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Necrotising fasciitis of the extremities: implementation of new management technologies

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KEYWORDS

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Upper extremity
Lower extremity
LRINEC
Negative pressure wound therapy
Hydro-bisturi debridement

ABSTRACT

Introduction: Necrotising fasciitis (NF) is potentially life-threatening soft-tissue infection. Early diagnosis and aggressive surgical debridement are critical to decrease mortality and morbidity. The impacts of new management technologies such as hydro-bisturi-assisted debridement (HAD) and negative pressure wound therapy (NPWT) are not yet clear with respect to treatment of NF. The objective of this study was to describe laboratory (including LRINEC score), clinical and microbiological factors, treatment methods and outcomes related to managing necrotising fasciitis, focusing on the implementation of new treatment methods in our centre.
Methods: From June 2010 to June 2014, adult patients diagnosed with necrotising fasciitis affecting an upper or lower limb that were admitted to our hospital, a referral tertiary care centre, were eligible to participate in this study. Demographic data, clinical features, location of infection, Laboratory Risk Indicator for Necrotising Fasciitis (LRINEC) score on the day of admission, microbiology and laboratory results, use of HAD, wound management using NPWT, and patient outcomes were retrospectively analysed. A univariate risk factor analysis was performed, in an attempt to define prognostic factors for mortality.
Results: A total of 20 patients satisfied the inclusion criteria. Type II NF (Group A ß-haemolytic streptococci) was found in 8 cases (40%). The average LRINEC score on the day of admission was 6. The lower extremity was affected in 60% of the cases. All patients were treated operatively, with 2.5 interventions on average. Hydro-bisturi was used in the first debridement in 40% of the cases (8 out 20). In 75% of the studied cases, Negative Pressure Wound Therapy (NPWT) was the technique selected for surgical wound management. The global mortality rate was 30%. On univariate analysis, the only factors significantly associated with mortality were high levels of creatinin ($p = 0.033$) and low blood glucose levels ($p = 0.012$). Finally, four amputations were observed in this series.
Conclusion: We confirm that necrotising fasciitis (NF) of the extremities, despite new advancements in treatment and critical care management, is still a potentially life-threatening soft-tissue infection (30% mortality). New, advanced wound management modalities have been heavily used in management of necrotising fasciitis, but these have not had significant impacts on morbidity and mortality rates.

Introduction

Necrotising fasciitis (NF) is a relatively rare but frequently lethal soft-tissue infection, primarily involving the superficial fascia [1–3]. The term is broadly defined as an infection of the skin, soft tissue, and muscles, which tends to progress rapidly through the fascial planes [4,5]. It can affect any part of the body, but the lower extremities are the most common infection sites [3]. Such infections have long been recognized; for example, they were described by Hippocrates in the 5th century BCE [1,6]. The condition has been known under different names, such as phagedema, non-clostridial gas gangrene, and hospital gangrene [7]. In 1951, Wilson coined the term most used today, "necrotising fasciitis" [1,8].

From a microbiological point of view, there are four types of NF [6]. (1) Type I NF: polymicrobial/synergistic; (2) Type II NF: monomicrobial, caused by Gram-positive organisms (most frequently by Group A

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ß-haemolytic streptococci or occasionally by *Staphylococcus aureus*); (3) Type III NF: Gram-negative monomicrobial NF, including marine-related organisms and (4) Type IV NF: caused by fungi.

Early recognition and aggressive treatment remain the most important factors influencing survival [9,10] and the need for amputation. Despite advances in surgical treatment, antibiotics and critical care management, the mortality rate for NF ranges from 6% to 76% [5,11]. Some authors [12] have recently reported better outcomes with mortality rate below 10%, suggesting that more effective management is improving results; however, the cause of these improvements is not yet clear. In a study conducted in Turkey [13], 9 out of 22 patients (41%) required above-knee amputations, showing that the condition's sequelae can be severely disabling.

In recent years there has been a scientific effort to develop more reliable diagnostic tools and management protocols. The Laboratory Risk Indicator for Necrotising Fasciitis (LRINEC) scoring system [11] was proposed to differentiate NF from other soft-tissue infections using standard analytical parameters. Reportedly, with an LRINEC score of 8 or higher, the probability that NF is present is greater than 75%. In any case, concerns remain regarding the usefulness of the LRINEC score for early recognition of NF [14].

Appropriate surgical debridement remains the cornerstone of treatment. In an attempt to improve the effectiveness of the classic cold-knife tangential debridement technique, the Hydro-bisturi-assisted debridement (HAD) (*Versajet*®; Smith & Nephew, Memphis, Tennessee, USA) [15,16] has recently been developed. The new technique appears to offer remarkable advantages, though its effectiveness in treating necrotising fasciitis has not yet been fully validated (Figure 1).

Careful management is critical for the extensive open dermo-fasciotomy wounds often resulting from this radical debridement. Wounds should be kept covered for protection against secondary infection. In this setting, negative pressure wound therapy (NPWT) seems an attractive option, offering many advantages: isolation of the wound, increased tissue perfusion, decreased wound oedema, decreased bacterial load, and facilitation of subsequent reconstructive surgery [17,18] (Figure 2a, b).

We therefore sought to investigate (1) the current morbidity and mortality rates in cases of necrotising fasciitis of the extremities (2) diagnostic issues, focusing on the utility of the LRINEC score and (3) the treatment of these cases, focusing on the use of new treatment technologies.

Patients and methods

We retrospectively reviewed all adult cases of necrotising fasciitis affecting the extremities seen between June 2010 and June 2014 at Hospital Vall d'Hebron, a referral tertiary care hospital. Our centre is a 1000-bed tertiary university hospital which houses a national reference musculoskeletal infection unit.

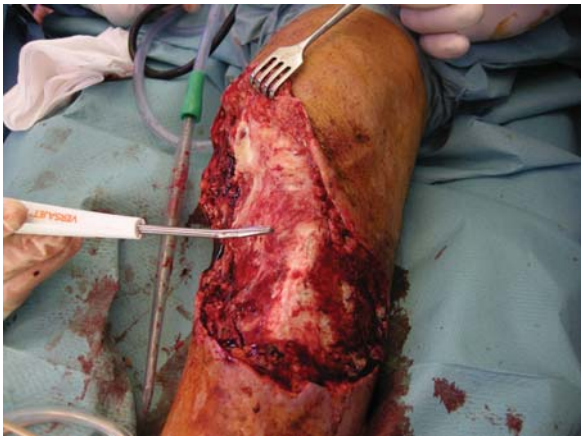

Fig. 1. 51-year-old man with necrotising fasciitis below the knee. Hydro-bisturi-assisted debridement using Versajet®.

All study patients complained of fever, local pain, swelling and erythema in the affected area. The final diagnosis of NF was established based on any of the following intraoperative parameters: (1) lack of resistance to blunt dissection in normally adherent fascia (the so-called "finger test" [1,10]) (2) surgeon's opinion of presence of necrotic fascia [19,20]; (3) purulent discharge with aspect of "dirty dishwater" coloured fluid [19,20]; (4) histopathological diagnosis of NF, where samples were available [21]. We excluded all cases in which the extremities were not affected.

We collected data on demographic characteristics, comorbidities, clinical features, blood tests on the day of admission – including C-reactive protein (mg/dl), leukocytes (cell/microl), serum sodium (mmol/L), creatinine (mg/dL) and glucose (mg/dL) – in order to determine LRINEC scores. Blood culture data was also collected, where available. We classified the NF according to microbiological findings, as one of the four types described by Morgan in 2010 [6]. We collected intraoperative parameters, including debridement technique used (classical cold-knife tangential debridement vs. HAD) and type of wound management employed (direct closure, moist dressing, shoelace technique [22] or NPWT). The NPWT used in our centre during the study period was Renasys-GO™ (Smith & Nephew, Memphis, Tennessee, USA) at 120 mm Hg continuous negative pressure. Also documented were the number of operative debridements (second looks), the need for and duration of intensive care admissions, in-hospital mortality rate, and amputations. Finally, a mortality univariate risk factor analysis was performed in an attempt to identify preoperative factors related to increased risk of death. The study was conducted as part of the routine work of our institution. Institutional review board approval was not required because the patients were treated according to local standards of care.

Microbiological methods

Affected tissues were collected for cultures and histopathological study. Samples were transferred to the microbiology laboratory in dry, sterile, plastic containers. They were inoculated directly onto conventional solid or liquid media for aerobic and anaerobic bacterial growth (blood agar plate enriched with 5% of sterile bovine blood, and thioglycolate broth). Blood agar cultures were incubated a 37°C in a 5% CO_2 atmosphere, with daily readings of the plates. Thioglycolate broth cultures were incubated at 37°C in an air atmosphere, and were also checked daily. If any growth was suspected in an anaerobic liquid culture, it was sub-cultivated on a Schaedler medium with a 5% sheep blood agar plate, with and without antibiotics, and incubated in an anaerobic atmosphere. Cultures were deemed negative if no growth was visible at ten days. Microorganisms isolated were identified by conventional biochemical and metabolic tests (plasmocoagulase, in case of staphylococci) or using an automatic system (Vitek or API System from bioMérieux Inc., Marcy-l'Etoile, France). Antimicrobial susceptibility was assessed by the disk-diffusion susceptibility test (Neo-Sensitabs™, ROSCO Diagnostica A/S, Denmark), E-test (bioMérieux Inc.), or microdilution technique (MicroScan WalkAway System from Siemens Healthcare Diagnostics). Susceptibility testing was performed and interpreted according to Clinical and Laboratory Standards Institute (CLSI) recommendations.

Statistical analysis

All the recorded data were entered in an Excel database (Microsoft Office Excel, 2007). Descriptive statistics were used to present the results. Categorical data are expressed as the count and percentage, and numerical data as the median and interquartile range (IQR) or the mean and standard deviation, as appropriate. The chi-square test or