

# Severe necrotising soft tissue infections in orthopaedic surgery

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## ABSTRACT

**Purpose.** To review all cases of necrotising infection managed in the Department of Orthopaedic Surgery of Dunedin Hospital in New Zealand between 1989 and 1998.

**Methods.** Hospital records were analysed for predisposing factors, clinical features, diagnostic results, treatment strategies, and outcomes.

**Results.** 13 cases (9 males and 4 females) of necrotising infection were identified. The mean age was 48 years (range, 8–76 years). Presenting symptoms included painful swelling, erythema, and necrosis. Most patients had predisposing factors and had received non-steroidal anti-inflammatory drugs before presentation. 12 patients underwent surgical debridement including a total of 4 amputations. Septic shock developed in 9 patients who required dialysis for renal failure. Four patients died. The most common organisms identified were group A beta-haemolytic streptococci.

**Conclusion.** Severe necrotising infections require a high index of suspicion and rapid medical and surgical intervention to reduce the mortality and morbidity.

**Key words:** musculoskeletal; necrotising infection; soft tissue

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## INTRODUCTION

Severe necrotising soft tissue infections are rare in orthopaedic practice,<sup>1,2</sup> but they can lead to limb loss and are potentially life-threatening if not recognised and treated early.<sup>3</sup> Different names have been attached to these infections following the first description under the name of hospital gangrene by Joseph Jones towards the end of last century.<sup>4</sup> Jones defined the condition as a clinical syndrome of progressive inflammation and necrosis that begins in the subcutaneous tissues and spreads rapidly along the fascial planes to cause secondary necrosis of overlying skin and occasionally adjacent muscle. Generally, there is no pus formation.

Several different organisms have been identified as being responsible for the infection, the predominant one being *Streptococcus pyogenes*.<sup>5</sup> Despite giving antibiotic therapy and performing surgical debridement, mortality rate remains high, at 30% to 60%.<sup>3</sup> Underlying debilitating disease predisposes to necrotising infection, but previously well patients can also be affected. Risk factors for this type of infection have not been clearly identified. The use of non-steroidal anti-inflammatory drugs (NSAIDs) has recently been implicated as a contributing factor.<sup>6</sup> More research, however, is required before this can be firmly established.

**Table**  
**Clinical characteristics of patients with necrotising infections**

Patient	Age (yrs)/sex	Year	Organism(s)	Site of infection	Fever	Use of NSAID*	Renal failure	Surgery	Hospital stay (days)/outcome
1	52/M	1989	$\beta$ -Haem strep <sup>†</sup>	Forearm	Yes	No	No	Nil	10/died
2	8/M	1990	$\beta$ -Haem strep	Thigh	Yes	No	PD <sup>§</sup>	Hip disarticulation	2/died
3	21/M	1992	$\beta$ -Haem strep	Foot	Yes	Yes	No	Debridement	8/survived
4	44/F	1993	$\beta$ -Haem strep	Arm/chest	No	Yes	No	Debridement	2/died
5	76/F	1993	Pseudomonas	Leg	Yes	Yes	HF <sup>  </sup> /HD <sup>¶</sup>	Above-knee amputation	56/survived
6	52/F	1994	$\beta$ -Haem strep	Foot/leg	Yes	Yes	HF/HD	Above-knee amputation	112/survived
7	51/M	1994	$\beta$ -Haem strep	Chest wall	Yes	Yes	HF/HD	Debridement	28/survived
8	72/M	1994	Unknown	Leg	Yes	Yes	No	Below-knee amputation	32/survived
9	54/M	1995	$\beta$ -Haem strep	Thumb	Yes	Yes	No	Debridement	14/survived
10	61/M	1995	Gp C strep <sup>‡</sup>	Leg	No	Yes	No	Debridement	18/survived
11	34/F	1995	Staphylococcus; Corynebacterium	Thigh	Yes	Yes	HF	Debridement	77/survived
12	27/M	1996	Gp C strep	Thigh	Yes	Yes	No	Debridement	12/survived
13	72/M	1998	Septicum; Pseudomonas	Thigh	Yes	No	HF	Debridement	14/died

\* NSAID non-steroidal anti-inflammatory drugs

<sup>†</sup>  $\beta$ -Haem strep beta-haemolytic streptococcus

<sup>‡</sup> Gp C strep group C streptococcus

<sup>§</sup> PD peritoneal dialysis

<sup>||</sup> HF haemofiltration

<sup>¶</sup> HD haemodialysis

We conducted a retrospective study of patients presenting with necrotising infection at Dunedin Hospital, to identify common features of this infection and its management.

## MATERIALS AND METHODS

We reviewed all cases of necrotising infection that were seen and treated by the Department of Orthopaedic Surgery of Dunedin Hospital, University of Otago, Dunedin, between 1989 and 1998. The hospital records were analysed for predisposing factors, clinical features, diagnostic results, treatment strategies, and outcomes.

## RESULTS

13 cases of necrotising infection were identified. Patients included 9 males and 4 females, whose mean age was 48 years (range, 8–76 years). Four cases of infection involved an upper limb, and 9 involved a lower limb. The clinical features are summarised in the Table.

### Predisposing factors

Most patients were healthy and had no associated chronic medical illnesses, except 2 who had long-standing diabetes with chronic renal failure. All patients had predisposing factors: minor skin infec-

tion (n=4), soft tissue trauma (n=3), splenectomy (n=2; lymphoma and hereditary spherocytosis, respectively), diabetes (n=2), surgery (n=1; femoral osteotomy), and pseudo gout (n=1). Ten (77%) patients had received NSAIDs before admission.

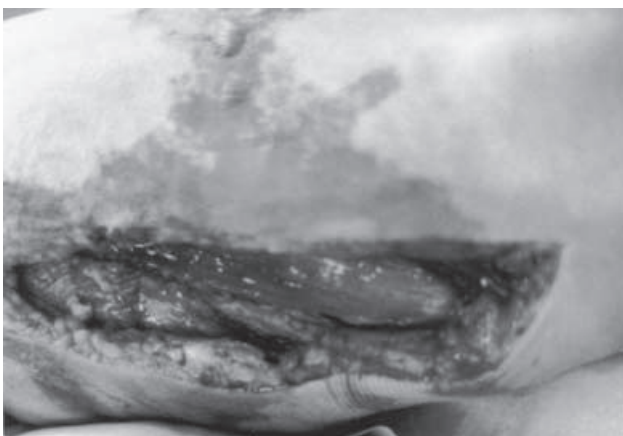
### Clinical features

The source of infection was not always clear, but 6 patients had been healed or were healing minor skin infections or abrasions. Although the clinical presentation varied dramatically within the groups, all patients presented with severe pain in the infected area. Only 7 of the 13 patients presented initially with erythema and cellulitis, but all eventually developed skin changes during the course of their illness. Blister formation and skin necrosis in the area of infection were common findings, especially in patients who presented late (Fig. 1). Ten patients had fever at the time of presentation, but for several patients, the fever was only of low grade. Nine patients developed septic shock that resulted in renal failure in all cases.

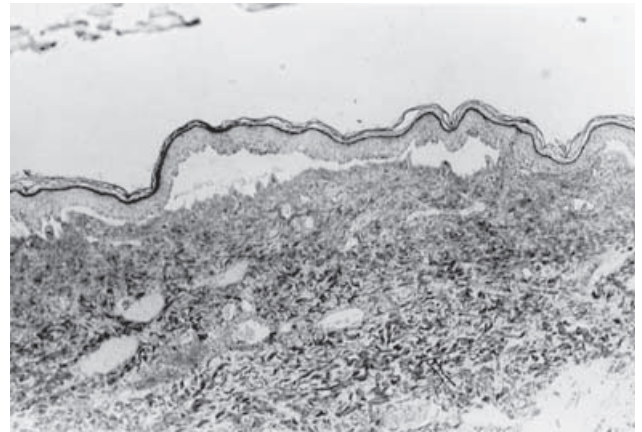
### Diagnostic results

An infective organism was isolated in 12 cases. The predominant organisms were beta-haemolytic streptococci (Table). Most organisms were identified from intra-operative swabs and tissue samples.

The diagnosis of necrotising infection was confirmed at the time of surgery in most cases. Typical findings were marked oedema of the subcutaneous tissues, fascia, and sometimes muscles, with dishwasher-like fluid seeping out of the tissues. There was subsequent necrosis of skin, subcutaneous tissue, and



**Figure 1** Adductor region showing a surgical incision and extensive skin necrosis.



**Figure 2** Skin histology (H&E x 200). Severe epidermal involvement and bullae formation with separation of the epidermis from its basement membrane.

sometimes muscle. No pus or gas, however, was found in any of our cases, and the fascial plane did not offer any resistance to the passage of a finger or hand in most cases. Skin necrosis was patchy and muscle necrosis variable.

The microscopic appearance of surgically debrided tissue was similar in each case. Inflammation, which was associated with very high bacterial counts, was most prominent in the septal components of the subcutaneous adipose connective tissue, and in fascial planes. The extent of the inflammatory response varied between cases, ranging from one case, in which there were large numbers of bacteria and relatively few neutrophils and macrophages, to others in which the extent of the inflammatory response was more appropriate for the number of bacteria present. As infection advanced, the epidermis became involved—for example, acantholysis and intradermal splitting, or bulla formation with separation of the epidermis from its basement membrane (Fig. 2). Areas of fat necrosis also occurred in the subcutaneous tissue, together with some infiltration of connective tissue planes within striated muscle. Muscle swelling was related mainly to the formation of a fluid exudate; the amount of muscle necrosis varied, but was much less marked than that in the subcutaneous tissue. Focal haemorrhage accompanied the inflammatory process.

### Medical management

All 9 patients in whom septic shock developed required cardiovascular and respiratory resuscitation in the intensive care unit, before undergoing urgent surgical debridement. Intravenous high-dose antibiotic

therapy was started as soon as the diagnosis was suspected; broad-spectrum agents were used initially until the infective organism was identified. Streptococci were cultured in 9 of the 13 cases; once these organisms were identified, penicillin became the antibiotic of choice.

Acute renal failure developed in 9 patients, 6 of whom received some form of renal replacement therapy. Five patients were treated with continuous haemofiltration during the acute phase of the infection, and one patient required peritoneal dialysis. Two of these 6 patients died. Those who survived received haemofiltration within 48 hours of admission to the intensive care unit, and the procedure was continued for 3 to 5 days. Once these patients were haemodynamically stable, haemodialysis was performed until their renal function improved. At the time of discharge, all these 4 patients who received renal replacement therapy displayed normal renal function.

### Surgical management

12 of the 13 patients underwent surgery for debridement and excision of necrotic tissue; one patient did not receive surgical treatment. Four patients underwent primary or secondary amputations in the form of 2 above-knee amputations, one below-knee amputation, and one hip disarticulation. All 8 patients who did not undergo amputation underwent repeated debridement and excision of dead skin and muscle, followed by split skin grafts and plastic surgery. In 2 such cases, the extent of the skin and muscle necrosis was so extensive that surgical control was impossible; these 2 patients died.

### Mortality

In all, 4 of the 13 patients died, which corresponded to a mortality rate of 31%. Three of these deaths occurred in the early part of the study period, when necrotising infection was not well recognised in our department; the fourth patient was elderly and had longstanding diabetes and renal failure.

### DISCUSSION

Necrotising soft tissue infections in orthopaedic practice are rare, but they are serious because of the high morbidity and mortality associated. We have documented 13 cases over a period of 9 years that were treated by an orthopaedic service. In our view, serious necrotising soft tissue infections are more common

than in the past,<sup>3,7</sup> but it is difficult to get a true idea of the incidence of these infections because they can present in a variety of ways and can be caused by a whole range of organisms, resulting in a plethora of names in the literature.

Most patients in this case series were healthy, but all had predisposing factors—mostly skin abrasions and minor skin infections. A significant proportion of the patients (77%) had received NSAIDs to treat soft tissue pain before hospital admission. NSAIDs have recently been shown to inhibit prostaglandins and alter the inflammatory response to the organisms involved in necrotising infections, as well as a possibly suppression to the cytoprotective effects of prostaglandins.<sup>6,8,9</sup> NSAIDs also inhibit renal prostaglandin synthesis, which can potentiate the development of acute renal failure in patients with necrotising infection. Further investigation, however, is necessary to further evaluate whether this class of drug can predispose an individual to necrotising soft tissue infections or simply mask the early symptoms and signs.

Patient presentation in our case series was variable but included a typical clinical picture consisting of painful swelling, erythema, and necrosis. In the initial stages of the disease, the diagnosis can be difficult—especially if there is an associated minor injury. A high index of suspicion should be kept in clinicians' mind when a patient presents with excessive pain in the soft tissues, even in the presence of only a minor injury. It is also important to look for healing or healed skin abrasions and minor infections, which are often the portal of entry of the organisms. The infection often develops at a distance from the initial skin lesion and, in most cases, there is a time interval between these 2 events.

Diagnosis in the early stages of the infection, although difficult, can be assisted by fine-needle aspiration, magnetic resonance imaging (MRI), and surgical exploration or biopsy. Aspiration can yield fluid from the infected area that can be used to identify the organism by gram staining. MRI is helpful if the process is deep or in an area that is difficult to access.<sup>10</sup> MRI scan will show marked diffuse increased signal in the soft tissue and muscles. In our experience, however, it is difficult to tell whether the tissues are dead or not, although some authors have reported the contrary.<sup>11</sup> Another advantage is that the MRI results provide an idea of the extent of the process, and identify the muscle compartments that are affected. In cases in which the diagnosis is not clear, surgical exploration can be very useful, as can bacteriological and histological analysis of multiple swabs and tissue samples.

Although beta-haemolytic streptococci are commonly isolated in necrotising fasciitis, it is clear that necrotising infection is part of a spectrum of soft tissue infections that include clostridial gas gangrene and synergistic necrotic infections (multibacterial infections involving both aerobic and anaerobic organisms).<sup>12</sup>

Antibiotic treatment must be started immediately and without waiting for the culture results if necrotising fasciitis is suspected. Antibiotic choice is guided by clinical factors, but extensive penicillin therapy associated with clindamycin offers the only reasonable chance of survival in cases of overwhelming streptococcal infections. In cases of penicillin allergy, erythromycin or cephalosporins can be used as first line of treatment.

Septic shock and multi-organ failure developed in a large proportion of our patients (9 out of 13), who subsequently required cardiovascular and respiratory support. These patients had, on average, a more aggressive disease and presented late. Early diagnosis, prompt resuscitation, antibiotic therapy, and surgical debridement are associated with better outcome.<sup>1</sup> The mortality rate in our series was 31%. Most of the cases that were unresponsive to treatment were associated with late presentation, delay in diagnosis, and chronic medical conditions.

We believe that early intervention, including continuous haemofiltration, is associated with a better outcome. In both human and animal studies, haemofiltration appears to be beneficial in removing circulating endotoxins. Studies in pigs with

endotoxic shock that were treated with high-volume haemofiltration showed improved right ventricular ejection fractions,<sup>13</sup> less endotoxin-mediated lung injury,<sup>14</sup> and a trend to improved survival compared with control animals.<sup>15</sup> In humans with acute renal failure, survival can be improved in patients treated with haemofiltration, possibly because of faster elimination of toxins by at a high volume and flux.

Aggressive surgical intervention is recommended to excise all dead and infected tissue, followed by repeat procedures to check for evidence of progressive tissue necrosis,<sup>16,17</sup> with the aim of removing the source of systemic toxins. Amputation should be considered if extensive muscle necrosis and excision would leave the patient with poor function as far as the limb is concerned. If the infective process is localised at the root of the limb, there is often involvement of the trunk, which then makes it difficult for the amputation to control the infection; in such cases, the indications for amputation are not well established.

The role of hyperbaric oxygen in the management of non-clostridial infections is not well defined. There is so far no clinical or experimental evidence to suggest that hyperbaric oxygen will modify the course of non-gas-forming tissue infections.

Overall, necrotising soft tissue infections are serious life- and limb-threatening conditions that can start quite innocuously, and require a high index of suspicion on behalf of the clinician. Rapid medical and surgical intervention is essential to reduce the likelihood of severe morbidity and mortality.

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