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Early diagnosis and management of Necrotizing Fasciitis

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Abstract:
Introduction: *The term Necrotising Fasciitis (NF) refers to 'severe inflammation of the muscle sheath that leads to necrosis of the subcutaneous tissue and adjacent fascia'. Incidence of NF varies from 0.24 – 0.4 per 100 000 adults with high morbidity and mortality Early clinical suspicion, repeated aggressive wound debridement and broad spectrum antibiotics with interdisciplinary management improve the survival rate and reduce morbidity. However, early NF can be difficult to distinguish from non-necrotising soft tissue infections in the absence of severe sepsis, multi organ failure or pain. Based on the evolving cutaneous features, Wang Y et al described three stages of NF. Based on various microbial flora involved, Morgan classified NF into types I–IV. Wong et al first described the laboratory risk indicator (LRINEC) for scoring the severity of NF. We are presenting a retrospective observation study of 112 cases of Necrotizing Fasciitis to analyse the methods for early diagnosis and management.*
Materials and methods: *All the case sheets of the patients diagnosed and treated as necrotizing fasciitis from 03-06-2014 to 12-08-2015 were retrieved from medical records department of our Medical College Hospital. From the case sheets, the patients' demographic, clinical, investigation management and morbidity & mortality data were collected, tabulated and analysed to find out the best possible methods for early diagnosis and management of NF.*
Results: *The data collected in of our study are comparable with and similar to those of previous authors.*
Conclusion: *Clinical findings to suspect / diagnose NF are neither specific nor sensitive especially in early stages. LRINEC scoring is a sensitive diagnostic tool but it is less specific. Imaging modalities are not useful in early cases. Gas in soft tissue X-ray is seen in 40% of cases only. Negative wound culture and biopsy do not rule out NF. Bedside finger test is more specific. Extensive literature review does not show any study to suggest definitive methods for early diagnosis and management of NF. To create proper level of evidence larger prospective study is needed with set protocols for early diagnosis and specific indications for emergency operative intervention, delayed operative intervention and conservative management.*
Keywords: *Aggressive wound debridement, clinical staging, finger test, LRINEC scoring, microbial flora.*

I. Introduction

Even though Hippocrates [1] described Necrotizing Fasciitis (NF) as a rapidly progressing infection of the skin and soft tissues, now the term Necrotising Fasciitis (NF) refers to 'severe inflammation of the muscle sheath that leads to necrosis of the subcutaneous tissue and adjacent fascia' [2]. Wilson coined the term necrotizing fasciitis in the 1950s to describe necrosis of the fascia and subcutaneous tissue with relative sparing of the underlying muscle [3]. Hemolytic streptococcal gangrene, Meleney ulcer, acute dermal gangrene, hospital gangrene, suppurative fasciitis, flesh eating bacterial disease and synergistic necrotizing cellulitis are other terms used to describe NF. Jones [4] in 1871 described it as "hospital gangrene" with a mortality of 46%. Shortly afterwards, Jean-Alfred Fournier [5] described similar soft tissue infection of male perineum, now known as Fournier's gangrene which now includes necrotizing infections of women perineum also. Surgical debridement first performed by Meleney [6] in the early 1920s is still an integral part of current treatment for NF. Incidence of NF varies from 0.24 – 0.4 per 100 000 adults with high morbidity and mortality; early clinical suspicion, repeated aggressive wound debridement and broad spectrum antibiotics involving interdisciplinary team, improve the survival rate and reduce morbidity [1,3,4,7-10]. Many significant risk factors and co-morbidities like old age, immunocompromise, diabetes mellitus, cirrhosis liver, medical renal disease, congestive heart failure, gout, use of non steroidal anti inflammatory drugs (NSAID), pre existing skin and soft tissue infections precipitate NF and worsen the prognosis with increased morbidity and mortality [2,4,5,11-13]. However, in the absence of severe pain, sepsis or multi organ failure, it is difficult to distinguish early NF from non-necrotising soft tissue infections. Clinical features typical of a NF include agonising pain, tenderness beyond erythematous areas, blister or bullae formation, swelling of muscle compartments, which may give rise to a compartment syndrome, and rapid progression of invading microorganisms through tissue planes [14]. Wang Y et al Staged necrotising fasciitis based on the evolving cutaneous features [15] (TABLE 1).

Table 1: Stages of necrotising fasciitis based on the evolving cutaneous features[15].

Stage 1 (early)	Stage 2 (intermediate)	Stage 3 (late)
Warm on palpation Erythema	Blister or bullae formation (serous fluid)	Haemorrhagic bullae
Tenderness to palpitation (extending beyond apparent areas of skin involvement)	Skin fluctuance	Skin anaesthesia Crepitus
Swelling	Skin induration	Skin necrosis with dusky discoloration progressing to frank gangrene

Many studies by Park et al [16], Hsiao et al [17], Huang et al. [18], Frazee B et al [19], Dworkin M et al [20], Singh G et al [21], Shimizu T [22]' et al and Hakkarainen TW et al [23] have documented trauma including operative trauma with mono or polymicrobial infections, consumption of raw or undercooked seafood or injury by fish fins, seawater contamination of wounds infected with marine organisms as common aetiological factors. Many other authors [24-29] also reported similar conclusions on various spectrums of synergistic pathogenesis with polymicrobial infections including marine organisms in NF. However, there are increasing reports of NF caused by monomicrobial infection, especially in Asia [27]. Based on Various microbial flora involved, Morgan [30] classified NF into four types:

- Type 1 - polymicrobial infection with aerobic and anaerobic bacteria.
- Type 2 - Group A streptococcus (GAS) with or without staphylococcal infection.
- Type 3- Gram-negative monomicrobial infection (marine organisms such as *Vibrio* spp. and *Aeromonas hydrophila*)
- Type 4 - fungal infection such as *Zygomycetes* and *Candidiasis*.

Microbiology report from wound and blood cultures remains mandatory for the antibiotic selection over empirical treatment.

The laboratory risk indicator for NF (LRINEC) score first described by Wong et al [31] is shown in (TABLE 2)**.**

Table 2: The laboratory risk indicator for NF (LRINEC) score[31].

VARIABLE	RESULT	SCORE
C-REACTIVE PROTEIN [mg/dl]	<150 ≥150	0 4
WBC [$x10^6$ / mm^3]	<15 15-25 >25	0 1 2
HEMOGLOBIN [g/dl]	>13.5 11-13.5 <11	0 1 2
SODIUM [mmol/l]	>135 ≤135	0 2
CREATININE [mmol/l]	<160 ≥160	0 2
GLUCOSE [mmol/l]	<10 ≥10	0 1

Maximal scoring is 13 A score of ≤ 5 points (stage 1) indicates a low risk (< 50% probability) of NF deserving conservative management; 6–7 points (stage 2) indicate an intermediate risk (50%–75% probability) of NF where operative intervention can be delayed up to 24 hours with conservative management; ≥ 8 points (stage 3) denoting a high risk (> 75% probability) is a strong indication for early operative intervention.

We are presenting a retrospective study of 112 cases of Necrotizing Fasciitis to analyse the methods for early diagnosis and management.

Aim Of The Study

To find out the best possible methods for early diagnosis and management of NF by analysing the data collected from case sheets of NF patients included in the study.

II. Materials And Methods

All the case sheets of the patients diagnosed and treated as necrotizing fasciitis from 03-06-2014 to 12-08-2015 were retrieved from medical records department of our Medical College Hospital. From the 112 case sheets thus included in the study, the patients' demographic, clinical, investigation, management and morbidity & mortality data were collected, tabulated and analysed to find out the best possible methods for early diagnosis and management of NF.

III. Results

The data regarding sex & age of the patients, site of NF, clinical symptoms & signs, laboratory parameters, microbiology, type of management, major morbidity & mortality collected from the case sheets are shown in TABLES 3-10**.** Bedside finger test was done only in 20 % of cases with 80% positive findings. The negative results were partly due to very early stage recovered with conservative treatment and a very few patients wrongly suspected to be NF.

Table 3: Demographic data:

Total number of patients enrolled	**112**
Total number of male patients (%)	**66.0**
Total number of female patients (%)	**46.0**
Mean age of patients in years	**54.36**

Table 4: Co-morbidities

Diabetes	**51.7 %**
Peripheral vascular disease	**16.0 %**
Alcoholic Liver disease	**12.5 %**
No co-morbidities	**19.6 %**

Table 5: Presentation of NF according to site

Site of lesion	**No of patients (%)**
Head and neck	**13 (11.61%)**
Extremity	**79 (70.54%)**
Perineum	**20 (17.85%)**

Table 6: Signs and symptoms

Pain and tenderness, erythema, warmth and swelling were present in all patients.	
Other signs and symptoms:	
Bullae	**42.8 %**
Crepitus	**22.3 %**
Skin necrosis	**38.3 %**
Fever □> □37·5°C	**32.1 %**
Hypotension	**13.3 %**
Gas on X–ray	**41.9 %**

Table 7: LRINEC scoring

< 6	**12.6 %**
6-8	**42.8%**
□ 8	**44.6 %**

Table 8: Microbiology

No growth in wound culture	**13.3 %**
Positive wound culture	**86.6 %**
Monomicrobial	**15.1 %**
Polymicrobial	**71.4 %**

Table 9: Type of management

Conservative	**12.6 %**
Early operative intervention (< 24 □h)	**44.6 %**
Late operative intervention (< 24 □h)	**42.8%**

Table 10: Major morbidity and mortality

Amputations	**3.57 %**
Deaths	**4.46 %**

IV. Discussion

A conclusion section must be included and should indicate clearly the advantages, limitations, and possible applications of the paper. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extentions Even though early diagnosis and surgical intervention of NF can reduce mortality and morbidity including amputation rates, it is a major diagnostic challenge because, pathognomonic signs are absent in most of the cases [32]. But still a high index of suspicion will prompt any clinician to make early diagnosis based on clinical findings depending upon the stage of the disease at the time of presentation and

confirm it with LRINEC scoring, imaging modalities like ultrasonography, X-ray, computerised tomography, magnetic resonance imaging, bed side finger test, biopsy from wound and culture sensitivity of blood, wound swab or needle aspirate. NF usually presents with the triad of pain, swelling and erythema [2,3,6,8,15,16]. Cellulitis and abscess are quiet often misdiagnosed as NF. Majority of NF patients present with severe pain out of proportion to the swelling or erythema [6,8,12,16]. Few other features of diagnostic importance are tenderness extending beyond the area of swelling & erythema, due to enzymes and toxins spreading along the fascia below the skin, indistinct margins, absence of superficial lymphangitis and rapid worsening despite antibiotics usage [33]. Repeated review of the patient's condition for spread of signs and worsening symptoms will prompt the clinician to venture further. The development of bullae in the skin marks the intermediary stage. Skin necrosis is a feature of late NF [15]. The best way to diagnose NF is 'bedside finger test'. This is done by infiltrating the suspected area with local anaesthetic and cutting down to the deep fascia through 2 cm skin incision. If the index finger dissects the subcutaneous tissue off the deep fascia easily along the tissue plane, the test is positive. Presence of grey necrotic tissue and thrombosed vessels in the floor of incision wound, with thin, watery, foul-smelling fluid, described as dishwater pus oozing from beneath oedematous fascial plane and non-contracting muscles are other diagnostic findings in this simple test [34]. Urgent definitive surgical debridement should follow.

Treatment depends upon the stage and LRINEC scoring at the time of presentation of the disease. In stage I (LRINEC scoring $\leq$ 5), conservative treatment may be useful with broad spectrum antibiotics subsequently replaced by appropriate ones based on culture sensitivity report, intravenous immunoglobin [35], hyperbaric oxygen [3] and other supportive measures. If there is no response or if disease worsens, switch over to operative line of management is essential. Stage II (LRINEC scoring 6-8) may be observed for not more than 24 hours with conservative line of management and must be switched over to operative management. Stage III (LRINEC scoring $\geq$ 8) cases straight away need early aggressive operative line of management ranging from simple fasciotomy to aggressive repeated wound debridement, vacuum assisted closed drainage and appropriate amputations followed by delayed wound closure or reconstructive and rehabilitative procedures [36-38]. Results of our study as compared with those of previous similar studies are shown in TABLE 11**.** Even though the clinical findings are the main criteria to suspect / diagnose NF, it is neither specific nor sensitive especially in early stages. In intermediate and late cases also the clinical findings are not reliable because they are altered due to conservative line of management already given. LRINEC scoring is recommended as standard diagnostic tool by many authors. It is sensitive but less specific. However, this is also unreliable in early cases and in cases treated conservatively. Imaging modalities like CT & MRI are not cost effective in Indian scenario and not useful in early cases. Ultrasonography also may not be useful in early cases. Gas in soft tissue X-ray is seen in 40% of cases only. Infra red spectroscopy to assess the oxygen saturation level in soft tissues under question as a tool for early diagnosis of NF is not documented well. With reference to wound swab and needle aspirate for culture & sensitivity, negative culture does not rule out NF. Similar scenario is with biopsy. Bedside finger test is more specific. In early case, it may be negative. However, repeat finger test during continuous monitoring period might prove to be useful. Extensive literature review does not show any study suggesting definitive methods for early diagnosis. There is no study to suggest definitive protocol for emergency operative intervention, delayed operative intervention or conservative management. Only one detailed review article in 2014 by Goh T et al. [30] gives some idea on these lines.

Table 11: Results of our study as compared with those of previous similar studies

	Our study	Elliot et al[10]	Nisbet et al[11]	Wong et al[12]	Park et al[15]	Hsiao et al[16]	Huang et al[17]	Frazee et al[18]	Dworkin et al[19]	Singh et al[20]
No.of patients	**12**	**98**	**2**	**9**	**17**	**28**	**72**	**22**	**0**	**5**
Erythema	**100**	**6.3**		**00**	**8.9**	**2.3**	**1.0**	**0.3**	**1**	**2**
Warmth	**100**			**7**			**4.1**			
Pain	**100**	**2.9**	**9**	**8**	**00**	**4.7**	**4.3**	**4.1**	**00**	**1**
Swelling	**100**	**5.0**	**7**		**9.7**	**1.1**	**3.7**		**4**	**9**
Bullae	**42.8**	**3.7**	**2**	**5**	**7.1**		**3.3**	**1.5**	**1**	**5**
Crepitus	**22.3**	**6.5**		**4**				**.6**	**4**	**5**
Skin necrosis	**38.3**	**1.1**		**4**				**3.8**	**9**	
Fever	**32.1**	**1.6**	**4**	**3**	**1.8**	**3**	**0.1**	**4.3**	**6**	**7**
Hypotension		**1.1**		**8**	**3**	**5**	**2.2**	**1.3**	**0**	
Gas on x-ray %	**47**	**7.4**		**7**			**.9**	**2**	**4**	**6**
Lab data reported	**Y**									
Positive wound	**86.6**	**9.2**		**2**	**2.7**	**7.3**	**0.9**	**2**	**5**	**7**

culture										
No growth	**13.3**	**1.8**		**8**	**7.3**	**2.7**	**.1**	**8**	**5**	**3**
Polymicrobial	**71.4**	**4.6**	**2**	**4**	**.8**	**3.4**	**3.7**	**5.3**	**4**	**9**
Monomicrobial	**15.1**	**5.4**	**8**	**8**	**6**	**3.4**	**7.2**	**6.7**	**1**	**9**
Blood culture	**-**		**8**		**6.1**	**8.9**	**5.7**			

V. conclusion

The limitations of our study are: this is a retrospective study, the size of this study sample is small, and available data in the case sheets were not complete. To create appropriate evidence level for specific guidelines, larger prospective study is needed with set protocols with mandatory LRINEC scoring and 'bedside finger test' for early diagnosis and specific indications for treatment protocol for emergency operative intervention, delayed operative intervention and conservative management.

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