylococcus aureus	Escherichia coli
Enterococcus species	Pseudomonas aeruginosa
Streptococcus species	Proteus
	Acinetobacter
	Klebsiella species
	Enterobacter species
	Bacteriodes

Table 1. Isolation from tissue cultures. Shown in order of detection (Yanar et al., 2006)

While aerobic bacteria often cause platelet aggregation, anaerobes are able to produce heparinase. Both organisms tend to activate intravascular clotting. These effects are fundamental to the onset of vascular thrombosis and dermal gangrene.

Microorganisms causing gangrene also release a variety of proteins that have the capacity to destroy tissue directly.

Gram negative bacteria such as E. coli, Proteus and Klebsiella are known to produce lipopolysaccharide endotoxin also implicated in thrombosis of small vessels. Streptococci and Staphylo segregate hyaluronidase driving to connective tissue necrosis. Some anaerobic organisms also produce hydrogen and nitrogen which accumulate in the tissues causing crepitus.

Thus a destructive infection results from a combination of relatively nonpathogenic bacteria. Patient's immunosuppression could in most cases worsen the processes. (Smith et al., 1998)

4. Predisposing factors

The common denominator in all these patients is impaired host resistance from reduced cellular immunity

4.1 Age and sex

Although the description of Fournier's Gangrene is done in young patients and males, it is increasingly evident that the disease affects elderly people and women also. In most studies the ratio between males and female is 10:1 (Eke, 2000)

The usual form of presentation is men between 50 and 70 years, with one or more predisposing factors. From early studies in the mid-twentieth century, the average age likely to present the clinical picture has been increasing. In 1945 the average age was 40.9 years and currently ranges between 50 and 70 years.

At present as opposed to what was believed at the time of Fournier, it is accepted that children may be affected by the disease. (Montoya et al., 2009). More than fifty cases have been reported until today. Due to the usual absence of predisposing factors in children some reports have indicated a better prognosis in this patients. Debridement in this cases need to be radical too. In the pediatric literature there is description of healing with limited excision of scrotal affection. (Ameh et al., 2004)

4.2 Diabetes mellitus

It is considered the most frequent predisposing factor. Presence of Diabetes mellitus has been reported as 39%-64% of patients with Fournier's Gangrene in different reviews Hyperglycemia has been found to have detrimental effects on cellular immunity.

Theoretically, decreased phagocytic activity and neutrophil dysfunction typically presented in diabetic patients could be associated with more progressive fatal outcome. Although numerous review articles have failed to demonstrate this item. (Korkut et al., 2003)

4.3 Chronic alcoholism

Chronic alcoholism is the second predisposing factor, according to some authors. In others publications, is considered the most prevalent factor (Smith et al., 1998)

4.4 Other factors

Exists a large number of factors that can be associated with the disease. Liver diseases, Malignancy, Obesity, HIV, leukemia, are just one example of diseases, all with some degree of alteration of the immune system

5. Clinical presentation

5.1 Symptoms and physical findings. Pain as most common presentation. Keys for clinical suspicion

The most common presentation was perianal or scrotal pain.

Systemic signs and symptoms are often associated to systemic inflammatory response syndrome (SIRS). Any patient suffering from gangrene could present fever, tachycardia, leucocytosis or tachypnea, We consider severe sepsis if there is dysfunction of one organ, hypotension or hypoperfusion.

In early stages, patients often have systemic symptoms of sepsis which appear disproportionate to appearance of the perineal-scrotal skin. (Smith et al., 1998)

Besides pain, other local symptoms are swelling,, purulent discharge from the perineum or crepitus. (Ersay et al., 2007)

It is very important to consider the strict control of all patients with perianal pain and no external lesion detected, because it could be the initial phase of the disease. The velocity of

fascial necrosis has been noted to be as 2-3 cm per hour, making early diagnosis crucial (Safioleas et al., 2006)

In contrast to the typical scrotal involvement, testicular involvement is rare. The blood supply to the scrotum comes from the pudendal arteries, while testicular artery is a direct branch from aorta. When testicular involvement occurs, it indicates a possible intra-abdominal source of infection.

Crepitus in gangrenous tissues gives the false impression of clostridial infection. Nevertheless, the gas-gangrene organism *Clostridium perfringens*, has occasionally been isolated.

Gas production was demonstrated by the finding of crepitus (cellulitis crackling) may be due to the presence of this anaerobic microorganisms or facultative anaerobes like *Escherichia coli*.

Cellulitis
Strangulated hernia
Scrotal abscess
Herpes simplex
Gonococcal infections
Pyoderma Gangrenosum
Vasculitis
Local traumatism

Table 2. Main differential diagnosis of Fournier's Gangrene. (Smith et al., 1998)

The importance of recognizing patients who have vasculitis or pyoderma gangrenosum is that optimal treatment of these diseases is the opposite of Fournier's Gangrene, because they need high doses of corticosteroids.

In summary the key to diagnosis is the presence of pain in perineal region and rapid local changes associated with systemic symptoms, that often seems in many cases excessive in relation to the initial findings.

5.2 Laboratory findings

In a large retrospective study of 68 patients, Corcoran et al. described significant differences between non survivors and survivals in admission laboratory parameters such as high serum Creatinine, lactate and calcium or low bicarbonate. Increased calcium in serum may be due to renal failure, bacteriemia or use of parenteral nutrition. (Corcoran et al., 2008)

Clayton et al reported that BUN level (UREA) >50 mg/dL was statistically significant for mortality among the parameters.

Creatinine, hematocrit, hemoglobin and alkaline phosphatase levels correlated with a worse prognosis in non survival group.

Some studies have demonstrated that admission hypomagnesaemia is associated with high mortality in critical ill patients. Reduced intestinal absorption, increased urinary losses or intracellular shift are possible reasons of this action. Monitoring serum magnesium levels in patients with Fournier's Gangrene might have prognostic and therapeutic implications and is used today in specialized groups. (Erol et al., 2010)

5.3 Severity Index. FGSI

In a study published by Laor et al. was described for the first time a Fournier's gangrene severity index (FGSI) along the lines of the Acute Physiology and Chronic Health Evaluation score (APACHE II). They identified several prognostic factors associated with a worse prognosis.

The FGSI score were calculated twice, at the time of admission and at the time of discharge or death.

Physiological variable					Normal				
	+4	+3	+2	+1	0	+1	+2	+3	+4
Temperature	>41	>39		38.5-38.9	36-38.4	34-35.9	32-33.9	<31.9	<29.9
Heart rate	>180	140-179	110-139		70-109		55-69	40-54	<39
Respiratory rate	>50	35-49		25-34	12-24	10-11	6-9		<5
Na	>180	160-179	155-159	150-154	130-149		120-129	111-119	<110
K+	>7	6-6.9		5.5-5.9	3.5-5.4	3-3.4	2.5-2.9		<2.5
Creatinine	>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
Leucocytes	>40		20-39.9	15-19.9	3-14.9		1-2.9		<1
Bicarbonate	>52	41-51.9		32-40.9	22-31.9		18-21.9	15-17.9	<15

Table 3. Fournier's Gangrene Severity Index

In the FCSI score, nine parameters were calculated, temperature, heart rate, respiratory rate, serum sodium, potassium, Creatinine, bicarbonate levels, hematocrite and leukocyte. The degree of derivation from normal is graded from 0 to 4. The individual values are summed to obtain the FCSI score. (Laor et al., 1995)

Results published in the articles shows that a score >9 has 75% of death and patients with a score <9 were associated with 78% of survival.

Other series of patients analyzed with the same score shows FCSI >10.5 is associated with 96% of death and <10.5 96% of survival. (Kabay et al. 2008)

Other medical groups use Chalon Comorbidity Index (useful not only in case of Fournier's Gangrene). It was calculated using 17 weighted indicators of coexisting conditions. A high score in Chalon Comorbidity Index is associated with a high mortality. (Erol et al., 2010)

5.4 Pathways of disease spread

Perineal anatomy and its fascial planes could be compared with two triangles: the anal triangle and the urogenital triangle. The anal triangle is posterior to the line that crosses the ischial tuberosities, instead the urogenital triangle is anterior to this line. Infection arising from the anal triangle can spread along the

Colles fascia and progress anteriorly along the Dartos fascia to involve the scrotum and penis. It can also pass superiorly to involve the anterior abdominal wall.

Buttocks and thighs may be affected if the infection goes beyond the barrier of Colles fascia. Infection originating from the urogenital triangle, can initially involve the ventral aspect of the penis. If infection is not initially treated it may progress as I wrote before. (Levenson et al., 2008)

5.5 Radiological explorations. Role of X-ray exploration

Although the diagnosis of Fournier gangrene is most commonly made clinically, CT can be used in doubtful cases or to assess the extent of involvement.

Presence of collections, subcutaneous emphysema and its extent, including retroperitoneal extension, are well evaluated at CT. Actually, CT has greater specificity for evaluating disease extent than does any other radiological exploration or physical examination

In early Fournier gangrene, CT can show small bubbles in the subcutaneous tissues, that has not yet been detected by physical examination.

Post treatment follow-up CT could be used to determine improvement or worsening of disease and schedule additional surgery interventions

In any case, a radiological exploration is not a justification for surgical delay if the clinical suspicion is present.

Ultrasonography is also useful in differential diagnosis with others entities as presence of gas gangrene from inguinoscrotal incarcerated hernia;

Soft-tissue air is also more obvious at US than at radiography. In ultrasonography evidence of gas within the scrotal wall may be seen prior to clinical crepitus (Levenson et al., 2008)

6. Treatment

6.1 Medical treatment

6.1.1 Prompt resuscitation of the patient. Fluid therapy

In the first phase of the disease is essential to maintain the patient's hemodynamic stability, providing fluid therapy with crystalloids. Some groups also managed these septic patients with colloids like albumin that seems to improve haemodynamics.

If necessary, begin with vasoactive drugs in the emergency room.

6.1.2 Broad spectrum antibiotics coverage

Antibiotic treatment alone will not cure in any case this disease.

Recommendations of published guidelines are based on low levels of scientific evidence, hence the difficulty to agree on a single therapeutic strategy.

Empiric broad-spectrum antibiotic therapy should be instituted as soon as possible, until the culture results could make adjusted the therapy

The antibiotic regimen chosen must have a high degree of effectiveness against sthylococcal and streptococcal bacteria, gram-negative, coliforms, pseudomona, bacteroides and clostridium. (Laucks, 1994) Classically Triple therapy is usually recommended. Third generation cephalosporins or aminoglycosides, plus penicillin and metronidazole.

Sometimes if we doubt of the possible origin of the sepsis and a streptococcal toxic syndrome could cause the clinical symptoms, we should associated clindamycin and penicillin to the antibiotic therapy

The reason is that clindamycin in vitro studies demonstrated both toxin suppression and modulation of cytokine production (Stevens et al., 2005)

Clindamycine always should be administrated in association, because is described a high percentage of resistances of Bacteroides.

6.1.3 New antibiotics strategies

New clinical guidelines currently recommend the use of Carbapenems (Imipenem, meropenem, ertapenem) or piperaziline-tazobactam.

Tigecycline is a macrolid related antibiotic that could be a good alternative in penicilline allergies patients

These therapies have good antibacterial spectrum, a large volume of distribution and lower renal toxicity compared with the aminoglycoside.

This new trend suggest that classically triple therapy could be replaced in certain circumstances for the use of new generation antibiotics.(Jimeno et al., 2010)

If there are risk factors for colonization by resistant bacteria (previous hospital admission, prior prolonged antibiotic treatment, institutionalization), we recommended adding therapy to linezolid or Daptomicine (Stevens et al., 2005)

6.2 Fournier's Gangrene: A surgical emergency

6.2.1 Radical surgical debridement. Early aggressive treatment that saves lives

It is widely recommend a debridement of the necrotic tissue as soon as possible

(Laor et al. 1995) found no significant difference between the onset time of symptoms, early surgical treatment and mortality, but others studies from (kabay et al. 2008) and (Korkut et al. 2003) shows that this time interval should be as short as possible.

Asfar et al. reported that insufficient debridements results in increased mortality. However, repeated aggressive debridements with one or two days intervals have resulted in reduced mortality rates (Kabay et al., 2008)

The actual relationship between the lesion size of Fournier gangrene and the final survival is still controversial.

Debridement of deep fascia and muscle is not usually required as these areas are rarely involved similar to testes. Debridement should be stopped when separation of the skin and the subcutaneous is not perform easily, because the cutaneous necrosis is not a good marker.

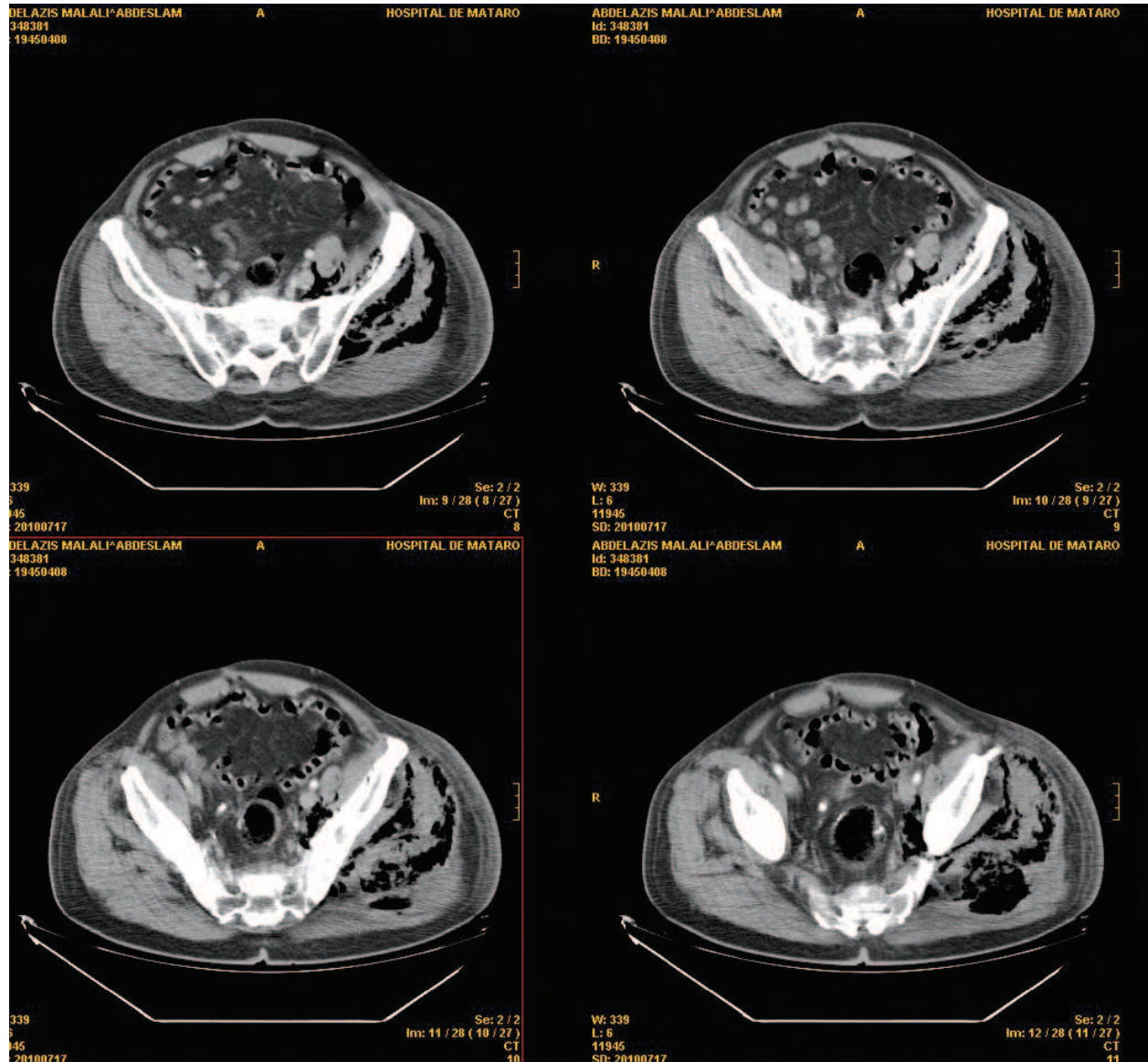


Fig. 1. CT-Scan showing gas in gluteus and in the retroperitoneal space in a 66 years old patient with ascendant Fournier's Gangrene (Author's image)

In some series orchiectomy was performed because of observed severe infection in peritesticular tissues, although in the pathological review the testicles were not found to be involved (Yanar et al., 2006)

It is possible to temporally place the testes into subcutaneous pouch until healing or reconstruction complete (Smith et al. 1998)

Penectomy was required only in very isolated cases. (Corman et al. 1999)

6.2.3 Role of hyperbaric oxygen therapy

Hyperbaric oxygen therapy implies placing the patient in a environment of increased ambient pressure while breathing 100% oxygen, resulting in enhanced oxygenation of the arterial blood and tissues. (Wilkinson & Doolette, 2004)

In vitro demonstrated benefits of hyperbaric oxygen include adequate oxygenation for optimal neutrophil phagocytic function, inhibition of anaerobic growth, increased fibroblast proliferation and angiogenesis, reduction of edema by vasoconstriction and increased intracellular antibiotics transportation.

Hypoxia may also reduce the effectiveness of several antibiotics (vancomycin, ciprofloxacin) while hyperoxia may help others. For example aminoglycosides cross the cell membrane of the microorganism by an oxygen-dependent pump. In addition, some side effects have been described as toxic reaction of central nervous system and barotrauma injury to the middle ear. In some cases a surgical procedure (tympanostomy tube insertion or myringotomy) should be performed prior to the hyperbaric oxygen therapy.

The use of Hyperbaric Oxygen Therapy continues to be cause of debate. Certainly no prospective controlled trials have been published for this condition. Although this treatment is supported by some small studies, hyperbaric oxygen should not delay surgical debridement. (Riseman et al. 1990)

There are 6 studies examining the effect of O₂ therapy in necrotizing soft tissues infections. 4 report a significant survival advantage for patients and 2 not (Wilkinson & Doolette, 2004)

In many cases, lack of facilities to perform hyperbaric therapy makes difficult his recommendation today generally.

6.2.4 Topical therapy

Natural and unprocessed honey was used with good results in debridement areas. This antibacterial effect is considered to result from hypertonic environment and phenolics acids making and antibacterial effect.

Honey has a low pH of 3.6 and contains enzymes which digest necrotic tissues. These changes occurs within a week of applying honey to the wound. Unfortunately there is no randomized study about the efficacy of honey in this special situations. (Eke, 2000)

Application of Sodium Hypochlorite 0.5 % (Dakin's Solution) or hydrogen peroxide in the postoperative period was described with good results.

Application is justified when hydrogen peroxide is used in the correct circumstances, but but should take precautions when used in closed spaces or under pressure, where liberated oxygen cannot escape, and dangerous side effects are described as blood oxygen embolism. From the same way, hydrogen peroxide subcutaneous crepitus can be confused with typical disease progression. (SLEIGH & LINTER, 1985)

Enzymatic debridements with lypophilized collagenase application are other local treatment that have been shown to be beneficial (Aşci et al., 1998)

Use of fibrin glue has recently been suggested in skin defects with no active infection (DeCastro & Morey, 2002)

6.2.5 Local negative pressure treatment (VAC)

The vacuum assisted closure system consist of a foam dressing placed in large areas of debridement with an overlying adhesive seal to maintain the zone in subatmospheric pressure. This has been shown to reduce the local oedema increase local blood flow and improves the formation of granulation tissue. The device could be cut for better adjust in cavities or irregular wounds. It is recommended to change the device every to 2-3 days

Possible handicaps are high costs and the necessary immobilization of the patient

6.3 Fecal diversion. Colostomy vs rectal diversion devices

6.3.1 Colostomy

Performing a colostomy is a common technique in patients with extensive involvement of the perineal area for the disease. The rationale for rectal diversion includes a decrease in the number of germs in perineal region and improved wound healing. (Estrada et al., 2009)

Justification for its construction are anal sphincter involving, fecal incontinence or continues fecal contamination of the wound's margins.

In several papers, the percentage of patients with a colostomy is around 15% depending on the series.. (Yanar et al., 2006))

In contrast to the study of Corocan et al, others series reported that formation of a diverting colostomy were associated with increased mortality. (Erol et al., 2010)) Korkut et al. reported 45 cases of FG and showed that mortality among patients not requiring a stoma was 7%, but was 38% among patients in whom stoma was required.

Diverting colostomy does not eliminate the necessity of multiple debridements, nor reduces the number of these procedures. However this associated technique may lead to early oral intake and thus may help to improve the wound cure process with better nutrition and less contamination of wounds. Anyway, serious stoma- related complications were described like wound infection, stomal ischemia, and evisceration. (Akcan et al. 2009)) We must also take into account the psychological consequences of a colostomy, in a patient with extensive mutilation of his body.

6.3.2 Rectal diversion devices

The Flexi-seal Fecal Management system is a silicone catheter designed to divert fecal matter in patients with diarrhea, local burns or skin ulcers. The device protects the wounds from fecal contamination and reduces the same way that a colostomy both the risk of skin breakdown and repeated inoculation with colonic flora. We consider that in selected cases the utilization of the device can replace colostomy, with the equivalent results regarding wound healing and local infection control.

It is recommended to explore the canal anal before placement of the catheter in order to avoid rectal injuries. This device avoids complications related to stomas, including better psychological recovery of the patient and also may have an economic benefit. (Estrada et al., 2009) A formal contraindication is rectal neoplasm, penetrating rectal injuries or fistulas.

Although some authors suggest cystostomy for urinary diversion, most authors believe that urinary catheterization is sufficient for satisfactory diversion (Yanar et al., 2006)

6.4 Postoperative period in the Intensive care unit

6.4.1 Renal function

Renal failure is the most common complication in this patients, associated with hemodynamic instability and massive toxin liberation to the bloodstream. Fluid resuscitation, vasoactive drugs and in some cases hemodialysis are important components required to manage potential fatal complications like acidosis or uremia.

Administration of albumin in this septic patients, appears to improve survival in many trials.

6.4.2 Blood glucose control

Strict glucose control in the intensive care period seems to be one of the most important parameters to preserve for the optimums homeostasis of the septic patient. In some cases, insulin pump infusion is necessary to achieve this objective.



Fig. 3. Patient with Fournier's Gangrene and extensive debridement zone. See de rectal catheter placement that prevents local contamination and avoids colostomy performing. (Author's image)

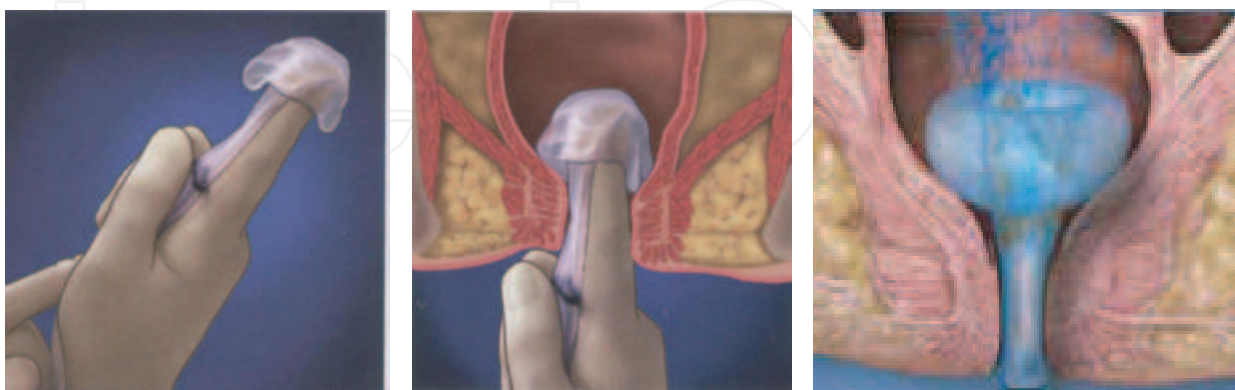


Fig. 4. Flexi seal rectal catheter placement. Rectal balloon is placed to the sphincter to prevent faecal leakage

6.4.3 Nutritional support

Physicians have long recognized that stress causes increase in basic energetic requirements in septic patients. In this population, repeated surgical procedures and mechanical ventilation decreases the possibility of oral intake. In these cases provision of nutritional support via parenteral nutrition does not assure adequate nutrient intake in a high percentage of patients. Some data shows that this critically ill population needs a provision of calories at about 125% of basal requirements (Graves et al., 2004)

This point can be achieved providing additional enteral intake.

Many articles define the theoretical benefit of oligoelements (like arginine, citrulline and glutamine) in the nutrition of these patients.

Plasma concentrations of L-arginine are substantially decreased in patients with sepsis and has been correlated with a worse prognosis in this population. Arginine participates in important physiological roles, including wound healing and immune function, and the arginine-NO system is essential in the regulation of vascular tone and blood pressure

However, further studies are necessary to identify the potential utility of supplementation with arginine and/or glutamine in septic patients.

6.5 Plastic surgery. The final step

There are two main strategies for reconstructive surgery, at the same time of admission (De la Cruz et al., 1996) or in a posterior period when the acute process is fully resolved. A reconstructive procedure was considered for patients presenting with an extensive healthy granulation tissue formation on the wound base

Secondary healing or delayed primary closure was applied safely for small areas.

The scrotal advancement technique was used for small sized skin defects of the scrotum.

Split-thickness skin grafts were performed in patients with a large area of skin loss, especially in the abdominal wall

Myocutaneous flap as Gracilis muscle flap is useful in some cases. Patients with a large and deep perineal defect often need this technique to eliminate the dead space. The well vascularized muscle flap demonstrates greater resistance to bacterial inoculum and in wounds with some degree of contamination. (Chen et al., 2010) Another alternative is the pudendal thigh flap. It is a fasciocutaneous flap based on the terminal branches of the superficial perineal artery, which arises from the internal pudendal artery. The advantages of this flap are relatively simplicity and good blood supply. The donor site can be closed primarily and no muscle function is sacrificed.

7. High mortality rates. Still a problem in the 21st century

The mortality rate associated with Fournier's Gangrene varies from 3 to 45 % depending on the series. Although it is lower than other forms of necrotizing fasciitis, probably because the scrotal area allows a relatively more efficient surgical debridement (Eke, 2000)

In this retrospective review of 45 consecutive patients, the presence of diabetes and the interval on the onset of clinical symptoms to the initial surgical intervention affected outcome in both univariate and multivariate analyses. (Korkut et al., 2003) but other studies failed to demonstrate this relation (Corcoran et al., 2008)

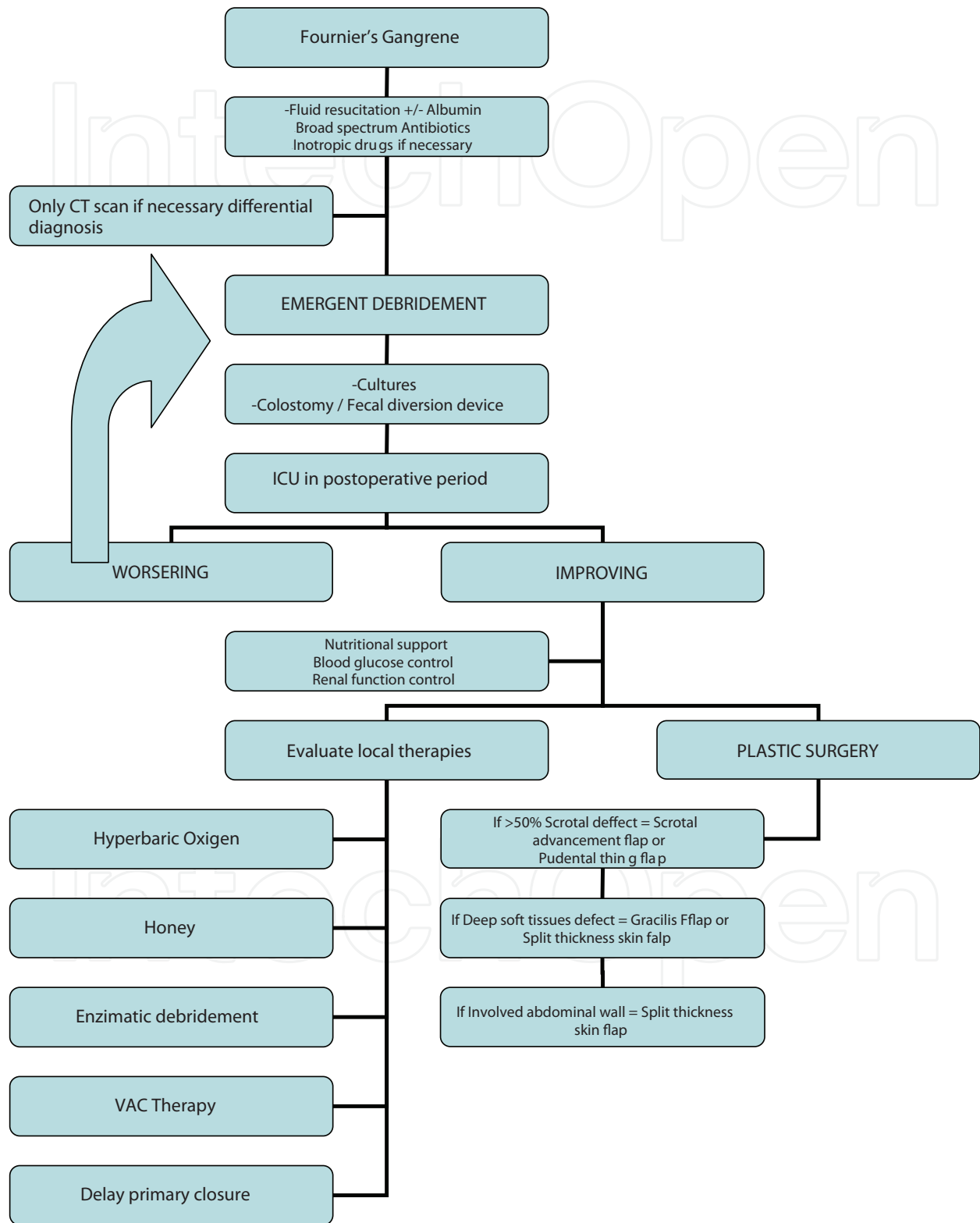
Idiopathic Fournier's Gangrene is not an independent additional contributory factor to the mortality in many series (Kabay et al., 2008)

When comparing survivors and no survivors, the presence of lower extremity involvement or abdominal wall involvement was significantly associated with inpatient mortality



Fig. 5. Forunier's Gangrene in a young female originated in a vulvar Bartholin's abscess. See the aggressive debridement in the ilio-pubic region. In a final step a dermolipectomy was performed to close the defect. (Author's figure)

8. Annex: Proposed treatment's algorithm



9. Conclusion

In summary, Fournier's Gangrene is a potentially fatal disease, with characteristic signs and symptoms that regularly becomes a surgical emergency. Multidisciplinary approach is essential to reduce mortality and severe sequels in these patients.

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Gangrene is the term used to describe the necrosis or death of soft tissue due to obstructed circulation, usually followed by decomposition and putrefaction, a serious, potentially fatal complication. The presented book discusses different aspects of this condition, such as etiology, predisposing factors, demography, pathologic anatomy and mechanisms of development, molecular biology, immunology, microbiology and more. A variety of management strategies, including pharmacological treatment options, surgical and non-surgical solutions and auxiliary methods, are also extensively discussed in the book's chapters. The purpose of the book is not only to provide a reader with an updated information on the discussed problem, but also to give an opportunity for expert opinions exchange and experience sharing. The book contains a collection of 13 articles, contributed by experts, who have conducted a research in the selected area, and also possesses a vast experience in practical management of gangrene and necrosis of different locations.

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